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A Joint Report by the OECD Nuclear Energy Agency
and the International Atomic Energy Agency
2010

Uranium 2009: Resources, Production and Demand

NUCLEAR ENERGY AGENCY

A Joint Report by
The OECD Nuclear Energy Agency
And the International Atomic Energy Agency

Uranium 2009: Resources, Production and Demand

NEA No. 6891

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

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PREFACE

Since the mid-1960s, with the co-operation of their member countries and states, the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA) have jointly prepared periodic updates (currently every two years) on world uranium resources, production and demand. These updates have been published by the OECD/NEA in what is commonly known as the "Red Book". This 23rd edition of the Red Book replaces the 2007 edition and reflects information current as of 1st January 2009.

The Red Book features a comprehensive assessment of current uranium supply and demand and projections to the year 2035. The basis of this assessment is a comparison of uranium resource estimates (according to categories of geological certainty and production cost) and mine production capability with anticipated uranium requirements arising from projections of installed nuclear capacity. In cases where longer-term projections of installed nuclear capacity were not provided by national authorities, projected demand figures were developed with input from expert authorities. Current data on resources, exploration, production and uranium stocks are also presented, along with historical summaries of exploration and production, and plans for future mine production. In addition, individual country reports provide detailed information on recent developments in uranium exploration and production, updates on environmental activities and information on relevant national uranium and nuclear energy policies.

The Red Book also includes a compilation and evaluation of previously published data on unconventional uranium resources. Available information on secondary sources of uranium is presented and their potential market impact is assessed.

This publication has been prepared on the basis of data obtained through questionnaires sent by the NEA to OECD member countries (17 countries responded and one country report was prepared by the Secretariat of the Joint NEA/IAEA Group on Uranium) and by the IAEA for those states that are not OECD member countries (18 countries responded and four country reports were prepared by the Secretariat). The opinions expressed in Parts I and II do not necessarily reflect the position of the member countries or the international organisations concerned. This report is published on the responsibility of the OECD Secretary-General.

Acknowledgement

The OECD Nuclear Energy Agency (NEA), Paris, and the International Atomic Energy Agency (IAEA), Vienna, would like to acknowledge the co-operation of those organisations (see Appendix 2) which replied to the questionnaire.

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EXECUTIVE SUMMARY

Uranium 2009 – Resources, Production and Demand presents, in addition to updated resource figures, the results of the most recent review of world uranium market fundamentals and provides a statistical profile of the world uranium industry as of 1 January 2009. First published in 1965, this is the 23rd edition of what has become known as the "Red Book." It contains official data provided by 35 countries (and five Country Reports prepared by the Secretariat) on uranium exploration, resources, production and reactor-related requirements. Projections of nuclear generating capacity and reactor-related uranium requirements through 2035 are provided as well as a discussion of long-term uranium supply and demand issues.

Exploration

Worldwide exploration and mine development expenditures in 2008 totalled about USD 1.641 billion, an increase of 133% compared to updated 2006 figures, despite declining market prices since mid-2007. Most major producing countries reported increasing expenditures, as efforts to identify new resources and bring new production centers online moved forward. The majority of global exploration activities remain concentrated in areas with potential for hosting unconformity-related and ISL (*in situ* leach; sometimes referred to as *in situ* recovery, or ISR) amenable sandstone deposits, primarily in close proximity to known resources and existing production facilities. However, generally higher prices for uranium since 2003, compared to the preceding two decades, have stimulated "grass roots" exploration, as well as increased exploration in regions known to have good potential based on past work. About 80% of the exploration and development expenditures in 2008 were devoted to domestic activities. Non-domestic exploration and development expenditures, although reported by only China, France, Japan and the Russian Federation, declined to USD 324.3 million in 2008 from USD 352.5 million in 2007, but remain significantly above the USD 19.2 million reported in 2003. Domestic exploration and development expenditures are expected to decline somewhat but remain strong throughout 2009, amounting to about USD 1.342 billion.

Resources[1]

1. Uranium Resources are classified by a scheme (based on geological certainty and costs of production) developed to combine resource estimates from a number of different countries into harmonised global figures. "**Identified Resources**" (*RAR* and *Inferred*) refer to uranium deposits delineated by sufficient direct measurement to conduct pre-feasibility and sometimes feasibility studies. For Reasonably Assured Resources (*RAR)*, high confidence in estimates of grade and tonnage are generally compatible with mining decision making standards. *Inferred Resources* are not defined with such a high a degree of confidence and generally require further direct measurement prior to making a decision to mine. "**Undiscovered Resources**" (*Prognosticated* and *Speculative*) refer to resources that are expected to occur based on geological knowledge of previously discovered deposits and regional geological mapping. *Prognosticated Resources* refer to those expected to occur in known uranium provinces, generally supported by some direct evidence. *Speculative Resources* refer to those expected to occur in geological provinces that may host uranium deposits. Both *Prognosticated* and *Speculative Resources* require significant amounts of exploration before their existence can be confirmed and grades and tonnages can be defined. For a more detailed description see Appendix 3.

Total Identified Resources (Reasonably Assured & Inferred) as of 1 January 2009 declined slightly to 5 404 000 tonnes of uranium metal (tU) in the <USD 130/kgU (<USD 50/lb U_3O_8) category (a decrease of 1.2% compared to 1 January 2007), but increased to 6 306 300 tU in the re-introduced high-cost (<USD 260/kgU or <USD 100/lb U_3O_8) category (an increase of 15.5% compared to total 2007 resources reported in the <USD 130/kgU cost category).

The high-cost category of <USD 260/kgU was added to this edition in response to both the overall increase in market prices for uranium since 2003 and increased mining costs. Although total Identified Resources have increased overall, there has been a significant reduction in lower cost resources owing principally to increased mining costs (a 73% reduction of <USD 40/kgU and a 16% reduction of <USD 80/kgU). Though a portion of the overall increases in the new high cost category relate to new discoveries, the majority result from re-evaluations of previously Identified Resources. At current (2008) rates of consumption, Identified Resources are sufficient for over 100 years of supply for the global nuclear power fleet.

Total Undiscovered Resources (Prognosticated Resources & Speculative Resources) as of 1 January 2009 amounted to more than 10 400 000 tU, declining slightly from the 10 500 000 tU reported in 2007. It is important to note however that some countries, including major producers with large identified uranium resource inventories, do not report resources in this category.

The uranium resource figures presented in this volume are a “snapshot” of the situation as of 1 January 2009. Resource figures are dynamic and related to commodity prices. The overall increase in Identified Resources from 2007 to 2009, including the re-introduced high cost category, equivalent to over 13 years of supply of 2009 uranium requirements, demonstrates that uranium prices impact resource totals and new resources are readily identified with appropriate market incentives. Favourable market conditions will stimulate exploration and, as in the past, increased exploration effort will lead to the identification of additional resources through intensified effort on existing deposits and the discovery of new deposits of economic interest. For example, recent efforts in Australia have led to the discovery of several new deposits and potentially significant occurrences: Double 8 (Western Australia), Beverley North and Blackbush (South Australia), Ranger 3 Deeps, Thunderball, N147 and Crystal Creek (Northern Territory). Continued effort in Canada has led to high-grade discoveries in the Athabasca Basin, such as Centennial, Shea Creek, Wheeler River and Roughrider.

Production

Uranium production in 2008 totalled 43 880 tU, a 6% increase from the 41 244 tU produced in 2007 and an 11% increase from the 39 617 tU produced in 2006. As in 2006, a total of 20 countries reported output in 2008. Global production increases between 2006 and 2008 were driven principally by significantly increased output in Kazakhstan (61%). More modest increases were recorded in Australia, Brazil, Namibia and the Russian Federation. Reduced production was recorded in a number of countries between 2006 and 2008 (including Canada, Niger and the United States) owing to a combination of lower than expected ore grades, technical difficulties and preparations for mine expansions. Underground mining accounted for 32% of global production in 2008; ISL mining, 30% (rising rapidly in importance, principally because of capacity increases in Kazakhstan); open pit mining, 27%; with co-product and by-product recovery from copper and gold operations and other unconventional methods accounting for most of the remaining 11%. Global uranium production in 2009 is expected to increase by 16% to over 51 000 tU, with production beginning in Malawi and continuing to ramp up in Kazakhstan (the largest production increase – more than 60% from 2008 to 2009 – is expected to occur once again in Kazakhstan).

Environmental aspects of uranium production

Although the focus of the Red Book remains uranium resources, production and demand, environmental aspects of the uranium production cycle are once again included in some Country Reports in this volume. Efforts can generally be divided into two areas. The first encompasses work to remediate the consequences of uranium production practices, no longer licensed today, that resulted in a number of legacy uranium mining sites in several countries (e.g. Brazil, Bulgaria, Canada, the Czech Republic, Germany, Hungary, Kazakhstan, Poland, Slovenia, Spain, Ukraine and the United States). Included in this volume are updates of some of these activities. These experiences are an important reminder of the consequences of outdated mining practices that must continue to be avoided in coming years as uranium production is poised to expand to countries with no past experience in this type of activity.

The second area encompasses efforts to ensure that ongoing operations are conducted in ways that protect people and the environment and avoid the creation of new uranium mining legacies. Information presented in a number of National Reports includes notes on crucial aspects of modern uranium mine development, such as environmental assessment processes prior to mine openings or expansions (e.g. Australia, Canada), monitoring programmes at currently operating mines (e.g. Kazakhstan), efforts to reduce water consumption (e.g. Namibia) and the establishment of new, more stringent environmental radiation protection regimes (e.g. China). Uranium mining is bringing benefits to local populations and the use of revenues arising from taxes on uranium mining operations, as well as efforts by the mining companies themselves, to improve living conditions of people in the vicinity of mining operations (e.g. Kazakhstan, Namibia) are outlined. Uranium mining companies also continue to obtain the internationally recognised ISO 14001 series of international standards on environmental management to enhance sustainable management and environmental protection at their operations (achievements in this regard are noted in Namibia and Niger).

Additional information on these two areas of environmental aspects of uranium production may be found in a joint NEA/IAEA Uranium Group publications entitled *Environmental Remediation of Uranium Production Facilities*, Paris, OECD, 2002 and *Environmental Activities in Uranium Mining and Milling*, Paris, OECD, 1999.

Uranium demand

At the end of 2008, a total of 438 commercial nuclear reactors were connected to the grid with a net generating capacity of about 373 GWe requiring about 59 065 tU, as measured by uranium acquisitions. Uranium acquisitions have declined in recent years because increased uranium costs have motivated utilities to specify lower tails assays at enrichment facilities in order to reduce uranium consumption and due to inventory drawdown. By the year 2035, world nuclear capacity is projected to grow to between about 511 GWe net in the low demand case and 782 GWe net in the high demand case, increases of 37% and 110% from 2009 capacity, respectively. Accordingly, world annual reactor-related uranium requirements are projected to rise to between 87 370 tU and 138 165 tU by 2035.

The nuclear capacity projections vary considerably from region to region. The East Asia region is projected to experience the largest increase that, by the year 2035, could result in the installation of between 120 GWe and 167 GWe of new capacity, representing increases of over 150% to more than 210% compared to 2009 capacity, respectively. Nuclear capacity in non-European Union countries in Europe is also expected to increase considerably (between 75% and 170%). Other regions projected to experience growth include the Middle East and Southern Asia; Central and South America; Africa and

South-eastern Asia. Nuclear capacity and requirements display wide variation in North America (from a decrease of 30% to an increase of over 40%) and in the European Union (from a decrease of 10% to an increase of almost 20%).

However, there are uncertainties in these projections as there is ongoing debate on the role that nuclear energy will play in meeting future energy requirements. Key factors that will influence future nuclear energy capacity include projected base load electricity demand, non-proliferation concerns, public acceptance of nuclear energy and proposed waste management strategies, as well as the economic competitiveness of nuclear power plants, the ability to fund such capital intensive projects and the cost of fuel compared to other electricity generating technologies. Concerns about longer-term security of supply of fossil fuels and the extent to which nuclear energy is seen to be beneficial in meeting greenhouse gas reduction targets could contribute to even greater projected growth in uranium demand.

Supply and demand relationship

In 2008, world uranium production (43 880 tU) provided about 74% of world reactor requirements (59 065 tU), with the remainder being met by supplies of already mined uranium (so-called secondary sources) including excess government and commercial inventories, low enriched uranium (LEU) produced by down-blending highly enriched uranium (HEU) from the dismantling of nuclear warheads, re-enrichment of depleted uranium tails and spent fuel reprocessing.

Uranium mine development has responded to the market signal of increased prices and rising demand. As currently projected, primary uranium production capabilities including Existing, Committed, Planned and Prospective production centres could satisfy projected high case world uranium requirements through 2028 and low case requirements through 2035. Beyond this date, in order for production to be able to provide fuel for all reactors for their entire operational lifetime, including new reactors added to the grid to 2035, additional resources will need to be identified and new mines and mine expansions will need to take place in a timely fashion. Should demand increase as projected growth in nuclear power is realised, uranium prices would be expected to rise, stimulating additional investment in mine production capacity. However, sufficiently high uranium market prices will be required to fund these activities, especially in light of rising costs of production. Secondary sources will continue to be required, complemented to the extent possible by uranium savings achieved by specifying low tails assays at enrichment facilities and developments in fuel cycle technology.

Although information on secondary sources is incomplete, they are generally expected to decline in market importance, particularly after 2013. However, there remains a potentially significant amount of previously mined uranium (including material held by the military), and it is feasible that at least some of this material could make its way to the market in a controlled fashion. As secondary supplies are reduced in the coming years, reactor requirements will have to be increasingly met by mine production. The introduction of alternate fuel cycles, if successfully developed and implemented, could profoundly impact the market balance, but it is too early to say how cost-effective and widely implemented these proposed fuel cycles will be. What is clear is that a sustained strong market for uranium will be needed to stimulate the timely development of production capability and to increase Identified Resources. Because of the long lead-times required to identify new resources and to bring them into production (typically on the order of 10 years or more), the relatively sparse global network of uranium mine facilities, and geopolitical uncertainties in some important producing countries, the market will have to provide the incentive for exploration and mine development activities to continue in order to avoid potential uranium supply shortfalls.

Conclusion

Despite recent declines stemming from the global economic and financial crisis, world demand for electricity is expected to continue to grow significantly over the next several decades to foster economic growth and meet the needs of an increasing population. The recognition by many governments that nuclear power can produce competitively-priced, base-load electricity that is essentially free of greenhouse gas emissions, combined with the role that nuclear can play in enhancing security of energy supplies, increase the prospects for growth in nuclear generating capacity, although the magnitude of that growth remains uncertain.

Regardless of the role that nuclear energy ultimately plays in meeting rising electricity demand, the uranium resource base described in this document is more than adequate to meet projected requirements. Meeting even high-case requirements to 2035 would consume less than half of the identified resources described in this volume. Nonetheless, the challenge remains to develop environmentally sustainable mining operations and to bring increasing quantities of uranium to the market in a timely fashion. A strong market will be required for resources to be developed within the timeframe required to meet projected uranium demand.

I. URANIUM SUPPLY

This chapter summarises the current status of worldwide uranium resources, exploration and production. In addition, production capabilities in reporting countries for the period ending in the year 2035 are presented and discussed.

A. URANIUM RESOURCES

Identified Conventional Resources

In this edition, Identified Resources consist of ***Reasonably Assured Resources*** (RAR) and ***Inferred Resources*** (previously EAR-I), recoverable at a cost of less than USD 260/kgU (USD 100/lbU_3O_8).[1] A higher cost resource category (USD 130/kgU to USD 260/kgU) was added to complement previous editions that tabulated resources available at costs up to the USD 130/kgU (USD 50/lbU_3O_8). Relative changes in different resource and cost categories of Identified Resources between this edition and the 2007 edition of the Red Book are summarised in Table 1. As shown in Table 1, Identified Resources recoverable at costs of <USD 130/kgU decreased by some 65 000 tU between 2007 and 2009 (about 1.2%) to a total of 5 404 000 tU, mainly the result of significant reductions reported in Kazakhstan, the Russian Federation, South Africa, Ukraine and the United States amounting to more than additions reported in Argentina, Australia, Canada, China, India, Malawi and Namibia. Reduced resources were principally the result of re-classification of previously known resources into higher cost categories in light of increased mining costs.

Despite the decline in resources recoverable at costs of <USD 130/kgU, the overall increase in Identified Resources recoverable at <USD 260/kgU between 2007 and 2009 (above those reported in the 2007 <USD 130/kgU category), amount to over 837 000 tU, equivalent to over 13 years of supply of 2009 uranium requirements. Though some of these reported increases are due to new discoveries resulting from increased exploration, most relate to re-evaluations of known deposits and increased exploration effort to extend the lives of or to expand production at existing mining facilities.

In contrast to the overall increase in the highest cost category, Identified Resources in the two lowest cost categories (USD 40/kgU and USD 80/kgU; or about USD 15/lbU_3O_8 and USD 30/lbU_3O_8) declined by almost 2 174 000 tU and 715 000 tU, respectively (decreases of 73% and 16% compared to 2007). Significant reductions occurred in RAR and Inferred Resources (IR) in the lowest cost

1. All Identified Conventional Resources are reported as recoverable uranium. In cases where resources were reported by countries as *in situ*, resource figures were adjusted to estimate recoverable resources either by using recovery factors provided by the country or applying Secretariat estimates according to expected production method (see ***Recoverable Resources*** in Appendix 3).

category (<USD 40/kgU), principally the result of reclassification of resources into higher cost categories in Australia, Kazakhstan, Namibia, Niger, the Russian Federation, South Africa and Ukraine. However, it is important to note that the decline in the lowest cost category in Australia may not be as great as indicated owing to the inability to estimate the cost of producing uranium as a by-product at Olympic Dam, site of the world's largest uranium deposit. Current estimates of Identified Resources, RAR and Inferred Resources, on a country-by-country basis, are presented in Tables 2, 3 and 4, respectively.

Distribution of Identified Conventional Resources by Categories and Cost Ranges

The most significant changes between 2007 and 2009 in the overall amount of Identified Conventional Resources (Table 2) occurred in Australia, Canada, Namibia and the United States. The distribution of Identified Resources, RAR and Inferred Resources, among countries with major resources, is shown in Figures 1, 2 and 3, respectively.

Table 1. Changes in Identified Resources 2007-2009
(1 000 tU)

Resource category	2007	2009	Changes[(a)]
Identified (Total)			
<USD 260/kgU	NA	> 6 306	+ 837[(b)]
<USD 130/kgU	5 469	5 404	- 65
<USD 80/kgU	>4 456	3 742	- 715
<USD 40/kgU[(c)]	2 970	> 796	- 2 174
RAR			
<USD 260/kgU	NA	> 4 004	+ 666[(b)]
<USD 130/kgU	>3 338	3 525	+ 187
<USD 80/kgU	2 598	> 2 516	- 82
<USD 40/kgU[(c)]	>1 766	570	- 1 196
Inferred Resources			
<USD 260/kgU	NA	2 302	+ 172[(b)]
<USD 130/kgU	>2 130	> 1 879	- 251
<USD 80/kgU	>1 858	1 226	- 632
<USD 40/kgU[(c)]	1 204	> 226	- 978

(a) Changes might not equal differences between 2007 and 2005 because of independent rounding.

(b) Above those reported in the 2007 <USD 130/kgU category.

(c) Resources in the cost categories of <USD 40/kgU are likely higher than reported, because some countries have indicated that either detailed estimates are not available, or the data are confidential.

Figure 1. Global Distribution of Identified Resources (<USD 130/kgU)

The global distribution of Identified Resources amongst 14 countries that are either major uranium producers or have significant plans for growth of nuclear generating capacity illustrates the widespread distribution of these resources. Together, these 14 countries are endowed with 97% of the identified global resource base in this cost category (the remaining 3% are distributed among another 19 countries). The widespread distribution of uranium resources is an important geographic aspect of nuclear energy in light of security of energy supply.

Table 2. Identified Resources (RAR + Inferred)

(recoverable resources as of 1 January 2009, tonnes U, rounded to nearest 100 tonnes)

COUNTRY	Cost Ranges			
	<USD 40/Kg U	<USD 80/Kg U	<USD 130/Kg U	<USD 260/Kg U
Algeria (a) (b) (c)	0*	0*	19 500	19 500
Argentina	0	11 400	19 100	19 100
Australia	NA	1 612 000	1 673 000	1 679 000
Brazil	139 900	231 300	278 700	278 700
Canada	366 700	447 400	485 300	544 700
Central African Republic (a) (b) (c)	0*	0*	12 000	12 000
Chile (c)	0	0	0*	1 500
China (c)	67 400	150 000	171 400	171 400
Congo, Dem. Rep. of (a) (b) (c)	0	0*	0*	2 700
Czech Republic	0	500	500	500
Denmark (b) (c)	0	0	0	85 600*
Egypt	0	0	0	1 900
Finland (b) (c)	0	0	1 100	1 100
France	0	0	100	9 100
Gabon (a) (b)	0	0	4 800	5 800
Germany (b) (c)	0	0	0	7 000
Greece (a) (b)	0*	0*	0*	7 000
Hungary	0	0	0	8 600
India (c) (d)	0	0	80 200	80 200
Indonesia (b) (c)	0*	0*	4 800	6 000
Iran, Islamic Republic of	0	0	0*	2 200
Italy (a) (b)	0	0	4 800	6 100
Japan (b)	0	0*	6 600	6 600
Jordan (a) (c)	0*	111 800	111 800	111 800
Kazakhstan (c)	44 400	475 500	651 800	832 000
Malawi*	0	8 100	15 000*	15 000
Mexico (a) (b) (c)	0	0	0*	1 800
Mongolia (b) (c)	0	41 800	49 300	49 300
Namibia (a) (c)*	0	2 000	284 200	284 200
Niger (a) (c)*	17 000	73 400	272 900	275 500
Peru (c)	0	0	2 700	2 700
Portugal (a) (b)	0	4 500	7 000	7 000
Romania (a)	0	0	6 700	6 700
Russian Federation	0	158 100	480 300	566 300
Slovakia*	0	0	0	10 200
Slovenia (a) (b) (c)	0	0*	9 200	9 200
Somalia (a) (b) (c)	0	0*	0*	7 600
South Africa (b) (f)	153 300	232 900	295 600	295 600
Spain (b)	0	2 500	11 300	11 300
Sweden (a) (b)	0	0	10 000	10 000
Tanzania (c)	0	0	0	28 400*
Turkey (b) (c)	0	0*	7 300	7 300
Ukraine (c)	5 700	53 500	105 000	223 600
United States	0	39 000	207 400	472 100
Uzbekistan (a) (c) (e)	0	86 200*	114 600*	114 600*
Vietnam (a) (b) (c)	0	0*	0*	6 400
Zimbabwe (a) (b) (c)	0	0*	0*	1 400
Total (g)	**796 400**	**3 741 900**	**5 404 000**	**6 306 300**

NA Data not available.
* Secretariat estimate.
(a) Not reported in 2009 responses, data from previous Red Book
(b) Assessment not made within the last five years.
(c) *In situ* resources were adjusted by the Secretariat to estimate recoverable resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method.
(d) Cost data not provided, therefore resources are reported in the < USD 130/kgU category.
(e) Data from previous Red Book, reduced by past production.
(f) Resource estimates do not account for production.
(g) Totals related to costs <USD 40/kgU and <USD 80/kgU are higher than reported because certain countries do not report low-cost resources. Totals may not equal sum of components due to independent rounding.

Table 3. Reasonably Assured Resources (RAR)
(recoverable resources as of 1 January 2009, tonnes U, rounded to nearest 100 tonnes)

COUNTRY	Cost Ranges			
	<USD 40/Kg U	<USD 80/Kg U	<USD 130/Kg U	<USD 260/Kg U
Algeria (a) (b) (c)	0*	0*	19 500	19 500
Argentina	0	7 000	10 400	10 400
Australia	NA	1 163 000	1 176 000	1 179 000
Brazil	139 900	157 700	157 700	157 700
Canada	267 100	336 800	361 100	387 400
Central African Republic (a) (b) (c)	0*	0*	12 000	12 000
Chile (c)	0	0	0*	800
China (c)	52 000	100 900	115 900	115 900
Congo, Dem. Rep. of (a) (b) (c)	0	0*	0*	1 400
Czech Republic	0	400	400	400
Finland (b) (c)	0	0	1 100	1 100
France	0	0	0	9 000
Gabon (a) (b)	0	0	4 800	4 800
Germany (b) (c)	0	0	0	3 000
Greece (a) (b)	0*	0*	0*	1 000
India (c) (d)	0	0	55 200	55 200
Indonesia (b) (c)	0*	0*	4 800	4 800
Iran, Islamic Republic of	0	0	0*	700
Italy (a) (b)	0	0*	4 800	4 800
Japan (b)	0	0*	6 600	6 600
Jordan (a) (c)	0*	44 000	44 000	44 000
Kazakhstan (c)	14 600	233 900	336 200	414 200
Malawi*	0	8 100	13 600	13 600
Mexico (a) (b) (c)	0	0	0*	1 300
Mongolia (b) (c)*	0	37 500	37 500	37 500
Namibia (e)	0*	2 000*	157 000*	157 000
Niger (a) (c)*	17 000	42 500	242 000	244 600
Peru (c)	0	0*	1 300	1 300
Portugal (a) (b)	0	4 500*	6 000	6 000
Romania (a)	0	0	3 100	3 100
Russian Federation	0	100 400	181 400	181 400
Slovakia*	0	0	0	5 100
Slovenia (a) (b) (c)	0	0*	1 700*	1 700
Somalia (a) (b) (c)	0	0	0*	5 000
South Africa (b) (f)	76 800	142 000	195 200	195 200
Spain (b)	0	2 500	4 900	4 900
Sweden (a) (b)	0	0	4 000	4 000
Tanzania (c)	0	0	0	8 900*
Turkey (b) (c)	0	0*	7 300	7 300
Ukraine (c)	2 500	38 700	76 000	142 400
United States	0	39 000	207 400	472 100
Uzbekistan (a) (b) (e)	0	55 200*	76 000*	76 000*
Vietnam (a) (b) (c)	0	0	0*	1 000
Zimbabwe (a) (b) (c)	0	0	0*	1 400
Total (g)	**569 900**	**2 516 100**	**3 524 900**	**4 004 500**

NA Data not available.
* Secretariat estimate.
(a) Not reported in 2009 responses, data from previous Red Book
(b) Assessment not made within the last five years.
(c) *In situ* resources were adjusted by the Secretariat to estimate recoverable resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method.
(d) Cost data not provided, therefore resources are reported in the < USD 260/kgU category.
(e) Data from previous Red Book, reduced by past production.
(f) Resource estimates do not account for production.
(g) Totals related to costs <USD 40/kgU and <USD 80/kgU are higher than reported because certain countries do not report low-cost resources. Totals may not equal sum of components due to independent rounding.

Table 4. Inferred Resources
(recoverable resources as of 1 January 2009, tonnes U, rounded to nearest 100 tonnes)

COUNTRY	Cost Ranges			
	<USD 40/Kg U	**<USD 80/Kg U**	**<USD 130/Kg U**	**<USD 260/Kg U**
Argentina	0	4 400	8 700	8 700
Australia	NA	449 000	497 000	500 000
Brazil	0	73 600	121 000	121 000
Canada	99 700	110 600	124 200	157 200
Chile (a) (b) (c)	0	0	0	700
China (c)	15 400	49 100	55 500	55 500
Congo, Dem. Rep. of (a) (b) (c)	0	0*	0*	1 300
Czech Republic	0	100	100	100
Denmark (b) (c)	0	0	0	85 600*
Egypt	0	0	0*	1 900
France (b)	0	0	100*	100
Gabon (a) (b)	0	0	0*	1 000
Germany (b) (c)	0	0	0	4 000
Greece (a) (b)	0*	0*	0*	6 000
Hungary	0	0	0	8 600
India (c) (d)	0	0	24 900	24 900
Indonesia (b) (c)	0	0*	0*	1 200
Iran, Islamic Republic of (c)	0	0	0*	1 400
Italy (a) (b)	0	0	0*	1 300
Jordan (a) (c)	0*	67 800	67 800	67 800
Kazakhstan (c)	29 800	241 500	315 600	417 900
Malawi*	0	0	1 500	1 500
Mexico (a) (b) (c)	0	0	0*	500
Mongolia (b) (c)	0	4 300*	11 800*	11 800*
Namibia (a) (c) (d)*	0	0	127 200	127 200
Niger (a) (c)*	0	30 900	30 900	30 900
Peru (b) (c)	0	0*	1 400*	1 400*
Portugal (a) (b)	0	0*	1 000	1 000
Romania (a)	0	0	3 600	3 600
Russian Federation	0	57 700	298 900	384 900
Slovakia*	0	0	0	5 200
Slovenia (a) (b) (c)	0	0*	7 500	7 500
Somalia (a) (b) (c)	0	0	0*	2 600
South Africa (b) (e)	78 500	90 900	100 400	100 400
Spain (b)	0	0	6 400	6 400
Sweden (a) (b)	0	0	6 000	6 000
Tanzania*	0	0	0	19 500
Ukraine (c)	3 200	14 900	29 000	81 200
Uzbekistan (a) (b) (c)	0	31 000	38 600	38 600
Vietnam (a) (b) (c)	0	0*	0*	5 400
Total (e)	**226 600**	**1 225 800**	**1 879 100**	**2 301 800**

NA Data not available.
* Secretariat estimate.
(a) Not reported in 2009 responses, data from previous Red Book using Inferred or EAR-I data.
(b) Assessment not made within the last five years.
(c) *In situ* resources were adjusted to estimate recoverable resources, using recovery factors provided by the countries or estimated by the Secretariat according to the expected production method.
(d) Cost data not provided, therefore resources are reported in the < USD 130/kgU category.
(e) Totals related to costs <USD 40/kgU and <USD 80/kgU are higher than reported because certain countries do not report low-cost resources. Totals may not equal sum of components due to independent rounding.

Reasonably Assured Conventional Resources (RAR) recoverable at costs <USD 40/kgU, the most economically attractive category, decreased by 1 196 500 tU since 2007 to a total of 569 900 tU (a decrease from 2007 of about 68%). Significant decreases were recorded in Australia, Kazakhstan, Namibia, the Russian Federation, Ukraine and Uzbekistan. RAR recoverable at a cost of <USD 130/kgU increased by 186 600 tU, compared to 2007 (about 6%), to a total of 3 524 900 tU, as

significant increases reported by Australia, and to a lesser extent in Canada, China and the Russian Federation, were greater than decreases reported by Kazakhstan, Ukraine and the United States. Inclusion of the new higher cost category (USD 130/kgU to USD 260/kgU) added 666 200 tU to RAR, principally as a result of resources reported in Kazakhstan, Ukraine and the United States, and to a lesser extent Australia and Canada. Overall, these changes were principally the result of re-evaluation of known deposits. Of particular note are changes reported by Australia and Kazakhstan. In Australia, low cost RAR (<USD 40/kgU) are no longer reported, owing to rapidly increasing mining costs and the challenge of determining mining costs at Olympic Dam, where uranium is produced as a by-product with copper, gold and silver. In Kazakhstan, low cost RAR (<USD 40/kgU) decreased by over 220 000 tU and decreases were also reported in the <USD 80/kgU (over 110 000 tU) and <USD 130/kgU (over 41 000 tU), owing to rising costs and changes in the tax system. Similar, but less extensive reclassifications were reported by the Russian Federation, Ukraine and the United States.

Inferred Conventional Resources (IR) decreased in all cost categories, with the exception of the new high cost category (USD 130/kgU to USD 260/kgU). Low cost IR (USD 40/kgU) was reduced by as much as 977 000 tU (81%, compared to 2007). Australia, Kazakhstan, the Russian Federation and Ukraine all reported declining IR, with Kazakhstan registering the greatest decreases. Kazakhstan, the Russian Federation and Ukraine re-classified a significant amount of resources into the highest cost category, principally the result of re-evaluation of resources in light of increased costs of production, while exploration efforts in Canada, China and Denmark (Greenland) resulted in the introduction of new high cost IR.

Together, the changes in Identified Conventional Resources (i.e. RAR plus IR), recoverable at a cost of <USD 40/kgU, decreased by 2 173 600 tU (about 73% from 2007) and at costs <USD 130/kgU decreased by 64 800 tU, some 1.2% less than in 2007. Resources reported in the newly introduced highest cost category (USD 130/kgU to USD 260/kgU) contributed 837 500 tU to the overall Conventional Resource base as of 1 January 2009.

Distribution of Resources by Production Method

In 2009, countries reported Identified Resources by cost categories and by the expected production method, i.e., ***open-pit*** or ***underground*** mining, ***in situ leaching***, ***heap leaching or in-place leaching***, ***co-product/by-product*** or as unspecified.

Of the remaining low-cost RAR (<USD 40/kgU) reported by production method, recovery by underground mining is the most important (mainly in Canada), followed by co-product/by-product production and ISL (Table 6), although the co-product/by-product contribution is likely under-estimated owing to the difficulty in attributing mining costs to uranium production in these operations, in particular the Olympic Dam mine in Australia. With respect to RAR recoverable at costs <USD 130/kgU, most are expected to be produced by underground mining (almost 1/3 of the reported resources), followed by co-product/by-product, open-pit mining and ISL. The ranking is the same for resources reported in the new high cost category (<USD 260/kgU).

With respect to Inferred Resources (Table 7), what remains in the <USD 40/kgU category is dominated by underground and ISL. In the <USD 130/kgU category, underground mining is expected to be the most important production method, followed by recovery as co-product/by-product, ISL and open-pit mining. The ranking is much the same for the new high cost category (<USD 260/kgU), although open-pit mining is slightly more important than co-product/by-product in this cost category.

Distribution of Resources by Deposit Type

In 2009, countries also reported Identified Resources by cost categories and by geological types of deposits, i.e., unconformity related, sandstone, hematite breccia complex, quartz-pebble conglomerate, vein intrusive, volcanic and caldera-related, metasomatite or as other. Definition of the deposit types can be found in the glossary of definitions in Appendix 3.

In what remains of the low cost RAR (<USD 40/kgU) category, unconformity related (in Canada and Australia) deposits dominate, followed by metasomatite and quartz pebble types (Table 8). In the <USD 130/kgU category, the hematite breccia complex (in Australia) is the largest, followed closely by sandstone related resources (in the United States, Kazakhstan and Niger), then unconformity related deposits. In the new high cost category (<USD 260/kgU), sandstone deposits rank highest, followed closely by hematite breccia complex deposits.

Similar observations can be made for the Inferred Resources (Table 9). In the greatly reduced low cost (<USD 40/kgU) category, resources related to unconformity related deposits dominate, followed by the quartz pebble type. In the <USD 130/kgU category, resources related to sandstone deposits (in Kazakhstan and Russia) are the most important, followed by resources related to hematite breccia complex (in Australia) and metasomatite (in Russia and Ukraine) deposits. In the new high cost category (<USD 260/kgU), sandstone deposit remain the most important, followed by metasomatite and hematite breccias deposits.

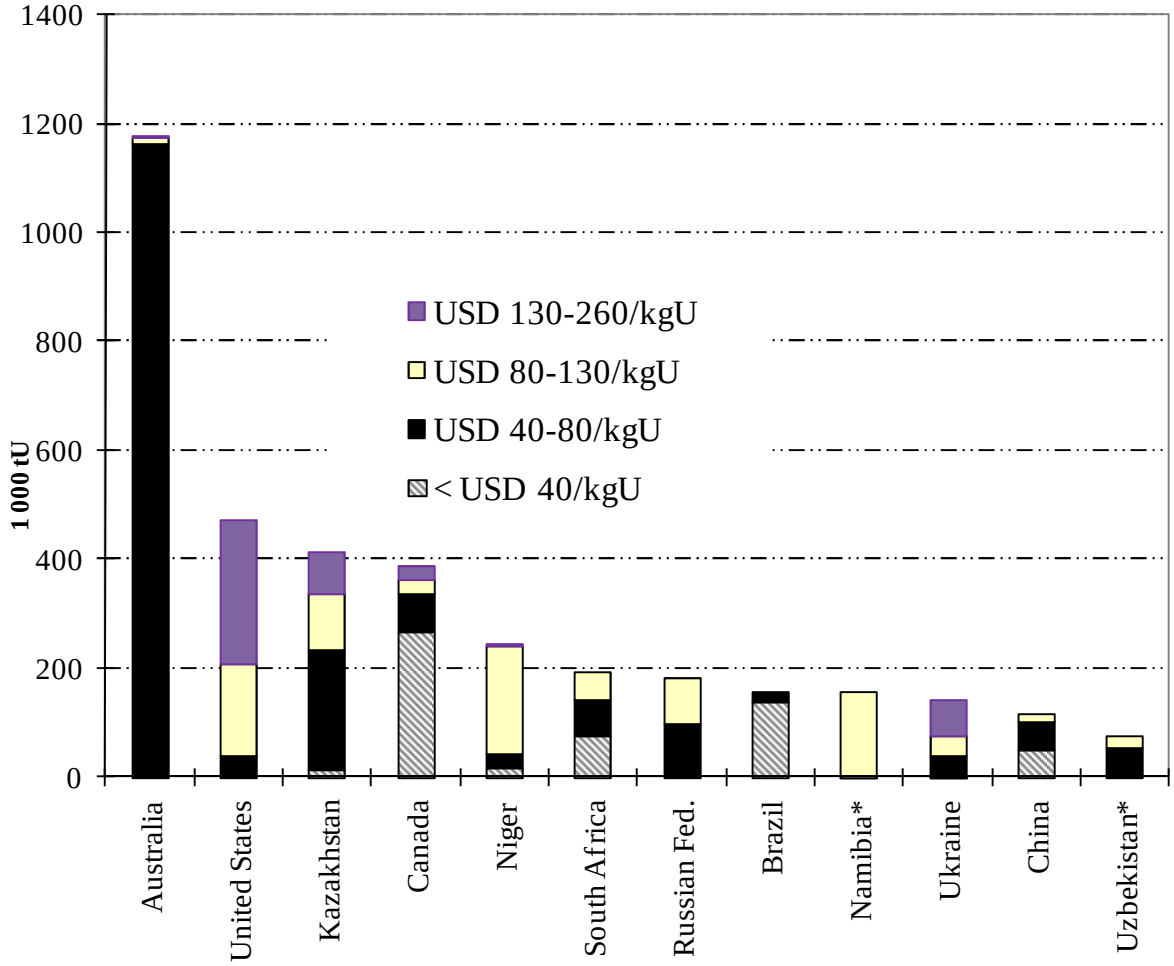
Table 5. Major Identified Resource changes by country
(recoverable resources in 1 000 tonnes U)

Country	Resource category	2007	2009	Changes	Reasons
Australia	RAR				Additional resources defined at Olympic Dam, Ranger, Mt Fitch, Mt Gee, Westmoreland and Valhalla deposits. Upgrade between resource categories.
	<USD 40/kgU	709	NA	NA	
	<USD 80/kgU	714	1 163	+449	
	<USD 130/kgU	725	1 176	+451	
	<USD 260/kgU	NA	1 179	NA	
	Inferred				
	<USD 40/kgU	487	NA	NA	
	<USD 80/kgU	502	449	-53	
	<USD 130/kgU	518	497	-21	
	<USD 260/kgU	NA	500	NA	
Canada	RAR				Re-evaluation of deposits discovered in the 1970s resulted in several new NI 43-101 compliant resource assessments.
	<USD 40/kgU	270	267	-3	
	<USD 80/kgU	329	337	+8	
	<USD 130/kgU	329	361	+32	
	<USD 260/kgU	NA	387	NA	
	Inferred				
	<USD 40/kgU	82	100	+18	
	<USD 80/kgU	94	111	+17	
	<USD 130/kgU	94	124	+30	
	<USD 260/kgU	NA	157	NA	
Denmark	RAR				Increase in high cost inferred resources and decrease in RAR due to re-evaluation of Kvanefjeld deposit.
	<USD 130/kgU	20	0	-20	
	<USD 260/kgU	NA	0	NA	
	Inferred				
	<USD 130/kgU	12	0	-12	
	<USD 260/kgU	NA	86	NA	
India	RAR				Re-evaluation of resources.
	<USD 130/kgU	49	55	+6	
	<USD 260/kgU	NA	55	NA	
	Inferred				
	<USD 130/kgU	24	25	+1	
	<USD 260/kgU	NA	25	NA	

Table 5. Major Identified Resource changes by country (contd.)
(recoverable resources in 1 000 tonnes U)

Kazakhstan	RAR				Re-evaluation resulting in movement to higher cost categories based mainly on changes in legal framework.
	<USD 40/kgU	236	16	-220	
	<USD 80/kgU	344	263	-81	
	<USD 130/kgU	378	366	-12	
	<USD 260/kgU	NA	472	NA	
	Inferred				
	<USD 40/kgU	282	34	-248	
	<USD 80/kgU	407	243	-164	
	<USD 130/kgU	439	357	-82	
	<USD 260/kgU	NA	478	NA	
Mongolia	RAR				Re-evaluation of deposits by Secretariat in light of increased mining costs.
	<USD 40/kgU	8	0	-8	
	<USD 130/kgU	46	38	-9	
	<USD 260/kgU	NA	38	NA	
	Inferred				
	<USD 40/kgU	8	0	-8	
	<USD 80/kgU	16	4	-12	
	<USD 130/kgU	16	12	-4	
	<USD 260/kgU	NA	12	NA	
Namibia	RAR				Additional resources defined at Rossing, Langer Heinrich, Rossing South, Trekopje, Valencia, Ida Dome, Etango and Husaf deposits.
	<USD 40/kgU	145	114	-31	
	<USD 80/kgU	176	206	+30	
	<USD 130/kgU	NA	206	NA	
	Inferred				
	<USD 40/kgU	85	83	-2	
	<USD 80/kgU	99	161	+62	
	<USD 130/kgU	NA	161	NA	
Russian Federation	RAR				Resource re-evaluation, mainly among cost categories. Upgrade between resource categories.
	<USD 40/kgU	48	0	-48	
	<USD 80/kgU	172	100	-72	
	<USD 130/kgU	172	181	+9	
	<USD 260/kgU	NA	181	NA	
	Inferred				
	<USD 40/kgU	36	0	-36	
	<USD 80/kgU	323	58	-265	
	<USD 130/kgU	373	299	-74	
	<USD 260/kgU	NA	384	NA	
South Africa	RAR				Re-evaluation of resources.
	<USD 130/kgU	285	284	-1	
	<USD 260/kgU	NA	284	NA	
	Inferred				
	<USD 40/kgU	120	78	-41	
	<USD 80/kgU	137	91	-46	
	<USD 130/kgU	151	100	-51	
	<USD 260/kgU	NA	100	NA	
Ukraine	RAR				Re-evaluation resulting in movement to higher cost categories.
	<USD 80/kgU	127	45	-82	
	<USD 130/kgU	135	87	-48	
	<USD 260/kgU	NA	161	NA	
	Inferred				
	<USD 80/kgU	58	17	-41	
	<USD 130/kgU	65	33	-32	
	<USD 260/kgU	NA	92	NA	
United States	RAR				Re-evaluation resulting in movement to higher cost categories.
	<USD 80/kgU	99	39	-60	
	<USD 130/kgU	339	215	-125	
	<USD 260/kgU	NA	481	NA	

Figure 2. Distribution of Reasonably Assured Resources (RAR) among countries with major resources



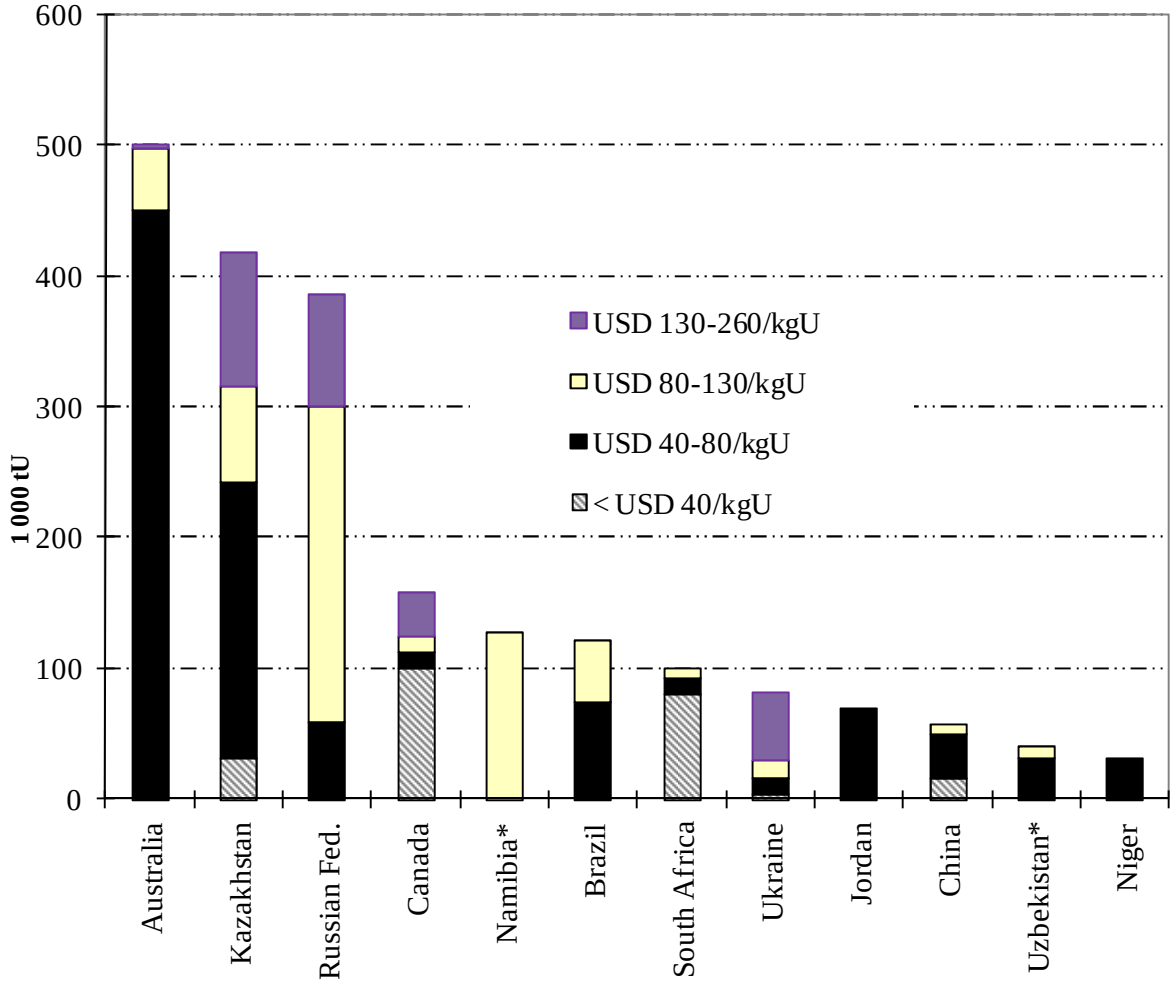
* Secretariat estimate.

Table 6. Reasonably Assured Resources (RAR) by production method
(tonnes U)

	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining	41 400	370 600	833 400	950 900
Underground mining	386 400	710 700	1 031 800	1 354 500
In situ leaching	51 600	407 200	519 000	541 500
Heap leaching*	5 000	19 300	64 600	64 600
In-place leaching	0	0	6 300	6 300
Co-product / by-product	71 100	972 900	972 900	972 900
Unspecified mining method	14 400	35 400	96 900	113 700
Total	**569 900**	**2 516 100**	**3 524 900**	**4 004 500**

* Secretariat estimate.

Figure 3. Distribution of Inferred Resources among countries with major resources



* Secretariat estimate.

Table 7. Inferred Resources by production method
(tonnes U)

	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining	2 400	160 400	347 600	463 000
Underground mining	181 000	332 900	637 500	862 000
In situ leaching	41 800	329 000	387 700	389 000
Heap leaching*	0	13 000	22 600	22 600
In-place leaching	0	0	3 200	7 100
Co-product / by-product	0	346 200	398 600	398 600
Unspecified mining method	1 430	44 300	81 900	159 500
Total	**226 600**	**1 225 800**	**1 879 100**	**2 301 800**

* Secretariat estimate.

Table 8. Reasonably Assured Resources (RAR) by deposit type
(tonnes U)

	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	267 100	536 800	559 400	564 300
Sandstone	32 900	424 200	888 500	1 118 800
Hematite breccia complex	0	900 300	908 000	908 000
Quartz-pebble conglomerate	61 100	82 100	108 800	108 800
Vein	0	7 400	64 600	129 100
Intrusive	1 000	5 000	97 100	100 100
Volcanic and caldera-related	0	132 400	166 800	193 500
Metasomatite	88 800	147 600	246 700	314 300
Other*	53 600	138 600	263 000	278 200
Unspecified	65 400	141 700	222 000	289 400
Total	**569 900**	**2 516 100**	**3 524 900**	**4 004 500**

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rock types with elevated uranium content. Pegmatite and black shale are not included.

Table 9. Inferred Resources by deposit type
(tonnes U)

	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	99 700	163 600	165 500	169 400
Sandstone	32 200	396 000	480 500	528 700
Hematite breccia complex	0	339 900	347 500	347 500
Quartz-pebble conglomerate	73 906	88 900	94 500	107 100
Vein	0	700	50 700	159 600
Intrusive	800	5 900	92 500	181 200
Volcanic and caldera-related	0	31 300	48 000	98 500
Metasomatite	3 200	28 000	335 900	413 300
Other*	0	118 300	190 400	201 300
Unspecified	16 800	53 200	73 600	95 200
Total	**226 600**	**1 225 800**	**1 879 100**	**2 301 800**

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rock types with elevated uranium content. Pegmatite and black shale are not included.

Proximity of Resources to Production Centres

A total of eight countries provided estimates of the availability of resources for near-term production by reporting the percentage of Identified Resources (RAR and Inferred Resources) recoverable at costs <USD 80/kgU and <USD 130/kgU that are tributary to existing and committed production centres (Table 10). Resources tributary to existing and committed production centres in eight countries listed below total 2 486 752 tU at <USD 80/kgU, about 10% below the 2007 value of 2 757 590 tU reported in the same cost category.

Table 10. Identified Resources proximate to existing or committed production centres*

Country	RAR + Inferred recoverable at <USD 80/kgU in Existing or Committed Production Centres			RAR + Inferred recoverable at <USD 130/kgU in Existing or Committed Production Centres		
	Total resources	%	Proximate resources	Total resources	%	Proximate resources
Australia	1 612 000	83	1 337 960	1 673 000	NA	NA
Brazil	231 300	66	152 658	278 700	66	183 942
Canada	447 400	75	335 550	485 300	69	334 857
Czech Rep.	500	100	500	NA	NA	NA
Kazakhstan	475 500	93	442 215	651 800	82	534 476
Russian Fed.	158 100	90	142 290	480 300	NA	NA
South Africa	232 900	13	30 277	295 600	NA	NA
Ukraine	53 500	89	47 615	105 000	82	86 100
Total	**3 211 200**	**77**	**2 486 752**	**3 969 700**		**NA**

NA Not available.
* Identified resources only in countries that reported proximity to production centres; not world total.

Undiscovered Resources

Undiscovered Resources (***Prognosticated*** and ***Speculative)*** refer to resources that are expected to occur based on geological knowledge of previously discovered deposits and regional geological mapping. ***Prognosticated Resources*** refer to those expected to occur in known uranium provinces, generally supported by some direct evidence. ***Speculative Resources*** refer to those expected to occur in geological provinces that may host uranium deposits. Both Prognosticated and Speculative Resources require significant amounts of exploration before their existence can be confirmed and grades and tonnages can be defined. All Prognosticated Resources and Speculative Resources are reported as *in situ* resources (Table 11).

Worldwide, reporting of SR is incomplete, as only 26 countries have historically reported resources in this category. Only 16 countries reported SR for this edition, compared to the 27 that reported RAR. A number of countries did not report Undiscovered Resources for the 2009 Red Book, while others indicated that they do not regularly update evaluations of this type of resource. Nonetheless, some of these countries, such as Australia, Gabon and Namibia, are considered to have significant resource potential in as yet sparsely explored areas.

Prognosticated Resources are estimated to total about 2.81 million tU recoverable at <USD 130/kgU (a 2% increase from 2.77 million tU in 2007), including about 1.70 million tU at <USD 80/kgU (1.95 million tU in 2007, a 12% decrease). Prognosticated Resources are estimated to total about 2.91 million tU recoverable at <USD 260/kgU. Major changes in Prognosticated Resources between 2007 and 2009 occurred in Kazakhstan (an increase from 280 000 tU to 321 600 tU in the <USD 80/kgU cost category and an increase from 300 000 tU to 498 500 tU in the <USD 130/kgU cost category), the Russian Federation (decrease from 276 500 tU to182 000 tU in the <USD 80/kgU category) and Ukraine (decrease from 22 500 tU to15 300 tU in the <USD 130/kgU category). The total Prognosticated Resources reported in the new high cost category amounted to 2 905 000 tU, a 5% increase from the total reported in the <USD 130/kgU category in 2007.

The total for countries reporting Speculative Resources (SR) recoverable at <USD 130/kgU is about 3.7 million tU, a decrease of over 1 059 000 tU (22%) compared to the 2007 total.

Speculative Resources (SR) recoverable at <USD 260/kgU amounted to a little over 3.9 million tU. About 3.6 million tU of SR are reported without an estimate of production cost, a decrease of 620 500 tU (21%) compared to 2007. The most significant changes in SR are reported in Kazakhstan, where 200 000 tU were upgraded from Speculative to high cost (<USD 260/kgU) Prognosticated Resources, and the Russian Federation, where Speculative Resources were reduced by 714 000 tU in the <USD 130/kgU category and 633 000 tU were added to the unassigned cost range. Indonesia and the Islamic Republic of Iran recorded slight increases (<5000 tU) in Speculative Resources. Total reported SR are estimated to amount to almost 7.5 million tU, down slightly (3.6%) compared to the 2007 total of 7.7 million tU.

Table 11. Undiscovered Resources*
(in 1 000 tonnes U, as of 1 January 2009)

COUNTRY	Prognosticated Resources			Speculative Resources			
	Cost ranges			Cost ranges			
	< USD 80/kgU	< USD 130/kgU	< USD 260/kgU	< USD 130/kgU	< USD 260/kgU	Cost range unassigned	Total
Argentina	NA	1.4	1.4	NA	NA	NA	NA
Brazil	300.0	300.0	300.0	NA	NA	500.0	500.0
Bulgaria	NA	NA	25.0	NA	NA	NA	NA
Canada	50.0	150.0	150.0	700.0	700.0	0.0	700.0
Chile (a)	NA	1.5	1.5	NA	NA	3.2	3.2
China (a)	3.6	3.6	3.6	4.1	4.1	0.0	4.1
Colombia (a)	NA	11.0	11.0	217.0	217.0	0.0	217.0
Czech Republic	0.2	0.2	0.2	0.0	0.0	179.0	179.0
Denmark (a)	0.0	0.0	0.0	50.0	50.0	10.0	60.0
Germany	0.0	0.0	0.0	0.0	0.0	74.0	74.0
Greece (a)	6.0	6.0	6.0	0.0	0.0	0.0	0.0
Hungary	0.0	18.4	18.4	NA	NA	NA	NA
India (a)	NA	NA	63.6*	NA	NA	17.0	17.0
Indonesia (a)	NA	NA	NA	16.1	16.1	0.0	16.1
Iran, Islamic Rep. of	0.0	4.2	4.2	NA	14.0	NA	14.0
Italy (a)	NA	NA	NA	NA	NA	10.0	10.0
Jordan (a)	67.8	84.8	84.8	84.8	84.8	NA	84.8
Kazakhstan	321.6	498.5	500.0	270.5	300.0	NA	300.0
Mexico (a)	NA	3.0	3.0	NA	NA	10.0	10.0
Mongolia (a)	0.0	0.0	0.0	1 390.0	1 390.0	NA	1 390.0
Niger (a)	14.5	24.6	24.6	NA	NA	NA	NA
Peru	6.6	6.6	6.6	19.7	19.7	NA	19.7
Portugal	1.0	1.5	1.5	NA	NA	NA	NA
Romania (a)	NA	3.0	3.0	3.0	3.0	NA	3.0
Russian Federation	NA	182.0	182.0	NA	NA	633.0	633.0
Slovenia	0.0	1.1	1.1	NA	NA	NA	NA
South Africa	34.9	110.3	110.3	NA	NA	1 112.9	1 112.9
Ukraine	NA	15.3	15.3	NA	120.0	135.0	255.0
United States	839.0	1 273.0	1 273.0	858.0	858.0	482.0	1 340.0
Uzbekistan (a)	56.3	85.0	85.0	0.0	0.0	134.7	134.7
Venezuela (a)	NA	NA	NA	0.0	0.0	163.0	163.0
Vietnam (a)	0.0	7.9	7.9	100.0	100.0	130.0	230.0
Zambia (a)	0.0	22.0	22.0	NA	NA	NA	NA
Zimbabwe (a)	0.0	0.0	0.0	25.0	25.0	0.0	25.0
Total (reported by countries)**	**1 701.5**	**2 814.8**	**2 905.0**	**3 738.2**	**3 901.7**	**3 593.8**	**7 495.5**

Undiscovered resources are reported as *in situ* resources. NA Data not available.
* Secretariat estimate in cost category.
** Totals may not equal sum of components due to independent rounding.
(a) Not reported in 2009 responses, data from previous Red Book.

Other Resources and Materials

Conventional resources are defined as resources from which uranium is recoverable as a primary product, a co-product or an important by-product, while unconventional resources are resources from which uranium is only recoverable as a minor by-product, such as uranium associated with phosphate rocks, non-ferrous ores, carbonatite, black schists, and lignite. Most of the unconventional uranium resources reported to date are associated with ***uranium in phosphate rocks***, but other potential sources exist (e.g. seawater and black shale). Since few countries reported updated information a comprehensive compilation of unconventional uranium resources and other potential nuclear fuel materials (e.g. thorium) is not possible. Instead, a summary of information documented over recent years and data reported in this edition is provided below.

Historically phosphate deposits [1] are the only unconventional resource from which a significant amount of uranium has been recovered. Processing of Moroccan phosphate rock in Belgium produced 686 tU between 1975 and 1999 and about 17 150 tU were recovered in the United States from Florida phosphate rocks between 1954 and 1962. As much as 40 000 tU was also recovered from processing marine organic deposits (essentially concentrations of ancient fish bones) in Kazakhstan. In the 1990s, the price of uranium dropped to a level that made these operations uneconomic and most of these plants were shut down. Those that were operating in the United States were decommissioned and demolished.

Estimated production costs for a 50 tU/year uranium by-product recovery project, including capital and investment, ranged between USD 40/kgU and USD 115/kgU (USD 15/lb U_3O_8 and USD 45/lb U_3O_8) in the United States in the 1980s [2]. More recently, production costs between USD 65/kgU and USD 78/kgU (USD 25/lb U_3O_8 and USD 30/lb U_3O_8) have been put forward by Australia's Uranium Equities [3], although supporting feasibility study results have not yet been produced. In November 2009, Cameco invested USD 16.5 million in Uranium Equities to develop and commercialise the company's PhosEnergy process.

An IAEA Technical Meeting was convened in November 2009 to update activities in this area. During the meeting, a broad spectrum of issues relating to the potential of unconventional resources was covered, along with research, technological developments and related environmental aspects [4]. It is clear that with stronger uranium prices and expectations of rising demand a variety of projects and technologies are being investigated by both governments and commercial entities.

Unconventional uranium resources were reported occasionally by countries in Red Books beginning in 1965. In 2009, only very few countries (Egypt, Finland, Peru and South Africa) mentioned or reported such resources (Table 12). But with the price of uranium having generally increased since 2003, compared to the preceding 20 years, unconventional uranium resources, particularly those contained in phosphate rocks, are gaining more attention. In Brazil, development of the St. Quitéria Project is ongoing, with production of as much as 1 000 tU/yr from phosphoric acid produced from the Itataia phosphate/uranium deposit expected to begin in 2012. Egypt reports an estimate of 42 000 tU contained in upper Cretaceous phosphate deposits, with U content ranging between 50-200 ppm. Peru notes the potential of the Bayovar deposit in Piura, estimated to contain as much as 16 000 tU at an average grade of 60 ppm. And South Africa makes note of the long-term potential of uranium recovery from phosphate deposits off its west coast with uranium grades as high

as 430 ppm. Although not reported in this edition of the Red Book, other countries, such as Jordan, Morocco and Tunisia have also expressed an interest in recovering uranium from phosphate rocks during fertiliser production.

But interest is not restricted to phosphate rocks alone. In Finland, low-grade polymetallic (nickel, zinc, copper and cobalt) sulphide ores in the Talvivaara black shales have been in commercial production since October 2008 using bio-heap leaching. Although uranium recovery is not included in the extraction process at present, the uranium contained in ore could be extracted under favourable market conditions.

In 2007, the Ministry of Employment and the Economy in Finland granted a two-year extension of the Sokli mining concession on phosphate ore containing niobium, thorium and uranium. The environmental assessment delivered in support of its development includes an option for uranium production. Also in Finland, Mawson Resources and Namura Finland are working toward development of the Nuottijärvi deposit. The deposit has a high cost (>USD 130/kgU) historic resource estimate of 1 000 tU.

If uranium prices reach levels in excess of USD 260/kgU (USD100/lb U_3O_8), by-product recovery of uranium from unconventional resources, and in particular from phosphate processing facilities, is likely to become economically viable. If potential barriers such as regulatory requirements and qualified personnel development can be overcome, by-product uranium production from phosphoric acid could again become an important, competitive source of uranium. In this way, uranium that is now being dispersed in very low concentrations on the land surface in fertiliser could be recovered and used in the nuclear fuel cycle.

Table 12. Unconventional Resources reported in 2009
(tonnes U)

Country	Tonnes U	Types of deposit
Egypt	42 000	Phosphorite
Finland	5 500	Black shale and carbonatite deposits
Peru	21 600	Phosphorite and polymetallic (Cu, Pb, Zn, Ag, W, Ni) deposits
South Africa	NR	Phosphorite and coal deposits

NR = not reported.

Table 13 summarises ranges of unconventional resources reported in Red Books since 1965 [5]. These figures are incomplete. They do not include all worldwide unconventional resources since large uranium resources associated with the Chattanooga (United States) and Ronneburg (Germany) black shales, which combined contain a total of 4.2 million tU, are not listed. Neither are large uranium resources associated with monazite-bearing coastal sands in Brazil, India, Egypt, Malaysia, Sri Lanka and the United States. Unconventional resources are also not regularly reported in former USSR countries.

Table 13. Unconventional Uranium Resources (1 000 tU) **reported in 1965–1993 Red Books**

Country	Phosphate rocks	Non-ferrous ores	Carbonatite	Black schist, lignite
Brazil*	28.0 – 70.0	2.0	13.0	
Chile	0.6 – 2.8	4.5 – 5.2		
Columbia	20.0 – 60.0			
Egypt**	35.0 – 100.0			
Finland	1		2.5	3.0 – 9.0
Greece	0.5			
India	1.7 – 2.5	6.6 – 22.9		4.0
Jordan	100 – 123.4			
Kazakhstan	58			
Mexico	100 – 151	1.0		
Morocco	6 526			
Peru	20	0.14 – 1.41		
Sweden				300.0
Syria	60.0 – 80.0			
Thailand	0.5 – 1.5			
United States	14.0 – 33.0	1.8		
Venezuela	42.0			
Vietnam				0.5

* Considered a conventional resource in Brazil and is thus included in conventional resource figures for Brazil.
** Includes an unknown quantity of uranium contained in monazite.

The total uranium reported in previous Red Books as unconventional resources, dominated by phosphorite deposits in Morocco (>85%), amounts to about 7.3 – 7.6 million tU. As noted above, this total does not include significant deposits in other countries and is therefore a conservative estimate of the existing unconventional uranium resource base.

Other estimates of uranium resources associated with marine and organic phosphorite deposits point to the existence of almost 9 million tU in four countries alone: Jordan, Mexico, Morocco and the United States [6]. Others estimate the global total to amount to 22 million tU, as cited in the 2005 Red Book [7]. Surveys of uranium content in phosphate rocks [8], combined with estimates of the extent of such deposits [9], support estimates of substantial amounts of uranium contained in phosphate rocks. The variation in these estimates shows that these figures should be considered as part of a general mineral inventory rather than conforming to standard categories used in reporting resources. The development of more rigorous estimates of uranium in phosphate rocks is needed to define the extent of these resources, their accessibility and the economics of uranium production given that uranium market prices may justify the exploitation of these deposits.

Efforts to recover uranium from tailings deposits in South Africa have also been advanced recently. Harmony Gold has been investigating the potential of recovering uranium from 11 tailings dumps southwest of Johannesburg, where the Cooke dump near Doornkop alone contains an estimated 9 500 tU, as well as gold. Gold Fields is also investigating the potential of tailings dumps and a gold – uranium quartz – pebble conglomerate at the Beatrix mine near Welkom, containing an estimated 24 600 tU and 75 t Au. And First Uranium is working toward uranium production from 14 old tailings dams included in the Mine Waste Solutions (MWS) tailings reclamation project.

Canadian based Sparton Resources has been actively developing the technology for the recovery of uranium from coal ash, focussing efforts on a Chinese coal-fired power station, but is also exploring other potentially suitable ash disposal sites in China, South Africa and Eastern Europe. Although the process has been conducted on a limited scale in the past, as with other unconventional sources of uranium, strong uranium prices will be necessary for such extraction technologies to be commercially viable. Although uranium recovery from tailings and coal ash would be a welcome addition, these projects, as currently outlined, would contribute annually only small amounts of material, on the order of a few hundred tU/year from each operation.

UraMin Inc. (now AREVA Resources South Africa) had been investigating uranium recovery from the Springbok Flats coal field, estimated to contain 77 000 tU at grades of 0.06 – 0.1% U. However, developing a cost effective, environmentally acceptable means of uranium extraction from this potential source remains a challenge.

Seawater has long been regarded as a possible source of uranium, due to the large amount of uranium contained (about 4 billion tU) and its almost inexhaustible nature. However, because of the low concentration of uranium in seawater (3-4 ppb), it is estimated that it would require the processing of about 350 000 tonnes of water to produce a single kg of uranium. Nonetheless, with the exception of its high recovery cost, there is no intrinsic reason why at least some of these significant resources could not be extracted from various coast lines at a total rate of a few hundred of tonnes annually.

Research on uranium recovery from seawater was carried out in Germany, Italy, Japan, the United Kingdom and the United States of America in the 1970s and 1980s, but is now only known to be continuing in Japan. Japanese researchers continued trials of a recovery system, based on polymer braids, directly moored to the ocean floor, which recovered about 2.0 gU per kg absorbent over the test period [10]. The annual recovery factor of large scale systems was estimated in 2006 to be about 1 200 tU/year at a recovery cost of over USD 700/kgU. Research is continuing through pilot trials in Japan, [11] to improve the recovery factor and lower costs towards competitive ranges. Use of this type of technology eliminates the need to process large quantities of seawater.

Thorium

Thorium, abundant and widely dispersed, could also be used as a nuclear fuel resource. Most of the largest identifed thorium resources were discovered during the exploration of carbonatites and alkaline igneous bodies for uranium, rare earth elements, niobium, phosphate and titanium. Today, thorium is recovered mainly from the mineral monazite as a by-product of processing heavy-mineral sand deposits for titanium-, zirconium-, or tin-bearing minerals. Information on thorium resources [1,5] was published in Red Books between 1965 and 1981, typically using the same terminology used for uranium resources at that time (e.g. Reasonably Assured Resources and Estimated Additional Resources I and II, which are now termed Inferred and Prognosticated Resources, respectively). No additional information is available since the publication of the 2007 Red Book. Worldwide thorium resources, which are listed by major deposit types in Table 14, are estimated to total about 6.08 million t Th, including undiscovered resources.

Table 14. Major thorium deposit types and resources [5]

Deposit type	**Resources** (1 000 t Th)
Carbonatite	1 900
Placer	1 500
Vein-type	1 300
Alkaline rocks	1 120
Other	258
Total	**6 078**

Table 15 lists these thorium resources on a country by country basis, classified in categories similar to those used for uranium resources.

Table 15. World thorium resources (1 000 tU) [3]

Country	**RAR** < USD 80/kgTh	**EAR I (Inferred)** <USD 80/kgTh	**Identified Resources** <USD 80/kgTh	**Prognosticated**
Australia*	46	406	452	NA
Brazil*	172	130	302	330
Canada	NA	44	44	128
Egypt	NA	100	100	280
Greenland	54	NA	54	32
India	319	NA	319	NA
Norway	NA	132	132	132
Russian Fed.	75	NA	75	NA
South Africa	18	NA	18	130
Turkey*	NA	NA	NA	NA
USA	122	278	400	274
Venezuela	NA	300	300	NA
Others	23	10	33	81
Total	**829**	**1 400**	**2 229**	**1 387**

NA Data not available.
* Based on updated assessments [8].

World total thorium resources estimated in the categories RAR, EAR-I (Identified Resources) and Prognosticated Resources listed in Table 15 total 3.6 million t Th, or about 60% of the world thorium resources listed in Table 14. Differences in these estimates are the result of the differing approaches used (e.g. different costs and degrees of geological assurance).

So-called secondary sources of uranium, though small compared with the resources described above, play a significant role in supplying current nuclear fuel requirements and are expected to continue to do so for several years. These resources are discussed in detail in the Uranium Demand section of this volume.

B. URANIUM EXPLORATION

Exploration and development activities in 2007 and 2008 continued at a pace not seen for almost two decades, driven by increases in the uranium spot price until mid-2007. These activities were conducted in countries which explored for and developed uranium deposits in the past and also in many countries where exploration for uranium had not been conducted for some time. Since most of these countries did not report exploration and development expenditures, total worldwide uranium exploration and development expenditures are likely higher than what is reported here.

Worldwide uranium exploration continues to be unevenly distributed geographically, with the majority of exploration expenditures being concentrated in areas considered to have the best likelihood for the discovery of economically attractive deposits, mainly ***unconformity-related***, ***sandstone-type*** and ***hematite breccia complex*** deposits.

In 2008, only China, France, Japan and the Russian Federation reported non-domestic exploration and development expenditures amounting to a total USD 324.3 million (Table 16). In 2007, Canada, China, France, Japan and Switzerland reported non-domestic expenditures amounting to USD 352.5 million, more than 20 times the 2002 total. In 2009, non-domestic exploration and mine development expenditures are expected to decline to USD 197.0 million, although only France, Japan and the Russian Federation reported expected expenditures. Total non-domestic exploration expenditures are incomplete, as expenditures are known to have been made abroad in recent years by companies based in Australia and the Republic of Korea, but no data were reported. Trends in domestic and non-domestic exploration expenditures are depicted in Figure 4.

Domestic exploration and development expenditures generally decreased from 1998 to 2001, then began to slightly increase in 2002 where a total of 18 countries reported domestic expenditures of about USD 95.1 million (Table 17). In 2003 and 2004, 20 and 21 countries, respectively, reported exploration and development activities amounting to about USD 123.8 million and USD 218.8 million, respectively. But these figures are likely underestimating the total amount of exploration since a number of countries either did not report exploration and mine development expenditures or did so for government expenditures only, as discussed below.

In 2005, 19 countries reported domestic exploration and development expenditures totalling about USD 393.7 million, an increase of about 80% compared to 2004. In 2006, 17 countries reported domestic expenditures totalling about USD 704.5 million, an increase of about 79% compared to 2005 (these figures include conservative Secretariat estimates for Namibia and Uzbekistan). In 2007, exploration and development expenditures reported by 22 countries increased a further 89%, amounting to about USD 1.328 billion, and in 2008 increased by 24% to a total of USD 1.641 billion (again with 22 countries reporting and Secretariat estimates for Namibia and Uzbekistan).

The bulk of 2008 expenditures were reported in only six countries: Australia, Canada, Kazakhstan, Niger, the Russian Federation and the United States. These countries together accounted for over 90% of reported domestic exploration and development expenditures. Of reported domestic expenditures, 60% were made in only three countries; Australia, Canada and the United States. Overall, domestic exploration and development expenditures are expected to remain strong but decline by 18% in 2009 to USD 1.342 billion, based on reports from 18 countries (although South Africa reported expenditures for only one operation). The most significant increases anticipated in 2009 are expected to occur in Australia, Canada, Jordan, Kazakhstan, Niger and the Russian Federation. Figure 4 portrays these trends, showing the recent, rapid divergence between domestic and non-domestic expenditures.

Table 16. Non-domestic uranium exploration and development expenditures
(USD in year of expenditures)

COUNTRY	Pre-2002	2002	2003	2004	2005	2006	2007	2008	2009 (expected)
Australia	NA	NA	NA	1 571	8 855	4 580	NA	NA	NA
Belgium	4 500	0	0	0	0	0	0		
Canada	22 820	2 549	2 547	9 559	53 968 p	124 546 p	139 655	NA	NA
China	0	0	0	0	NA	NA	157 237 [1]	183 717 [1]	NA
France	722 623	14 370	16 701	59 701	127 500	85 000	53 985	87 092	84 406
Germany	403 158	0	0	0	0	0	0	0	0
Japan	418 331	NA	NA	NA	NA	NA	1 570 [2]	3 810 [2]	4 430 [2]
Korea, Republic of	24 049	NA	NA	NA	NA	NA	NA	NA	NA
Russian Federation	NA	NA	NA	NA	NA	NA	NA	49 724	108 190
Spain	20 400	0	0	0	0	0	0	0	0
Switzerland	29 657	0	0	3	0	3	16	0	0
United Kingdom	61 263	0	0	0	0	0	0	0	0
United States	260 598	NA	NA	NA	NA	NA	NA	NA	NA
Total	**1 967 399**	**16 919**	**19 248**	**70 834**	**190 323**	**214 129**	**352 463**	**324 342**	**197 026**

Note: Domestic exploration and development expenditures represent the total expenditure from domestic and foreign sources within each country. Expenditures abroad are thus a subset of domestic expenditures.

1. Government development expenditures only.
2. Government expenditures only.

p Provisional data.
NA Data not available.

Table 17. Industry and government uranium exploration and development expenditures – domestic
(USD thousands in year of expenditure)

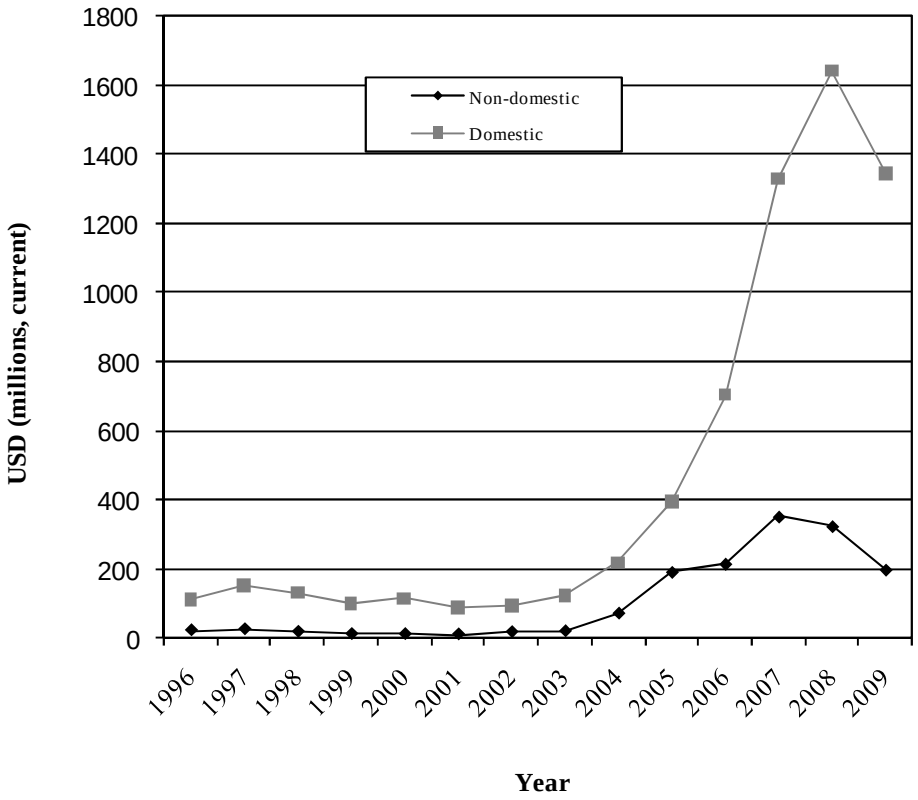
COUNTRY	Pre-2002	2002	2003	2004	2005	2006	2007	2008	2009 (expected)
Argentina (a)	51 022	265	627	701	966	649	439	481	1 268
Australia	501 813	3 020	4 116	9 971	31 366	61 603	149 917	211 612	139 179
Bangladesh	453	NA	NA	NA	NA	NA	NA	NA	NA
Belgium	2 487	0	0	0	0	0	0	0	0
Bolivia	9 343	NA	NA	NA	NA	NA	NA	NA	NA
Botswana	825	NA	NA	NA	NA	NA	NA	377	NA
Brazil	186 128	NA	NA	449	0	0	0	0	4 304
Cameroon	1 282	0	0	0	0	0	0	0	0
Canada	1 243 914	22 876	21 687	78 676	184 921	316 364	532 710	514 751	224 774
Central African Rep.	21 800	NA	NA	NA	NA	NA	NA	NA	NA
Chile	6 627	154	115	133	84	100	113	NA	NA
China	10 200	7 200	7 600	9 500	13 500	23 905	33 971	43 240	40 176
Colombia	19 946	NA	NA	0	0	0	6000	NA	NA
Costa Rica	364	NA	NA	NA	NA	NA	NA	NA	NA
Cuba	972	NA	NA	NA	NA	NA	NA	NA	NA
Czech Republic (b)	313 995	25	56	23	53	132	33	373	108
Denmark	4 140	0	0	0	0	NA	NA	NA	NA
Ecuador	1 945	NA	NA	NA	NA	NA	NA	NA	NA
Egypt	95 990	7 186	5 631	2 589	1 730	1 736	1 761	2 378	2 777
Finland	13 984	0	0	210	803	1 798	1 511	2 418	NA
France	907 240	0	0	0	0	0	0	0	0
Gabon	102 433	0	0	0	0	NA	NA	NA	NA
Germany (c)	2 002 789	0	0	0	0	0	0	0	0
Ghana	90	NA	NA	NA	NA	NA	NA	NA	NA
Greece	17 547	NA	NA	NA	NA	NA	NA	NA	NA
Guatemala	610	NA	NA	NA	NA	NA	NA	NA	NA
Hungary	3 700	0	0	0	0	NA	112	239	NA
India	289 134	11 922	14 172	14 333	16 588	16 422	19 793	25 093	31 983
Indonesia	15 815	30	33	31	NA	120	122	0	217
Iran, Islamic Rep of	4 561	1 389	3 781	3 751	3 723	4 826	3 930	8 047	16 357
Ireland	6 200	NA	NA	NA	NA	NA	NA	NA	NA
Italy	75 060	NA	NA	NA	NA	NA	NA	NA	NA
Jamaica	30	NA	NA	NA	NA	NA	NA	NA	NA
Japan	19 697	0	0	0	0	0	0	0	0
Jordan	920	0	0	0	0	0	0	353	115 819
Kazakhstan	31 040	11 836	4 372	723	1 169	8 500	34 318	78 155	130 083
Korea, Republic of	17 886	0	0	0	0	0	0	0	0
Lesotho	21	NA	NA	NA	NA	NA	NA	NA	NA
Madagascar	5 293	NA	NA	NA	NA	NA	NA	NA	NA

Table 17. Industry and Government Uranium Exploration and Development Expenditures – Domestic (contd.)
(USD thousands in year of expenditure)

COUNTRY	Pre-2002	2002	2003	2004	2005	2006	2007	2008	2009 (expected)
Malaysia	10 478	NA	NA	NA	NA	NA	NA	NA	NA
Mali	58 693	NA	NA	NA	NA	NA	NA	NA	NA
Mexico	30 306	NA	NA	NA	NA	NA	NA	NA	NA
Mongolia	8 153	NA	NA	NA	NA	12 527	26 138	26 649	19 178
Morocco	2 752	NA	NA	NA	NA	NA	NA	NA	NA
Namibia	25 631	0	110	1 747	2 000*	2 000*	8 000*	14 000*	12 000*
Niger	208 513	3 126	4 545	4 222	6 400*	12 453	152 984	207 173	312 097
Nigeria	6 950	NA	NA	NA	NA	NA	NA	NA	NA
Norway	3 180	0	0	0	0	0	0	0	0
Paraguay	26 360	NA	NA	NA	NA	NA	NA	NA	NA
Peru	4 776	0	0	0	0	NA	NA	NA	NA
Philippines	3 456	4	2	NA	NA	NA	NA	NA	NA
Portugal	17 637	0	0	0	0	0	0	0	0
Romania	10 060	NA	NA	NA	NA	NA	NA	NA	NA
Russian Fed.	76 939	10 420	7 241	10 597	24 946	33 496	64 218	221 528	258 761
Rwanda	1 505	0	0	0	0	0	0	0	0
Slovenia[d]	1 581	NA	NA	NA	NA	0	0	0	0
Somalia	10 000	NA	NA	NA	NA	NA	NA	NA	NA
South Africa	140 846	0	73	886	1 593	24 698	14 972	3 922[e]	6 787[e]
Spain	140 455	0	0	0	NA	427	3 887	4 552	NA
Sri Lanka	43	NA	NA	NA	NA	NA	NA	NA	NA
Sudan	200	0	0	0	0	0	0	0	0
Sweden	47 900	0	0	0	0	NA	NA	NA	NA
Switzerland	3 359	0	0	0	0	0	0	0	0
Syria	1 151	NA	NA	NA	NA	NA	NA	NA	NA
Thailand	11 299	NA	NA	NA	NA	NA	NA	NA	NA
Turkey	21 981	NA	7	7	23	56	50	74	189
Ukraine	10 341	1 898	3 415	4 259	4 801	6 168	6 560	7 548	4 725
United Kingdom	3 815	0	0	0	0	0	0	0	0
United States	2 506 761	352	31 300	59 000	77 800	155 300	245 700	246 400	NA
Uruguay	231	NA	NA	NA	NA	NA	NA	NA	NA
USSR	3 692 350								
Uzbekistan	112 402	13 255	13 923	16 995	21 230*	21 230*	21 230*	21 230*	21 230*
Vietnam	2 842	132	980	45	NA	NA	NA	NA	NA
Zambia	25	NA	NA	NA	NA	NA	NA	NA	NA
Zimbabwe	6 902	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	**13 196 836**	**95 090**	**123 786**	**218 848**	**393 696**	**704 510**	**1 328 468**	**1 640 593**	**1 342 012**

NA Data not available. * Secretariat estimate.
(a) Government exploration expenditures only
(b) Includes USD 312 560 expended in Czechoslovakia (pre-1996)
(c) Includes USD 1 905 920, spent in GDR between 1946 and 1990.
(d) Includes any expenditures spent in other parts of the former Yugoslavia.
(e) Data from Ezulwini only.
(f) Includes reclamation and restoration expenditures from 2004 to 2008. Reclamation expenditures amounted to USD 50.9 million, 50.2 million and 49.1 million in 2006, 2007 and 2008, respectively.
NOTE: Domestic exploration and development expenditures represent the total expenditure from domestic and foreign sources in each country for each year.

Figure 4. Trends in exploration and development expenditures



Current Activities and Recent Developments

North America. In **Canada,** domestic uranium exploration expenditures alone amounted to USD 385 million in 2008, down slightly from the peak in exploration expenditures of USD 386 million that occurred in 2007. Exploration expenditures in 2009 are expected to decline further to USD 170 million.

As in previous years, uranium exploration remained focused on areas favourable for the occurrence of deposits associated with Proterozoic unconformities in the Athabasca Basin of Saskatchewan, and to a lesser extent, similar geologic settings in the Thelon and Hornby Bay basins of Nunavut and the Northwest Territories. Uranium exploration also remained very active in the Otish Mountains of Quebec where Strateco Resources Inc. has applied for a licence to conduct underground exploration on the Matoush deposit. Exploration activity in the Central Mineral Belt of Labrador, where Aurora Energy Resources Inc. is proposing to develop the Michelin and Jacques Lake deposits, reduced significantly after April 2008 when the regional aboriginal government imposed a three-year moratorium on uranium mining on their lands. In April 2008, the British Columbia government extended a moratorium on uranium and thorium exploration and in July that same year the province of New Brunswick limited lands available for uranium exploration. The decline in uranium spot prices since the second half of 2007 triggered a decrease in exploration activity in other areas of Canada.

Uranium exploration and development drilling totalled 821 300 m in 2008, compared to the record 853 200 that was reported in 2007. Over 60% of the combined exploration and development drilling in 2007 took place in Saskatchewan.

In 2008, overall Canadian uranium exploration and development expenditures amounted to USD 515 million, down about 3% from 2007 expenditures of USD 533 million. Less than one-third of the overall exploration and development expenditures in 2008 can be attributed to advanced underground exploration, deposit appraisal activities, and care and maintenance expenditures associated with projects awaiting production approvals.

In 2008, the **United States** recorded a significant increase in domestic exploration and mine development activity with expenditures since 2006, amounting to USD 246.4 million, up slightly from expenditures in 2007 of USD 245.7 million. Although a portion of these expenditures relate to decommissioning and reclamation activities, this continued upward trend in investment indicates a significant turnaround for the industry. Much of the recent increase in development and production expenditures is due to the general rise in uranium (and vanadium) prices. The number of exploration and development holes drilled was 9 355 in 2008 and 9 347 in 2007 with significant increases in the total drilling length (1 552 656 m in 2008 and 1 568 501 m in 2007, compared to 576 682 in 2006). Renewed interest in leasing activity for historical uranium reserve properties led to the purchase of uranium mineral rights and the formation of new joint ventures to explore and develop prospective new deposits principally in Arizona, California, Colorado, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, and Wyoming.

Central and South America. Argentina reported government exploration expenditures totalling about USD 0.481 million in 2008, up slightly from about USD 0.439 million in the previous year. A number of foreign companies are active in exploration projects in the country, including AREVA, but expenditure data was not reported. Government exploration activities included a programme to complete the final feasibility study of the Cerro Solo deposit and evaluation of the surrounding areas. In addition, more exploration programmes (investigating vein type deposit at Las Thermas and sandstone type deposits favourable for *in situ* leach mining) are planned in the near future. Government expenditures and drilling efforts are expected to increase in 2009 to USD 1.268 million and 20 000 m, up from 2 956 m in 2008. Local opposition to uranium exploration and mining remains strong in some areas of the country.

No exploration work was carried out in **Brazil** from 2005 to 2008. In 2009, a drilling programme is planned to confirm the continuity of the Cachoeira and Engenho deposits at Lagoa Real (Caetité site), in addition to geological mapping of new targets in Bahia State and preliminary exploration activities in the Rio Cristalino area of Pará State. Exploration expenditures are expected to amount to USD 4.304 million in 2009.

In **Peru**, the Instituto Peruano de Energia Nuclear (IPEN) is promoting potential areas of interest for uranium exploration. In 2007 and 2008, several companies conducted work in the area of Macusani, where the bulk of the county's Identified Resources are located, in order to explore and develop these resources through bore holes in different prospects. Details of these and other activities were not reported by the Government of Peru.

Exploration activities were also conducted in Chile, Colombia, Ecuador, Guyana, Paraguay, and Venezuela, although details were not reported.

European Union. No fieldwork was conducted in the **Czech Republic** and exploration activities were focused on drilling in the deeper part of the Rozna deposit to identify additional resources to further extend the life of the mine. In **Denmark (Greenland)** significant exploration

effort in recent years resulted in the delineation of a large multi-metal deposit containing significant amounts of uranium, although details of the exploration effort were not reported by the government. The resource estimate is based on data derived during exploration for other metals, since exploration and mining of radioactive elements is prohibited in Greenland.

Finland reported domestic exploration expenditures in 2007 and 2008 of USD 1.51 million and USD 2.42 million, respectively. Because of the difficulties and delays in licensing, activities in Finland have mainly been limited to grass roots exploration, first in claim reservation and then in claim application areas. AREVA carried out an aerogeophysical survey on its target in eastern Finland in 2007, followed by trenching and diamond drilling in 2008, after a favourable court decision. Prolonged licensing, including probable appeals of claim decisions and the general decline in funding of exploration may cause the companies to reduce activities in Finland during the year 2009.

Although no domestic activities have been carried out in recent years, **France** reported increasing non-domestic uranium exploration and development expenditures of USD 54 million in 2007 and USD 87 million in 2008, although these figures are down from the peak of USD 127.5 million in 2005. Expenditures of over USD 84 million are expected in 2009. French exploration and development activities were reported in Australia, Canada, the Central African Republic, Finland, Kazakhstan, Mongolia, Niger and South Africa.

In **Hungary**, exploration activity focussed on development of a new geological model of the previously mined Mecsek sandstone deposit, allowing calculation of revised resource estimates. Drilling of the Bátaszék roll-front deposit and limited drilling of the Dinnyeberki deposit also took place. These efforts amounted to total expenditures of USD 0.11 million and USD 0.24 million in 2007 and 2008, respectively. Drilling amounted to a total of 950 m in 2008.

In 2007 and 2008, several foreign companies expressed an interest in obtaining mineral rights for the Nisa area in **Portugal**. In **Spain**, Berkeley Resources through its Spanish filial Minera de Rio Alagón S.L (MRA, has been actively investigating a total of 11 exploration licences spanning 45 214 hectares. By reassessing historic data and conducting reverse circulation and diamond drilling programs, it developed a JORC complaint resource base of 27 million lbs U_3O_8 (10 385 tU) distributed in four deposits. Exploration expenditures in 2007 and 2008 amounted to USD 3.9 million and USD 4.6 million, respectively. International uranium exploration companies were also active the **Republic of Slovakia** and **Sweden**, but expenditures related to these activities were not reported by governments.

Europe outside the EU. In **Armenia**, a joint venture was established with the Russian Federation in April 2008 for uranium exploration, mining and processing in Armenia and work, beginning with the assessment of archival material, began shortly thereafter. The work plan calls for exploration beginning in 2009. In the **Russian Federation,** most uranium exploration was performed in the Republic of Kalmykia, the Republic of Buryatia, Trans-Baikal Territory and the Chukotka Peninsula. Prospecting in Buryatia (the Vitim uranium district) identified a group of uranium bearing paleovalleys and the Dulesminskoe uranium occurrence. In Kalmykia, two-well trial *in-situ* leaching (ISL) at the Balkovskoe deposit yielded positive results and prospecting in the Trans-Baikal Territory (area to the north of Lake Baikal) identified promising areas for subsequent exploration. Total exploration and development expenditures increased in the Russian Federation in 2008 to over USD 221.5 million, compared to USD 64.2 million in 2007. Exploration and development expenditures are expected to increase further to USD 258.8 million in 2009 as prospecting in regions located near the operating uranium mines, as well as in the promising regions of Eastern Siberia and Kalmykia continues and development of the Elkon, Gornoe and Olovskoe deposits proceeds.

Exploration and mine development activities were not confined to within the Russian Federation in recent years, as non-domestic expenditures of USD 49.7 million and USD 108.2 million were reported in 2008 and 2009, respectively.

In **Turkey**, granite and acidic intrusive and sedimentary rocks were explored for radioactive raw materials, covering a 10 000 km^2 area in the Kırşehir-Nevşehir-Aksaray-Ankara region in 2007 and 2008. In 2009, granite and acidic intrusive and sedimentary rocks will be explored over a 5 000 km^2 area in the Kütahya-Uşak-Manisa region. Exploration expenditures amounted to USD 0.05 million and USD 0.07 million in 2007 and 2008, respectively, and are expected to increase to USD 0.19 million in 2009 with a 1 000 m drilling campaign planned.

Ukraine continued exploration for ***vein-type*** and unconformity-related deposits in the Ukrainian shield area and unconformity type deposits (Verbovskaya, Khotynskaya, Drukhovskaya) were discovered on its western slopes. Efforts to follow-up on Prognosticated Resources calculated in the Rozanovskaya, Gayvoronskaya and Khmelnitskoy areas were also undertaken. Exploration and development expenditures totalled USD 6.6 million in 2007, rose in 2008 to USD 7.5 million but are expected to decline to USD 4.7 million in 2009.

Africa. The Government of **Botswana** reported exploration expenditures of USD 0.377 million in 2008 as regulations for uranium mining and milling were being developed. In **Egypt,** exploration and development activities were focussed on four uranium prospects in southern and northern portions of the Eastern Desert and the southwest of the Sinai Peninsula. In early 2009, comprehensive geological, geophysical, and geochemical exploration works in the southern part of the Eastern Desert and Red Sea region were initiated, concentrating on potential uranium resources in new target environments. Unconventional resources, including phosphorite deposits, are also under investigation. Total expenditures in Egypt have steadily increased from USD 1.76 million in 2007 to USD 2.38 million in 2007 and 2008, respectively. Expenditures are expected to increase further to about USD 2.8 million in 2009.

In **Namibia**, major drilling programmes were conducted in support of proposed expansions of the Rössing and Langer Heinrich mines, ongoing development of the Trekkopje mine and continuing evaluation of several deposits for possible mine development, including Husab, Etango, Marenica, Rössing South and Omahola deposits. However, the Government of Namibia reported expenditure and drilling activity details for Rössing only. In **Niger**, activities focused on resource development in and around the existing mine sites in an effort to expand the resource base in the western Arlit area. Several deposits in this area are also under development (Ebba, Tamgak and Tabele). New exploration and development projects, with intensive drilling campaigns on the Azelik, Imouraren and Teguidda deposits, continued through 2009. Exploration and development expenditures reported by the Ministry officials in Niger amount to USD 153 million in 2007 and USD 207 million in 2008, with USD 312.1 million expected in 2009. In **Malawi**, infill drilling amounting to 9 955 m was conducted in 2008 on the Kayelekera deposit, where open pit mining began in April 2009, but expenditures were not reported.

In **South Africa**, a stronger market and supportive government policy stimulated at least eight companies to actively explore, develop and mine deposits in recent years. Companies are also actively assessing uranium by-product opportunities associated with the Witwatersrand gold reefs and recovery from tailings piles (“slimes”). Renewed interest in uranium occurrences in the Karoo Basin has also been evident in recent years, along with investigations of unconventional sources of uranium, such as the Springbok Flats coal field. Total expenditures in South Africa decreased from a peak of USD 24.7 million in 2006 to USD 14.97 million in 2007. With only the Ezulwini mining company

reporting in 2008 and 2009, exploration expenditures declined further to USD 3.92 million in 2008, but are expected to increase to USD 6.78 million in 2009. In **Tanzania**, about 70 licences have been issued to companies interested in uranium exploration and investigations of Karoo-age sediments in southern Tanzania (the Mkuju River, Mbamba Bay and Southern Tanzania Projects) and paleochannel associated calcrete and sandstone hosted uranium targets within the Bahi catchment of central Tanzania (the Bahi North and Handa Projects), but expenditure and drilling details were not reported by the government. Updated resource estimates and pre-feasibility studies have been published by the companies involved.

Exploration activities are also known to have been conducted in Burkina Faso, Cameroon, the Central African Republic, the Democratic Republic of Congo, Gabon, Guinea, Madagascar, Malawi, Mali, Mauritania, Mozambique, and Zambia, although details and associated costs were not reported by the governments of these countries.

Middle East, Central and Southern Asia. In **India**, active programmes are being conducted in several provinces, concentrating on Meso-Proterozoic, Neo-Proterozoic and Cretaceous sandstone basins. Annual drilling increased sharply from 46.6 km in 2006 to 60.46 km and 117.75 km in 2007 and 2008, respectively. In 2009, an extensive drilling programme totalling over 321 km is planned. Exploration expenditures are increasing commensurately, from USD 19.8 million and USD 25 million in 2007 and 2008, respectively, to USD 32 million in 2009.

In **Iran**, in addition to projects already under study outlined in the 2007 Red Book, exploration was begun in 2007 and 2008 in new areas in the southeast and east of Iran (in the Kerman, Sistan-va-Baluchstan, South Khorasan and Razavi Khorasan provinces). In 2009, regional structural studies will continue covering almost the entire eastern half of Iran. Reconnaissance of sedimentary type uranium deposits using modern procedures is on-going over the entire country in order to evaluate the potential of favourable sedimentary basins for uranium mineralisation. Total exploration expenditures alone amounted to about USD 1.8 million and USD 5.4 million in 2007 and 2008, respectively, and are expected to increase substantially to about USD 6.9 million in 2009, including funding for a 40 km drilling campaign. Total exploration and mine development expenditures amounted to USD 3.9 million, USD 8.0 million and USD 16.4 million in 2007, 2008 and 2009, respectively.

In **Jordan**, the Jordan Atomic Energy Commission (JAEC) was established in 2008 to develop the Jordanian nuclear power program, including the exploration, extraction and mining of uranium and other nuclear materials. In September 2008, JAEC created the Jordanian - French uranium mining company (JFUMC) to carry out all exploration activities leading to a feasibility study of developing resources in Central Jordan. Rio-Tinto is carrying out reconnaissance and prospecting in three areas in cooperation with JAEC and exploration activities in co-operation with SinoU of China are being carried out in two other areas. Exploration and development expenditures amounted to USD 0.4 million in 2008 and are expected to increase substantially to USD 116 million in 2009.

In **Kazakhstan**, exploration expenditures increased from USD 7.84 million in 2006, to USD 13.2 million in 2007 and to USD 42 million in 2008, with 1 036 holes drilled in 2007 and 1 693 in 2008, amounting to a total length of 514 783 m and 853 862 m. In 2009, increasing effort will continue with expenditures expected to amount to over USD 60 million and length drilled totaling over 1 081 000 m. From 2005 to 2008, exploration of sandstone-type deposits was performed at Moinkum, Inkai, Mynkuduk and Buddenovskoye in the Shu-Sarysu Uranium Province and at Northern Kharassan in the Syrdaria Uranium Province. Geological and economic re-estimation of vein-type deposits in the Northern Kazakhstan Uranium Province was conducted in 2007-2008. In 2009, exploration and ISL pilot production is to be completed on the western site of the

Mynkuduk deposit, at site No. 4 of the Inkai deposit and at the central site of the Mynkuduk deposit. The Akbastau JSC will start exploration at sites No. 1, 3 and 4 of the Buddenovskoye deposit in 2009-2010, with ISL pilot production at these three sites planned. In 2010, the Volkovgeology JSC is to renew geological exploration of sandstone-type deposits in new perspective areas of the Shu-Sarysu and the Syrdaria Uranium Provinces. Including significant mine development expenditures raise the totals to USD 34.3 million, USD 78.2 million and USD 130.1 million in 2007, 2008 and 2009, respectively.

Exploration continues in **Uzbekistan** in order to increase uranium production, although details were not reported by the government. Chinese and Japanese companies have signed agreements in recent years with the Government of Uzbekistan in order to assess uranium production from black shale deposits and to explore sandstone deposits.

South-eastern Asia. Limited activities were carried out in **Indonesia** in 2007 (exploration drilling at Semut) and in 2009 exploration drilling is to be continued in the Kalan Sector. Detailed, systematic prospection in the Kawat area is also planned, where Speculative Resources have been increased by 11 000 tU. No exploration activities were reported by governments in other South-eastern Asia.

East Asia. China reported increasing exploration and development expenditures of USD 33.9 million and USD 43.2 million in 2007 and 2008, respectively. China continues to focus exploration efforts on sandstone-type deposits amenable to *ISL* in the Yili basin of the Xinjiang region and the Erdos basin in Inner Mongolian Autonomous Region. In addition, work was restarted on hydrothermal vein-type deposits in southern China. In 2009, exploration expenditures are expected to amount to USD 40.2 million, featuring a significant drilling programme (1 590 holes, 500 km). Non-domestic exploration and development activities, carried out mainly in Kazakhstan and Niger, amounted to a total of USD 157.0 million and USD 183.7 million in 2007 and 2008, respectively. China has adopted a “two market, two resources” approach to meet rapidly rising domestic uranium demand, as reflected in the increased domestic and non-domestic expenditures outlined above.

In **Japan**, no domestic exploration has taken place since 1988, but the Japan-Canada Uranium Co. Ltd. is carrying out exploration activities in Canada and Japanese private companies hold shares in developing and mining operations in Canada, Niger, Kazakhstan and elsewhere. Non-domestic government mine development and exploration activities amounted to USD 1.6 million and USD 3.8 million in 2007 and 2008 respectively, and are expected to increase to over USD 4.4 million in 2009.

Exploration continues in **Mongolia**, performed principally by Canadian companies Khan Resources Inc., Western Prospector Group Ltd., East Asia Minerals Corporation, Denison Mines and Cameco. Solomon Resources Mongolia and foreign affiliates of Areva, the Chinese National Nuclear Corp, Japan and the Russian Federation, among others, have also been active in recent years. Activities included development of the Dornod deposit, the Gurvanbulak, Nemer and Mardaingol deposits of the Saddle Hills and the Kharat and Khairkhan deposits of the eastern Gobi region. Industry exploration expenditures amounted to a total of USD 26.1 million and USD 26.6 million in 2007 and 2008 respectively, and are expected to decline slightly to USD 19.2 million in 2009. Drilling length has been steadily increasing in recent years, from 167 259 m in 2006, to 170 637 m and 172 669 m in 2007 and 2008, respectively.

Pacific. Exploration continued vigorously in several regions of **Australia**, with uranium exploration and development expenditures increasing from USD 61.6 million in 2006, to USD 149.9 million in 2007, and USD 211.6 million in 2008. Exploration focused on the Gawler Craton/Stuart Shelf region (South Australia, SA) for hematite breccia complex deposits, the Frome Embayment (SA) for sandstone uranium deposits, the Alligator Rivers region (Northern Territory) for unconformity-related deposits in Palaeoproterozoic metasediments and the Mount Isa Region (Queensland) for extensions of metasomatite type deposits. Significant discoveries in 2007 and 2008 included the Double 8 deposit in Tertiary palaeochannels sands in Western Australia, the Blackbush deposit in South Australia, the Thunderball deposit near Hayes Creek in the Northern Territory and the N147 project south east of Nabarlek, also in the Northern Territory. Domestic exploration and mine development expenditures are expected to decline to USD 139.2 million in 2009. During 2007 and 2008, Paladin Energy Ltd (an Australian exploration company) completed the development of an open cut mining operation at the Kayelekera deposit in Malawi. Mine production commenced in May 2009. Paladin is also the operator of the Langer Heinrich uranium mine in Namibia, where production began in 2007 and production capability is being expanded. No details on non-domestic exploration and mine development expenditures were provided by the government.

C. URANIUM PRODUCTION

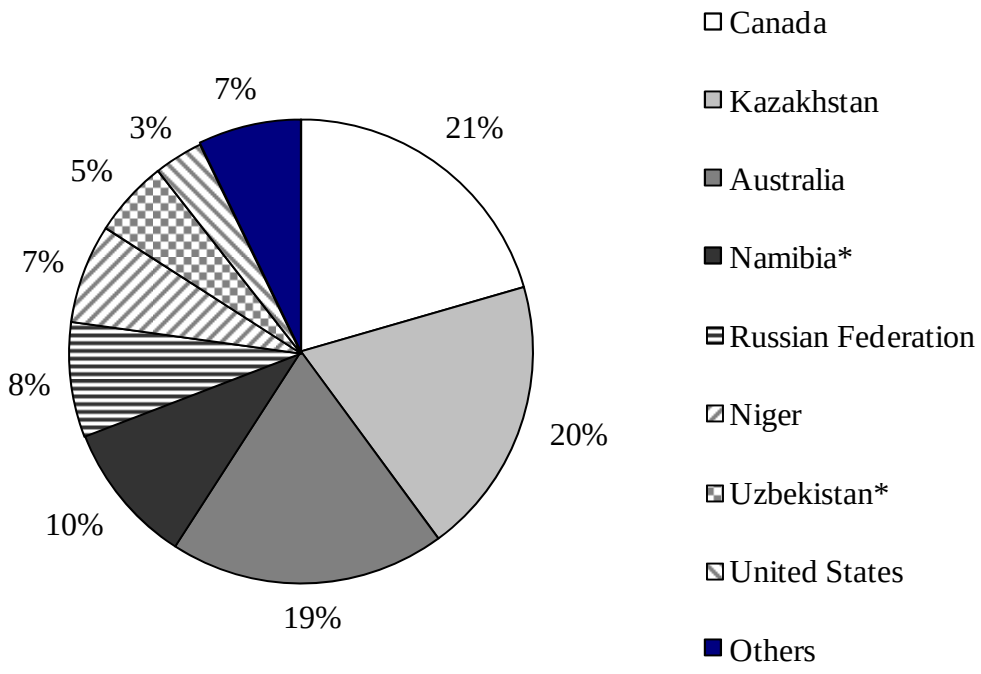
In 2008, uranium was produced in 20 different countries; the same number as in 2006 (although Germany had no production from mine water treatment in 2008; Bulgaria reported production from this method for the first time). In three of the 20 producing countries (Bulgaria, France and Hungary), uranium was produced only as a result of mine remediation efforts. Production grew faster in Kazakhstan since 2006 than in any other country, increasing by 26% and 28% in 2007 and 2008, respectively. In 2008, Kazakhstan became the world's second largest producer and if plans for future expansion are realised, as they have been in the recent past, it is poised to become the world's largest producer in 2009. Namibia also increased production significantly and in 2008 ranked as the world's fourth largest producer. Four countries; Australia, Canada, Namibia and Kazakhstan, accounted for 69% of world production in 2008 and just eight countries, Canada (21%), Kazakhstan (20%), Australia (19%), Namibia (10%), the Russian Federation (8%), Niger (7%), Uzbekistan (5%) and the United States (3%), accounted for about 93% of world production in 2008 (Figure 5).

Overall, world uranium production increased from 39 617 tU in 2006 to 41 244 tU in 2007 (a 4.1% increase) and to 43 880 tU in 2008 (a 6% increase from 2007). In 2009, uranium production is expected to increase by 16% to over 51 000 tU.

Within OECD countries, production increased slightly from 19 705 tU recorded in 2006 to 20 176 tU in 2007, then declined to 19 203 tU in 2008. Production in 2009 is expected to increase marginally to 20 108 tU. Table 18 summarises the significant changes that occurred in production in selected countries between 2006 and 2008. Historical uranium production on a country-by-country basis is provided in Table 19 and Figure 6.[2]

2. Some historical production figures have changed since the last edition of the Red Book as a result of new data made available by member countries.

Figure 5. Uranium production in 2008: 43 880 tU



* Secretariat estimate.

Table 18. Production in selected countries and reasons for major changes (tonnes U)

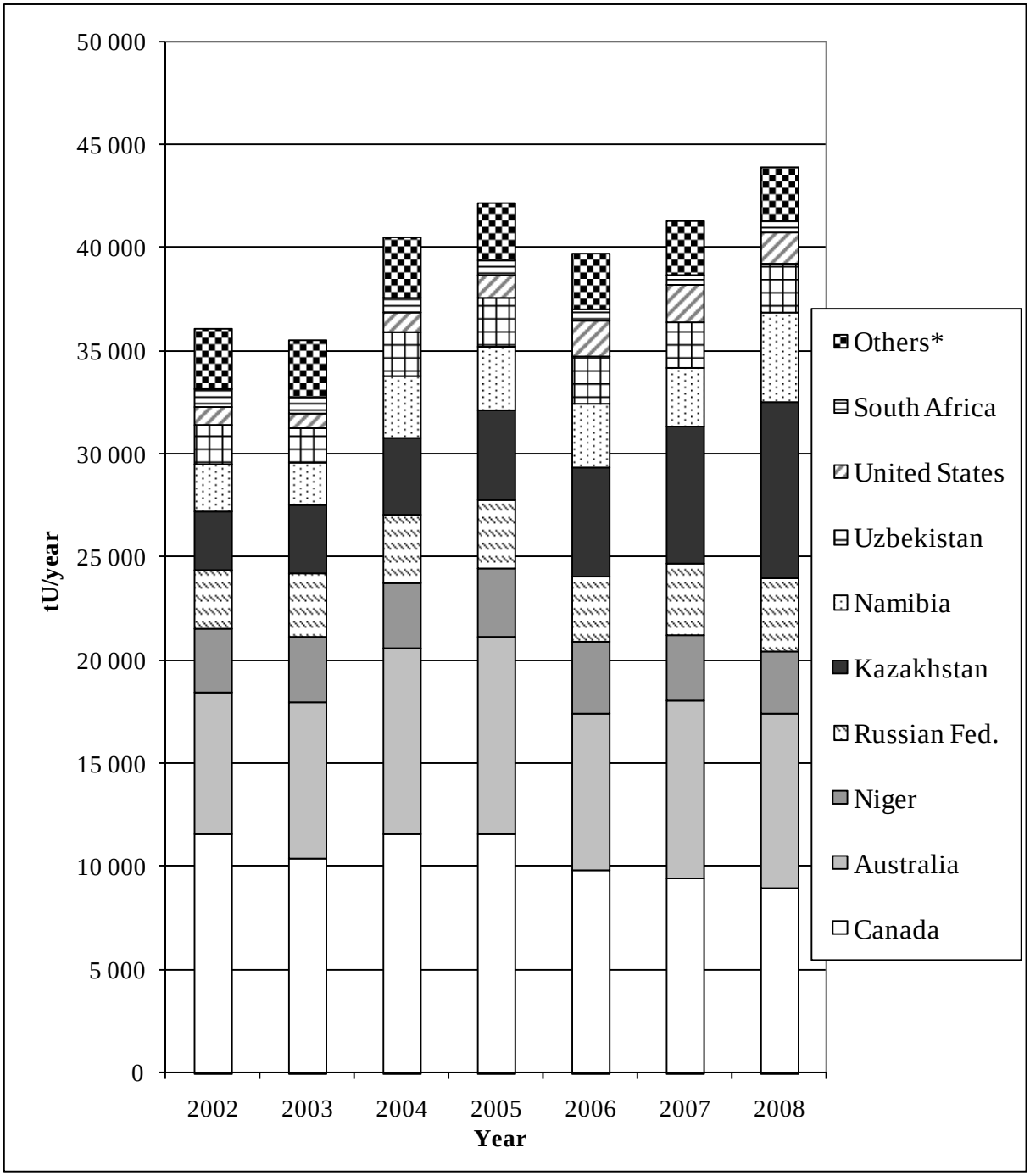
Country	Production 2006	Production 2008	Change 2006-2008	Reasons for changes in production
Australia	7 593	8 433	+840	Production increased at all three mines, (Olympic Dam, Ranger and Beverley).
Brazil	200	330	+130	Production increased at Caetité according to the planned development.
Canada	9 862	9 000	-862	Low grade ore milled at McClean Lake and Rabbit Lake; Cigar Lake delay.
Czech Republic	375	275	-100	Low grade ore at Rozna mine, decreased recovery at remediated ISL mine.
Kazakhstan	5 281	8 512	+3 231	Increase of production at existing mines and new mines started.
Namibia	3 076	4 400	+1 324	Langer Heinrich opening and increased production at it and Rössing according to development plan.
Niger	3 443	3 032	-411	Preparations for production increases temporarily reduced output.
Russian Federation	3 190	3 521	+331	Increase of production at existing mines according to the planned development.
United States	1 805	1 492	-313	Technical difficulties leading to decreased production at existing mines.

Table 19. Historical uranium production
(tonnes U)

COUNTRY	Pre-2006	2006	2007	2008	Total to 2008	2009 (expected)
Argentina	2 513	0	0	0	2 513	0
Australia	131 800	7 593	8 602	8 433	156 428	8 500
Belgium	686	0	0	0	686	0
Brazil	2 009	200	300	330	2 839	340
Bulgaria	16 357	2 (c)	2(c)	1 (c)	16 362	2 (c)
Canada	398 332	9 862	9 476	9 000	426 670	9 900
China*	29 169	750	710	770	31 399	750
Congo, Democratic Republic of	25 600*	0	0	0	25 600	0
Czech Republic (a)	109 470	375	307	275	110 427	255
Finland	30	0	0	0	30	0
France	75 975	3 (c)	2*(c)	2*(c)	75 982	2*(c)
Gabon	25 403	0	0	0	25 403	0
Germany (b)	219 411	65 (c)	41 (c)	0 (c)	219 517	50 (c)
Hungary	21 048	2 (c)	1 (c)	1 (c)	21 052	1 (c)
India*	8 423	230	250	250	9 153	250
Iran, Islamic Rep of	0	6	5	6	17	10
Japan	84	0	0	0	84	0
Kazakhstan	106 474	5 281	6 633	8 512	126 900	13 900*
Madagascar	785	0	0	0	785	0
Malawi	0	0	0	0	0	100*
Mexico	49	0	0	0	49	0
Mongolia	535	0	0	0	535	0
Namibia	84 980	3 076	2 832*	4 400*	95 288*	4 623*
Niger	100 644	3 443	3 193	3 032	110 312	3 208
Pakistan*	1 039	40	40	40	1 159	40
Poland	660	0	0	0	660	0
Portugal	3 717	0	0	0	3 717	0
Romania	18 169	90	80*	80*	18 419*	80*
Russian Federation	129 611	3 190	3 413	3 521	139 735	3 611
Slovenia	382	0	0	0	382	0
South Africa	154 673	534	540*	565*	156 312*	600*
Spain	5 028	0	0	0	5 028	0
Sweden	200	0	0	0	200	0
Ukraine	121 957	810	800	830	124 397*	900
United States	358 596	1 805	1 747	1 492	363 640	1 400*
USSR (e)	102 886	0	0	0	102 886	0
Uzbekistan (d)	28 069	2 260	2 270*	2 340*	34 939*	2 500*
Zambia (f)	86	0	0	0	86	0
OECD	1 325 086	19 705	20 176	19 203	1 384 170	20 108
TOTAL	**2 284 850**	**39 617**	**41 244**	**43 880**	**2 409 591**	**51 022**

* Secretariat estimate.
(a) Includes 102 241 tU produced in the former Czechoslovakia and CSFR from 1946 through the end of 1992.
(b) Production includes 213 380 tonnes U produced in the former GDR from 1946 through the end of 1989.
(c) Production from mine rehabilitation only.
(d) Production since 1992 only.
(e) Includes production in former Soviet Socialist Republics of Estonia, Kyrgystan, Tadjikistan, Uzbekistan.
(f) Correction based on re-calculation of 102 tonnes U_3O_8 to U.
Note: For Pre-2006, other sources cite 6 156 tonnes U for Spain, 91 tonnes U for Sweden.

Figure 6. Recent world uranium production



* "Others" includes the remaining producers (Table 15)
Values for China, France, India, Namibia, Pakistan, Romania, South Africa and Uzbekistan are estimated.

Present Status of Uranium Production

North America production, about 24% (10 492 tU) of the world total in 2008, declining from 11 667 tU produced in 2006. **Canada** remained the world's leading producer in 2008, despite producing below full capacity. In 2008, production amounted to 9 000 tU, some 5% below 2007 production 9 476 tU of due to lower grade ore and operational difficulties. In 2009, production is expected to increase to 9 900 tU. A proposal to increase production at McArthur River and Key Lake by some 18% annually (from 7 200 tU/year to 8 500 tU/year) remains under regulatory review. Rehabilitation of the Cigar Lake mine, flooded during development work in 2006 and again in 2008 continues but the mine is not expected to begin production until 2012 at the earliest. In November 2008, it was announced that development of the Midwest mine would be postponed due to the prevailing economic climate, delays and uncertainties associated with the regulatory approval process, rising capital and operating costs and the current uranium market. And in late 2009, AREVA Resources Canada Inc. announced that the McClean Lake mill would be put in care and maintenance after July 2010, with the timing of the re-start dependent upon market conditions and the Cigar Lake development schedule. Production in the **United States** in 2008 was 1 492 tU, 15% less than 2007 production (1 747 tU) and 17% less than 2006 production (1 805 tU), due to operational challenges and declining uranium prices. Despite these recent declines, 2008 production is a significant increase (58%) over 2004 production of 943 tU.

Brazil was the only producing country in **South America** in 2007 and 2008. Production at the country's only production centre, Lagoa Real (Caetité), increased from 200 tU in 2006 to 300 tU in 2007, then to 330 tU in 2008. Expansion of this facility to a nominal capacity to 670 tU/year remains on course for completion in 2010, with open pit mining to be replaced by underground mining in 2011. Production of uranium at the St. Quitéria project at the Itataia phosphate/uranium deposit is scheduled to begin in 2012. Work continues in **Argentina** to restart production at the Sierra Pintada mine of the San Rafael complex, placed on standby in 1999.

Output from the **European Union** remained very low in 2008, representing less than 1% of total world production. Production in the **Czech Republic** amounted to 275 tU in 2008, but is expected to decline slightly to 255 tU in 2009. Production at the Rozna mine is to continue as long as it remains profitable. **Bulgaria**, **France** and **Hungary** ended domestic uranium production in 1990, 2001and 1997, respectively. Today, only small amounts are recovered through mine remediation efforts. In **Germany**, 41 tU were recovered from mine rehabilitation activities in 2007 but none in 2008. It is expected that about 50 tU will be recovered in 2009.

Production in **non-EU Europe** increased slightly from 4 090 tU in 2006 to 4 401 tU in 2008, about 10% of total world production. In 2009, production is expected to increase slightly to 4 521 tU. Production in the **Russian Federation** increased from 3 190 tU in 2006 to 3 521 tU in 2008. Although the majority came from the Priargunsky mine, 471 tU were produced in 2008 at the Dalur ISL facility (the Dalmatovskoe deposit) in the Transural district. Production is expected to rise slightly to 3 611 tU in 2009. Production in **Ukraine** increased from 810 tU in 2006 to 830 tU in 2008. Production from the underground mines of Michurinskoye and Vatutinskoye is expected to amount to 900 tU in 2009.

Three countries in **Africa**, Namibia, Niger and South Africa, contributed about 18% to world production in 2008. Overall, production in Africa increased from 7 053 tU in 2006 to 7 997 tU in 2008. Production in **Namibia** increased from 3 076 tU in 2006 to 4 400 tU in 2008 and is expected to increase further in 2009 as expansion of the Langer Heinrich open-pit mine, commissioned in 2007, continues. Combined with proposed expansion of the existing Rössing facility and ongoing mine development activity at Trekkopje, production is poised to increase even further in the near future.

Niger's output decreased from 3 443 tU in 2006 to 3 032 tU in 2008, but is expected to increase to over 3 200 tU in 2009. Ongoing development of the Imouraren and Azelik mines, with production capacities of 5 000 tU/year and 700 tU/year respectively, indicates that production is also set to increase significantly in the near-term. Production in **South Africa** remained relatively steady at about 534 tU in 2006 and to 565 tU in 2008, but is expected to increase to 600 tU in 2009, as operators are developing circuits to recover uranium in gold mines, as well as from tailings stored at these facilities. Uranium production in South Africa is determined to a large extent by the gold content of the ore, since uranium is produced as a by-product or co-product of gold mining. Production in **Malawi** began in April 2009 as open-pit mining of the Kayelekera deposit was initiated. Efforts at the facility are directed toward attaining full production capacity of 1 270 tU/year, as early as 2010.

Production in the **Middle East, Central** and **Southern Asia** increased dramatically between 2006 and 2008, totalling 11 148 tU (about 25% of the world total) in 2008, compared to 7 817 tU in 2006. This increase is largely driven by developments in **Kazakhstan**, where production rose from 5 281 tU in 2006 to 8 512 tU in 2008 (a 61% increase). In 2009, production is expected to be increased by a further 63% to 13 900 tU. Mine development expenditures amounted to USD 21.11 million and USD 36.17 million in 2007 and 2008, respectively, and are expected to increase to USD 69.48 million in 2009 as development plans continue to move forward. Production in **Uzbekistan,** estimated to have reached 2 340 tU in 2008, is expected to increase to 2 500 tU in 2009. **Iran** reported production of 6 tU by open-pit mining of the Gachin deposit and is working toward the opening of a second facility at Ardakan (the Saghand plant) with a nominal production capacity of 50 tU/year in 2012. Mine development expenditures amounted to USD 2.2 million and USD 2.6 million in 2007 and 2008, respectively, and are expected to increase to USD 9.4 million in 2009. **India** and **Pakistan** do not report production data but output is estimated to have increased slightly from 2006 to 2008 at 270 tU and 290 tU, respectively. Based on the available preliminary data, it is expected that the region will have a new producer in the near future, as production in **Jordan** is expected to start in 2012, building to an estimated annual output of 2 000 tU.

China, the only producing country in **East Asia**, does not report official production figures. Annual production is estimated to have increased slightly from 750 tU in 2006 to 770 tU in 2008. Production is not expected to increase in 2009, although neither the Qinlong underground nor the Yining ISL mines have achieved full design capability. The Shaoguan production centre in South China, an underground – heap leach mine, was recently completed and put into operation.

Australia, the only producing country in the **Pacific** region, reported a 2% decrease from 8 602 tU in 2007 to 8 433 tU in 2008. Production decreases at Olympic Dam and Beverley were recorded in 2008, due to a combination of processing lower grade ore and operational difficulties. Production in Australia is expected to remain at about 8 500 tU in 2009, but forecast to increase thereafter as the Four Mile ISL mine is brought into production and operational improvements and expansion plans are implemented at Ranger and Beverley.

Ownership

Table 20 shows the ownership of uranium production in 2008 in the 20 producing countries. Domestic mining companies controlled about 67.6% of 2008 production, compared to about 71.3% in 2006. Non-domestic mining companies controlled about 32.2% of 2008 production with approximately 10.2% controlled by government-owned companies and 22.0% by privately-owned companies.

Table 20. Ownership of uranium production based on 2008 output

COUNTRY	Domestic mining companies				Non-domestic mining companies				TOTAL
	Government-owned		Privately-owned		Government-owned		Privately-owned		
	tU	%	tU	%	tU	%	tU	%	
Australia	0	0.0	2 547	30.2	0	0.0	5 886	69.8	8 433
Brazil	330	100.0	0	0.0	0	0.0	0	0.0	330
Bulgaria	1	100.0	0	0.0	0	0.0	0	0.0	1
Canada	0	0.0	6 126	68.0	2 780	31.0	94	1.0	9 000
China*	770	100.0	0	0.0	0	0.0	0	0.0	770
Czech Republic	275	100.0	0	0.0	0	0.0	0	0.0	275
France*	2	100.0	0	0.0	0	0.0	0	0.0	2
Hungary	1	100.0	0	0.0	0	0.0	0	0.0	1
India*	250	100.0	0	0.0	0	0.0	0	0.0	250
Iran, Islamic Rep of*	6	100.0	0	0.0	0	0.0	0	0.0	6
Kazakhstan	5 135	60.3	0	0.0	451	5.3	2 926	34.4	8 512
Namibia*	152	3.5	4 198	96.5	0	0.0	0	0.0	4 350
Niger*	1 006	33.6	0	0.0	1 251	41.8	736	24.6	2 993
Pakistan*	40	100.0	0	0.0	0	0.0	0	0.0	40
Romania*	80	100.0	0	0.0	0	0.0	0	0.0	80
Russian Federation	3 521	100.0	0	0.0	0	0.0	0	0.0	3 521
South Africa	0	0.0	565	100.0	0	0.0	0	0.0	565
Ukraine*	800	100.0	0	0.0	0	0.0	0	0.0	800
United States*	0	0.0	1 492	100.0	0	0.0	0	0.0	1 492
Uzbekistan*	2 340	100.0	0	0.0	0	0.0	0	0.0	2 340
Total	**14 709**	**33.6**	**14 928**	**34.1**	**4 482**	**10.2**	**9 642**	**22.0**	**43 761**

* Secretariat estimate.

Employment

Although the data are incomplete, Table 21 shows that employment levels at existing uranium production centres increased by 8.3% from 2006 to 2008, and are expected to continue to do so in 2009 (by 4.3%), mainly due to min expansions and the development of new projects in Australia, India, Kazakhstan, Namibia and South Africa. Table 22 provides, in selected countries, employment directly related to uranium production (excluding head office, R&D, pre-development activities, etc.).

Table 21. Employment in existing production centres of countries listed
(in person-years)

COUNTRY	2002	2003	2004	2005	2006	2007	2008	2009 (expected)
Argentina	60	60	60	60	133	133	133	140
Australia (a)	502	655	743	889	959	3 010	3 347	3 173
Brazil	128	140	140	140	580	580	640	640
Canada (b)	972	965	985	1 067	1 665	1 873	1 984	1 600
China	8 000	7 700	7 500	7 000	7 300	7 400	7 450	7 500
Czech Republic	2 507	2 426	2 409	2 312	2 251	2 294	2 287	2 261
Germany (c)	2 691	2 444	2 230	2 101	1 835	1 775	1 770	1 683
India	4 200	4 200	4 200	4 200	4 300	4 300	4 634	4 634
Iran, Islamic Rep. of	0	0	0	0	285	285	285	300
Kazakhstan	3 770	3 870	5 120	6 522	6 941	7 845	7 940	9 448
Namibia*	782	NA	NA	NA	1 400	1 900	2 200	2 900
Niger	1 558	1 606	1 598	1 657	1 741	1 900*	1 932	1 950*
Portugal (c)	11	0	0	0	0	0	0	0
Romania*	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Russian Federation	12 800	12 785	12 670	12 551	12 575	12 950	12 870	12 870
Slovenia (c)	48	45	40	28	20	NA	NA	NA
South Africa	150	150	150	150	150	1 150	3 000	5 500
Spain (c)	56	56	56	56	58	58	43	43
Ukraine	NA	NA	4 380	4 350	4 310	NA	NA	NA
United States	277	204	299	524	600	1 076	1 409	NA
Uzbekistan*	8 370	8460	8 560	8 620	8 700	8 700	8 700	8 700
Total	**48 882**	**47 766**	**53 140**	**54 227**	**57 803**	**57 229**	**62 624**	**65 342**

* Secretariat estimate.
(a) Olympic Dam does not differentiate between copper, uranium, silver and gold production. Employment has been estimated for uranium-related activities.
(b) Employment at mine sites only.
(c) Employment related to decommissioning and rehabilitation.

Table 22. Employment directly related to uranium production and productivity

COUNTRY	2006		2007		2008	
	Production employment (person-years)	Production (tU)	Production employment (person-years)	Production (tU)	Production employment (person-years)	Production (tU)
Australia	959	7 593	302	8 602	385	8 433
Brazil	340	200	340	300	340	330
Canada	1 152	9 862	1 294	9 476	1 416	9 000
China	6 700	750*	6 720	710*	6 740	770*
Czech Rep.	1 213	375	1 106	307	1 122	275
Kazakhstan	4 460	5 281	4 706	6 633	6 598	8 512
Namibia	426	3 067	573	2 832*	1 106	4 400*
Niger	1 388	3 443	1 400*	3 193	1 450*	3 032
Russian Fed	4 804	3 190	5 100	3 413	5 120	3 521
South Africa	65	534	85	540*	450	565*
Ukraine	1 720	810	1 690	800	1 580	830
United States	412	1 805	701	1 747	952	1 492
Uzbekistan*	7 200	2 260	7 200	2 270	7 200	2 340

* Secretariat estimate.

Production Methods

Uranium is mainly produced using open-pit and underground mining techniques processed by conventional uranium milling. Other mining methods include *in-situ* leaching (ISL; sometimes referred to as *in-situ* recovery, or ISR); co-product or by-product recovery from copper, gold and phosphate operations; heap leaching and in-place leaching (also called stope or block leaching). Stope/block leaching involves the extraction of uranium from broken ore without removing it from an underground mine, whereas heap leaching involves the use of a leaching facility on the surface once the ore has been mined. Small amounts of uranium are also recovered from mine water treatment and environmental restoration activities.

Historically, uranium production has principally involved open-pit and underground mining. However, over the past two decades, ISL mining, which uses either acid or alkaline solutions to extract the uranium directly from the deposit, has become increasingly important. The uranium dissolving solutions are injected into, and recovered from, the ore-bearing zone using a system of wells. ISL technology is currently being used to extract uranium from sandstone deposits only and in recent years has become an increasingly important method of uranium production.

The distribution of production by type of mining or “material sources” for 2005 through 2009 is shown in Table 23. The category “Other methods” includes recovery of uranium through treatment of mine waters as part of reclamation and decommissioning.

As shown in Table 23, production by ISL exceeded production by open-pit mining in 2006 and by 2009 is expected to become the dominant method of uranium production. Open-pit and underground mining with conventional milling, once the dominant methods of uranium production, remain important technologies, accounting for 60.9% of total production in 2007 and 59.3% in 2008.

The increase in ISL since 2005 is the primarily the result of increased production in Kazakhstan, but also in Australia, China, the Russian Federation, the United States and Uzbekistan. The contribution from co-product/by-product recovery, which increased slightly from 8.6% in 2006 to 8.9% in 2008, is mainly the result of increased production at the Olympic Dam mine in Australia.

In 2009, open-pit and underground mining are expected to continue to account for a majority of the world's uranium production (53.9% of total production), although both open-pit and underground shares are expected to decrease slightly. Production using ISL technology is expected to increase its relative share, again principally due to increasing production expected in Kazakhstan (a 63% increase from 2008 to 2009 is expected). In the near future, ISL could continue to increase in significance if planned projects in Kazakhstan, the Russian Federation, the United States and Uzbekistan are realised. On the other hand, implementation of a major increase in capacity at Olympic Dam, a proposal currently under consideration, would ensure a continued important role for the co-product/by-product category.

Table 23. Percentage distribution of world production by production method

Production method	2005	2006	2007	2008	2009 (expected)
Open-pit	28.1	24.2	24.4	27.3	25.0
Underground	39.4	39.8	36.5	32.0	28.9
In situ leaching	20.0	25.0	27.2	29.5	36.3
In place leaching*	<0.1	<0.1	<0.1	<0.1	<0.1
Co-product/by-product	10.3	8.6	9.5	8.9	7.8
Heap leaching**	1.9	2.2	2.3	2.3	1.9
Other methods***	0.3	0.2	0.1	<0.1	0.1

* Also known as stope leaching or block leaching.
** A subset of open-pit mining, since it is used in conjunction with open-pit mining.
*** Includes mine water treatment and environmental restoration.

Projected Production Capabilities

To assist in developing projections of future uranium availability, member countries were asked to provide projections of ***production capability*** through 2035. Table 24 shows the projections for ***existing and committed production centres*** (A-II columns) and for existing, committed, ***planned and prospective production centres*** (B-II columns) in the <USD 130/kgU category through 2035 for all countries that either are currently producing uranium or have the potential to do so in the future. Note that both the A-II and B-II scenarios are supported by currently identified local RAR and IR in the <USD 130/kgU category, with the exception of Pakistan and Romania.

Several current or potential uranium producing countries, including China, India, Iran, Jordan, Malawi, Mongolia, Namibia, Pakistan, Romania, the United States and Uzbekistan, did not report projected production capabilities. As a result, estimates of production capability for these countries were developed using data submitted for past Red Books and company reports. Projections of future production capability for Pakistan and Romania in Table 24 are based on reports that these countries intend to meet their future domestic reactor requirements with domestic production, even though the currently Identified Resource bases are insufficient to meet these projected requirements.

The reported production capability of existing and committed production centres in 2010 is about 70 180 tU. For comparison, 2007 production capability totalled 54 370 tU. Hence by 2010, projections of production capability have increased by over 16 000 tU since 2007. However, in 2007 actual production amounted to 41 244 tU, or about 76% of stated production capability. In 2005, production was 84% of stated capability, and in 2003, 75%. Full capability is rarely, if ever achieved. Total production capability for 2010, including planned and prospective centres (category B-II), amounts to 75 405 tU, over 18 000 tU more than the 2007 B-II total capability of 56 855 tU. However, in 2007 production amounted to 73% of total B-II capability; in 2005, 81% and in 2003, 74%.

Clearly, an expansion in production capability driven by generally higher uranium prices since 2003 is underway, and although production is also increasing, it is not increasing as rapidly. Increasing production takes time and appropriate market conditions for the stated production capability increases to be turned into production. For 2010, significant increases in production capability are projected in Kazakhstan and to a lesser extent, Canada. By 2015, significant production capability increases are expected in Kazakhstan, Namibia and Niger, and to a lesser extent in Australia, Canada, Malawi, the Russian Federation, the United States and Uzbekistan. By 2015, Jordan is also expected to be producing significant amounts of uranium.

Later, closure of existing mines due to resource depletion is expected to be offset by the opening of new mines. As currently projected, production capability of existing and committed production centres is currently expected to reach over 98 000 tU/year in 2020 and total potential production capability (including planned and prospective production centres, category B-II) is currently projected to rapidly climb to over 140 000 tU/year by 2020.

Changes in Production Facilities

Production capability at existing and committed production centres increased only slightly between 2001 (45 310 tU/year), when uranium prices began to increase, 2003 (47 170 tU/year) and 2005 (49 720 tU/year). Driven principally by increasing demand, production capability at existing and committed production centres increased to 54 370 tU/year in 2007 and 70 180 tU/year in 2010, even though market prices have declined from the peak achieved in mid-2007. Significant new production capability is planned for the near-term, both through the expansion of existing production centres and the opening of new mines. Some of the significant changes that are expected in the next few years include:

Planned mine re-openings or expansion of existing facilities

2009 Australia (Ranger: Construction of a laterite treatment plant to produce an additional 400 tU/year).

2009 Niger (Expansion of Somair and Cominak production capability by 700 tU/year to a total of 4 500 tU/year).

Kazakhstan (Southern Zarechnoye, 1 000 tU/year).

2010 Canada (McArthur River and Key Lake expansion to produce 8 800 tU/year).

Brazil (Caetité expansion to 670 tU/year).

Namibia (Langer Heinrich expansions to 2 000 tU/year).

2012 Namibia (Rössing expansion to 4 500 tU/year).

2016 Australia (Proposed Olympic Dam expansion, to produce as much as 16 100 tU/year).

Table 24. World uranium production capability to 2035

(in tonnes U/year, from RAR and Inferred Resources recoverable at costs up to USD 130/kgU, except as noted)

COUNTRY	2010		2015		2020		2025		2030		2035	
	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II
Argentina	120	120	300	300	500	500	500*	500*	500*	500*	500*	500*
Australia	9 700	9 700	10 100	16 600	10 100	24 200	10 100	27 900	9 800	27 600	9 800	27 600
Brazil	340	340	1 600	1 600	2 000	2 000	2 000	2 000	2 000*	2 000*	2 000*	2 000*
Canada	16 430	16 430	17 730	17 730	17 730	19 000	17 730	19 000	17 730	19 000	17 730	19 000
China*	940	1 040	940	1 040	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Czech Republic	500	500	50	50	50	50	50	50	30*	30*	20*	20*
India*	295	980	980	980	980	1 200	1 000	1 600	1 000	2 000	1 000	2 000
Iran, Islamic Rep. of*	20	20	70	70	100	100	100	100	100	100	100	100
Jordan*	0	0	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Kazakhstan	18 000	18 000	28 000	28 000	24 000	24 000	14 000	14 000	12 000	12 000	5 000	6 000
Malawi*	0	500	1 270	1 270	1 425	1 100	0	0	0	0	0	0
Mongolia*	0	0	0	500	150	1 000	150	1 000	150	1 000	150	1 000
Namibia*	5 000	6 500	6 000	15 000	8 000	19 000	6 000	14 000	5 000	10 000	5 000	7 500
Niger	4 000	4 000	9 500*	11 000*	9 500*	10 500*	5 000*	9 500*	5 000*	5 000*	5 000*	5 000*
Pakistan* (a)	65	65	65	110	140	155	140	140	140	650	140	650
Romania* (a)	230	230	230	230	350	475	350	475	350	630	350	630
Russian Federation	3 520	3 520	5 240	5 900	7 600	11 990	7 600	13 800	6 800	13 900	6 800	13 400
South Africa (b)	4 860	4 860	4 860	6 320	4 860	6 320	4 860	6 320	4 860	6 320	4 860	6 320
Ukraine	960	1 700	810	3 230	810	5 500	250	5 500*	170	5 500*	170*	5 500*
United States (c)	2 900	4 600	3 400	6 100	3 800	6 600	3 700	6 500	3 100	5 600	3 100*	5 600*
Uzbekistan (c)	2 300	2 300	3 000	3 750*	3 000	3 750*	3 000	3 750*	3 500	3 500	3 500*	3 500*
TOTAL	70 180	75 405	96 145	121 780	98 295	140 640	79 730	129 335	75 430	118 530	68 420	109 520

A-II Production Capability of Existing and Committed Centres supported by RAR and Inferred Resources recoverable at <USD 130/kgU.
B-II Production Capability of Existing, Committed, Planned and Prospective Centres supported by RAR and Inferred Resources recoverable at <USD 130/kgU.
NA Data not available or not reported.
* Secretariat estimate.
(a) Projections are based on reported plans to meet domestic requirements but will require the identification of additional resources.
(b) From resources recoverable at costs <USD 40/kgU.
(c) Data from previous Red Book.

Recent mine openings

2007

China	(Qinlong, 100 tU/year)
Kazakhstan	(Kendala JSC- Central Mynkuduk, 2 000 tU/year in 2010)

2008

Kazakhstan	(Kharasan-1, pilot production, 1 000 tU/year by 2010-2012)

New mines planned (date indicates estimated start of production)

2009

Kazakhstan	(Kharasan-2, pilot production, 2 000 tU/year by 2010-2012)
Kazakhstan	(Appak LLP-West Mynkuduk, 1 000 tU/year in 2010)
Kazakhstan	(Karatau LLP – Budenovskoye-1 pilot production)
Malawi	(Kayelekera, 1 270 tU/year in 2010)
South Africa	(Uranium One – Dominium & Rietkuil, 1 460 tU/year in 2010)

2010

Australia	(Honeymoon, 340 tU/year)
Australia	(Four Mile, 1 000 tU/year)
India	(Tummalapalle, 215 tU/year)
Kazakhstan	(Semizbai-U LLP – Irkol, 500 tU/year by 2012)
Kazakhstan	(Kyzylkum LLP – Kharasan-1, 1 000 tU/year; 3 000 tU/year in 2014)
Kazakhstan	(Southern Inkai, 1 000 tU/year)
Kazakhstan	(Baiken-U LLP– Northern Kharasan, 1 000 tU/year; 2 000 tU/year in 2014)
Namibia	(Valencia, 1 150 tU/year)
United States	(Lost Creek, 770 tU/year)
United States	(Moore Ranch, 770 tU/year)

2011

India	(Mohuldih, 75 tU/year)
Kazakhstan	(Zhalpak, 750 tU/year by 2015)
Kazakhstan	(Akbastau JV JSC – Budenovskoye, 3 000 U/year by 2014)
Kazakhstan	(Central Moinkum, 500 tU/year by 2018)
Namibia	(Trekkopje, 1 600 tU/year; potential expansion to 3 500 tU/year)
Namibia	(Valencia, 1 000 tU/year)
Niger	(Azelik, 700 tU/year)
Russia	(Khiagda, 1 000 tU/year; 1 800 tU/year by 2018)

2012

Brazil	(St. Quitéria/Itataia, 1 000 tU/year)
India	(Killeng-Pyndengsohiong, Mawthabah 340 tU/year)
India	(Lambapur-Peddagattu, 130 tU/year)
Iran	(Saghand, 50 tU/year)
Jordan	(Central Jordan, 2 000 tU/year
Kazakhstan	(Semizbai-U LLP – Semizbai, 500 tU/year)
Mongolia	(Dornod, 1 150 tU/year)
Niger	(Imouraren, 5 000 tU/year)

2013

Namibia	(Husab, 5 700 tU/year)
Canada	(Cigar Lake, 6 900 tU/year)
Canada	(Midwest, 2 300 tU/year); timing dependent on market conditions

2014

Russia	(Gornoe, 600 tU/year)
Russia	(Olovskaya, 600 tU/year)

2015

Russia	(Elkon, 5 000 tU/year)
Ukraine	(Novokonstantinovskoye, 1 500 tU/year)

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II. URANIUM DEMAND

This chapter summarises the current status and projected growth in world nuclear electricity generating capacity and commercial ***reactor-related uranium requirements***. Relationships between uranium supply and demand are analysed and important developments related to the world uranium market are described. The data for 2009 and beyond are estimates and actual figures may differ.

A. CURRENT COMMERCIAL NUCLEAR GENERATING CAPACITY AND REACTOR-RELATED URANIUM REQUIREMENTS

World (372.69 GWe net as of 1 January 2009)

On 1 January 2009, a total of 438 commercial nuclear reactors were connected to the grid in 30 countries and 46 reactors were under construction (a total of 40.7 GWe net).[1] During 2007 and 2008, three reactors were connected to the grid, one reactor was re-started after a long-term shutdown (for a combined total of about 2.9 GWe net) and one reactor was permanently shut down (about 0.4 GWe net) on 31 December 2008. Table 25 and Figures 7 and 8 summarise the status of the world's nuclear power plants as of 1 January 2009. The global nuclear power plant fleet generated a total of about 2 600 TWh of electricity in 2007 and about 2 611 TWh in 2008 (Table 26).

World annual uranium requirements amounted to 59 065 tU in 2008 and are expected to increase to about 61 730 tU in 2009.

OECD (310.32 GWe net as of 1 January 2009)

As of 1 January 2009, the 343 reactors connected to the grid in 17 OECD countries constituted about 83% of the world's nuclear electricity generating capacity. A total of 11 reactors were under construction with a net capacity of about 13 GWe. During 2007 and 2008, one reactor was connected to the grid (about 1.1 GWe net) and one reactor was shut down (about 0.4 GWe net).

Within the OECD there are significant differences in nuclear energy policy. Countries like Japan and South Korea remain committed to continued growth in nuclear energy generating capacity, whereas some member countries in Western Europe have made commitments to phase out nuclear energy, notably Belgium, Germany, Spain and Sweden, although Sweden is in the process of reconsidering this commitment. In 2009, Italy effectively ended a 20-year moratorium on new nuclear construction and other European Union countries, such as the Czech Republic, Finland, France, Hungary and the Slovak Republic are committed to maintaining nuclear energy as a part of the energy mix. In North America there are growing indications that construction of new capacity will take place, particularly in the United States, stimulated by incentives provided in the 2005 *Energy Policy Act*.

The OECD reactor-related uranium requirements were 47 130 tU for 2008 and are expected to increase slightly to 47 820 tU in 2009.

1. Figures include the reactors operating and under construction in Chinese Taipei.

Table 25. Nuclear data summary
(as of 1 January 2009)

COUNTRY	Operating reactors	Generating capacity (GWe net)	2008 Uranium requirements (tU)	Reactors under construction	Reactors started up during 2007 and 2008	Reactors shut down during 2007 and 2008	Reactors using MOX
Argentina	2	0.935	160	1	0	0	0
Armenia	1	0.375	90	0	0	0	0
Belgium	7	5.865	1 030 (c)	0	0	0	1
Brazil	2	1.766	450	0	0	0	0
Bulgaria	2	1.906	255	2	0	0	0
Canada (a)	18	12.700	1 600	0	0	0	0
China (b)	11	8.438	1 800	12	1	0	0
Czech Republic	6	3.634	635	0	0	0	0
Finland	4	2.680	485	1	0	0	0
France	59	63.130	9 000 (c)	1	0	0	20
Germany	17	20.470	2 300 (c)	0	0	0	4
Hungary	4	1.860	420	0	0	0	0
India	17	3.782	750	6	1	0	1
Iran, Islamic Rep. of	0	0.00	0	1	0	0	0
Japan	55	47.94	6 915	3	0	0	1
Korea, Republic of	20	17.70	3 400	5	0	0	0
Lithuania	1	1.185	210	0	0	0	0
Mexico	2	1.365 +	160 +	0	0	0	0
Netherlands	1	0.480	60	0	0	0	0
Pakistan	2	0.425	65*	1	0	0	0
Romania	2	1.300	200*	0	1	0	0
Russian Federation	31	21.743	4 100	8	0	0	NA
Slovak Republic	4	1.710	380	0	0	1	0
Slovenia	1	0.666	230	0	0	0	0
South Africa	2	1.800	280	0	0	0	0
Spain	8	7.450	1 515	0	0	0	0
Sweden	10	9.000	1 575	0	0	0	0
Switzerland	5	3.238	280 (c)	0	0	0	0
Ukraine	15	13.100	2 480	2	0	0	0
United Kingdom	19	10.100	950	0	0	0	0
United States	104	101.000	16 425	1	1	0	0
OECD	343	310.322	47 130	11	1	1	26
TOTAL	**438**	**372.692**	**59 065**	**46**	**4**	**1**	**27**

Sources: IAEA Power Reactor Information System (www.iaea.org/programmes/a2/) except for Generating capacity and 2008 Uranium requirements, which use Government-supplied responses to a questionnaire, unless otherwise noted and rounded to the nearest five tonnes. MOX not included in U requirement figures.

* Secretariat estimate.

\+ Data from NEA Nuclear Energy Data, OECD, Paris, 2009.

(a) Includes three units currently under refurbishment (Point Lepreau, Bruce A units 1 and 2).

(b) The following data for Chinese Taipei are included in the world total but not in the total for China: six nuclear power plants in operation, 4.949 GWe net; 865 tU; two reactors under construction; none started up or shut down during 2007 and 2008.

(c) Excluding MOX fuel.

Figure 7. World installed nuclear capacity: 372.69 GWe net
(as of 1 January 2009)

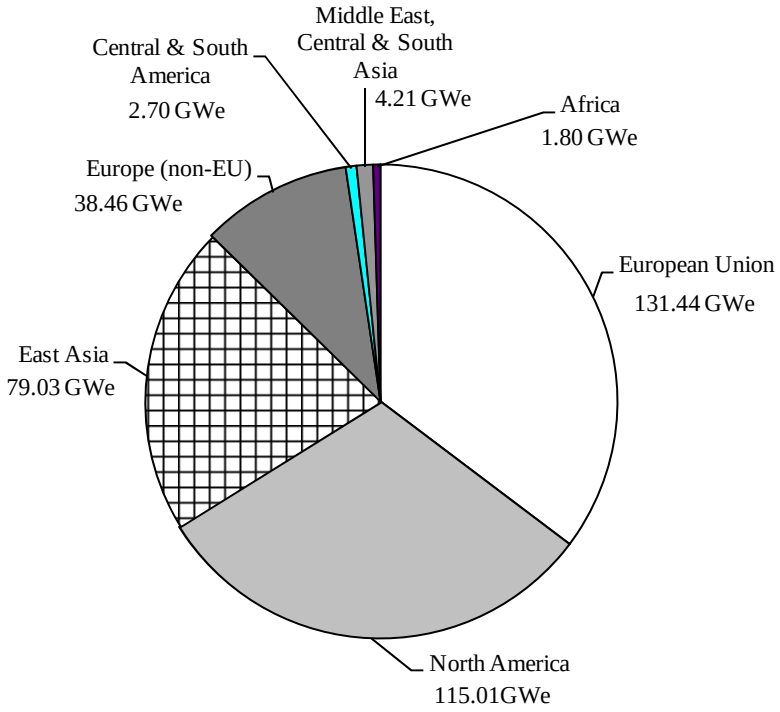

Figure 8. 2008 world uranium requirements: 59 065 tU

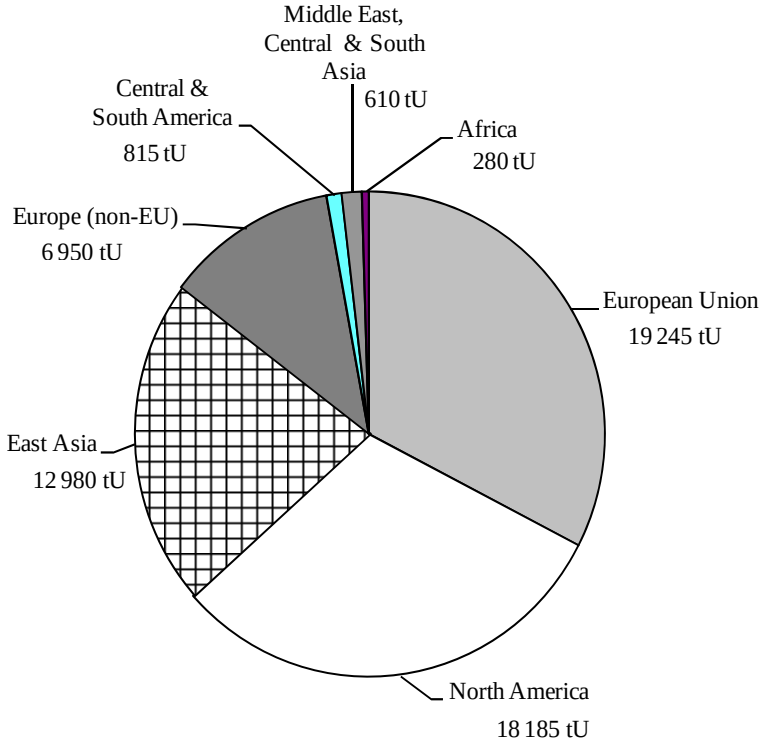

Table 26. Electricity generated using nuclear power plants
(TWh net)

COUNTRY	2005	2006	2007	2008
Argentina	6.40*	7.15*	6.7	6.8
Armenia	2.50*	2.42*	2.4	2.3
Belgium	45.30	44.31	45.9 +	43.4 +
Brazil	9.85	13.77	11.7 (d)	13.2 (d)
Bulgaria	17.30 (d)	18.13 (d)	13.7*	14.7*
Canada	86.70	94.00	88.2	88.6
China (c)	50.30	51.80	59.3	65.3
Czech Republic	23.30	24.50	24.6	25.0
Finland	22.40	22.30	22.5 (a)	22.1
France	430.00 (a)	428.70 (b)	418.0	417.6
Germany	154.60	158.70	133.2	140.9
Hungary	13.00	12.66	13.8	14.0 (a)
India	15.70 (d)	15.59 (d)	15.8 (d)	13.2 (d)
Japan	280.70 (d)	291.50 (d)	263.8	258.1
Korea	139.50 (a) +	141.18 (a) +	135.4 +	143.4 (a) +
Lithuania	9.50	8.70	9.1*	9.1*
Mexico	10.80 +	10.90 (a) +	9.9 +	9.4 +
Netherlands	3.30	3.60	4.0	4.0
Pakistan	2.40*	2.55*	2.3	1.7
Romania*	5.10	5.18	7.1	10.3
Russian Federation	149.40	156.40	148.0 (d)	152.1 (d)
Slovak Republic	16.30	16.60	14.1 +	15.4 +
Slovenia	5.61	5.29	5.3	6.0 (a)
South Africa*	12.20	10.07	12.6	12.8
Spain	55.40 +	57.80 +	52.7 +	56.4 +
Sweden	69.50 (b)	65.05	63.8 +	61.3 (b)
Switzerland	22.64	26.63 (a)	26.5 +	26.3 +
Ukraine	75.20	84.90*	87.2	84.5*
United Kingdom	75.20 +	69.40 (d)	57.3 +	47.7 +
United States	782.00 +	787.00 +	806.4 (a)	806.2
OECD	2 230.64	2 254.83	2 180.10	2 179.80
TOTAL	**2 630.50**	**2 675.08**	**2 600.30**	**2 611.10**

* Secretariat estimate.
\+ *Nuclear Energy Data*, OECD, Paris, 2009.
(a) Generation record.
(b) Provisional data.
(c) The following data for Chinese Taipei are included in the World Total but not in the total for China: 38.4 TWh in 2005, 38.3 TWh in 2006, 39.0 TWh in 2007, 39.3 TWh in 2008.
(d) Gross capacity converted to net by Secretariat.

European Union (131.4 GWe net as of 1 January 2009)

As of 1 January 2009, 145 nuclear reactors were operating in the European Union (EU). During 2007 and 2008, one reactor was connected to the grid (Cernavoda 2, Romania, about 0.65 GWe) and one was shut down (Bohunice 2, Slovak Republic, about 0. 41 GWe, a condition of entry into the European Union). Two European Pressurised-water Reactors (EPRs) were under construction (one each in Finland and France) and a third EPR had been committed to construction in France, beginning in 2012. These advanced design plants are expected to commence operations in 2012, 2013 and 2017, respectively. In the Slovak Republic, construction to complete Mochovce units 3 and 4 was officially begun in late 2008 and in Bulgaria preliminary construction work on two reactors was initiated at the Belene site. Both of these latter two projects are aimed at replacing capacity lost by the required shut down of older designs in these countries, a condition of entry into the EU.

Nuclear phase-out policies remain in place in Belgium, Germany, Spain and Sweden, although such policies are under reconsideration in some of these countries, in particular Sweden. The European Commission's proposal to reduce the impacts of climate change by reducing carbon emissions by 20% compared to 1990 levels was adopted by the European Parliament and Council in 2008. That, combined with concerns over security of energy supply heightened by temporary interruptions in the flow of gas supplies from the Russian Federation to parts of Europe in early 2009, has put the nuclear energy option in the spotlight as a secure source of low-carbon, base-load electricity generation.

In **Belgium**, the government's policy to phase out nuclear energy by limiting the operational lives of its seven reactors to 40 years and not permitting construction of new plants continues, although the policy can be overridden if the country's security of energy supply is threatened. Government commissioned reports in recent years have recommended removal of the phase-out in order to meet carbon emission reduction targets and, at the same time, maintain sufficient electrical generating capacity beyond 2015, when the first of the existing plants are expected to be shut-down under the conditions of the phase-out. A study by an expert group created by the government to provide scenarios of ideal national energy mixes is expected to have completed its work in late 2009. In 2008, the Belgium cabinet proceeded with its plan to collect a 250 million euro "contribution" from nuclear power plant operators (principally Electrabel, the majority owner of nuclear generating plants in the country) in order to balance the budget. In 2009, Electrabel's owner, Gaz de France Suez, announced that it will proceed with court action in a bid to recover this payment.

In **Bulgaria**, following the closure of two additional reactors at Kozloduy (about 0.41 GWe net each) at the end of 2006, only two larger units (about 0.95 GWe net each) remain in operation at the site that once had six operating reactors. The remaining two units generated about 33% of the country's electricity in 2008. To compensate for the loss of generating capacity and to regain its position as a major exporter of electricity in the region without increasing greenhouse gas emissions, preliminary construction of two VVER reactors (about 0.95 GWe net each) began in 2008 at the Belene site, with the first expected to begin operating in the 2013-2014 time frame, although this could be pushed back owing to difficulties raising funds in the wake of the global financial crisis. In late 2008, the Bulgarian Natsionaina Elektricheska Kompania EAD (NEK) and RWE Power signed a joint venture agreement for the Belene project (Belene Power Company AD). RWE Power is seeking partners in its 49% share in the Belene Power Company AD that will operate these units.

Atomstroyexport is supplying the plant with key components supplied by Siemens and AREVA. A change of government resulting from elections in July 2009 has led to a review of the Belene reactor construction project and the government's 51% share in the venture, with a decision on how to proceed expected later in 2009.

In the **Czech Republic**, six reactors were in operation on 1 January 2008 with an installed capacity of about 3.6 GWe net. Ongoing modernisation of the Dukovany nuclear power plant units (4 VVERs with a capacity of 0.43 GWe net each) is expected to increase generation capacity by about 14% in 2012. In 2007, replacement parts were installed to the turbines of both units at the Temelin nuclear power plant (0.96 GWe net capacity for each reactor), resulting in an overall capacity increase of about 0.3 GWe and an extended turbine life span. In August 2008, Czech utility CEZ requested that the Ministry of Environment conduct an environmental impact assessment of adding two new units to the Temelin plant. CEZ considers this a technical step outside the political decision process. In August 2009, CEZ launched a public tender for the construction of these two new units, characterising this as a follow-up administrative step in a process anticipated to take some seven or eight years prior to the actual commencement of construction. A coalition formed after the 2006 election agreed not to promote nuclear power due to opposition for the junior ruling partner, the Green Party.

In **Finland**, construction of the Olkiluoto 3 EPR (about 1.6 GWe net) nuclear power plant has been further delayed due to the need to re-cast some large steel components and regulatory concerns about the quality of the concrete used in construction. The plant is now expected to be in operation in 2012, three years after the originally planned start-up date. The participants in this turn-key, fixed price contract, AREVA and Teollisuuden Voima Oy (TVO), entered into arbitration in the International Chamber of Commerce to resolve opposing claims for compensation. Three utility groups, Fortum, TVO and Fennovoima have each submitted applications to government for a decision-in-principle to build a total of three new nuclear power plants. Decisions in principle are expected to be delivered in late 2009 or early 2010. However, cabinet has indicated that at most only one reactor would be needed. In 2009, cabinet determined that nuclear and hydro power plants in Finland would be subject to a tax to reduce profits resulting from what was termed "unearned income" accrued from low carbon generating plants built before the Kyoto Protocol of 1997. Such profits are said to have resulted from avoided costs of carbon trading in the European Union (EU) Emissions Trading Scheme.

In **France**, construction of a new EPR at the Flamanville site began in late 2007 and the unit is scheduled to begin operating in 2012. In January 2009, President Sarkozy confirmed that a second EPR construction project would begin in 2012 at Penly. Like Flamanville, Penly is the site of two currently operating reactors. In 2006, AREVA began construction of the 3 billion Euro centrifuge enrichment facility (Georges Besse II) at Tricastin to replace the existing, energy intensive gas diffusion plant. Construction is on schedule with commercial production expected to begin in 2009, ramping up to full capacity of 7.5 million SWU around 2016 (expandable to 11 million SWU, depending on market conditions). In March 2009, AREVA received regulatory approval to begin construction of the Pierrelatte component of the COMURHEX II conversion facility. With a planned capacity of 15 000 tU to be achieved in 2012, the 610 million Euro facility, including both the Pierrelatte and Malvesi sites, is designed to accommodate a potential increase in capacity of up to 21 000 tU, depending on market conditions.

In **Germany**, the 2002 *Nuclear Power Act* (NPA) that governs the long-term phase-out of nuclear energy for commercial power generation has brought about the early shutdown of two reactors. In April 2009, 53% of the generation allotted to the nuclear fleet under the terms of the NPA had been used. In early 2007, an application to transfer capacity from a decommissioned reactor to the currently operating Brunsbuettel and Biblis plants was turned down by the Minister of Environment and subsequently ruled unlawful by the German Federal Administrative Court, since these two reactors were not among the seven listed as being eligible to receive transfers from the decommissioned Muelheim-Kaerlich plant. Because the NPA allows the transfer of allotted generation between specific plants and maintenance outages and other shutdowns could stretch out the timing of the life of individual plants, it is not possible to predict the lifetime of each of the remaining 17 reactors in operation. However, the results of the September 2009 German federal election raise the possibility that a new centre-right coalition government would ease conditions of the NPA to allow lifetime extensions to all operating reactors, subject to regulatory approval.

In **Hungary**, the four VVER reactors in operation at the Paks nuclear power plant generated 37.2% of the total gross Hungarian electricity production in 2008. In order to enhance the economic and operational effectiveness of the plant and to improve its market position, a programme that includes power uprates, maintenance optimisation and operating lifetime extension (by 20 years) was initiated in 2005. In 2008, the nominal electric capacity of Unit 2 was brought to 500 MWe and the process of uprating Unit 3 will be completed during a planned outage in 2009 (Units 4 and 1 were uprated in 2006 and 2007, respectively). In order to foster the long-term safety, competitiveness and sustainability of energy supply, the Hungarian parliament developed a national energy policy for the period of 2008-2020. As a part of this policy, parliament instructed the government to begin preparatory work for a possible decision on new nuclear energy generating capacity. In April 2009, the Hungarian parliament strongly supported (by a vote of 330 to 6) a government proposal to prepare for the construction of new nuclear generating capacity at the Paks plant.

In **Italy**, the April 2008 re-election of the centre-right government has set in motion processes to bring about the removal a 20 year ban on nuclear power, as promised during the campaign. A new National Energy Strategy is set to include the rebuilding of the nuclear sector, improving competition in electricity production, diversifying energy sources and reducing greenhouse gas emissions. The goal of this strategy is to have the first new nuclear power plants under construction by 2013 and by 2020 the electricity generation mix is expected to include 25% nuclear, 25% renewable energy and 50% fossil fuels. The country now relies on imports to meet 87% of its energy needs, with oil (43%) and gas (36%) accounting for a large share of its energy use. Italy has had to endure high electricity prices and occasional electricity shortages in recent years.

In **Lithuania**, the only remaining operating reactor, Ignalina 2 (about 1.2 GWe net), is scheduled to be shut down at the end of 2009 in accordance with agreements governing entry into the European Union (Ignalina 1 was shut down on 31 December 2004 under the same agreement). In 2008, Ignalina 2 provided almost 73% of the electricity generated in the country. Facing a looming electricity shortage, Lithuania has developed an agreement with Latvia, Estonia and Poland to build a new nuclear power plant to replace Ignalina, but progress on implementing the agreement has been slow. The Lithuanian government is now expected to invite tenders for the plant in 2009 and it appears unlikely that a new plant would be operating until at least 2018. Efforts to delay the Ignalina 2 closure by modifying the EU agreements have been unsuccessful to date and in order to cope with the electricity shortage resulting from the closure of Ignalia 2 at the end of 2009, activity has been recently focussed on developing links to the European electrical grid.

In the **Netherlands**, the CEO of Delta, 50% owner of the single PWR operating in the country at the Borssele site, said in 2008 that the company intended to start the licensing procedure to build an additional two to four reactors at the site. Responses to this statement by members of the coalition government underscored the opposing views of the parties on the prospect of new nuclear construction, with the Environment Minister from the Labour Party stating that no decisions would be taken by the current government, whereas the Economy Minister from the Christian Democrat Party indicated that there is no ban on thinking and that the length of time it takes to permit nuclear facilities means that the current government would not have to make a decision on new nuclear power plant construction. In early 2009, following an in-depth review of the country's energy policies, the IEA encouraged the Dutch government to reach a clear position on the future role of nuclear power because of the length of time required to plan, build and commission a reactor. Without nuclear power, noted the IEA, oil and coal use is likely to expand, making the country's ambitious carbon emission reduction goals more challenging to achieve.

In **Poland**, the Prime Minister announced energy sector priorities in January 2009 which included participation in a project to replace the Ignalia reactor in Lithuania and the construction of two new nuclear power plants in Poland, the first of which is targeted to begin production in 2020. Poland currently generates more than 90% of its electricity in coal fired plants. In September 2009, the Minister of Economics developed an action plan for the introduction of nuclear power plants in Poland that includes determining the size and possible location of the reactors, costs, sources of finance and the social and economic impact of the development of this option of generating electricity. According to this plan, the first nuclear power plant is expected to be under construction in 2016.

In **Romania**, a second reactor at the Cernavoda site, a CANDU 6 PHWR (about 0.65 GWe net), was connected to the grid in October 2007. In 2008, the two CANDU units provided about 18% of the electricity generated in the country, reducing the country's electrical imports in that year by nearly 30%. In 2007, the Romanian government launched a tender for the USD 5 billion construction of Cernavoda units 3 and 4 (each with a capacity of 0.72 GWe) that are expected to come on line in the 2014 to 2015 time frame. In November 2008, EnergoNuclear SA was formed to undertake the construction, commissioning and operation of the two new reactors. Romania's state-owned Nuclearelectrica SA will hold a 51% stake in EnergoNuclear SA, while Czech utility CEZ, Belgium's Electrabel (part of GDF-Suez), Italy's Enel and Germany's RWE Power will each hold a 9.15% stake, while Spain's Iberdrola and steel producer ArcelorMittal will each hold a 6.2% stake.

In the **Slovak Republic**, a total of four reactors with a combined capacity of about 1.7 GWe net were in operation as of 1 January 2009 following the shut-down of Bohunice 2 (0.41 GWe net) on 31 December 2008 in accordance with agreements made for entry into the European Union (Bohunice 1, a reactor of the same design and capacity, was shut down at the end of 2006 under the same agreement). In 2008, the five operating reactors provided about 56% of the total electricity generated in the country. Power uprating of Mochovce 1 and 2 was completed in 2008 and a project to uprate Bohunice units 3 and 4 will see step-wise power increases between 2008 and 2010. Design and development work to use more highly enriched nuclear fuel (up to 4.87%) in all four reactors from 2011 on is underway. In August 2008 the National Regulatory Authority approved the revised design for the completion of Mochovce 3 and 4 (construction of two reactors at the site was stopped in 1992) and in November 2008, construction was officially initiated with completion expected in 2013 and 2014. When completed, the two units will add 0.9 GWe of electrical generating capacity. In December 2008, the Czech company CEZ was selected to form a partnership with the Slovak government to build an additional two reactors at the Bohunice site, expected to be completed in the 2020 timeframe.

In **Slovenia,** the single nuclear reactor in operation (Krško, 0.67 GWe) is jointly owned and operated with Croatia (Nuklearna Elektrana Krško). Krško entered commercial operation in 1983 and has an operational life designed for 40 years. Steam generators were replaced and the plant was uprated in 2001. The unit accounted for 42% of the electricity generated in Slovenia in 2008 although a proportion of this is exported to supply about 20% of Croatia's electricity supply. In addition to considering life time extension to the existing plant, the Government of Slovenia is also reported to be considering building a second reactor to be brought on line as early as 2017.

In **Spain**, the government's plan to phase out nuclear energy in an orderly and progressive way without compromising security of electricity supply continues. In January 2009, the Industry Minister confirmed that no new nuclear plants would be built. However, the Spanish government has indicated that it may extend the operating lives of the country's eight aging reactors (operating permits for seven of the plants are up for renewal between 2009 and 2011). In June 2009, Spain's nuclear regulator issued a non-binding report stating that the 38 year-old Garona reactor was safe to run for another 10 years. In July 2009 the regulator approved a government request to renew the operating licence for only four years. In September 2009, the Garona plant operator Nuclenor filed an appeal in court against the government decision.

In **Sweden**, the government signalled its intention in early 2009 to overturn the existing ban on the construction of new nuclear power plants and the phase-out of nuclear energy. In 1980, following a successful referendum to phase out nuclear power, legislation was passed that led to the closure two reactors before the end of their design lifetimes (Barsebäck 1 and 2, a total of about 1.2 GWe net). Although originally intended to see the closure of all nuclear power plants in Sweden by 2010, the conditions of the phase-out were amended and there is now no time limit for the shutdown. An ongoing program of upgrades to the existing reactor fleet, when fully completed, will amount to nearly the total generating capacity lost by the Barsebäck closures. Shifting public opinion, concerns about climate change and physical limits to increasing the amount of hydro generation, the other significant low-carbon source of electricity, led the ruling coalition government to forge an alliance necessary to overturn the phase-out. The new legislation reportedly calls for new reactors to be built to replace the 10 existing reactors as they reach the end of their operational lifetime. Legislation to overturn the country's existing phase-out legislation must be passed by Parliament.

In the **United Kingdom**, the government remains committed to establishing a framework to allow private industry to replace nuclear generating capacity in order to meet demand and new carbon emission reduction targets as the current fleet of aging reactors is retired from service over the course of the next ten years. In 2008, the Energy and Climate Change Minister said that there must be an investment in nuclear power in order for the UK to meet its 80% greenhouse gas emission reduction target by 2050. That same year the House of Lords Economic Affairs Committee released a report indicating that nuclear power was a less expensive option than renewables and a government appointed independent committee on climate change reported that nuclear power is cost competitive with conventional fossil fuel generation, even when decommissioning and high uranium prices are taken into account. In early 2009, Électricité de France (EDF) completed 12.5 billion pound (about USD 18 billion) purchase of British Energy, the UK's nuclear operator, indicating that it wanted to work with partners to build four new nuclear reactors with the first plant on line in 2017. In March 2009, the Nuclear Decommissioning Authority began an auction of land for proposed new nuclear plants, expecting bids from companies that hope to be involved in new build partnerships, including E.On and RWE. In April 2009, the government published a list of eleven sites in England and Wales where new nuclear power plants could be built, initiating a month-long public consultation process.

The reactor-related uranium requirements for the European Union in 2008 amounted to about 19 245 tU and are expected to decrease slightly to 18 685 tU in 2009.

North America (115.1 GWe net as of 1 January 2009)

At the beginning of 2009, a total of 104 reactors were connected to the grid in the United States, 18 in Canada and two in Mexico. Construction to complete one reactor was resumed (Watts Bar 2, the United States) and none were shut down in 2007 and 2008. One reactor in long-term shutdown in the United States (Brown's Ferry-1) was returned to service in 2007.

In **Canada**, several new nuclear build projects under consideration by private companies and governments have to date resulted in no firm commitments to proceed. Both Ontario Power Generation (OPG) and Bruce Power submitted formal applications for new reactor construction and in June 2008, the Ontario Government announced that it had selected an existing site (Darlington) as the location for new reactor construction. AREVA, Westinghouse and Atomic Energy of Canada Ltd. submitted bids in February 2009, but on 29 June 2009 the Ontario Government announced that it had suspended plans for new build because it had concerns about pricing. On 23 July 2009, Bruce Power (Ontario) announced that due to declining energy demand it would focus on reactor refurbishment projects rather than going ahead with its application for new reactor construction. Refurbishment projects are also currently underway or have been announced in New Brunswick and Quebec, although some delays and cost overruns have been encountered. Bruce Power Alberta's proposal to build up to four reactors to provide power for the oil sands development and the Government of New Brunswick's examination of the feasibility of building a second reactor in the province are ongoing. The Governments of Alberta and Saskatchewan formed expert panels to deliver information on the possibility of using nuclear power plants to generate electricity and Bruce Power completed a feasibility study of building nuclear power in Saskatchewan. However, in September 2009 the Premier of Saskatchewan stated that nuclear power may be too costly an option for the province.

In **Mexico**, a USD 600 million refurbishment programme of the two units at Laguna Verde is proceeding successfully. Expected to be completed in 2010, the programme is designed to increase the power of the two units by about 20%. The possibility of building additional nuclear power plants at Laguna Verde and other sites on the coast of the Gulf of Mexico to reduce dependence on gas fired electricity generating plants has been examined but a decision to proceed has not been made.

In the **United States**, a total of 13 combined Construction and Operating License applications representing more than 30 TWh of new nuclear generating capacity had been filed by the end of 2008. Although less than half of the applicants have completed contract negotiations with the firm that will build the reactor, five projects are considered "fully committed" to the construction of a total of nine new reactors (Calvert Cliffs, Levy County, South Texas, Virgil Summer, and Vogtle). Although these developments are firm indications of intentions to build new nuclear power plants, financing remains an important issue. The cost of labor and materials are high and the size of the investments has led some utilities to announce that new nuclear build will not proceed without loan guarantees (part of the incentives for new power plant construction contained in the *Energy Policy Act* of 2005 amounting up to a total of USD 18.5 billion for nuclear power plant construction and up to USD 2 billion for "front-end" nuclear power facility projects, such as enrichment). In 2007, the Tennessee Valley Authority (TVA) resumed construction of the Watts Bar 2 reactor, a programme that is expected to cost about USD 2.5 billion. It is anticipated that the Westinghouse-designed 1 100 MWe reactor will be on line in 2013. This follows the successful return to service in May 2007 of TVA's Browns Ferry-1 plant (shut down since 1985) after a USD 1.8 billion restart programme.

Annual uranium requirements for North America were about 18 185 tU in 2008 and are expected to decline slightly to 18 050 tU in 2009.

East Asia (79.03 GWe net as of 1 January 2009)

As of 1 January 2009, 86 reactors[2] were in operation in East Asia. In this region, which is undergoing the strongest growth in nuclear capacity in the world, two power plants were connected to the grid (about 1.2 GWe net) during 2007 and 2008 whereas none were shut down. During these same two years, construction of a total of 13 reactors was initiated. When completed, a total of about 13.3 GWe net to the grid in the East Asia region (if an additional 4 reactors for which government approval has been granted but concrete has not yet been poured, the total added to the grid amounts to 18.2 GWe).

In China, there were 11 reactors in operation (about 8.44 GWe net) and eight under construction (about 7.61 GWe net) as of 1 January 2009. In 2007, construction of the Qinshan II-4, (0.61 GWe) and Hongyanhe 1 (1.0 GWe) reactors was initiated and in 2008 construction an additional six reactors officially began (Ningde 1, Hongyanhe 2, Ningde 2, Fuqing 1, Yangjiang 1 and Fangjiashan 1, each reactor with a net capacity of 1.0 GWe). This pace of construction of nuclear power plants in China is expected to continue in order to meet the government's plan to substantially increase the total nuclear capacity to between 60 GWe and 70 GWe by 2020. A number of technologies are already in use or expected to be used to increase capacity, including the AP 1000, VVER 1000, EPR 1600, Candu 6 and the CPR-1000 designs (a Chinese design based on French designs). The government has also expressed intent to further increase nuclear capacity to between 120 GWe and 160 GWe by 2030, accompanied by the gradual development and phase-in of a closed fuel cycle with fast reactors. Such ambitious plans would not, however see a large change in the relative contribution of nuclear generating capacity to the energy mix in China (for example, planned increases in nuclear capacity to 2020 are only expected to raise the share of nuclear generation from 4% to 5%), such is the rate at which demand is expected to increase and, as a result, other means of generating electricity are expected to grow.

In **Japan**, construction of the Tomari 3 pressurised water reactor (0.912 GWe)**,** which is expected to begin operation in late 2009, continues. In late 2005, construction of Shimane 3 boiling water reactor (1.373 GWe) was initiated and in mid-2008 construction of the Ohma boiling water reactor was initiated. Work is also continuing to re-start the Monju fast reactor. Output from the Japanese reactor fleet has been reduced over the past several months, principally due to the extended shut down of the seven large reactors at Kashiwazaki Kariwa after a strong earthquake in July 2007. Although all reactors shut down safely at the time with no loss of life, required repairs and testing have taken about 8 GWe of capacity off line for almost two years. Procedures to re-start units 6 and 7 were underway in September 2009. On 31 January 2009, the Hamaoka 1&2 boiling water reactors (0.515 and 0.806 GWe) were officially shut down. The Government of Japan has approved a basic energy plan to enhance security of supply by placing greater importance on developing nuclear power and a closed fuel cycle with nuclear fuel recycling and fast reactors.

In the **Republic of Korea**, construction of Shin Kori 2 (0.96 GWe) and Shin Wolsong 1, (0.96 GWe) began in 2007 and construction of Shin-Wolsong 2 (0.96 GWe) and Shin-Kori 3 (1.34 GWe) began in 2008. In June 2007, the 30-year operating license of Kori 1, the first nuclear power plant built in Korea, came to an end. After a refurbishment and equipment replacement program performed during a six month outage and safety review, a license renewal was granted for an additional 10 years of operation. Kori 1 restarted power generation in December 2007. In late 2008, the Government of Korea announced a new "National Energy Basic Plan" that calls for an increase in nuclear generating capacity to amount to about 60% of the country's total electricity generation by

2. There were also six nuclear power plants in operation in Chinese Taipei (about 4.9 GWe net) and two plants under construction (about 2.6 GWe net).

2030. To do so will require commissioning 10-12 new nuclear power plants in addition to the 8 units that are already planned or are under construction (this total includes two officially approved but not yet under construction). An additional four units are either planned or in the process of planning by 2022 (four OPR1000 reactors will be commissioned by 2013 and a total of eight APR1400 units are under construction and planned). By the end of 2022, nuclear capacity is expected to reach 32.9 GWe, representing a 33% share of total generation capacity.

Although **Mongolia** does not currently have nuclear power plants, it has signalled its interest in developing nuclear generation capacity by using small and medium sized reactors after signing an agreement with the Russian Federation on the exploration, extraction and processing of uranium resources.

The 2008 reactor-related uranium requirements for the East Asia region were 12 980 tU and for 2009 are expected to increase to 15 760 tU.

Europe (non EU) (38.46 GWe net as of 1 January 2009)

As of 1 January 2009, 52 reactors were operating in nine countries. This region is also undergoing strong growth with 10 reactors under construction that will add about 7.7 GWe net when completed. During 2007 and 2008, no new plants were connected to the grid, none were shut down, and construction was initiated on four reactors (a total of about 2.23 GWe net).

Two nuclear power plants were connected to the grid in **Armenia**, one in 1976 and the second in 1980, each with a design life of 30 years. Both were shut down following a major earthquake in 1989. In 1995, the younger of the two units (unit 2) was brought back on line. In 2008, this single unit, Armenia 2 (0.38 GWe) provided 39% of the electricity generated in the country. Concerns have been expressed about continued operation of the reactor and efforts have been directed toward safety and security upgrades. In June 2009, it was reported that the Armenian government had signed a contract with an international engineering firm to manage a project to construct a USD 4.5 billion nuclear power plant to replace the existing aging unit. This new unit is currently expected to be on line in 2017.

In the **Russian Federation,** 31 reactors (about 21.7 GWe net) were in operation as of 1 January 2009, providing about 17% of the total electricity generated in the country. Eight reactors were under construction (about 5.8 GWe net combined), including the Beloyarsk 4 fast reactor (about 0.75 GWe net) that was initiated in July 2006. In April 2007, construction of two reactors for the world's first floating nuclear power plant (Severodvinsk – Akademik Lomonosov 1&2 (2x30 MWe) officially began whereas construction of the Balakovo 5 plant (0.95 GWe) was suspended. In 2008, construction of Balakovo 5 was re-started and construction of Novovoronezh 2-1 (1.1 GWe) and Leningrad 2-1 began (1.1 GWe). In April 2009, the government of the Russian Federation allocated an additional USD 1.5 billion to the state corporation Rosatom in order to attain the goal of nuclear power plants generating about 25% to 30% of the country's electricity in the face of the economic crisis. Achieving this target will require the construction of a total of 26 new reactors. Although current economic conditions limit the planned rate of construction to one reactor per year, in a few years it is expected that the rate of build will increase to 2-3 GWe/year of capacity. By 2050 the current plan calls for inherently safe nuclear plants to be in operation using fast reactors with a closed fuel cycle and MOX. Plans are also in place to upgrade existing power plants by using improved fuels more efficiently and to extend operating lives.

In **Switzerland**, proposals to build a total of three new reactors to replace plants in the current fleet as they reach the end of their operational lifetime were filed in 2008. In June, energy group Atel submitted a framework permit application for construction of a new reactor in Gösgen and in December, the Axpo Group and BKW FMB Energy submitted a further two applications for new reactors at Beznau and Mühleberg. Currently, Switzerland's electricity is produced by hydro and nuclear plants, supplemented by imports, but the potential for further hydro development is limited. The government, following the defeat of a referendum to continue the nuclear phase-out, passed the Nuclear Energy Act in 2003 that set the stage for the construction of replacement reactors as the oldest in the existing fleet are retired from service around 2020. This is also shortly after existing contracts with France to supply imported electricity will expire. The country is therefore expected to need to replace generating capacity, preferably without increasing carbon emissions. Federal Council and parliament must first approve the permit application plans and a decision to move forward with construction of new reactors will be subject to an optional referendum that could take place in the 2012 or 2013 time frame.

In **Turkey**, a bidding process to construct the country's first nuclear power plants (beginning with four units totalling 4.8 GWe generating capacity) resulted in a single bid being submitted by Atomstroyexport. On 20 November 2009, the bid was cancelled due to legal issues. The government is working to continue the program by means of an intergovernmental agreement. Such an agreement has been achieved with Russian Federation which is in the progress of ratification in parliament.

In **Ukraine**, 15 reactors with a combined installed capacity of 13.1 GWe net were in operation on 1 January 2009. In 2008, these reactors accounted for 47% of the electricity generated in the country. Two reactors are currently under construction (Khmelnitski 3 and 4) that, when completed, will add 1.9 GWe capacity to the electrical grid. Construction of these two reactors originally began in the mid-1980s, but was suspended. In 2008, Atomstroyexpport won a tender to complete the USD 4 billion construction project and the two reactors are now expected to be commissioned in 2015 and 2016. The current Ukrainian government strategy calls for the nuclear share to be retained through 2030 at the current level of 45-50% of the total national electricity generation. This is expected to require the construction of twelve new reactors, ten of which with a capacity of about 1.5 GWe net and life extensions of reactors in the existing fleet.

Although other countries in the region do not currently have nuclear power plants, some governments, including **Belarus** and **Serbia**, are also considering the possibility of building nuclear capacity to meet future energy demand and to reduce greenhouse gas emissions. In early 2009 it was reported that Atomstoyexport has been selected to build the first of two reactors in **Belarus**, as it was the only bidder that was prepared to provide financing for the project. These two reactors are expected to come on line in 2016 and 2020. In early 2009 it was reported that, despite a moratorium on the construction o new reactors in the country until 2015, the Minister of Energy in **Serbia** was quoted a saying that the possibility of building new nuclear power plants should be considered along with other options in defining the country's energy policy.

Reactor-related uranium requirements in 2008 for the Central, Eastern and South-eastern European region were about 6 950 tU and are expected to increase to 7 350 tU in 2009.

Middle East, Central and Southern Asia (4.21 GWe net as of 1 January 2009)

As of 1 January 2007, 19 reactors were in operation and 8 were under construction (about 4.1 GWe net). During 2007 and 2008, one reactor was connected to the grid (Kaiga-3, India, about 0.2 GWe net) and none were shut down.

In **India**, 17 reactors (about 3.8 GWe net) were operational on 1 January 2009 and six reactors (three PHWRs, two PWRs of Russian design and a prototype fast reactor), with a total capacity of about 2.9 GWe net, were under construction. In April 2007, construction of one PHWR was completed and the Kaiga-3 reactor (about 0.2 GWe net) was connected to the grid in November 2007. In 2008, the 17 reactors in operation provided a little over 2% of the electricity generated in the country. Total nuclear power generating capacity is expected to grow by about 2.4 GWe net by 2011 as five of the six units currently under construction are scheduled to be completed. Government plans call for the increase of the country's nuclear generation capacity by as much as 20 GWe by 2020 and as much as 60 GWe by 2030. In July 2007, India and the United States signed a civil nuclear cooperation agreement, in August 2008 an India-specific safeguards agreement was approved by the board of the IAEA and in September 2008, the Nuclear Suppliers Group cleared civilian nuclear commerce with India. These developments allow India access to foreign nuclear fuel and equipment for the first time in over three decades. Until these agreements were signed, the scope of India's nuclear growth and the capacity of its currently operating reactors had been periodically limited by uranium supply. This situation has changed significantly and India is currently negotiating and signing agreements with uranium producers and nuclear fuel and reactor suppliers, setting the stage for a significant development in the country's nuclear generating capacity.

In **Iran**, the expected start-up of the Bushehr-1 reactor (about 0.9 GWe net) supplied by Atomstroyexport has been delayed until early 2010. The start-up date of the reactor has already been pushed back a number of times due to technical difficulties and other issues. The Government of Iran has announced its intention to house 20 GWe net of installed capacity by 2026. In August 2008, local firms were engaged by the country's atomic energy organisation to identify potential locations for new nuclear power plants.

In **Jordan**, facing rising energy demand and currently importing around 95% of its energy needs, the Kingdom of Jordan has decided to work toward the construction of new nuclear power plants to generate electricity and desalinate water. Nuclear co-operation agreements have been signed with several countries, including Argentina, Canada, France, the Russian Federation, the United Kingdom and the United States, and in September 2009 an engineering firm was engaged to conduct a siting study of the country's first nuclear power plant. The long-term goal of these activities is to develop nuclear power to the point that is supplies 30% of domestic electricy production by 2030.

In **Pakistan**, two reactors (about 0.43 GWe net) were operational on 1 January 2009. In 2008, the two reactors provided 2% of the electricity produced in the country. In 2005, construction of a third reactor, Chasnupp-2 (about 0.3 GWe net), began under an agreement with the China National Nuclear Corporation. Completion is expected in 2011. In the face of severe power shortages, the Government of Pakistan is reported to be considering a plan to build an additional two units (0.3 GWe each) with financial and technical assistance from China. It is expected that these two plants could be brought on line by 2018. In 2005, the Government of Pakistan approved a plan to increase nuclear generating capacity to 8.8 GWe by the year 2030.

In the **United Arab Emirates**, increasing energy demand combined with the decision to reduce domestic consumption of natural gas to maintain the inflow of foreign capital have been central considerations in the government's push to develop nuclear power generating capabilities. It has signed agreements with the IAEA on the development of nuclear power plants for peaceful purposes and nuclear co-operation agreements with France, Japan and the United States. In October 2009, it was anticipated that a contract to build at least four reactors would be awarded soon. Although this proposed first nuclear power station will likely generate about 3% of the electricity supply in the country, the government plan is reportedly to have nuclear supply 15% of the electricity generated by 2025.

Other countries in the region, currently without nuclear power plants, have also been considering the development of such facilities, including **Bangladesh**, **Bahrain, Israel, Kazakhstan, Kuwait, Oman, Qatar**, **Saudi Arabia,** and **Yemen**.

Reactor-related uranium requirements for the Middle East, Central and Southern Asia region were about 815 tU in 2008 and are expected to remain to increase to 1 005 tU in 2009.

Central and South America (2.70 GWe net as of 1 January 2009)

As of 1 January 2009, a total of four reactors were in operations in two countries in this region and one reactor was under construction.

In **Argentina**, two reactors (Atucha 1 and Embalse; 0.34 GWe and 0.6 GWe, respectively) were in operation on 1 January 2009. In 2008, these two reactors accounted for a little over 6% of the electricity produced in the country. In August 2006, the state generating company Nucleoeléctrica Argentina re-started construction of the country's third reactor (Atucha-2), with the reactor expected to be brought on line in 2011. Construction was suspended in 1984 because of a lack of funds when the reactor was about 80% complete. A project to increase power, upgrade equipment and extend the life of the Embalse reactor is slated to begin in 2011. The government of Argentina is reportedly considering the construction of another two reactors to provide additional electrical generating capacity in 2017 and 2023. In May 2008, Argentina signed an agreement to import from Brazil to ease domestic electricity shortages.

In **Brazil**, two reactors (Angra 1 and 2; 0.5 GWe net and 1.3 GWe net, respectively) were in operation on 1 January 2009. In 2008, these two reactors accounted for a little over 3% of the electricity produced in Brazil. In March 2009, an environmental licence to begin preparatory work on re-starting construction of the Angra-3 reactor (1.2 GWe net) was received. Construction of this reactor began in 1984 but was suspended in 1986. With the re-start of construction now expected to begin in 2010, the reactor could be completed in 2015. The government of Brazil is considering the possibility of building an additional four to eight GWe of nuclear generating capacity by 2030 in order to meet energy demand.

Other countries in the region, currently without nuclear power plants, have also been considering the development of such facilities, including **Chile**, **Cuba** and **Venezuela**.

The uranium requirements for Central and South America were about 610 tU in 2008 and are expected to decline slightly to about 590 tU in 2009.

Africa (1.8 GWe net as of 1 January 2009)

Nuclear capacity remained constant in Africa with the region's only two reactors located in **South Africa**. In 2008, these two units accounted for less than 1% of the total electricity generated in the country, with coal fired plants currently providing about 90% of the electrical generating capacity. In order to meet electrical demand and reduce carbon emissions, South Africa's state-owned utility Eskom solicited bids for a fleet of up to 12 reactors in 2007. After delaying the decision for several months, it was announced in December 2008 that due to the ongoing financial crisis and the size of the necessary debt that would be incurred while building the facilities, it was forced to postpone the planned first step in the project, a four unit nuclear power station. South Africa still remains committed to nuclear power and the state company PBMR is continuing development of the Pebble Bed Modular Reactor, a high-temperature, helium-cooled reactor (0.1 GWe net). Given these

condition, despite the country suffering from instability in the electrical grid, Eskom stated in early 2009 that it had now lowered its forecasts for growth in nuclear generating capacity from 20 GWe to 6 GWe by 2025, with the first units expected to be brought on line in 2019, some two years later than originally planned.

Although no other countries in Africa have nuclear power plants at this time, several have expressed interest in developing nuclear capacity for electricity generation and desalination in recent years, including **Algeria**, **Egypt**, **Ghana**, **Kenya Morocco**, **Namibia**, **Niger**, **Nigeria, Tunisia** and **Uganda**. By early 2009, **Algeria** had signed nuclear energy agreements with Argentina, China, France and the United States and was negotiating with the Russian Federation and South Africa, aiming to use these cooperation agreements to enable development of its first nuclear power plant by 2020. In 2008, **Egypt** engaged a contractor to design and consult on the country's first nuclear power plant to help meet the country's growing electricity needs. In August 2009, it was reported that the site for a nuclear power plant had been identified in **Kenya** and an environmental study of the development had been completed. In late 2008, **Nigeria** produced a draft legal framework intended to help guide the implementation of a nuclear power program, a critical step along the path to development of nuclear energy.

Annual reactor-related uranium requirements for Africa were about 280 tU in 2008 and are expected to increase slightly to 290 tU in 2009.

South-eastern Asia (0 GWe net as of 1 January 2009)

This region has no current commercial nuclear generating capacity. However, the governments of **Cambodia**, **Malaysia**, the **Philippines**, **Thailand** and **Vietnam** are considering the deployment of nuclear power in the coming years to meet electricity demand without substantially increasing greenhouse gas emissions. The government of **Indonesia** had been considering the construction of nuclear power plants, but in April 2009 the President announced that the country was turning away from this plan and would instead focus on the development of renewable energy sources to meet electricity demand. In September 2009, the Deputy Governor of the Electrical generating Authority of **Thailand** stated that it plans to build two nuclear power plants, beginning in 2020 and 2021, in order to reduce exposure to fluctuating natural gas process, the fuel currently used to produce 70% of the country's electricity. In October 2008, the Ministry of Industry and Trade in **Vietnam** discussed plans under consideration to build as many as four 1.0 GWe nuclear power plants in the country between 2020 and 2024, potentially accounting for about 15% of the country's electricity output.

Pacific (0 GWe net as of 1 January 2009)

This region currently has no commercial nuclear capacity. Current policy prohibits the development of commercial nuclear energy in **Australia.** Construction of the Open Pool Australian Light-water (OPAL) research reactor was nonetheless completed, the first fuel loaded in August 2006 and the facility was in the final stages of testing and licensing in 2009. The government of **New Zealand** also has a policy prohibiting the development of nuclear power but is reported to be considering options for future electricity supply in light of greenhouse gas reduction targets and declining supplies of natural gas.

B. PROJECTED NUCLEAR POWER CAPACITY AND RELATED URANIUM REQUIREMENTS TO 2035

Factors Affecting Capacity and Uranium Requirements

Reactor-related requirements for uranium, over the short-term, are fundamentally determined by installed nuclear capacity, or more specifically by the number of kilowatt-hours of electricity generated in operating nuclear power plants. As noted, the majority of the anticipated near-term capacity is already in operation, thus short-term requirements can be predicted with relative certainty.

Uranium demand is also directly influenced by changes in the performance of installed nuclear power plants and fuel cycle facilities, even if the installed base capacity remains the same. Over the past several years there has been a general worldwide trend toward higher nuclear plant energy availability and capacity factors. In 2008, the average world nuclear energy availability factor (as defined by the IAEA) was 80%, compared to 71.0% [1] in 1990 (the world average availability factor has actually declined slightly from 82.9% in 2006, principally due to a large extend to the extended shut down of seven large reactors at the Kashiwazaki Kariwa station in Japan following a strong earthquake in July 2007). Longer operating lifetimes and increased availability tend to increase uranium requirements. Other factors that affect uranium requirements include fuel-cycle length and discharge burn-up and strategies employed to optimise the relationship between the price of natural uranium and enrichment services.[3]

Recent high uranium prices have provided the incentive for utilities to reduce uranium requirements by specifying lower tails assays at enrichment facilities, to the extent possible in current contracts and the ability of the enrichment facilities to provide the increased services. As noted in the 2008 Annual Report of the Euratom Supply Agency, 97% of utilities in the European Union (EU) are now specifying tails assays in the range of 0.20% and 0.30%, confirming that the slightly downward trend in tails assays continued in Europe in 2008 [2]. The trend toward lower tails assays is also a factor in the uranium requirements data collected for this edition, since global requirements have declined by about 12% over two years (from 66 500 tU in 2006 to 59 065 tU in 2008), despite slightly increased generating capacity (<1%) over that period. Uranium requirements (defined in the Red Book Questionnaire as anticipated acquisitions, not necessarily consumption) are expected to remain below 2006 levels until new capacity comes online, particularly in Asia, over the next three to four years. In 2010, the lowest number of nuclear units in the last fifteen years is scheduled to be refuelled in the United States [3], another factor, along with inventory draw-down, in this decline in uranium requirements.

The strong performance and economic competitiveness of existing plants, chiefly because of low operating, maintenance and fuel costs, has made retention and improvement of these plants desirable in many countries. This has resulted in a trend to keep existing plants operating as long as can be achieved safely as well as upgrading their generating capacity, where possible. This strategy is especially pronounced in the United States but other countries (e.g. Canada, France, Hungary, Mexico, the Netherlands, the Republic of Slovakia, the Russian Federation, Sweden and Switzerland) have or are planning to upgrade their generating capacities and/or extend the lives of existing power plants.

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3. A reduction of the enrichment tails assay from 0.3 to 0.25% ^{235}U would, all other factors being equal, reduce uranium demand by about 9.5% and increase enrichment demand by about 11%. The tails assay selected by the enrichment provider is dependent on many factors including the ratio between natural uranium and enrichment prices.

Installation of new nuclear capacity will increase uranium requirements, particularly since first load fuel requirements are roughly some 60% higher than re-loads for plants in operation, providing that new build capacity outweighs retirements. Many factors influencing decisions on building new nuclear generating capacity must be considered before any new significant building programmes will be undertaken. These factors include projected electricity demand, security and cost of fuel supplies, the cost of funding these capital intensive projects, the cost competitiveness of nuclear compared to other generation technologies and environmental considerations, in particular greenhouse gas emissions. With respect to nuclear, additional critical issues in need of resolution include public attitudes and acceptance of the safety of nuclear energy and proposed waste management strategies, as well as non-proliferation concerns stemming from the relationship between the civil and military nuclear fuel cycles.

Recent events indicate that several nations have decided that, on balance, objective analysis of these factors supports the construction of new nuclear power plants. Significant building programmes are underway in China, India and the Republic of Korea. And although the global financial crisis has pushed back immediate new build plans in for example, the Russian Federation and South Africa, these nations remain committed to long-term growth in nuclear electricity generating capacity. Smaller scale construction programmes are also underway in Finland and France and momentum is continuing to build in the United States, where the construction of as many as 26 plants is under consideration. As of 2009, the Government of the United States considered that nine of the 26 proposed plants have advanced to the stage that they are considered firmly committed to construction [4].

Increasing nuclear generating capacity has received support from political leaders and key international organisations. In May 2009, G8 Energy Ministers endorsed nuclear energy as means of diversifying the energy mix, enhancing energy security and reducing greenhouse gas emissions in a growing number of the world's leading industrial countries. In July 2009, G8 leaders agreed to a goal of achieving a 50% reduction in global greenhouse gas emissions by 2050, acknowledging that a growing number of countries recognise nuclear power as a means of addressing climate change and energy security, at the same time reducing consumption of fossil fuels. These and many other aspects of energy policy were the focus of the much-anticipated United Nations Climate Change Conference in Copenhagen in late 2009, but no definitive agreement was reached.

The 2009 World Energy Outlook notes that following the path of current energy policy is expected to result in severe climate change impacts, and that emissions resulting from electricity production are at the heart of the issue [5]. Achieving a 450 policy scenario, reference to the 450 ppm atmospheric CO_2 level concentration target required to avoid severe climate change impacts, is termed extremely challenging, but achievable. Although it requires heavy investment in both energy efficiency and low carbon power generation, including nuclear, the 450 policy scenario would bring numerous economic, energy security and human health co-benefits, along with facilitating economic development. The 2008 Nuclear Energy Outlook shows that as much as 11.6 Gt/yr CO_2 could be avoided with an ambitious but achievable global programme of nuclear power plant construction, in particular from 2030 to 2050 [6].

Despite these positive endorsements of nuclear power, nuclear phase-out programmes currently in place in some European nations will tend to reduce installed capacity over time in the region, although at least some of these programmes are being reversed (Italy has effectively removed moratorium on nuclear energy and Sweden has expressed the intention of reversing its nuclear

phase-out legislation). The global economic slowdown, the credit crisis and the recent slump in fossil fuel prices has made it more challenging to raise funds for capital intensive projects like nuclear power plant construction. However, construction programmes, particularly in east and central Asia, along with capacity upgrades and life extensions, are on balance expected to outweigh reactor shutdowns and world installed nuclear capacity is projected to increase through 2035, in turn increasing uranium requirements.

Projections to 2035[4]

Forecasts of installed capacity and uranium requirements, although uncertain due to the above-mentioned factors, point to future growth. Installed nuclear capacity is projected to grow from about 372 GWe net at the beginning of 2009 to between about 511 GWe net (low case) and 782 GWe net (high case) by the year 2035. The low case represents growth of 37% from current capacity, while the high case represents a net increase of about 110% (Table 27 and Figure 9).

The nuclear capacity projections vary considerably from region to region. The East Asia region is projected to experience the largest increase that, by the year 2035, could result in the installation of between 120 GWe and 167 GWe of new capacity, representing over 150% to over 210% increases over 2009 capacity, respectively. Nuclear capacity in non-European Union countries on the European continent is also projected to increase considerably, with between 30 and 65 GWe of capacity increases projected by 2035 (increases of about 75% and 170%, respectively). Other regions projected to experience growth include the Middle East and Southern Asia; Central and South America; Africa and South-eastern Asia. For North America, projected nuclear generating capacity in 2035 varies from a decrease of about 30% to an increase of over 40% (low and high case, respectively). A similar scenario is outlined for the European Union, where nuclear capacity is projected to decrease by over 10% in the low case scenario as plans to phase-out nuclear energy are implemented. In the high case projection, at least some of these phase-out plans are eased or eliminated, producing a slight increase in nuclear generating capacity of almost 20% in 2035.

World reactor-related uranium requirements by the year 2035 (assuming a tails assay of 0.30%) are projected to increase to between 87 370 tU/year in the low case and 138 165 tU/year in the high case, representing increases of about 40% and 120%, respectively, compared to 2009 requirements (Table 28 and Figure 10). As in the case of nuclear capacity, uranium requirements vary considerably from region to region, mirroring projected capacity increases. Annual uranium requirement increases are projected to be largest in the East Asia region (between 120% in the low case and over 180% in the high case above 2009 uranium requirements). In contrast to steadily increasing uranium requirements in the rest of the world, annual requirements in North America are either projected to decline by 25% or increase by 55% in the low and high cases, respectively. In the European Union, annual uranium requirements are either projected to decline by over 15% (low case) or increase by over 25% (high case) by the year 2035.

4. Projections of nuclear capacity and reactor-related uranium requirements are based on official responses from member countries to questionnaires circulated by the Secretariat. For countries that did not provide this information, Secretariat projections are based on data from the IAEA *Energy, Electricity and Nuclear Power Estimates for the Period up to 2030*. From 2030 to 2035, based on development trends, planned retirements and government stated intentions, where available. Because of the uncertainty in nuclear programmes in the years 2015 onward, high and low values are provided.

Table 27. Installed nuclear generating capacity to 2035
(MWe net, as of 1 January 2009)

COUNTRY	2008	2009	2010		2015		2020		2025		2030		2035	
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Argentina [b]	935	935	935	93*	1 660	1 660*	2 705	2 705*	2 705	2 705*	2 705	3 600*	2 705	3 600
Armenia [b]	375	375	375	375	375	375	950	950	950	1 900	1 900	1 900	1 900	1 900
Belarus*	0	0	0	0	0	0	0	1 100	1 100	2 200	1 100	2 200	1 100	2 200
Belgium	5 825	5 865	5 865	5 865	5 865	5 865	4 037	5 865	2 023	5 865	0*	7 300*	0*	7 300*
Brazil [b]	1 766	1 766	1 766	1 766	1 766	2 933	2 933	3 822	2 933	4 762	2 933	6 693	4 762*	8 566 *
Bulgaria [b]	1 906	1 906	1 906	1 906*	1 906*	3 800	3 800	4 186*	3 800	5 286*	3 800	5 286*	3 800*	5 286*
Canada+	12 700	12 700	11 400	14 300	10 500	14 300	11 400	15 300	14 300*	16 200*	16 200*	22 000*	14 200*	22 000*
China [a]	8 438	8 438	13 000	20 000	25 000	35 000	40 000	58 000	58 000	71 300	71 300	83 800	83 800	108 800
Czech Republic	3 634	3 634	3 634	3 634	3 700	3 800	3 800	4 900	4 900	6 000	6 000	6 200	6 000	6 200
Egypt*	0	0	0	0	0	0	0	0	0	1 000	1 000	3 000	1 000	3 000
Finland+	2 680	2 680	2 680	2 680	4 280	4 280	4 280	4 280	4 280	4 280	3 810	3 810	3 320	3 320
France	63 130	63 130	63 130	63 130	64 730	64 730	66 030	67 630	66 030	67 630	66 030	67 630	66 030	67 630
Germany+	20 470	20 470	20 470	20 470	12 100	13 400	3 500	3 500	0	0	0	0	0	0
Hungary+	1 860	1 860	1 890	1 890	1 890	1 890	1 890	1 890	1 890	1 890	1 890	1 890	950	1 890
India [b]	3 782	3 782	5 224*	6 224	8 066*	13 200	11 596*	21 278*	15 989*	32 196*	17 642*	45 776*	19 295*	57 776*
Indonesia*	0	0	0	0	0	0	0	0	0	1 200	0	2 400	0	2 400
Iran, Islamic Rep. of	0	0	915	915	915	915	3 175	5 075	6 975	7 925	6 975*	7 925*	6 975*	7 925*
Italy+	0	0	0	0	0	0	2 000	2 000*	7 000	7 000*	14 000	14 000*	14 000	14 000*
Japan	47 500+	47 940	47 940*	48 000*	48 300*	52 200*	53 700*	64 000*	59 200*	67 900*	63 300*	70 700*	65 600*	80 000*
Jordan*	0	0	0	0	0	0	0	0	0	1 000	0	1 000	0	1 000
Kazakhstan	0	0	0	0	0	600	300*	600*	300*	600*	600*	900*	600*	900*
Korea, Rep. of	17 700	17 700	18 700	18 700	25 900	25 900	31 500	31 500	34 000*	36 700*	42 700	42 700	42 700*	44 000*
Lithuania*	1 185	1 185	0	0	0	0	0	1 500	1 500	3 000	1 500	3 000	1 500	3 000
Malaysia*	0	0	0	0	0	0	0	0	0	900	0	900	0	900
Mexico+	1 365	1 365	1 365	1 570	1 365*	1 582	1 365*	1 582	1 365*	1 582	1 365*	1 582	1 365*	1 582
Mongolia	0	0	0	0	0	0	300	1 600	300*	1 600*	300*	1 600*	300*	1 600*

Table 27. Installed nuclear generating capacity to 2035 (contd.)
(MWe net, as of 1 January 2009)

COUNTRY	2008	2009	2010		2015		2020		2025		2030		2035	
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Morocco*	0	0	0	0	0	0	0	0	0	1 000	1 000	2 000	1 000	2 000
Netherlands+	480	480	480	480	480	480	480	480	480	480	480	480	0*	2 000*
Pakistan*	425	425	425	725	600	725	900	1 025	900	900	900	4 050	900	4 050
Poland	0	0	0	0	0	0	1 500	1 500	3 000	3 000	4 500	4 500	4 800*	4 800*
Romania*	1 300	1 300	1 300	1 300	1 300	1 300	2 000	2 700	2 000	2 700	2 000	3 600	2 000	3 600
Russian Fed.[b]	21 743	21 743	22 680	23 430	28 116	30 927	34 676	41 237	37 488	46 860	39 362	56 232	37 488	65 604
Slovak Republic+	2 100	1 710	1 640	1 780	2 460	2 740	2 460	3 850	2 480	4 060	3 400	4 060	3 400	4 060
Slovenia	666[b]	666[b]	690	704	690	704	690	704	0	0	0	0	0	0
South Africa	1 800	1 800	1 800	1 840	1 800*	1 840*	2 800*	4 130*	2 800*	7 625*	4 130*	10 120*	6 625*	12 500*
Spain+	7 450	7 450	7 600	7 600	7 600	7 600	7 600	7 600	7 300*	9 250*	7 300*	10 750*	2 350*	7 300*
Sweden+	9 000	9 000	10 100	10 100*	10 100*	10 100*	10 100	10 100*	10 100*	11 000*	10 100	11 000*	2 000*	11 000*
Switzerland	3 220	3 238	3 238	3 238	3 238	3 238	3 238	3 238	2 135	3 238	2 135	3 238	2 135	2 135
Thailand*	0	0	0	0	0	0	0	0	0	0	0	900	0	900
Turkey+	0	0	0	0	0*	0*	1 500*	4 500*	4 500*	4 500*	4 500*	5 500*	4 500*	5 500*
Ukraine[b]	13 100	13 100	13 100	13 100	15 000	17 000	15 800	19 200	17 900	24 800	19 000	24 900	21 000*	26 000*
United Arab Emirates*	0	0	0	0	0	0	0	0	0	1 000	0	1 000	0	1 000
United Kingdom+	10 100	10 100	10 500	10 500	7 200	7 200	4 400	5 800	6 200	10 600	7 200*	15 600*	7 200*	15 600*
USA	100 700	101 000	101 200	101 200	104 100	104 100	105 100	113 800	100 700	120 100	74 300	132 200	65 000*	140 000*
Vietnam*	0	0	0	0	0	0	0	1 000	2 000	2 000	2 000	3 000	2 000	4 000
OECD TOTAL	309 894	310 322	311 823	315 137	313 808	323 405	319 880	353 315	331 883	381 275	329 210	425 140	305 550	440 317
WORLD TOTAL	372 264	372 692	380 897	393 306	408 651	442 033	450 454	534 676	497 472	616 283	516 098	714 071	511 041	781 973

* Secretariat estimate, to 2030, based on *Energy, Electricity and Nuclear Power Estimates for the Period up to 2030*, IAEA (Vienna), August 2009; from 2030 to 2035, based on development trends, planned retirements and government stated intentions, where available.

\+ Data from Nuclear Energy Data, NEA (Paris), 2009.

(a) The following data for Chinese Taipei are included in the World Total but not in the totals for China: 4 949 MWe net in 2008 and 2009, 4 949 and net for the low and high cases of 2010, 7 649 MWe net for the low and high cases of 2015 and 2020, 7 469 and 8 949 MWe net for the low and high cases of 2020 and 2025, and 6 441 and 11 549 MWe net for 2030 and 2035 low and high cases, respectively.

(b) MWe gross converted to net by the Secretariat.

Table 28. Annual reactor-related uranium requirements to 2035
(tonnes U, rounded to nearest five tonnes)

COUNTRY	2008	2009	2010		2015		2020		2025		2030		2035	
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Argentina	160	140	110	110	265	265	370	370	370	370	370*	460*	370*	460*
Armenia	90	90	90	90	90	90	170	170	170	340	340	340	340	340
Belarus*	0	0	0	0	0	0	0	190	190	380	190	380	190	380
Belgium	1 030	835	1 055	1 055	730	1 055	730	1 055	365	1 055	0*	1 300*	0*	1 300*
Brazil	450	450	450	450	450	750	750	1 000	750	1 250	750	1 750	1 250*	2 000*
Bulgaria*	255	255	255	335*	1 065	1 065*	445	700*	445	700*	445	700*	445	700*
Canada	1 600	1 600	1 800	2 000	1 800	2 000	2 000	2 300	2 100	2 500	2 500*	3 235*	2 000*	3 235*
China[a]	1 800	3 300	2 340	4 600	4 600	6 450	6 450	8 200	10 100	12 000	12 300	16 200	14 400	20 500
Czech Republic	635	590	860	870	670	680	675	880	830	1 000	830	1 000	830	1 000
Egypt*	0	0	0	0	0	0	0	0	0	175	175	525	175	525
Finland+	485	460	440	480	650	705	650	705	650	705	470	605	470	505
France	9 000	9 000	8 500	9 500	8 000	9 000	8 000	9 000	8 000	9 000	8 000	9 000	8 000	9 000
Germany+	2 300	2 600	2 500	2 500	2 000	2 200	200	350	0	0	0	0	0	0
Hungary+	420	390*	360	360	360	360	360	360	360	360	360	360	180	380
India	750	930	950*	1 260	1 410*	2 530	2 030*	4 060	2 800*	5 635*	3 090*	8 010*	3 375*	10 110*
Indonesia*	0	0	0	0	0	0	0	0	0	210	0	420	0	420
Iran, Islamic Rep. of	0	0	160	160	160	160	590	910	1 230	1 390	1 230*	1 390*	1 230*	1 390*
Italy+	0	0	0	0	0	0	300	350*	1 100	1 225*	2 200	2 450*	2 200	2 450*
Japan	6 915	8 195*	8 195*	8 230*	8 455*	9 140*	9 400*	11 205*	10 365*	11 885*	11 080*	12 375*	11 480*	14 000*
Jordan*	0	0	0	0	0	0	0	0	0	175	0	175	0	175
Kazakhstan	0	0	0	0	0	60	50*	100*	50*	100*	100*	155*	100*	155*
Korea, Rep. of	3 400	3 400	4 200	4 200	4 400	4 400	6 200	6 200	6 700	6 700	7 500	7 500	7 500*	7 700*
Lithuania*	210	105	0	0	0	0	0	265	265	525	265	525	265	525
Malaysia*	0	0	0	0	0	0	0	0	0	160	0	160	0	160
Mexico+	160	290	420	420	210	360*	210	360*	410	410*	210	360*	200	360*
Mongolia*	0	0	0	0	0	0	55	280	55	280	55	280	55	280
Morocco*	0	0	0	0	0	0	0	0	0	175	175	350	175	350

Table 28. Annual reactor-related uranium requirements to 2035 (contd.)
(tonnes U, rounded to nearest five tonnes)

COUNTRY	2008	2009	2010		2015		2020		2025		2030		2035	
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Netherlands+	60	60	60	60	60	60	60	60	60	60	60	60	0	350*
Pakistan*	65	75	75	125	105	125	155	180	155	155	155	710	155	710
Poland*	0	0	0	0	0	0	260	260	350	350	785	785	840	840
Romania*	200	200	200	200	200	200	300	400	300	400	300	550	300	550
Russian Federation	4 100	4 500	5 400	5 400	7 200	7 700	8 200	9 700	8 800	11 000	9 200	13 000	9 700	15 000
Slovak Republic+	380	380	380	380	375	580	375	565	375	565	190	375	190	375
Slovenia	230*	230	210	245	210*	245*	210	245	0	0	0	0	0	0
South Africa	280	290	290	290	295	300*	490*	725*	490*	1 335*	725*	1 770*	1 160*	2 190*
Spain	1 515	680	1 700	1 800	1 300	1 300	1 300	1 300	1 275*	1 620*	1 275*	1 880*	410*	1 275*
Sweden+	1 575	1 685*	1 790*	1 790	1 800*	1 800	1 800*	1 800	1 800*	1 800	1 800*	1 800	410*	1 800
Switzerland	280	280	265	300	380	430	545	605	365	605	365	605	365	410
Thailand	0	0	0	0	0	0	0	0	0	0	0	160	0	160
Turkey*	0	0	0	0	0	0	260	785	785	785	785	960	785	960
Ukraine	2 480	2 480	2 480	2 480	2 480	3 230	3 020	3 660	3 390	4 800	3 600	4 800	3 775*	5 000*
United Arab Emirates*	0	0	0	0	0	0	0	0	0	175	0	175	0	175
United Kingdom+	950	1 215*	1 480	1 775	1 040	1 205	360	410	1 085*	1 855*	1 260*	2 730*	1 260*	2 730*
United States	16 425	16 160	17 530	17 530	19 870	19 870	18 560	19 950	18 050	21 075	13 125	23 465	11 260*	24 260*
Vietnam*	0	0	0	0	0	0	0	175	350	350	350	525	350	700
OECD TOTAL	47 130	47 820	51 535	53 250	52 100	55 145	51 985	57 715	54 240	62 770	52 010	69 885	47 595	71 950
WORLD TOTAL	59 065	61 730	65 410	68 860	71 965	79 650	76 920	91 445	86 325	107 480	87 790	126 665	87 370	138 165

* Secretariat estimate, to 2030, based on *Energy, Electricity and Nuclear Power Estimates for the Period up to 2030*, IAEA (Vienna), August 2009; from 2030 to 2035, based on development trends, planned retirements and government stated intentions, where available; if U requirement data not provided in Questionnaire response, requirements calculated assuming requirements of 175 tU/GWe/yr.

\+ Data from *Nuclear Energy Data*, NEA (Paris), 2009.

(a) The following data for Chinese Taipei are included in the World Total but not in the totals for China: 865 tU/year in 2008, 2009 and the low and high cases in 2010, 1 335 tU/year in the low and high cases in 2015and 2020, 1 335 tU/year and 1 565 tU/year in the low and high cases in 2025, respectively, 1 125 tU/year and 2 020 tU/year in the low and high cases in 2030 and 2035, respectively.

(b) Preliminary data.

Figure 9. Projected installed nuclear capacity to 2035
(low and high projections)

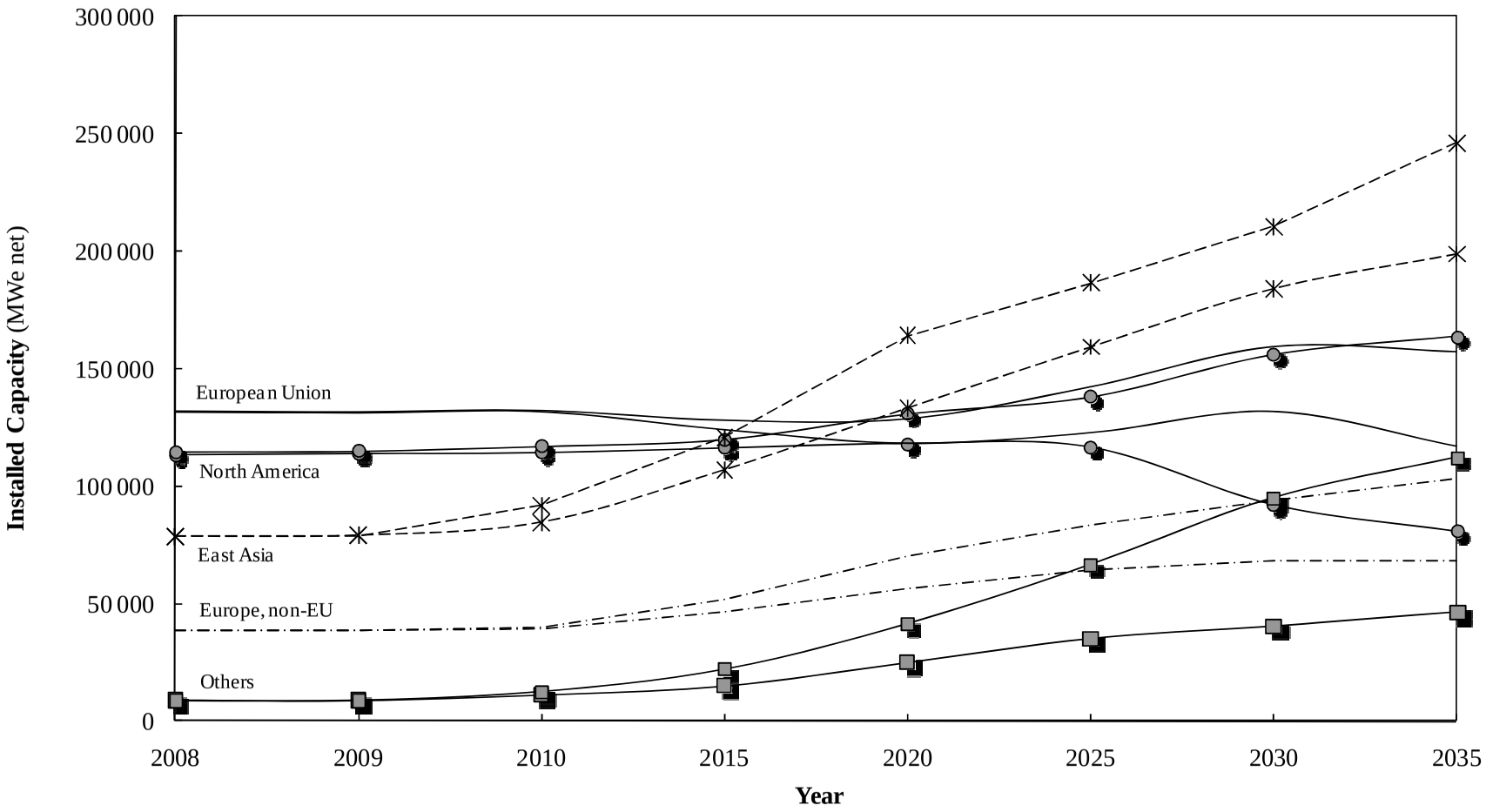
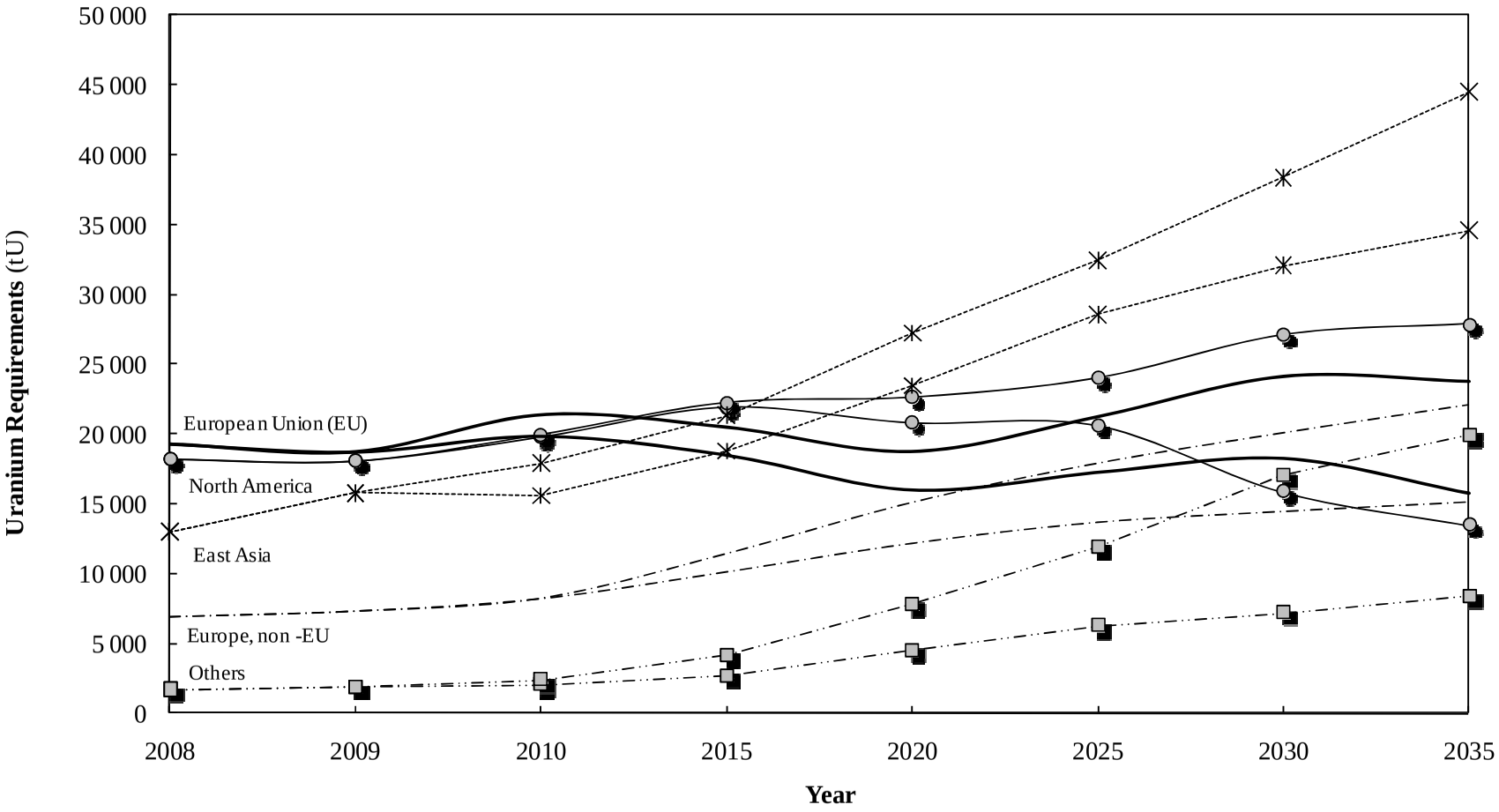


Figure 10. Annual reactor uranium requirements to 2035
(low and high projections)



C. URANIUM SUPPLY AND DEMAND RELATIONSHIPS

Uranium supply and demand remains in balance and there have been no supply shortages since the last report. However, a number of different sources of supply are required to meet demand. The largest is the primary production of uranium that, over the last several years, has satisfied some 50 - 75% of world requirements. The remainder has been provided or derived from secondary sources including stockpiles of natural and enriched uranium, down blending of weapons grade uranium, reprocessing of spent fuel and the re-enrichment of depleted uranium tails.

Primary Sources of Uranium Supply

Uranium was produced in 20 countries in 2008, the same number as in 2006. Although no uranium was recovered as part of mine remediation efforts in Germany in 2008, Bulgaria reported limited production by this method for the first time. This is expected to be a temporary situation only as 50 tU are expected to be recovered in Germany in 2009, and there will be 21 producing countries, of which four (Bulgaria, France, Germany and Hungary) will be producing uranium only as a result of mine remediation efforts. As of 2008, Kazakhstan was second only to Canada in uranium production and in 2009 Kazakhstan is on track to be the world's leading producer, continuing its run of sharp increases in production over the past several years (18%, 26% and 28% over the years, 2006, 2007 and 2008, respectively, with a 63% increase expected in 2009). In 2008, four countries, Australia, Canada, Kazakhstan and Namibia, accounted for 69% of world production and just eight countries, Canada (21%), Kazakhstan (20%), Australia (19%), Namibia (10%), the Russian Federation (8%), Niger (7%), Uzbekistan (5%) and the United States (3%), accounted for about 93% of the world's uranium mine output.

In comparison, 30 countries currently consume uranium in commercial nuclear power plants creating an uneven distribution between producing and consuming countries (Figure 11). In 2008, only Canada and South Africa produced sufficient uranium to meet domestic requirements. All others must use secondary sources or import uranium and, as a result, the international trade of uranium is a necessary and established aspect of the uranium market. Given the uneven geographical distribution between producers and consumers, the safe and secure shipment of nuclear fuel will need to continue without unnecessary delays and impediments. Difficulties that some producing countries, in particular Australia, have encountered with respect to international shipping requirements and transfers to international ports have therefore become a matter of some concern. However, efforts to better inform port authorities of the risks involved and recognition of the longstanding record of successful shipments of these materials have resulted in some improvements in the situation.

Due to the current availability of ample secondary supplies, primary uranium production volumes are significantly below world uranium requirements. In 2008, world uranium production (43 880 tU) provided about 74% of world reactor requirements (59 065 tU). In OECD countries, 2008 production of 19 203 tU provided about 40% of requirements (47 130 tU; Figure 12). Remaining requirements were met by imports and secondary sources.

Secondary Sources of Uranium Supply

Uranium is unique among energy fuel resources in that a significant portion of demand is supplied by secondary sources rather than direct mine output. These secondary sources include:

- Stocks and inventories of natural and enriched uranium, both civilian and military in origin.
- Nuclear fuel produced by reprocessing spent reactor fuels and from surplus military plutonium.
- Uranium produced by re-enrichment of ***depleted uranium*** tails.

Figure 11. Estimated 2009 uranium production and reactor-related requirements for major producing and consuming countries

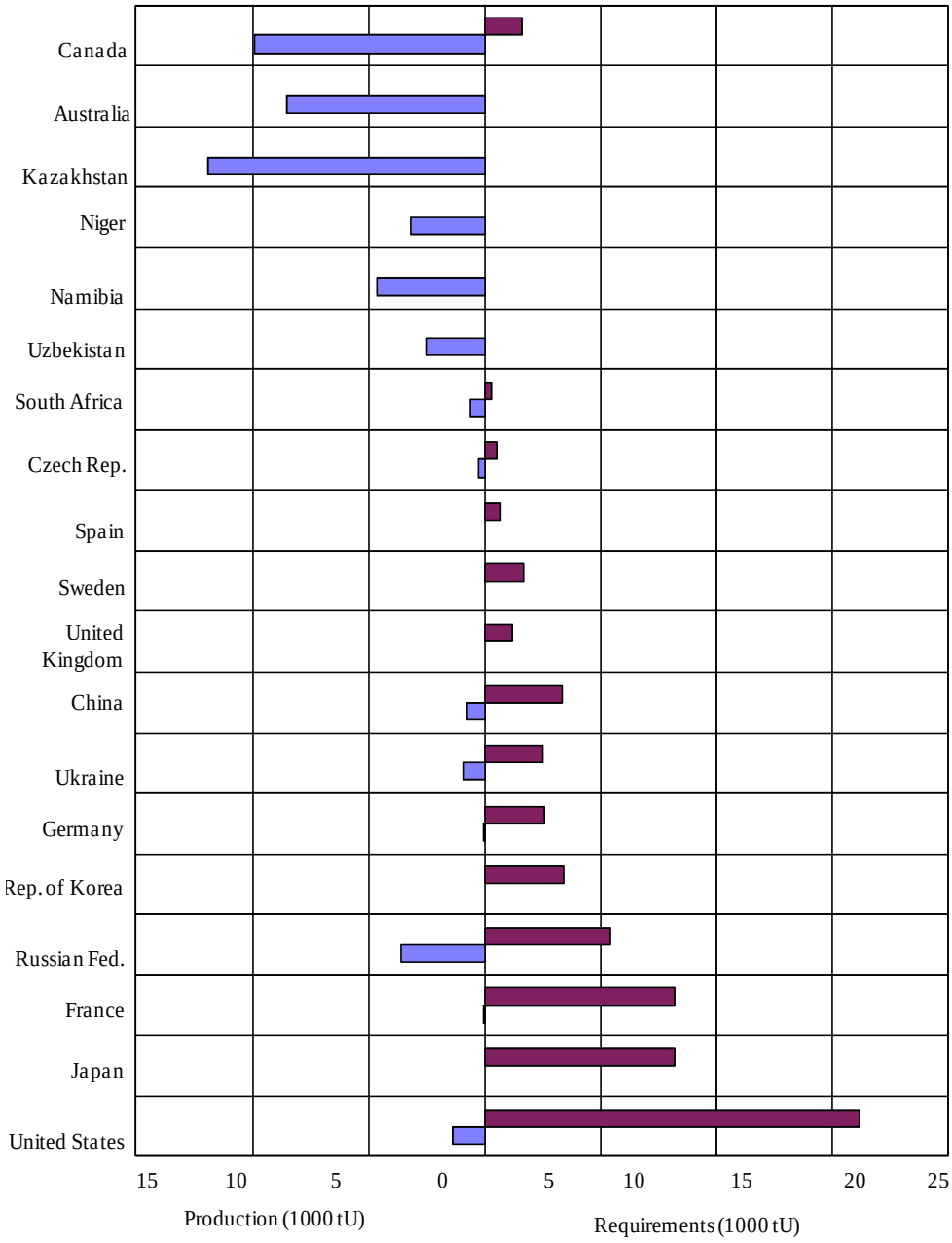
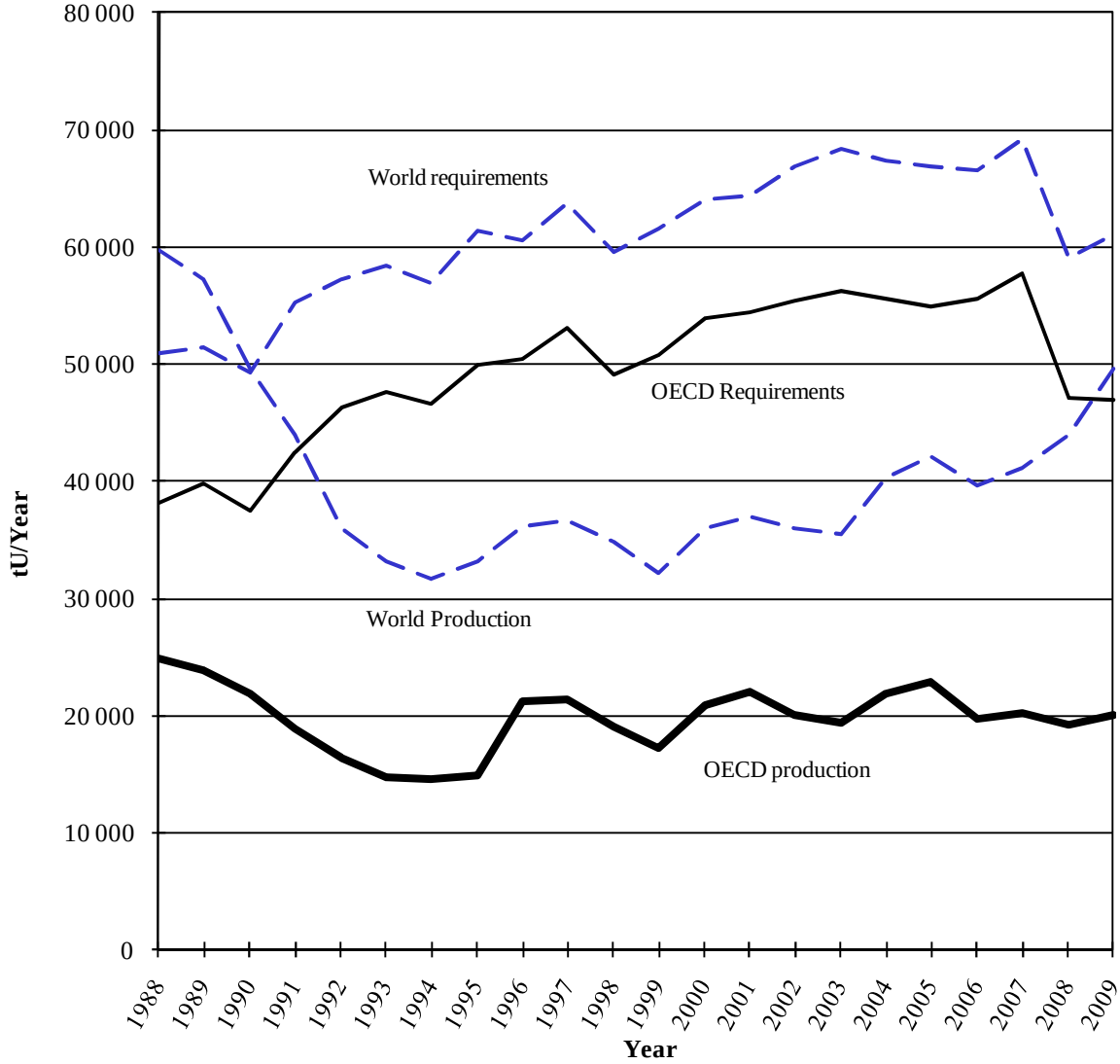


Figure 12. OECD and world uranium production and requirements*
(1988-2009)

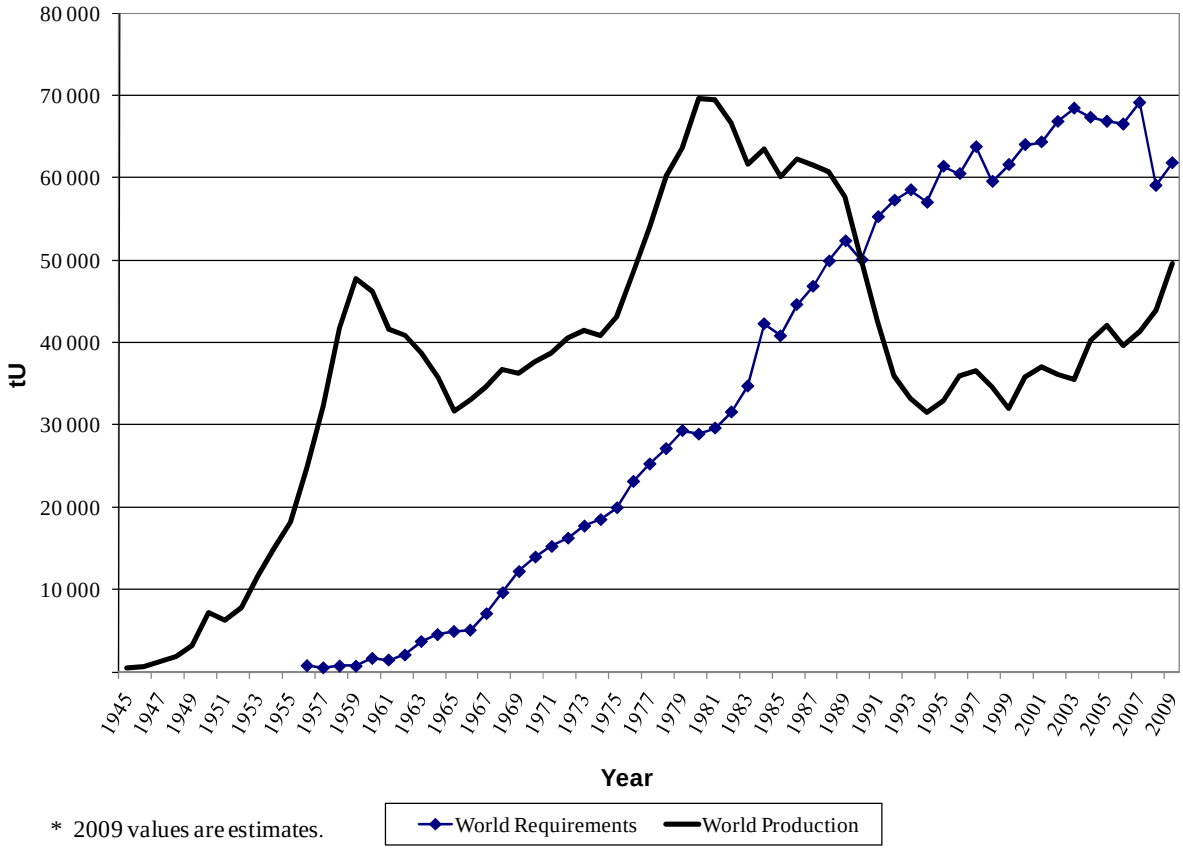


* 2009 values are estimates.

1. Natural and enriched uranium stocks and inventories

From the beginning of commercial exploitation of nuclear power in the late-1950s through to about 1990, uranium production consistently exceeded commercial requirements (Figure 13). This was mainly the consequence of a lower than expected nuclear electricity generation growth rate and high levels of production for military purposes. This over production created a stockpile of uranium potentially available for use in commercial power plants. Since 1990, production has fallen below demand as secondary supplies have fed the market. Initially, production dropped well below demand but clearly the gap has closed significantly in the last two years as mine production is increasing and uranium requirements have declined. The decline in uranium requirements in 2008 is likely related to utilities specifying lower tails assays at enrichment facilities and less reactor refuelling scheduled in 2008. Uranium requirements are currently expected to build up once again to levels at or above 70 000 tU by 2013.

Figure 13. Annual uranium production and requirements*
(1945-2009)

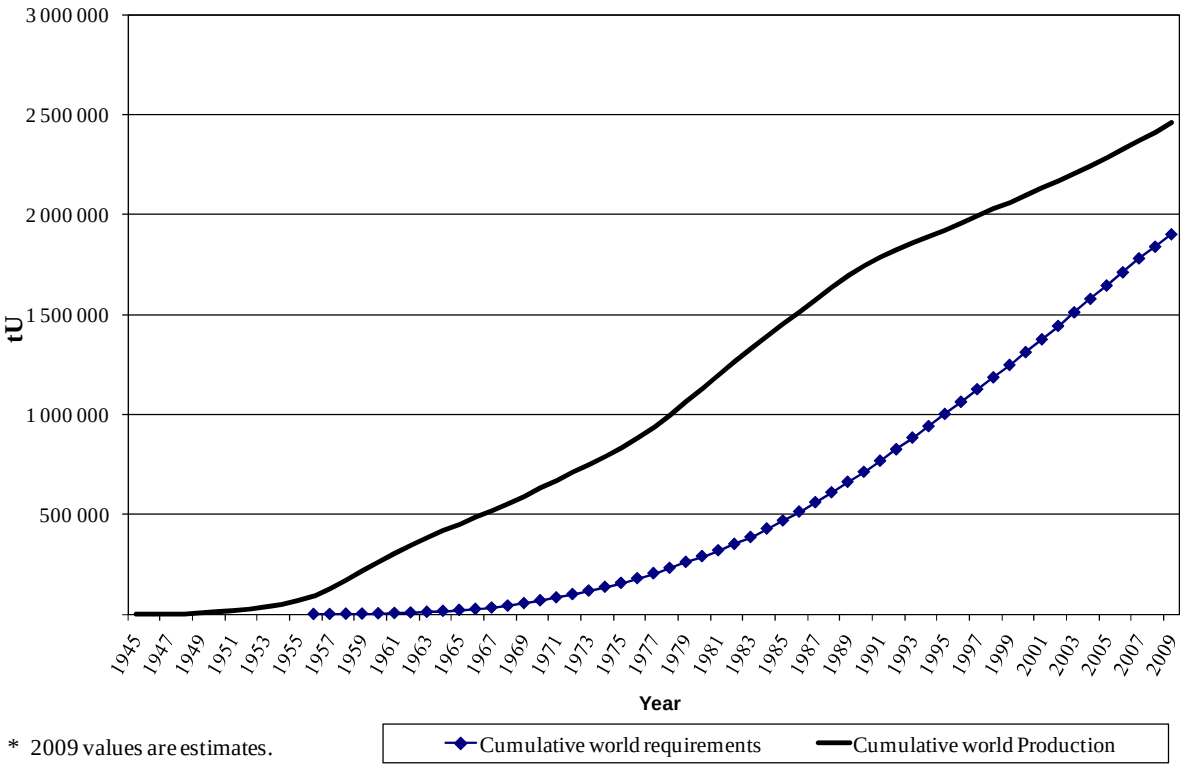


* 2009 values are estimates.

Following the political and economic reorganisation in Eastern Europe and the former Soviet Union in the early-1990s, major steps have been taken to develop an integrated commercial world uranium market. More uranium is now available from the former Soviet Union, in particular Kazakhstan, the Russian Federation and Uzbekistan, as is more information on the production and use of uranium in the former Soviet Union. Despite these developments and the increased availability of information regarding the amount of uranium held in inventory by utilities, producers and governments, uncertainty remains regarding the magnitude of these inventories as well as the availability of uranium from other sources. This, combined with uncertainty about the desired levels of inventories, continues to have significant influence on the uranium market.

However, data from past editions of this publication, along with information recently provided by member states, gives an indication of the possible upper bound total of potentially commercially-available inventories. Cumulative production through 2008 is estimated to have amounted to about 2 415 000 tU, whereas cumulative reactor requirements through 2008 amounted to about 1 840 000 tU. This leaves an estimated remaining stock of roughly 575 000 tU, the upper limit of what could potentially become available to the commercial sector (Figure 14). This base of already mined uranium has essentially been distributed into two sectors, with the majority used and/or reserved for the military and the remainder used or stockpiled by the civilian sector. Since the end of the Cold War, increasing amounts of uranium, previously reserved for military purposes, have been released to the commercial sector. However, a portion of this will likely always remain reserved for military uses.

Figure 14. Cumulative uranium production and requirements*
(1945-2009)



* 2009 values are estimates.

Civilian inventories include strategic stocks, pipeline inventory and excess stocks available to the market. Utilities are believed to hold the majority of commercial stocks because many have policies that require carrying the equivalent of one to two years of natural uranium requirements. Despite the importance of this secondary source of uranium, relatively little is known about the size of these stocks because few countries are able or willing, due to confidentiality concerns, to provide detailed information on stockpiles held by producers, consumers or governments (Table 29).

There is, however, some evidence that the industry has recently been depleting inventories. In the United States, 2008 year-end commercial uranium stocks (natural and enriched uranium equivalent) totalled 41 861 tU. This represents a decrease of about 3% compared to the 2007 levels of 43 227 tU. In the European Union in 2008, 18 622 tU were delivered to EU utilities, down from 21 932 tU in 2007 and below the 19 145 tU loaded into reactors [2]. Together these data indicate that the trend of building inventories over the last few years has reversed in the two largest regions of uranium demand, with inventories now being drawn upon. However, uranium requirements are growing rapidly in East Asia and by 2020 demand in this region is expected to surpass both that of North American and the EU. Questionnaire responses received during the compilation of this volume revealed little about inventory policies of countries in the East Asia region.

Table 29. Uranium stocks in countries that have reported data
(tonnes natural U equivalent as of 1 January 2009)

COUNTRY	Natural uranium	Enriched uranium
Argentina (a)	100	0
Australia (b)	NA	0
Belgium	0	NA
Bulgaria	0	81
Canada (b)	NA	0
China	NA	NA
Czech Republic (c)	< 200	NA
Egypt	NA	NA
Finland (d)	NA	NA
France (e)	NA	NA
Germany(f)	NA	NA
Hungary	5	0
India	NA	NA
Korea, Republic of (g)	2 000	6 000
Lithuania (h)	0	47
Mexico (i)	NA	NA
Netherlands	NA	NA
Niger	0	0
Poland	NA	NA
Portugal	168	0
Slovak Republic (j)	0	NA
South Africa	NA	NA
Spain (k)	NA	>611
Switzerland (l)	1 516	850
Turkey	2	0
Ukraine	1 229	NA
United Kingdom	NA	NA
United States (m)	40 184	21 404
Vietnam	0	0
TOTAL	45 404	>28 993

NA Not available or not disclosed.
(a) Government data only. Commercial data are not available.
(b) Government stocks are zero in all categories. Commercial data are not available.
(c) CEZ maintains stocks in all forms equivalent to about 2 years requirements.
(d) The nuclear power utilities maintain reserves of fuel assemblies sufficient for 7-12 months use.
(e) A minimum of three years forward fuel requirements is maintained by EDF.
(f) Holdings also include 3 500 t (U equivalent) of depleted U.
(g) A strategic inventory is maintained along with about one year's forward consumption in pipeline inventory.
(h) A three month's stock of enriched fuel is generally maintained at the Ignalina NPP.
(i) Maintain one to two reloads of natural uranium at an enrichment facility.
(j) The government maintains a small stock of enriched uranium in the form of fuel assemblies.
(k) Regulations require a strategic inventory of at least 611 tU be maintained jointly by nuclear utilities.
(l) Utilities also hold 78.5 t (U equivalent) of reprocessed uranium.
(m) Government and utility stocks only; producer stocks amounted to an additional 10 354 tU but a breakdown into amounts of natural and enriched uranium is not available. Government stocks also include 25 950 t (U equivalent) of depleted uranium.

Available information suggests that no significant excess inventories are held in non-EU Europe, with the exception of the Russian Federation. The inventory of enriched uranium product and natural uranium held by the Russian Federation, though never officially reported, is believed to be substantial. However, these inventories have been drawn upon for several years.

Large stocks of uranium, previously dedicated to military applications in both the United States and the Russian Federation, have become available for commercial applications, introducing a significant source of uranium to the market. Highly-enriched uranium (HEU) and natural uranium held in various forms by the military sector could total several years supply of natural uranium equivalent for commercial applications.

In March 2008, the Secretary of Energy of the United States released a policy statement on the management of the excess uranium inventory held by the US Department of Energy (DOE). The DOE excess uranium inventory comprises highly enriched uranium (HEU), low enriched uranium (LEU), natural uranium and depleted uranium that in total amounts to the natural equivalent of about 59 000 tU. The supporting management plan released later that same year states that the total natural uranium equivalent potentially entering the market in any one year would generally represent no more than 10% of the total domestic fuel requirements of all licensed nuclear power plants (total requirements are estimated to be about 19 230 tU/yr between 2008 and 2017), except in the case of potential sales of natural uranium for initial reactor cores [7]. This amount is not expected to have an adverse material impact on the domestic uranium mining, conversion and enrichment industries. While the plan guides the disposition of material over a 25 year period, it includes details of the form and amount of material that could be released over the next 10 years, ranging from 584 tU (natural uranium equivalent) in 2008 to a peak of 3 957 tU in 2014.

Highly-enriched Uranium from the Russian Federation

An Agreement between the Government of the United States and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons (HEU Purchase Agreement) was signed on 16 October 1992. The HEU Purchase provides for the blending down of 500 tonnes of HEU to low-enriched uranium (LEU) over 20 years. The United States Enrichment Corporation Inc. (USEC), the US Government´s sole executive agent for implementing the HEU Purchase Agreement, receives deliveries of LEU from the Russian Federation for sale to commercial nuclear power plants. USEC purchases and sells only the enrichment component of this LEU under existing commercial contracts with purchasers of enrichment services. An agreement for the maintenance of a domestic uranium enrichment industry that was signed on 17 June 2002 by the Department of Energy and USEC, contained conditions for USEC to continue as the US Government’s sole executive agent for the HEU Purchase Agreement. In June 2006, the Russian Federation indicated that the HEU agreement will not be renewed when the initial agreement expires in 2013.

Under a separate agreement under the HEU programme, the natural uranium feed component is sold under a commercial arrangement between three western corporations (Cameco, AREVA, and Nukem) and Techsnabexport of the Russian Federation. Outside of the natural uranium feed component of HEU-derived LEU, imports of uranium from the Russian Federation have been limited by the *Agreement Suspending the Antidumping Duty Investigation on Uranium from the Russian Federation* (Suspension Agreement) signed between the US Department of Commerce (DOC) and the Ministry of Atomic Energy of the Russian Federation in 1992. As a result of the Suspension Agreement, DOC suspended antidumping investigations and the Russian Federation agreed to sell uranium to the United States under a quota system whereby Russian imports would have to be matched by an equivalent quantity of newly produced US uranium. A 1994 amendment to the

suspension agreement contained language specifying an expected termination date of 31 March 2004. However, the Russian Federation did not request the DOC to undertake a termination review, a requirement for termination, and the DOC took the position that the Suspension Agreement had not expired. A second sunset review agreement was subsequently signed on 1 July 2005, maintaining the Suspension Agreement terms during the review.

In September 2005, the governments of the United States and Russian Federation issued a joint statement acknowledging that the implementation of the HEU Purchase Agreement had achieved its halfway point with 250 tonnes of HEU having been down-blended to LEU out of the total 500 metric tons of HEU covered in the agreement. As of 23 September 2009, 375 tonnes of HEU had been down-blended and 10 868 tonnes of LEU fuel have been delivered to the United States for use in commercial reactors. Deliveries as of this date represent the dismantlement of 15 000 nuclear warheads and the programme is on schedule to finish down blending the equivalent of 20 000 nuclear warheads into commercial nuclear power plant fuel by the end of 2013.

On 1 February 2008, senior US and Russian Federation officials signed an amendment to the Suspension Agreement. The amendment allows very small quantities of Russian LEU to enter the United States. starting in 2011, and allows much higher sales of Russian uranium products directly to US utility companies under quota from 2014 to 2020. The quota from 2014 to 2020 is a maximum of 20% of the US. reactor fuel needs based on World Nuclear Association projections, although Russian origin fuel supply to new reactors will be quota-free. Since the signing of the amendment, agreements for nuclear fuel supply deliveries have been signed by US. utilities and the Russian Federation.

On 30 September 2008, the Domenici Amendment to the Suspension Agreement was enacted into law. It reaffirms the aforementioned plans to allow the Russian Federation access to 20% of the post-2013 US. uranium nuclear fuel market, on the condition that the Russian Federation completes the down-blending of 500 tonnes of HEU under the terms and conditions of the existing HEU Purchase Agreement. The Domenici Amendment also contains a provision to allow the Russian Federation access to 25% of the post-2013 US. uranium market, on the condition that the Russian Federation signs a new agreement to blend down an additional 300 tonnes of HEU to LEU following the termination of the HEU Purchase Agreement at the end of 2013.

United States Highly-enriched Uranium

The United States has committed to the disposition of 174.3 tonnes of surplus HEU with about 151 tonnes planned to be eventually blended down for use as LEU fuel in research and commercial reactors and 23 tonnes slated for disposal as waste. By 30 June 2009, down blending was 95 % complete.

The DOE and Tennessee Valley Authority (TVA) entered an Interagency Agreement in April 2001, whereby TVA will utilise LEU derived from blending down about 33 tonnes of US surplus HEU. In 2004 this agreement was modified to increase the total to 39 tonnes of HEU and an additional 5.6 tonnes of HEU was added to the program in 2008. This LEU is considered “off-spec” because it contains 236 U in excess of the specifications established for commercial nuclear fuel. Different portions of this material are being down-blended at DOE’s Savannah River Site (SRS) and at a TVA contractor. Down-blending began at SRS in 2003 and at the contractor facility in 2004. This down-blending programme continues and use of the resultant Blended Low-enriched Uranium (BLEU) to produce electricity was initiated at TVA’s Browns Ferry reactor in early 2005. The implementation of the agreement is expected to continue providing fuel for TVA reactors until 2016.

In November 2005, the DOE announced that an additional 200 tonnes of HEU beyond the initially declared 174.3 tonnes of HEU would be permanently removed from further use by the United States in nuclear weapons. Of the additional 200 tonnes HEU, 160 tonnes will be provided for use in naval propulsion, 20 tonnes is to be blended down to low-enriched uranium fuel for use in power or research reactors, and 20 tonnes reserved for space and research reactors that currently use HEU, pending development of fuels that would enable the conversion to low-enriched uranium fuel cores. For power reactors, the LEU would become available gradually over a 25-year period.

About 10 tonnes of surplus HEU will be blended down to make low-enriched research reactor fuel through approximately 2016. In addition, 17.4 tonnes of HEU will be down-blended to low-enriched uranium fuel as part of the Reliable Fuel Supply initiative announced by DOE in September 2005. Under the Reliable Fuel Supply initiative, the United States will keep a reserve of low-enriched uranium that, in the event of a market disruption, can be sold to countries that forgo enrichment and reprocessing. On 29 June 2007, the DOE's National Nuclear Security Administration (NNSA) awarded a contract to Wesdyne International, LLC (a subsidiary of Westinghouse Electric Company, LLC) and Nuclear Fuel Services, Inc. to down-blend the 17.4 tonnes of HEU between 2007 and 2010, producing about 290 tonnes of low enriched uranium fuel. The fuel will be available for use in civilian reactors by nations that are not pursuing uranium enrichment and reprocessing technologies. Qualifying countries will have access to the fuel at the current market price only in the event of an emergency that disrupts the normal flow of fuel supply.

In December 2008, an additional 67.6 tonnes of HEU was declared unallocated (not presently obligated or approved for a specific purpose or program) in the DOE's *Excess Uranium Inventory Management Plan*. DOE stated that this material will become available for disposition gradually over several decades at a rate controlled by the rates of weapons dismantlement and the rejections of material from naval reactors.

In June 2009, NNSA announced that it had awarded a contract to WesDyne International LLC to down-blend an additional 12.1 tonnes of HEU between 2009 and 2012, producing about 220 tonnes of LEU. A small portion of the LEU will be sold to cover the cost of the programme, while the majority of the LEU produced in this programme will be stored in support of the MOX programme for the disposition of surplus weapons plutonium.

2. Nuclear fuel produced by reprocessing spent reactor fuels and surplus weapons-related plutonium

The constituents of spent fuel from power plants are a potentially substantial source of fissile material that could displace primary production of uranium. When spent fuel is discharged from a commercial reactor it is potentially recyclable, since about 96% of the original fissionable material remains along with the plutonium created during the fission process. The recycled plutonium can be reused in reactors licensed to use mixed-oxide fuel (MOX). The uranium recovered through reprocessing of spent fuel, known as reprocessed uranium (RepU), is not routinely recycled; rather, it is stored for future reuse.

The use of MOX has not yet significantly altered world uranium demand because only a relatively small and recently declining number of reactors are using this type of fuel. Additionally, the number of recycles possible using current reprocessing and reactor technology is limited by the build-up of plutonium isotopes that are not fissionable by the thermal neutron spectrum found in light-water reactors and by the build-up of undesirable elements, especially curium.

As of January 2009 there were 27 reactors, or about 6% of the world's operating fleet, licensed to use MOX fuel, including reactors in Belgium, France, Germany, India, and Japan (Tables 25, 30). Additional reactors could be licensed to use MOX in China and the Russian Federation. The United States licensed a reactor to use MOX as part of its weapons material disposition programme to conduct initial tests of MOX fuel between 2005 and 2008.

MOX reprocessing and fuel fabrication facilities exist or are under construction in China, France, India, Japan, the Russian Federation, the United Kingdom and the United States. JapanNuclear Fuel Ltd. has been performing test separation of plutonium at the Rokkasho reprocessing plant since March 2006 and Japanese utilities are aiming to use MOX fuel in 16 to 18 reactors, following consultations and licensing. Initially, MOX fuel manufactured overseas will be used, followed by the use of MOX fuel produced at JMOX. Commercial operation of JMOX, located adjacent to the Rokkasho reprocessing plant, is expected to begin in 2015 (capacity of 130 tHM/yr).

In 2003, the Cadarache MOX fuel production plant in France ceased commercial production and in 2006 the MOX fuel plant in Belgium (Belgonucléaire) was shut down. In 2007, the Melox plant in Marcoule, France was licensed to increase production from 145 tonnes to 195 tonnes of MOX fuel/yr.

The Euratom Supply Agency (ESA) reported that the use of MOX fuel in the EU-27 increased significantly in 2008 to 16 430 kg Pu from 8 624 kg Pu in 2007. Use of plutonium in MOX fuel reduced natural uranium requirements by an estimated 1 035 tU in 2007 and 1 972 tU in 2008. Since 1996, the ESA estimates that MOX fuel use in EU reactors has displaced a cumulative total of 14 521 tU through the use of 120.9 tonnes of plutonium [2]. Since the great majority of world MOX use occurs in Western Europe, this figure provides a reasonable estimate of the impact of MOX use worldwide during that period.

Responses to the questionnaire provided some data on the production and use of MOX (Table 30).

Table 30. MOX production and use
(tonnes of equivalent natural U)

COUNTRY	Pre-2006	2006	2007	2008	Total to 2008	2009 (expected)
MOX production						
Belgium	523	0	0	0	523	0
France	NA	1 160	1 000	1 008	14 038	1 160
Japan	598	0	9	4	611	36
United Kingdom*	NA	22	11	NA	NA	NA
United States	0	0	0	NA	NA	NA
MOX use						
Belgium	494	26	0	0	520	0
France	NA	NA	NA	NA	NA	NA
Germany	5 520	330	220	250	6 320	210
Japan	521.3	10.3	0	0	531.6	64.1
Switzerland	1 300	184	94	0	1 578	0
United States	0	0	N/A	N/A	N/A	N/A

NA Not available or not disclosed.
* Data from 2007 Red Book.

Uranium recovery through reprocessing of spent fuel, known as RepU, has been conducted in the past in several countries, including Belgium and Japan. It is now routinely done only in France and the Russian Federation, principally because recycling of RepU is a relatively costly endeavour, in part due to the requirement for dedicated conversion, enrichment and fabrication facilities. Changing market conditions and non-proliferation concerns are, however, leading to renewed consideration of this recycling option. Reprocessing was restarted in 2008 at the THORP plant in the United Kingdom. In France, reprocessed uranium use (currently about 300 t natural U equivalent/year in two Cruas reactors) is expected to double beginning in 2010, as an additional two Cruas reactors will begin using reprocessed uranium. Beyond this, very limited information is available concerning how much reprocessed uranium is used though available data indicate that it represents less than 1% of projected world requirements annually (Table 31).

Table 31. Re-processed uranium production and use
(tonnes of equivalent natural U)

COUNTRY	Pre-2006	2006	2007	2008	Total to 2008	2009 (expected)
Production						
France (a)	NA	1 100*	1 100*	<1 000	NA	NA
Japan (b)	645	0	0	0	645	0
Russian Federation*	NA	NA	NA	NA	NA	NA
United Kingdom	51 270	860	260	1 689	54 079	NA
Use						
Belgium	508(b)	0	0	0	508	0
France	NA	~300	~300	~300	NA	~300
Germany	NA	1 250	370	950	NA	700
Japan (c)	138	27	30	0	195	12
Switzerland	1 787	188	226	320	2 521	301
United Kingdom	~15 000	NA	NA	NA	~15 000	NA

NA Data not available.
* Data from 2007 Red Book.
(a) Production expected to increase to 1 050 tU in 2010.
(b) For fiscal year.
(c) From 1993 to 2002.

Mixed-oxide fuel produced from surplus weapons-related plutonium

In September 2000, the United States and the Russian Federation signed an agreement for the disposition of surplus plutonium. Under the agreement, both the United States and the Russian Federation will each dispose of 34 tonnes of surplus weapon-grade plutonium (enough to make more than 4 000 nuclear weapons) at a rate of at least two tonnes per year in each country once facilities are in place. Both countries agreed to dispose of surplus plutonium by fabricating it into MOX fuel for irradiation in nuclear reactors and the development of MOX fuel fabrication facilities is underway in both countries. This approach will convert the surplus plutonium to a form that cannot be readily used to make a nuclear weapon. In 2009, President Barack Obama and Russian President Dmitry Medvedev signed a joint statement on nuclear cooperation in Moscow that reaffirmed this commitment.

On 3 March 2005 the NRC announced that it had issued a license amendment that authorises Duke Power to use four mixed-oxide (MOX) fuel lead assemblies fabricated in France at its Catawba nuclear power plant near Rock Hill, S.C. The test of the four MOX fuel assemblies amongst the 189 conventional assemblies loaded in the reactor was stopped in May 2008 (less than three years after loading following two testing cycles, instead of the planned three) because of unexpected physical changes in the test MOX assemblies. The NRC determined that the issue did not threaten the safety of the reactor and it was later restarted with a full suite of conventional fuel assemblies.

On 1 August 2007, DOE's NNSA initiated construction of a MOX fuel fabrication facility at the US Department of Energy's Savannah River Site near Aiken, South Carolina. As of July 2009, the project was proceeding on schedule and within budget. It is expected to begin producing MOX fuel in 2016 for use in four specially licensed commercial reactors.

The 68 tonnes of weapons-grade plutonium would displace about 14 000 to 16 000 tonnes of natural uranium over the life of the programme. This represents about 1% of world annual uranium requirements over the period of the programme.

3. Uranium produced by re-enrichment of depleted uranium tails[5]

Depleted uranium stocks represent a significant reserve of uranium that could displace primary uranium production. However, the re-enrichment of depleted uranium has been limited as a secondary source of uranium since it is only economic in centrifuge enrichment plants that have spare capacity and low operating costs.

At the end of 2005 the inventory of depleted uranium is estimated at about 1 600 000 tU and to be increasing by about 60 000 tU annually based on uranium requirements of 66 000 tU per annum [8]. If this entire inventory was re-enriched to levels suitable for nuclear fuel it would yield an estimated 450 000 tU of equivalent natural uranium, which would be sufficient for about seven years of operation of the world's nuclear reactors at the 2006 uranium requirement levels.[6] However, this would require significant spare enrichment capacity that is not currently available.

Deliveries of re-enriched tails from the Russian Federation are an important source of uranium for the EU, representing 2-7% of the total natural uranium delivered annually to EU reactors between 2003 and 2008 (Table 32). However, in 2009, the Russian Federation indicated that it will stop the re-enrichment of depleted uranium tails once the existing contracts come to an end in 2009 and 2010.

Table 32. Russian Federation supply of re-enriched tails to European Union end users

Year	**Re-enriched tail deliveries** (tU)	**Percentage of total natural uranium deliveries**
2003	958	7.3
2004	925	6.2
2005	474	2.8
2006	728	3.3
2007	388	1.8
2008	688	3.7

Sources: Euratom Supply Agency (2009), *Annual Report 2008*, Luxembourg.

5. Depleted uranium is the by-product of the enrichment process having less ^{235}U than natural uranium. Normally, depleted uranium tails will contain between 0.25 and 0.35% ^{235}U compared with the 0.711% found in nature.
6. OECD Nuclear Energy Agency, (2007) *Management of Recyclable Fissile and Fertile Materials*, Paris, France. This total assumes 1.6 million tU at 0.3% assay is re-enriched to produce 420 000 tU of equivalent natural uranium, leaving 1 080 000 tU of secondary tails with an assay of 0.14%.

In the United States, the DOE and the Bonneville Power Administration have initiated a pilot project to re-enrich 8 500 tU of the DOE tails inventory. The pilot project conducted over a two-year period established the economic and technical viability of re-enriching a small portion of DOE's depleted uranium tailings inventory. Re-enrichment to a level of about 0.71% was completed at the USEC gaseous diffusion plant in Paducah, Kentuky and further enrichment will be completed uinder a separate contract with URENCO at European enrichment facilities. At the end of this process, about eight years of reactor fuel is scheduled to be produced for use in the Columbia Generating Station between 2009 and 2017. The US. reports that 924.5 t (nat. U equivalent) were produced by tails enrichment in 2006 but figures for recent years are not available.

Additional information on the production and use of re-enriched tails is not readily available. The information provided, however, indicates that its use is relatively limited (See Table 33).

Table 33. Re-enriched tails use
(tonnes of equivalent natural U)

COUNTRY	Pre-2006	2006	2007	2008	Total to 2008	2009 (expected)
Belgium (a)	345	0	0	0	345	0
Finland	718	NA	125	0	843	0
France (b)	NA	NA	NA	NA	NA	0
Sweden (c)	750	200	230	517	1 697	NA

NA Data not available.
(a) Purchased for subsequent re-enrichment.
(b) A small amount of tails are re-enriched in the Russian Federation and recycled within the Georges Besse enrichment plant.
(c) *Nuclear Energy Data*, OECD, Paris, 2008, 2009.

Uranium Market Developments

Uranium price developments

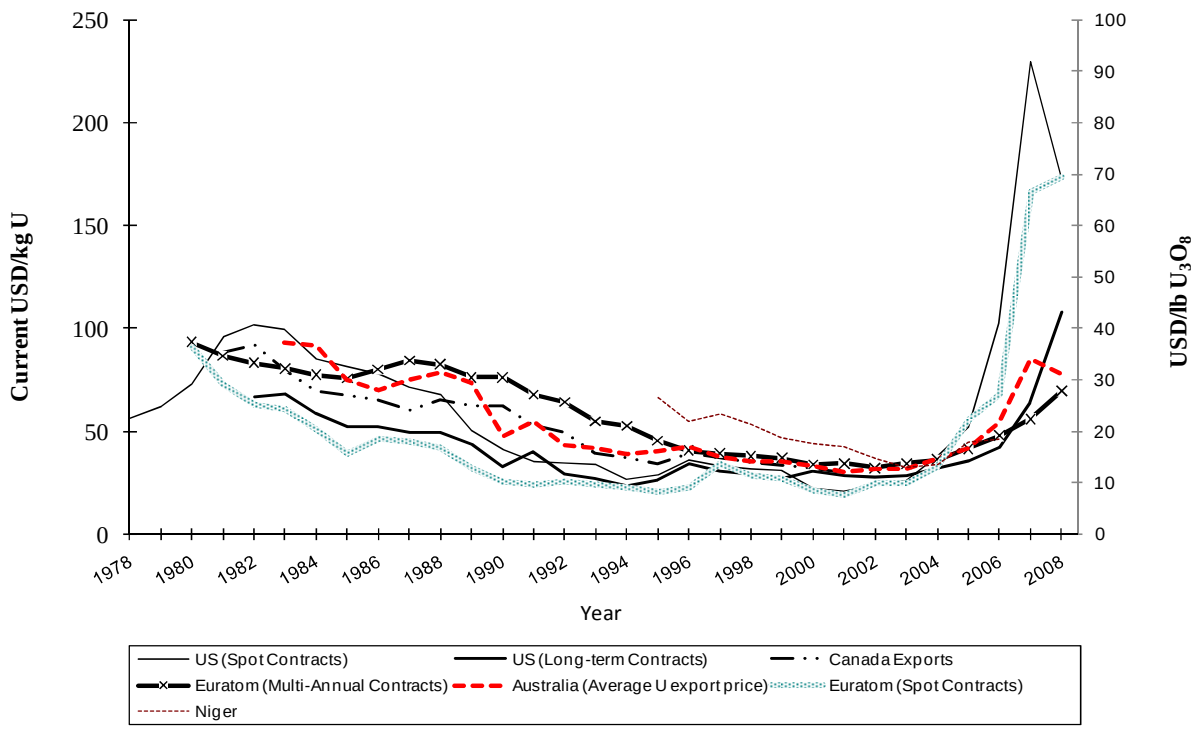
Some national and international authorities, i.e., Australia, United States and the Euratom Supply Agency, make available price indicators to illustrate uranium price trends. Additionally, spot price indicators for immediate or near-term delivery (typically less than 15% of all uranium transactions, although growing to 25% or more in recent years) are regularly provided by industry sources such as the TradeTech, Ux Consulting Company LLC (UxC) and others. Figure 15 shows a comparison of annual average delivered prices reported by various government sources.

The over-production of uranium, which lasted through 1990 (Figure 13), combined with the availability of secondary sources, resulted in uranium prices trending downward from the early-1980s until 1994 when they reached their lowest level in 20 years. Between 1990 and 1994 there were significant reductions in many sectors of the world uranium industry including exploration, production and production capability. This decreasing supply situation, combined with growing demand for uranium and the bankruptcy of an important uranium trading company, resulted in a modest recovery in uranium prices from October 1994 through mid-1996. This trend, however, reversed as increasingly better information about inventories and supplies maintained downward pressure on uranium prices until 2001.

Beginning in 2001, the price of uranium began to rebound from historic lows to levels not seen since the 1980s and continued to rise through 2007. Price information from a limited number of government sources all display this trend (Figure 15). In 2007 and 2008, prices increased dramatically in most indicators, although two price indicators (Australia average export price and US spot contracts price) declined from 2007 to 2008. Depending on the nature of the purchases (long term contracts versus spot market), the information available on uranium purchases in 2008 indicates that purchase prices ranged between USD 69/kgU and USD 174/kgU (USD 26/lbU_3O_8 and USD 67/lbU_3O_8).

While the trend of increasing prices is also evident for purchases made on the spot market since 2001, and in particular after 2003, the price has been much more volatile. In June 2007, the spot market price reached as high as USD 136/lb U_3O_8 (USD 354/kgU) before declining to USD 85/lb U_3O_8 (USD 221/kgU) in October 2007 and USD 44.50/lb U_3O_8 (USD 115.70/kgU) at the end of 2009; (Figure 16).[7] Note that Figure 15 reflects mostly long-term contracts and thus the dynamic changes of the past two years are not as evident as the changes shown in Figure 16.

Figure 15. **Uranium prices: 1978-2008**

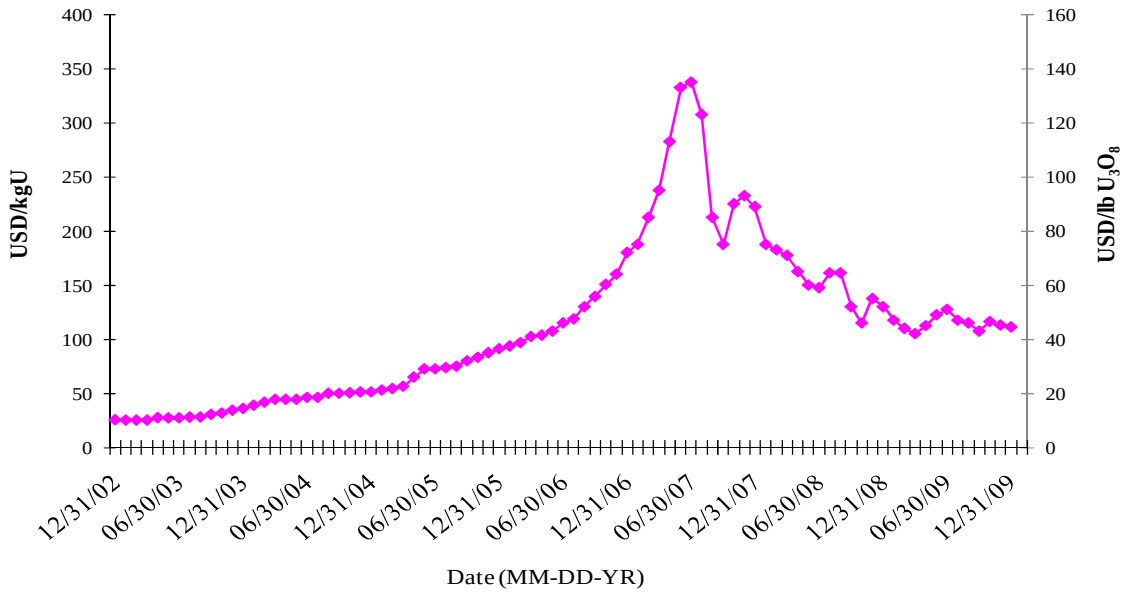


Notes: 1. Euratom prices refer to deliveries during that year under multi-annual contracts.
2. Beginning in 2002, Natural Resources Canada (NRCan) suspended publication of export price for 3-5 years pending a policy review.

Sources: Australia, Canada, Euratom Supply Agency, Niger, United States.

7. Spot price data courtesy of TradeTech (www.uranium.info).

Figure 16. **NUEXCO exchange value trend**
(31 December 2002 – 31 December 2009)



A variety of reasons have been put forward to account for the spot price dynamics between 2003 and 2009, including problems experienced in nuclear fuel cycle production centres in 2003 that highlighted dependence on a few critical facilities in the supply chain, as well as the weakness of the United States dollar, the currency used in uranium transactions. In addition, an increasing sense of the finite nature of inventories, the expansion of nuclear power generation in countries such as China, India and the Russian Federation, the recognition by many governments that nuclear power can produce competitively priced base load electricity that is essentially free of greenhouse gas emissions and the role nuclear can play in enhancing security of energy supply all likely contributed to the strengthening market through to 2007. The appearance of speculators in the market also contributed to pushing uranium prices upward by introducing new demand outside traditional purchasers. The downturn in the spot price since June 2007 has been attributed to a market correction, the reluctance of traditional buyers to engage in transactions at such high prices, and ultimately the global financial crisis stimulating sales by distressed sellers needing to urgently raise capital.

Since peaking in 2007, the uranium spot price has been in a gradual overall decline that settled in the USD 40/lb U_3O_8 (USD 104/kgU) to USD 50/lb U_3O_8 (USD 130/kgU) range in 2009. Proposed US government inventory sales seemed to offset rising demand in China and India as their programmes of strong nuclear growth were implemented. Although spot market prices through 2009 are significantly lower that the highs achieved during mid-2007, they nonetheless remain significantly (four to five times) higher than spot prices through the 1990s.

Other market developments

On 13 February 2002, the US. Department of Commerce (DOC) issued determinations in antidumping and countervailing duty investigations involving LEU from France, Germany, the Netherlands, and the United Kingdom. The DOC placed an antidumping duty order on LEU imports from France while all four countries were issued countervailing duty orders. The decision resulted in countervailing duties being assessed against France, but not against Germany, the Netherlands, and the

United Kingdom. The DOC determinations were challenged at the US Court of International Trade (CIT). The US Court of Appeals for the Federal Circuit (CAFC) affirmed in March 2005 a ruling by the US Court of International Trade (CIT) that contracts for the purchase of enrichment services, quantified by separative work units, were contracts for the sale of services, not goods. US antidumping law applies only to the sale or purchase of goods, not services.

In January 2009, the US. Supreme Court reversed a lower court decision of 2005 and upheld a petition of the USEC that the purchase of enrichment services, quantified by separative work units (SWU), represent sales of goods, not services, and should therefore be offered protection under the Tariff Act of 1930. Essentially, the decision supports enforcement of anti-dumping practices of LEU on the US market. The Supreme Court ruling does not affect imports of LEU from the Russian Federation, which are governed by the Domenici Amendment, outlined above.

Policy measures in the European Union

Nuclear materials for EU reactors come from diverse sources: Canada, Australia, Russia and Niger being the largest suppliers to the EU. Since its establishment in 1960 under the Euratom Treaty, the Euratom Supply Agency (ESA) has pursued a policy of diversification of sources of nuclear fuel supply in order to avoid over-dependence on any single source. Within the European Union, all uranium purchase contracts by EU end-users (i.e. nuclear utilities) have to be approved by ESA. Based on its contractual role and its close relations with the industry, ESA continuously monitors the market, especially supplies of natural and enriched uranium to the EU. ESA continues to stress the importance for utilities to maintain an adequate level of strategic inventory and to use market opportunities to increase their inventories, consistent with their circumstances. Furthermore, it recommends that utilities cover most of their needs under long-term contracts with diversified supply sources.

Legislative developments in 2008 expanded the ESA mandate to include market monitoring and acting as a nuclear observatory, aiming to provide the EU with expertise, information and advice on any subject connected with the operation of the market in nuclear materials and services. ESA aims to provide a wide range of information on nuclear market developments, as well as making reports on the EU market, average prices, total supply and demand etc. available to the public.

Uranium is sold mostly under long-term contracts and the terms are not made public. Until recently, ESA had been publishing two categories of natural uranium prices on an annual basis, i.e. multiannual and spot, both being historical prices calculated over a period of many years. With operators on the uranium market seeking greater price transparency, the ESA introduced in 2009 a new Natural Uranium Multiannual Contracts Index Price (MAC-3). This index price, developed to better reflect short-term changes in uranium prices and to track market trends more closely, is a three-year moving average of prices paid under new multiannual (long-term) contracts for uranium delivered to EU utilities in the reporting year. During 2008, the MAC 3 average price (USD 124.58/kgU or USD 47.94/lbU_3O_8) was calculated on 5.84% of the of the total uranium deliveries made to the EU [2]. During 2009, EU industry representatives recommended ESA to calculate retroactively MAC-3 indices and to publish them in its forthcoming Annual Report. Table 34 compares existing ESA uranium price index series.

Table 34. ESA average natural uranium prices (2004-2008)

Year	Multiannual contracts		Spot contracts		New multiannual contracts (MAC-3)	
	€/kgU	*US$/lb U_3O_8*	*€/kgU*	*US$/lb U_3O_8*	*€/kgU*	*US$/lb U_3O_8*
2004	29.2	13.97	26.14	12.51	NA	NA
2005	33.56	16.06	44.27	21.19	NA	NA
2006	38.41	18.38	53.73	25.95	NA	NA
2007	40.98	21.6	121.8	64.21	NA	NA
2008	47.23	26.72	118.19	66.86	84.75	47.94

More recently, ESA started to proceed with studies on a quarterly natural uranium price index (QUP) which could be the first ESA long term "forward looking" index. This could represent the current value of the long term uranium price by the time of signature of long term natural uranium contracts.

As the Russian Federation is an important supplier of nuclear materials to the EU, technical discussions between the European Commission and Russia continued during in 2008. By the end of 2009, the Commission's proposal for a renewed mandate to enter into negotiations with the Russian Federation with a view to establishing the terms of a new bilateral agreement on nuclear cooperation has been adopted by the Council.

Supply and Demand to 2035

Market conditions are the primary driver of decisions to develop new or expand existing primary production centres. As market prices have in general increased since 2003, even considering declining prices since mid-2007, plans for increasing production capability have developed in response to the market signal. A number of countries, notably Kazakhstan but also Australia, Brazil, Canada, Namibia, Niger, the Russian Federation and South Africa, have reported plans for significant additions to planned future capability. In addition, Malawi now has one production centre and Jordan plans to begin production in the near future. These developments are indeed timely as demand is projected to increase and secondary sources are expected to decline in availability. However, with rising mining and development costs, declining market prices since 2007 have caused at least some of these planned developments to be delayed.

The supply and demand picture is evolving as more countries move to increase nuclear generating capacity or develop such capacity for the first time. At the same time, producers are moving to increase production capability and governments are laying the groundwork (e.g. legislation, regulations) for the development of new production centres in cases where there has never before been uranium production. As reactor requirements are projected to rise through to 2035, an expansion of production capability is also projected to occur (Figure 17). As of 2009, these expansion plans, if successfully implemented, are expected to cover even high case demand requirements throughout much of this period, even without secondary supplies that have met between 25% and 48% of requirements between 2000 and 2008. These secondary sources are expected continue to be an important component of supply for some years to come (as discussed above), although the limited information available on secondary supplies makes it difficult to determine precisely how long they will contribute to meeting future demand.

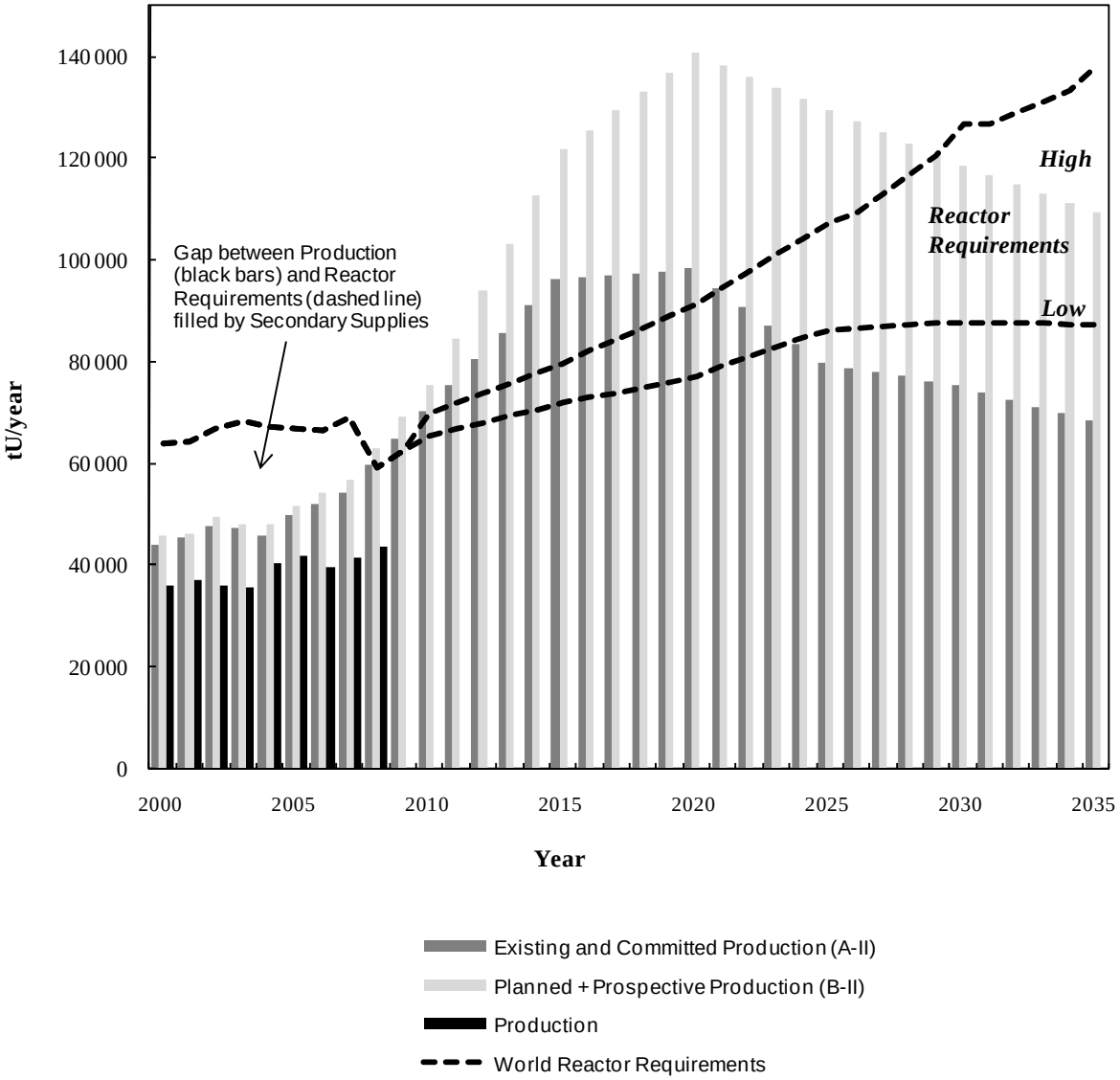
If all Existing and Committed mines produce at or near stated production capability, high-case demand is projected to be met through 2020. If Planned and Perspective production centres are included, high-case demand requirements are projected to be met until 2029. Planned capability from all reported Existing and Committed production centres, although potentially exceeding high case demand requirements between 2010 and 2020, is projected to satisfy about 78% of the low case requirements and only about 49% of the high case requirements by 2035. With Planned and Prospective production centres, primary production capability would satisfy low case requirements to 2035, but would fall short of meeting high case demand (79% of high case requirements in 2035). However, it is important to note that this projection covers uranium requirements arising from the global reactor fleet until 2035 only, not the entire lifetime of all the reactors in operation at 2035. Fuelling new reactors connected to the grid between 2010 and 2035 throughout the course of their operating lifespan will require the development of additional primary supply.

Although Figure 17 could be taken to suggest an oversupplied market in the near-term, past experience shows that this is not likely to be the case. Production capability is not production. The gap between production (black bars) and requirements (dashed line) from 2000 to 2008 has been met by drawing down secondary supplies. The challenge will be closing the gap between world production and high and low reactor requirements in the coming years, particularly in light of rising production costs and generally declining market prices for uranium from mid-2007 through 2009.

World production has never exceeded 89% of reported production capability [9] and since 2003 has varied between 75% and 84% of full production capability. Given the recent record of mine development, future delays in the establishment of new production centres can reasonably be expected, reducing and/or delaying anticipated production from Planned and Prospective centres. Infrastructure development and geopolitics could become more significant factors, particularly as new production centres are planned in developing countries with little or no previous experience in uranium mining. Hence, even though the industry has responded vigorously to the market signal of generally higher prices since 2003, compared to the previous 20 years, additional primary production and secondary supply will be required, supplemented by uranium savings achieved by specifying low enrichment tails assays, to the extent possible. After 2013, secondary sources of uranium are generally expected to decline in availability and reactor requirements will have to be increasingly met by primary production [10]. Therefore, despite the significant additions to production capability reported here, bringing facilities into production in a timely fashion remains important. To do so, strong market conditions will be required to bring the required investment to the industry.

A key element in the uranium market continues to be the availability of secondary sources, particularly the level of stocks available and the length of time remaining until those stocks are exhausted. As Table 29 shows, accurate information on secondary sources of uranium, especially inventory levels, is not readily available. However, the possibility of at least a portion of the potentially large inventory (including the military) continuing to make its way to the market after 2013 cannot be discounted. These uncertainties hamper effective decision making on new production capability. However, it is clear that the generally stronger market of recent years, compared to the last two decades of the 20th century, has spurred increased exploration and the development of production capability.

Figure 17. Projected annual world uranium production capability to 2035 compared with projected world reactor requirements*



Sources: Tables 24 and 28.

* Includes all Existing, Committed, Planned and Prospective production centres supported by RAR and Inferred Resources recoverable at a cost of <USD 130/kgU.

D. THE LONG-TERM PERSPECTIVE

Uranium demand is fundamentally driven by the number of operating nuclear reactors, which ultimately is driven by the demand for electricity. The International Energy Agency (IEA) reference scenario projection in the 2009 World Energy Outlook (WEO) states that 4 800 GW of new generating capacity will be needed by 2030 to meet the projected increases in electricity demand and to replace ageing infrastructure [5]. On average, electricity demand is expected to increase by about 2.5% a year, although in the short term (2011-2013), demand is expected to be lower compared to previous projections due to the impact of the global economic and financial crisis. About 80% of the overall growth to 2030 is expected to occur in non-OECD countries, with non-OECD Asia, led by India and China, growing most rapidly. The role that nuclear energy will play in helping meet projected future electricity demand will depend on how effectively a number of factors discussed earlier are addressed (economics, safety, non-proliferation concerns, security of supply, waste disposal, environmental considerations, etc.) and public acceptance of the technology.

The extent to which nuclear energy is seen as beneficial in meeting greenhouse gas reduction targets could increase the role of nuclear energy in meeting future electricity demand. As noted by the International Panel on Climate Change (IPCC), electricity generated from fossil fuels has been by far the biggest source of greenhouse gas emissions growth since 1970 (two times greater than the next largest energy contributor and growing at a much faster rate) [11]. Under the WEO reference scenario [5], fossil fuel use continues to rise (in particular coal), with consequent increases in global emissions and heightened concerns for security of energy supplies. In order to demonstrate how these issues could be addressed, the IEA presents an alternative policy scenario. This calls for a “low-carbon energy revolution,” in which energy efficiency, nuclear power and renewable energy sources, along with natural gas and carbon capture and storage, play increasing roles in meeting future electricity demand while limiting CO_2 emissions to a level (450 ppm) considered necessary to avoid the most serious consequences of climate change. Along with environmental benefits, in terms of reduced emissions of CO_2 and other gases, concerns about security of energy supply are eased, as overall fossil fuel import requirements decline. Although considerable financial benefit would be achieved by adopting the 450 scenario, considerable investment would be required (estimated to amount to USD 1.75 trillion more than the USD 13.65 trillion required in the power sector alone in the reference scenario). Funding capital intensive nuclear power projects could be challenging, in particular without carbon pricing. However, nuclear power is being re-considered by many governments in light of the near-zero carbon footprint of the technology and, as outlined above, prospects for growth in nuclear generating capacity are improving.

Several alternative uses of nuclear energy also have the potential to increase the role nuclear power worldwide, including desalination and heat production for industrial and residential purposes. In recent years several governments have been actively evaluating the possibility of using nuclear energy for desalination (e.g. China, Jordan, Libya and Qatar), building on experience gained by the operation of integrated nuclear desalination plants in India, Kazakhstan and Japan. The IAEA is fostering research and collaboration on the issue with the involvement of more than 20 countries. Economic analyses indicate that nuclear energy can be competitive compared to fossil-fuelled energy sources of desalination [6].

Cogeneration, combining industrial heat applications with electricity generation, is not a new concept; some of the first civilian reactors in the world were used to supply heat as well as electricity. District heating using nuclear heat has been used in some countries for decades. Industrial process heating has also been used and potential for further development also exists, but the extent to which reactors will be used for such applications will depend on the economics of heat transport, international pressure to reduce CO_2 emissions and national desires to reduce dependence on imported fossil fuels [6].

Energy use for transportation, which is projected to continue to grow rapidly over the coming decades, is also a major source of greenhouse gas emissions. Both electric and hydrogen powered vehicles are seen as potential replacements for fossil fuels. Nuclear energy offers base-load electricity production that could be used to power electric vehicles, as well as the potential of producing hydrogen that could make this alternate energy carrier available with significantly less greenhouse gas emissions compared to current methods of hydrogen production.

Small to medium-sized reactor designs also offer potential for expanded use of nuclear energy and consequent uranium demand. Most commercial reactor designs have large power outputs, typically 1 000-1 700 MWe that are unsuited to many developing countries, or isolated communities, where there is limited or localised electric grid capacity. Consequently, small to medium-sized reactor designs, with inherent and passive approaches to safety but without on-site refuelling, are being developed as they offer advantages to countries with limited nuclear experience. Commercial development of such designs could open a new market for reactor vendors in areas where electricity generating capacity needs are greatest [6].

Multilateral fuel cycle initiatives also have the potential to alter uranium demand. Driven by rising energy needs, non-proliferation and waste concerns, governments and the IAEA have made a number of proposals aimed at strengthening non-proliferation by establishing multilateral enrichment and fuel supply centres. As of December 2009, 25 partner nations (Armenia, Australia, Bulgaria, Canada, China, Estonia, France, Ghana, Hungary, Italy, Japan, Jordan, Kazakhstan, Lithuania, Morocco, Oman, Poland, the Republic of Korea, Romania, the Russian Federation, Senegal, Slovenia, Ukraine, the United Kingdom and the United States) further developed of the Global Nuclear Energy Partnership (GNEP). Owing to a sharp reduction in funding for the partnership in the United States, the GNEP programme recently altered aspects of its focus. On 15 April 2009, DOE confirmed that the domestic component of the program had been cancelled (deployment of a commercial-scale reprocessing plant in the US.) and that remaining resources would be directed to development of a proliferation resistant fuel cycle and waste reduction strategies.

On 27 November 2009, the IAEA announced that governors had approved a plan proposed by the Russian Federation for a multilateral, IAEA supervised nuclear fuel supply bank. Under the plan, the Russian Federation will host a 120 tonne LEU reserve, accessible to countries in compliance with safeguard obligations, if nuclear fuel supply was cut off for political reasons. The goal of this initiative is to stem the spread of sensitive enrichment technologies by removing the incentive to develop the technologies domestically as more nations advance their nuclear energy capabilities. The fuel bank could be ready to provide LEU as early as 2010. It is one component of the IAEA's goal of the full multi-nationalisation of sensitive parts of the fuel cycle – enrichment and reprocessing – as part of an overarching goal to eliminate nuclear weapons completely.

Technological advancements also promise to be a factor in defining the long-term future of nuclear energy and uranium demand. Advancements in reactor and fuel cycle technology are not only aimed at addressing economic, safety, security, non-proliferation and waste concerns, but also to increase the efficiency with which uranium resources are utilised. The introduction and use of

advanced reactor designs would also permit the use of other materials as nuclear fuel, such as uranium-238 and thorium, thereby expanding the available resource base. Moreover, fast neutron reactors could produce more fuel than they consume, since spent fuel could be recovered, reprocessed and reused to produce additional energy.

Many national and several major international programmes are working to develop advanced technologies, for example, the Generation IV International Forum (GIF) and the IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). In GIF, Argentina, Brazil, Canada, France, Japan, the People's Republic of China, the Republic of Korea, the Republic of South Africa, the Russian Federation, Switzerland, the United Kingdom, the United States and Euratom are working together to carry out the research and development needed to establish the feasibility and performance capabilities of the next generation (Gen IV) of reactor designs. These designs have stated objectives of construction and operation in a manner that will provide sustainable energy generation that meets clean air objectives, optimises resource utilisation, has clear life-cycle cost advantages over other energy sources, excels in safety and reliability and minimises nuclear waste. In 2002, the GIF reviewed 130 proposals and selected six nuclear energy system concepts to be the focus of continued collaborative research and development. These concepts are a sodium-cooled fast reactor, a very high-temperature reactor, a supercritical water reactor, a lead-cooled fast reactor, a gas-cooled fast reactor and a molten-salt reactor. The very high temperature reactor is the focus of much effort as it is being designed to be capable of co-generating both electricity and process heat for industrial purposes (including hydrogen production and desalination).

The objective of INPRO is to help to ensure that nuclear energy is available to contribute, in a sustainable manner, to the energy needs in the 21st century. As of 2009, 30 IAEA member states (Algeria, Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Italy, Japan, Kazakhstan, the Republic of Korea, Morocco, Netherlands, Pakistan, the Russian Federation, Slovakia, the Republic of South Africa, Spain, Switzerland, Turkey, Ukraine, and the United States) and the European Commission were engaged in the INPRO Project and another 10 member states either participated or were observers in INPRO meetings. Holders and users of nuclear technology are being brought together to consider international and national actions that would produce the innovations required in nuclear reactors, fuel cycles or institutional approaches. In 2009, INPRO members produced a plan of action for the next two years that includes application of a holistic, life-cycle assessment process for innovative nuclear systems (both planned and existing), furthering collaborative projects on the INPRO vision of sustainable nuclear energy development (e.g. environmental impact benchmarking and technological challenges for cooling high temperature reactor cores), using global and regional nuclear power growth scenarios to highlight interregional linkages in industrial capacity and resources, including uranium, and investigating options for a sustainable supply of fuel, including thorium.

As documented in this volume, sufficient uranium resources exist to support continued use of nuclear power and significant growth in nuclear capacity for electricity generation and other uses in the long-term. Identified Resources[8] are sufficient for over 100 years, considering 2008 uranium requirements of 59 065 tU. If estimates of current rates of uranium consumption in power reactors[9] are

8. Identified resources include all cost categories of RAR and Inferred Resources for a total of about 6 306 300 tU (Table 2).

9. Uranium usage per TWh is taken from OECD/NEA (2001), *Trends in the Nuclear Fuel Cycle*, Paris [12]. These were used to define how much electricity could be generated for the given levels of uranium resources. Years of generation were then developed by factoring in the 2008 generation rate (2 611 TWh net, Table 26) and rounding to the nearest five years.

used, the Identified Resource base would be sufficient for over 115 years of reactor supply. Exploitation of the entire Conventional Resource[10] base would increase this over 300 years, though significant exploration and development would be required to move these resources into more definitive categories. The uranium resource base described in this document is also more than adequate to meet projected growth requirements to 2035. Meeting low case growth requirements to 2035 would consume about 40% of the Identified Resources available at a cost of <USD 130/kgU (34% of Identified Resources available at a cost of <USD 260/kgU). Meeting high-case growth requirements to 2035 would consume slightly less than 50% of Identified Resources available at a cost of <USD 130/kgU (43% of Identified Resources available at a cost of <USD 260/kgU). Moreover, given the limited maturity and geographical coverage of uranium exploration worldwide there is considerable potential for the discovery of new resources of economic interest. As clearly demonstrated in the last few years, with appropriate market signals, new uranium resources can be readily identified.

As noted in the Uranium Supply chapter, there are also considerable Unconventional Resources, including phosphate deposits, that could be utilised to significantly lengthen the time that nuclear energy could supply energy demand using current technologies. However, considerable effort and investment would need to be devoted to better defining the extent of this potentially significant source of uranium.

Deployment of advanced reactor and fuel cycle technologies could also significantly add to world energy supply in the long-term. Moving to advanced technology reactors and recycling fuel could increase the long-term availability of nuclear energy from hundreds to thousands of years. In addition, thorium, which is more abundant than uranium in the earth's crust, is also a potential source of nuclear fuel, if alternative fuel cycles are developed and successfully introduced. Thorium-fuelled reactors have been demonstrated and operated commercially in the past.

Thus, sufficient nuclear fuel resources exist to meet energy demands at current and increased demand well into the future. However, to reach their full potential considerable exploration, research and investment is required, both to develop new mining projects in a timely manner and to facilitate the deployment of promising technologies.

10. Total conventional resources includes all cost categories of RAR, Inferred, Prognosticated and Speculative Resources for a total of about 16 706 300 tU (Tables 2 and 11). This total does not include secondary sources or unconventional resources, e.g. uranium from phosphate rocks.

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III. NATIONAL REPORTS ON URANIUM EXPLORATION, RESOURCES, PRODUCTION, DEMAND AND THE ENVIRONMENT

INTRODUCTION

Part III of the report presents the national submissions on uranium exploration, resources and production. These reports have been provided by official government organisations (Appendix 2) responsible for the control of nuclear raw materials in their respective countries and the details are the responsibility of the individual organisations concerned. In countries where commercial companies are engaged in exploration, mining and production of uranium, the information is first submitted by these companies to the government of the host country and may then be transmitted to the NEA or the IAEA at the discretion of the government concerned. In certain cases, where an official national report was not submitted and where deemed helpful to the reader, the Secretariat has provided additional comments or estimates to complete the Red Book. Where utilised, the Secretariat estimates are clearly indicated.

The Agencies are aware that exploration activities may be currently proceeding in a number of other countries which are not included in this report. They are also aware that in some of these countries uranium resources have been identified. However, it is believed that the total of these resources would not significantly affect the overall conclusions of this report. Nevertheless, both Agencies encourage the governments of these countries to submit an official response to the questionnaire for the next Red Book exercise.

Finally, it should be noted that the national boundaries depicted on the maps that accompany the country reports are for illustrative purposes and do not necessarily represent the official boundaries recognised by the member countries of the OECD or the Member states of the IAEA.

Additional information on the world's uranium deposits is available in the IAEA online database "World Distribution of Uranium Deposits – UDEPO" (http://www-nfcis.iaea.org/). A snapshot of this database is published as "World Distribution of Uranium Deposits (UDEPO) with Uranium Deposit Classification", 2009 Edition (IAEA-TECDOC-1629). UDEPO contains information on location, ranges of uranium tonnage and average grade, geological type, status, operating organisations (in case the deposit is being mined) and other technical and geological details about the deposits. The IAEA publication is accompanied with the database as of end of 2008 on a CD-ROM. It may be ordered from:

INTERNATIONAL ATOMIC ENERGY AGENCY
Sales & Promotion Unit, Division of Publications
P.O. Box 100, Wagramerstrasse 5, A-1400 Vienna, Austria
Telephone: (43) 1-2600-22529 (or 22530)
Facsimile: (43) 1-26007-29302
Electronic Mail: sales.publications@iaea.org
Web site: http://www-pub.iaea.org/MTCD/publications/publications.asp

Thirty-five member countries submitted a response to the questionnaire and the Secretariat drafted five country reports. As a result, there are a total of 40 national reports in the following section. This edition uses the revised format introduced in 2005, where the data tables are provided at the end of each country's report.

• Argentina •

URANIUM EXPLORATION

Historical review

See the 2001 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

In 1990, exploration was initiated in the vicinity of the Cerro Solo deposit in Patagonia. Since 1998, more than 56 000 metres have been drilled to test the potential of favourable portions of the paleochannel structure. The results included the localisation and partial evaluation of specific mineralised bodies containing resources of several thousand tonnes. These results allowed completion of the prefeasibility study for this U-Mo deposit. The National Atomic Energy Commission (CNEA) has developed a programme to complete the feasibility study of the Cerro Solo deposit including the exploration and evaluation of the surrounding areas. This last programme is going to be carried out in 2007 with 4 or 5 drills holes surrounding the sector C and 3 000 meters in the B sector.

The uranium exploration project of Las Thermas (vein type) has been the subject of study re-analyzing samples obtained from past work. At present, a new drill programme has been developed and results will be evaluated in the near future.

Some other areas were selected to develop geological studies. This includes the potential for exploitation by the *in situ* leaching (ISL) technology in favourable occurrences (sandstone type), as well as feasibility studies in granitic environments (vein and episyenite types).

During recent years, exploration in Cerro Solo and its vicinity has been intensified with 3 000 m drilling in 2008, 20 000 m expected in 2009 and 12 000 m during 2010.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Recent re-evaluation resulted in an increase in Identified Resources in both RAR and Inferred.

Undiscovered Conventional Resources (Prognosticated & SR)

There have been no significant changes in these figures since the 2003 Red Book.

URANIUM PRODUCTION

Historical review

See the 2003 edition of the Red Book for a historical review of uranium production.

Status of production capability

The production projects

For about 20 years the nuclear power plants in Argentina were fed with fuel obtained from national sources. At the end of the nineties, it was decided that due to the large gap between the costs of producing national concentrates compared to those produced abroad, uranium had to be imported.

At present CNEA proposes to re-start local production. There are better conditions to obtain competitive costs and the government has set up a policy to encourage growth in nuclear generating capacity.

Once a decision to complete the Atucha II power plant construction and begin operation was taken, Argentina's nuclear power plants fuel requirements are expected to increase in the medium-term from 120 tU/year to 220 tU/year.

The San Rafael Mining-Milling Complex Remediation and Reactivation Project

In June 2004 CNEA presented a proposal to re-activate the San Rafael mining-milling complex (Sierra Pintada mine) to the government of Mendoza Province and the national (Nuclear Regulatory Authority) licensing authorities. The main step in the licensing process is the Environmental Impact Assessment (EIA), which includes both the engineering required for the remediation of wastes generated by the former production stage, and an assessment of the environmental management of future production activities. The EIA was carried out by the National Technological University with the collaboration of the DBE TEC consultant company from Germany and some local institutions.

The EIA was elaborated after two years of intensive work. It includes base-line studies of local environmental components and the risks associated with the activity. It also aimed at solving some concerns that the community had with respect to the wastes currently under transitory management and the re-activation of the project.

The studies carried out concluded that the former operations had not detrimentally affected the quality of the underground and surface waters of the area, nor any other component of the regional environment.

Remediation can either be conducted prior to or simultaneous with the re-start of the production operations, which include substantial improvements consistent with the new methodologies now in practice. These methodologies incorporate additional safety measurements, oriented to improve the environmental protection compared to those in place during the previous operational stage. Production was initially expected to be re-started in 2006.

The feasibility of the project is based on re-evaluation studies of the main ore deposit areas, and on the changes in the methodology of mineral treatment which allows an important reduction in production costs. In the period 2003-2004, pilot tests were performed for confirm the results previously obtained, aimed at producing important changes in the methodology.

Authorities in Mendoza province rejected the proposed project and requested that the CNEA first remediate the open pit water and drums with accumulated wastes from purification in the previous round of production before considering the proposal to re-start production.

A recently adopted Local Law7722, which prohibits the use of sulfuric acid in mining operations, has further complicated plans to re-new mining activities. Before continuing with the project it will be necessary to resolve this issue.

The Cerro Solo Project

Prefeasibility studies of the Cerro Solo Project, in the Province of Chubut, are also being developed with the aim of reinitiating in the short term feasibility studies of the development-production stage.

With the present conditions in the market, the estimated cost of production at this project has become competitive, and the resources could be sufficient to supply the long term needs of domestic nuclear power plants.

Cerro Solo is a sandstone uranium-molybdenum ore deposit type, 0.3%U grade, lying between 50 and 120 m below the surface. The estimated resources are 5 000 tU (RAR & Inferred), and there are good prospects for the discovery of additional resources in the surrounding area.

In Cerro Solo there are similar difficulties as at Mendoza, because Local Law 5001/03 prohibits open-pit mining in the province. During the next two years however, the province will be divided into different sectors and it is possible that uranium mining in the Cerro Solo zone will be allowed.

Ownership structure of the uranium industry

At present, all of Argentina's uranium industry is government owned.

Employment in the uranium industry

Employment in uranium supply in Argentina is 140 persons.

Secondary sources of uranium

Argentina reported no information on mixed oxide fuels and re-enriched tails production and use.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

On behalf of the INCO-DC project of the European Union titled "Innovative Strategies for the Preservation of Water Quality in Mining Areas of Latin America", hydro-geochemical studies were performed in order to define baseline values prior to any mining operations in the Cerro Solo U-Mo deposit area. The tasks included: water and stream sediment surveys, chemical and isotopic studies, geochemical interpretation, ground radiometric mapping and environmental impact evaluation.

The ongoing project to update the Sierra Pintada feasibility study emphasises good environmental practices. Improvement of surface and underground water monitoring and studies of mining waste and mill tailings management are short-term objectives.

At present, the World Bank is working to supply a grant to remediate all former uranium mines and production plants.

URANIUM REQUIREMENTS

Supply and procurement strategy

Ongoing projects by CNEA aimed at re-starting uranium production in Argentina in the mid-term, described above, reflect a policy aimed at finding equilibrium between market opportunities and reduction of supply and price uncertainties.

NATIONAL POLICIES RELATING TO URANIUM

There are no restrictions that preclude local and foreign private companies from participating in uranium exploration and production, but the sale of uranium to other countries is dependent upon local consumption. The legal framework issued in the 1994-95 period, regulates these activities to ensure environmental practices that conform to international standards.

URANIUM STOCKS

As of 1 January 2009, total uranium stocks held by the CNEA amounted to 100 tU.

URANIUM PRICES

There is no uranium market in Argentina.

Argentina

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in ARS	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	2 000 000	1 351 000	1 500 000	4 350 000
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	NA	NA	NA	NA
Total expenditures	NA	NA	NA	NA
Industry* exploration drilling (m)	NA	NA	NA	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	1 879	2 956	20 000
Government exploration holes drilled	0	18	36	190
Industry* development drilling (m)	NA	NA	NA	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	NA	NA	NA	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	NA	NA	NA	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Uranium exploration and development expenditures – non-domestic

Expenses in ARS	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	7 000	10 400	10 400	82
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	7 000	10 400	10 400	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	0	
In-place leaching*	0	0	0	0	
Heap leaching**	0	7 000	10 400	10 400	82
Total	0	7 000	10 400	10 400	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	2 890	3 890	3 890
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	4 110	6 510	6 510
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	7 000	10 400	10 400

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	0
Open-pit mining	0	4 350	8 730	8 730	82
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	4 350	8 730	8 730	

Argentina

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	0	
In-place leaching*	0	0	0	0	
Heap leaching**	0	4 350	8 730	8 730	82
Total	0	4 350	8 730	8 730	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	2 550	2 620	2 620
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	1 800	6 110	6 110
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	4 350	8 730	8 730

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
NA	1 400	1 400

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining *	1 809	0	0	0	1 809	0
Underground mining *	704	0	0	0	704	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	2 513	0	0	0	2 513	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	502	0	0	0	502	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	2 011	0	0	0	2 011	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	2 513	0	0	0	2 513	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	2 513				2 513	
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other	0	0	0	0	0	0
Total*	2 513	0	0	0	2 513	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	0	0	0	0
Employment directly related to uranium production	133	133	133	140

Argentina

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
120	120	120	120	300	300	300	300	500	500	500	500

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	6.72	6.84

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 005	1 005	1 005	NA	1 785	NA

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
2 908	NA	2 908	NA	2 908	NA	2 908	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
160	140	110	110	265	265

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
370	370	370	370	NA	NA	NA	NA

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	100	0	0	0	100
Producer	0	0	0	0	0
Utility	NA	0	0	0	NA
Total	NA	0	0	0	NA

• Armenia •

URANIUM EXPLORATION AND PRODUCTION

On 23 April 2007, the Director General of the Russian Federation "Rosatom" State Corporation and the Minister of Ecology Protection of Armenia signed the Protocol on the realisation of uranium exploration work in Armenia.

Based on this Protocol, in April 2008, an Armenian-Russian joint venture CJ-SC "Armenian-Russian Mining Company" was established for uranium geological exploring, mining and processing. The founders of "Armenian-Russian Mining Company" CJ-SC are the Government of RA and "Atomredmetzoloto" Public Corporation of Russian Federation.

In the frame of this project, the collection and analysis of the archival material relevant to the uranium mining have been completed. The document "Geologic Exploration Activity for 2009-2010" aimed at the uranium ore exploration in the Republic of Armenia has been developed and approved. According to this document, in spring 2009, the field work related with the uranium ore exploration will begin.

URANIUM REQUIREMENTS

There have been no changes in Armenia's nuclear energy programme during the past two years. The country's short-term uranium requirements remain the same and are based on the operation of one VVER-440 unit. High-level uranium requirements forecast was completed taking into account the designed lifetime for this reactor facility, which has an installed capacity of about 407.5 MW(e).

The long-term requirements depend on the country's policy in the nuclear energy sector. According to the Armenian energy sector development plan, up to 2020, it is envisaged to construct a new nuclear unit with the capacity of about 1 000 MW(e), and another one with the same capacity – up to 2025 (according to the high-level energy forecast option).

SUPPLY AND PROCUREMENT STRATEGY

Nuclear fuel for the reactor of the Armenian NPP is supplied by the Russian Federation.

Armenia's nuclear fuel requirements and procurement strategy has remained the same during the past two years, and country's uranium supply position continues to be based on the fuel procurement from the Russian Federation.

In 2007, the Government of Armenia made a Decision on the Republic of Armenia joining to the Agreement between the Governments of the Republic of Kazakhstan and Russian Federation on establishment in Angarsk of International Uranium Enrichment Center in Russian Federation.

Net nuclear electricity generation

	2007	**2008**
Nuclear electricity generated (TWh net)	2.35	2.27

Installed nuclear generating capacity to 2035
(MWe net)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
375	375	375	375	375	375

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1 000	1 000	1 000	2 000	2 000	2 000	2 000	2 000

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
89	89	89	89	89	89

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
169	169	169	338	338	338	338	338

• Australia •

URANIUM EXPLORATION

Historical review

A comprehensive review of the history of uranium exploration and mine development in Australia is provided in "Australia's Uranium Resources, Geology and Development of Deposits" which can be viewed at:

www.ga.gov.au/about/corporate/ga_authors/uranium_resources.jsp

Recent and ongoing uranium exploration and mine development activities

Uranium exploration expenditure in Australia increased from AUD 80.7 million in 2006, to AUD 181.4 million in 2007, and AUD 220.5 million in 2008.

The main areas where uranium exploration was carried out during 2007 and 2008 were:

- Gawler Craton/Stuart Shelf region (South Australia, SA) – exploration for hematite breccia complex deposits;
- Frome Embayment (SA) – exploration for sandstone uranium deposits;
- Alligator Rivers region (Northern Territory) – exploration for unconformity-related deposits in Palaeoproterozoic metasediments;
- Mount Isa Region (Queensland) – exploration for extensions of metasomatite type deposits.

Olympic Dam

Drilling and exploration has outlined significant additional resources in the south eastern portion of the orebody. Exploration drilling since 2005 has more than doubled the size of total resources in all categories from 3.98 billion tonnes to 8.34 billion tonnes as at June 2008. Average grade of the resource is 0.88% Cu, 0.28 kg/t U_3O_8, 0.31 g/t Au and 1.5 g/t Ag.

Four Mile

The environmental impacts of the Four Mile *in situ* leach (ISL) project in South Australia were assessed in 2008 and early 2009 under the Australian Government's *Environment Protection and Biodiversity Conservation Act*. The government formally approved the project in July 2009. An ion exchange facility is to be constructed at Four Mile. Uranium-bearing resins from this plant will be transported 8 km by road tanker to the Beverley plant where uranium will be recovered to produce uranium oxide concentrates. It is proposed to commence ISL operations at Four Mile East deposit in 2010.

The Cameco-Mitsubishi joint venture will commence exploration drilling at Kintyre (Western Australia) in 2009 to establish a resource estimate and commence a mine feasibility study.

Several discoveries were announced in 2007 and 2008, namely: Double 8 deposit in Tertiary palaeochannels sands 180 km ENE of Kalgoorlie (Western Australia); Blackbush deposit at Mullaquana 20 km S of Whyalla (South Australia); Thunderball deposit near Hayes Creek in the Pine Creek Geosyncline (Northern Territory); N147 project south east of Nabarlek in Alligator Rivers region (Northern Territory).

Uranium exploration and development expenditures – abroad

During 2007 and 2008, Paladin Energy Ltd (an Australian exploration company) completed the developed of an open cut mining operation at the Kayelekera deposit in Malawi. Mine production commenced in May 2009. Paladin is also the operator of the Langer Heinrich uranium mine in Namibia, where production began in 2007 and production capability is being expanded.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Australia's Identified Conventional Resources recoverable at costs of <USD80/kgU amounted to 1 612 000 tU at 1 January 2009 – 33% higher than the estimates as at 1 January 2007. These increases were due to additional resources being defined at Olympic Dam (South Australia), Ranger (Northern Territory), and Four Mile deposits (South Australia).

Approximately 96% of Australia's Identified Conventional Resources recoverable at <USD 80/kgU are within the following six deposits:

- Olympic Dam, which is the world's largest uranium deposit;
- Ranger, Jabiluka, Koongarra in the Alligator Rivers region (NT);
- Kintyre and Yeelirrie (Western Australia).

Olympic Dam is the world's largest uranium deposit. Based on Ore Reserves and Mineral Resources reported by BHP Billiton as at June 2008, Geoscience Australia estimated that the deposit contains 884 400 tU in RAR recoverable at <US$80/kgU. This represents 30% of the world's total resources in this category. The total Identified Conventional Resources at <US$80/kgU for Olympic Dam were estimated to be 25% of world resources as at December 2008.

At Olympic Dam, uranium is a co-product of copper mining. Gold and silver are also recovered.

Of Australia's Identified Conventional Resources, 80% recoverable at <USD 80/kgU are tributary to existing and committed production centres.

Undiscovered Conventional Resources (Prognosticated & SR)

Estimates are not made of Australia's Undiscovered Conventional Resources.

Unconventional Resources and other materials

Estimates are not made of Australia uranium resources in the categories of Unconventional Resources and other materials.

URANIUM PRODUCTION

Historical review

A comprehensive review of the history of uranium production in Australia is given in "Australia's Uranium Resources, Geology and Development of Deposits", AGSO-Geoscience Australia, Resource Report No. 1: www.ga.gov.au/about/corporate/ga_authors/uranium_resources.jsp

Status of production capability and recent and ongoing activities

Australia has three operating uranium mines: Olympic Dam (underground), Ranger (open pit) and Beverley (ISL). Production decreased at all three mines during 2008 and total production was 2% less than for 2007.

Olympic Dam

In 2008, production from Olympic Dam was 3 344 tU, 1% lower than the previous year. The Environmental Impact Statement for Olympic Dam Expansion was released for public comment in May 2009. This expansion is based on a large open pit to mine the southeastern portion of the deposit. The expansion would increase combined output from the open cut and underground mine to an annual capacity of 16 100 tU (19 000 tU_3O_8); 750 000 tCu; 800 000 ounces Au. Removal of overburden is scheduled to commence in 2010 and processing of ore from the open cut to commence in 2016. The capacity of the existing underground mine will be increased to approximately 20 Mt per year by 2015. The smelting operation will produce 350 000 tpa of refined copper and in addition, 1.6 Mtpa of copper concentrates containing significant levels of uranium will be exported for further processing overseas.

Ran14ger

In 2008, Ranger mine produced 4 530 tU, 1% lower than the previous year. Energy Resources of Australia proposes to construct a heap leach facility for the extraction of up to 16 960 tU (20 000 tU_3O_8) contained in low grade mineralisation both in situ and on stockpiles.

Construction of a plant to treat stockpiled lateritic ores was completed in 2008 which will increase production by 340 tU (400 tU_3O_8) per year.

A new radiometric ore sorting plant was commissioned in 2008 and will upgrade 350 000 t of low grade ore per year. Total production from all existing low grade stockpiled ores is expected to be 930 tU (1 100 tU_3O_8).

Exploration drilling in the Ranger 3 Deeps area has defined a zone of contiguous high grade mineralisation east of the current operating pit. Construction of an underground decline to enable underground exploration is proposed to commence in 2010.

Beverley

In 2008, Beverley operation produced about 559 tU, approximately 12% lower than the previous year. Heathgate Resources has identified new zones of uranium mineralisation extending to the east of the Mining Lease (Beverley East) and also additional mineralisation in an area to the south. The Minister for the Environment, Water, Heritage and the Arts approved the expansion of the Beverley Mineral Lease in August 2008 enabling the company to mine these areas.

Ownership structure of the uranium industry

The Ranger uranium mine is owned by Energy Resources of Australia Ltd. which is majority owned by Rio Tinto (68.39%) with the remaining capital held publicly.

The Olympic Dam mine is fully owned by BHP Billiton.

The Beverley mine is fully owned by Heathgate Resources Pty Ltd, a wholly-owned subsidiary of General Atomics (USA).

Employment in the uranium industry

Total employment directly related to uranium production at Australia's three uranium mines increased from 302 employees in 2007 to 385 employees in 2008. It is anticipated that employment may decline to around 374 employees in 2009.

Future production centres

Honeymoon

Construction of the ISL mine and processing plant is underway at the Honeymoon project, South Australia. Production is planned to begin in 2010 at 340 tU (400 tU_3O_8) per annum.

Yeelirrie

BHP Billiton is undertaking drilling at Yeelirrie (WA) to upgrade the resource estimate and has commenced a feasibility study for development of the deposit. Yeelirrie currently has total resources of 44 520 tU (52 500 tU3O8) with an average grade of 0.13% U (0.15% U3O8). The company has commenced an EIS process for approval to develop a mining operation.

Oban

A Field Leach Trial was approved for the Oban deposit (65 km north of Honeymoon mine). The trial has potential to resolve the following issues: (a) disequilibrium; (b) hydrological continuity within aquifers which contain the uranium mineralisation; (c) leachability/recovery factors for uranium resource assessment and cost estimates.

Crocker Well

The PepinNini Minerals and Sinosteel joint venture has commenced an EIS process seeking government approval for development of the Crocker Well deposit (South Australia).

Uranium production centre technical details
(as of 1 January 2009)

	Centre # 1	Centre # 2	Centre # 3	Centre # 4	Centre # 5	Centre # 6
Name of production centre	Ranger	Olympic Dam	Beverley	Honeymoon	Four Mile	Yeelirrie
Production centre classification	Existing	Existing	Existing	Committed	Planned	Planned
Start-up date	1981	1988	2000	2010	2010	Not known
Source of ore:						
• Deposit name	Ranger No.3	Olympic Dam	Beverley	Honeymoon & East Kalkaroo	Four Mile	Yeelirrie
• Deposit type	Unconformity-related	Hem breccia complex	Sandstone	Sandstone	Sandstone	Calcrete
• Reserves (tU)	37 283	241 400	5 560	3 230	(f)	44 500
• Grade (% U)	0.13	0.05	0.15	0.17		0.13
Mining operation:						
• Type (OP/UG/ISL)	OP	UG	ISL	ISL	ISL	OP
• Size (t ore/year)	4.5 Mt (a)	12 Mt	NA	NA	NA	NA
• Average mining recovery (%)	100	85	65 (b)	65 (b)	65 (b)	NA
Processing plant (acid/alkaline):						
• Acid/Alkaline	Acid	Acid	Acid	Acid		Alkaline
• Type (IX/SX)	CWG, SX	CWG, FLOT, SX	IX	SX	(g)	NA
• Size (t ore/year)	2.5 Mt/year	12 Mt/year	1.62 ML/h	Not reported		(h)
• Average process recovery (%)	88	72	(b)	(b)		
Nominal production capacity (tU/year)	4 660	3 820	848	340	(g)	NA
Plans for expansion	(c)	(d)	(e)	NA		
Other remarks		NA	NA	NA		(i)

a) Capacity to mine a total of 4.5 million tonnes per year of ore and waste rock.

b) Recovery includes combined losses due to ISL mining and hydro-metallurgical processing.

c) Processing of lateritic ores is scheduled to commence in 2009 and will produce approximately 340 tU (400 t U_3O_8) per annum. In addition, a new radiometric ore sorter will allow an additional 930 tU (1 100 t U_3O_8) to be produced from existing low grade stockpiles. ERA proposes to construct a heap leach facility for the extraction of up to 20 000 t U_3O_8 contained in low grade mineralised material.

d) BHP Billiton is investigating the feasibility of expanding capacity of Olympic Dam operations to produce 16 100 tU (19 000 t U_3O_8) per year. It is proposed to mine the southern portion of the deposit by a large open pit in conjunction with underground mining (sub-level open stoping) in the northern portion of the deposit.

e) Approval has been granted to extend the capacity of the Beverley plant to produce 1 270 tU (1 500 t U_3O_8) per year when the company decides it is commercially viable to do so.

f) Four Mile West total resources 12 700 tU (15 000 t U_3O_8) averaging 0.31%U. Four Mile East Inferred Resources 3 900 tU (4 627 t U_3O_8) averaging 0.14% U.

g) Uranium bearing resin from Four Mile will be treated at Beverley plant to recover uranium.

h) BHP Billiton is investigating several options for processing the ores including tank leaching with ion exchange, and heap leaching with ion exchange.

i) BHP Billiton has commenced environmental approvals process.

Secondary sources of uranium

Australia has no production or use of mixed oxide fuels, re-enrichment of tailings or reprocessed uranium.

Environmental Impact Statement

All new mines and expansion of existing mines are required to go through environmental assessments under the *Environmental Protection and Biodiversity Conservation Act*. The environmental impacts of the Olympic Dam Expansion, Ranger heap leach and Four Mile projects were all being assessed as at January 2009.

Regulatory activities

The Uranium Industry Framework (UIF) is an Australian Government initiative, and was established to foster growth of the uranium mining industry in Australia. Work under the UIF is being undertaken in the areas of regulation, transport, royalties, skills and Indigenous peoples' engagement. As part of the regulation stream, an independent report titled Review of Regulatory Efficiency in Uranium Mining was completed in 2008. Implementation of the recommendations is expected to occur in 2009. Further information on the UIF is available at www.ret.gov.au/uif.

Work is proceeding on establishing a regulatory regime for the state of Western Australia as a result of the change in policy to allow uranium mining. The regime will build on the regulatory regimes in the states of South Australia and the Northern Territory, as well as the existing legislation for radiation protection for uranium exploration and mineral sands mining in Western Australia.

Australia

New legislation to establish a uranium royalty regime in the Northern Territory was introduced in the Australian Parliament in December 2008 and is expected to come into effect in the second half of 2009.

URANIUM REQUIREMENTS

Australia has no commercial nuclear power plants and thus has no uranium requirements.

NATIONAL POLICIES RELATING TO URANIUM

The Australian Government supports the development of a sustainable Australian uranium mining sector in line with world's best practice environmental and safety standards and allows the export of uranium to countries which observe the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and which are committed to non-proliferation and nuclear safeguards. Non-nuclear weapons states must also have in force an Additional Protocol.

In November 2008, the Government of Western Australia overturned the ban on uranium mining put in place by the previous State Government. Mining of uranium in Western Australia is subject to strict safety and security provisions including meeting all the necessary international safeguards and rigorous environmental approvals for mining and transporting uranium.

URANIUM STOCKS

For reasons of confidentiality, information on producer stocks is not available.

URANIUM PRICES

The average price of uranium exported from Australia in 2008 was USD 29.98/lbU_3O_8 (USD 77.95/kgU). Average export prices for the last five years are as follows:

	2008	2007	2006	2005	2004	2003
Average Export Value (AUD/lb U_3O_8)	35.17	39.07	27.71	21.03	19.32	18.78
(USD/lb U_3O_8)	29.98	32.77	20.88	16.03	14.22	12.24

The average of the daily AUD:USD exchange rates for the calendar year was used as the factor to convert AUD values to equivalent USD values for each year. Source: Reserve Bank of Australia daily currency exchange rates.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million AUD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	80.7	181.4	220.5	200
Government exploration expenditures	0	0	0	0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	80.7	181.4	220.5	200
Industry* exploration drilling (m)	NA	NA	NA	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	NA	NA	NA	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	NA	NA	NA	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	NA	NA	NA	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Uranium exploration and development expenditures – non-domestic

Expenses in million AUD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	6.0	NA	NA	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	6	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	NA	73 000	73 000	73 000	
Open-pit mining	NA	194 000	207 000	210 000	
In situ leaching	NA	12 000	12 000	12 000	
Co-product and by-product	NA	884 000	884 000	884 000	
Unspecified	NA	0	0	0	
Total	NA	1 163 000	1 176 000	1 179 000	

Australia

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	NA	1 163 000	1 176 000	1 179 000	
In-place leaching*	NA	0	0	0	
Heap leaching**	NA	0	0	0	
Total	NA	1 163 000	1 176 000	1 179 000	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	NA	200 000	202 000	202 000
Sandstone	NA	21 000	26 000	26 000
Hematite breccia complex	NA	886 000	886 000	886 000
Quartz-pebble conglomerate	NA	0	0	0
Vein	NA	0	0	0
Intrusive	NA	2 000	2 000	5 000
Volcanic and caldera-related	NA	3 000	6 000	6 000
Metasomatite	NA	10 000	10 000	10 000
Other*	NA	41 000	44 000	44 000
Total	NA	1 163 000	1 176 000	1 179 000

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	NA	47 000	56 000	56 000	
Open-pit mining	NA	67 000	98 000	101 000	
In situ leaching	NA	20 000	23 000	23 000	
Co-product and by-product	NA	315 000	320 000	320 000	
Unspecified	NA	0	0	0	
Total	NA	449 000	497 000	500 000	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	NA	449 000	497 000	500 000	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	NA	449 000	497 000	500 000	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	NA	53 000	54 000	54 000
Sandstone	NA	53 000	57 000	57 000
Hematite breccia complex	NA	329 000	335 000	335 000
Quartz-pebble conglomerate	NA	0	0	0
Vein	NA	0	0	0
Intrusive	NA	5 000	5 000	8 000
Volcanic and caldera-related	NA	1 000	2 000	2 000
Metasomatite	NA	8 000	17 000	17 000
Other*	NA	0	27 000	27 000
Total	NA	449 000	497 000	500 000

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining *	92 660	4 029	4 589	4 530	105 808	4 500
Underground mining *	838	0	0	0	838	0
In situ leaching	3 427	696	634	559	5 316	600
Co-product/by-product	34 875	2 868	3 379	3 344	44 466	3 400
Total	131 800	7 593	8 602	8 433	156 428	8 500

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	131 800	7 593	8 602	8 433	156 428	8 500
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	131 800	7 593	8 602	8 433	156 428	8 500

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	85 246	4 029	4 589	4 530	98 394	4 500
Sandstone	3 427	696	634	559	5 316	600
Hematite breccia complex	34 875	2 868	3 379	3 344	44 466	3 400
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	721	0	0	0	721	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	7 531	0	0	0	7 531	0
Other*	0	0	0	0	0	0
Total	131 800	7 593	8 602	8 433	156 428	8 500

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
0	0	2 547	30.2	0	0	5 886	69.8	8 443	100

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	NA	302	385	374
Employment directly related to uranium production	NA	3 010 *	3 347 *	3 173 *

* Figures are estimated and take into account total employment at BHP Billiton's Olympic Dam operations also including contractors employed at the mine. A breakdown of employees working for BHPB's uranium mining operations was not available.

NA Not available.

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
9 700	9 700	9 700	9 700	10 100	10 100	10 100	16 600	10 100	21 500	10 100	24 200

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
10 100	25 800	10 100	27 900	9 800	25 400	9 800	27 600	9 800	25 400	9 800	27 600

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	NA	0	0	NA	NA
Utility	0	0	0	0	0
Total	0	0	0	0	0

NA Not available.

• Botswana •

URANIUM EXPLORATION

Historical review

Prospecting dates date back to before the 80s but there has been no mining so far as there are no significant discoveries.

Recent and ongoing uranium exploration activities

Of the total of 178 Prospecting Licences in Botswana, 106 are currently active while 72 are waiting to be issued.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in BWP	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	2 384 343.14	Not yet reported
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	2 384 343.14	NA
Industry* exploration drilling (m)	NA	NA	NA	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	NA	NA	NA	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	NA	NA	NA	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Uranium exploration and development expenditures (non-domestic)

NIL.

Identified Conventional Resources (RAR &Inferred)

Although one or two companies have recently been reporting some findings, these resource figures have not yet been developed to the standards required for inclusion in the Red Book.

Undiscovered Conventional Resources (Prognosticated & SR)

NIL.

Unconventional Resources and other materials

NIL.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Environmental impact assessment study is currently ongoing for the purposes of application for a Uranium Mining License by one of the companies operating in Botswana.

NATIONAL POLICIES RELATING TO URANIUM

Regulations for uranium mining and milling are being drafted.

• Brazil •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

No exploration work was conducted in the period of 2005-2008. For 2009, drilling and other development activities in the Lagoa Real province are planned to confirm the extent of the Cachoeira and Engenho deposits. These activities include the ramp construction for the UG operation of the Cachoeira mine scheduled to begin in 2011.

Geological mapping of new targets in Bahia State is also planned to the end of 2009.

In the Rio Cristalino area, State of Pará, some exploration work such as trenching and processing tests are also planned.

URANIUM RESOURCES

Brazil's conventional identified and undiscovered uranium resources are hosted in the following deposits:

- Poços de Caldas (Osamu Utsumi Mine) with the orebodies A, B, E and Agostinho (collapse breccia pipe-type).
- Figueira and Amorinópolis (sandstone).
- Itataia, including the adjoining deposits of Alcantil and Serrotes Baixos (metasomatic).
- Lagoa Real, Espinharas and Campos Belos (metasomatic-albititic).
- Others including the Quadrilátero Ferrifero with the Gandarela and Serra des Gaivotas deposits (quartz pebble conglomerate).

Identified Conventional Resources (RAR & Inferred)

No additional data was produced in the period 2007-2008.

Undiscovered Conventional Resources (Prognosticated and SR)

No changes repo1rted since the 2007 edition of the red Book.

URANIUM PRODUCTION

The Poços de Caldas uranium facility was closed in 1997. A remediation/restoration study is being carried out. This industrial facility was used to produce rare earth compounds from monazite treatment until 2006. This operation is now closed for market reasons.

The Caetité Unit (Lagoa Real) started production in 2000, with 340 tU/yr nominal capacity.

Uranium production centre technical details
(as of 1 January 2009)

	Centre # 1	Centre # 2
Name of production centre	Caetité	St. Quitéria/Itataia
Production centre classification	Existing	Committed
Start-up date	1999	2012
Source of ore:		
• Deposit name	Cachoeira	St.Quitéria
• Deposit type	Metasomatite	Metamorphic/Phosphorite
• Reserves (tU)	12 700	76 100
• Grade (% U)	0.3	0.08
Mining operation:		
• Type (OP/UG/ISL)	OP	OP
• Size (t ore/day)	1 000	6 000
• Average mining recovery (%)	90	90
Processing plant (acid/alkaline):		
• Acid/Alkaline		
• Type (IX/SX)	HL/SX	
• Size (t ore/day)		
• Average process recovery (%)	80	
Nominal production capacity (tU/year)	340	1 000
Plans for expansion	Yes	Yes
Other remarks		By product Phosphoric acid

NA Not available.

Brazil

Status of production capability

The expansion of Caetité plant is underway and when completed, will double the nominal capacity to 670 tU/yr by the end of 2010. In 2011, the open pit of Cachoeira deposit will be replaced by an underground operation.

Ownership structure of the uranium industry

The Brazilian uranium industry is 100% government-owned through Indústrias Nucleares do Brasil S/A (INB).

Employment in the uranium industry

Employment in uranium supply in Brazil amounts to over 600 persons.

Future production centres

Development of the St. Quitéria Project, sited in Itataia phosphate/uranium deposit, is in progess. The partnership agreement with a Brazilian fertiliser producer is in the final stage. The start-up date is now scheduled in 2012 with nominal capacity of 1 000 tU/yr.

Secondary sources of uranium

None reported.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Government policies and regulations

Government policies and regulations are established by Comissão Nacional de Energia Nuclear – CNEN (Brazilian Nuclear Energy Commission), and include a standard "Diretrizes Básicas de Radioproteção" (Radioprotection Basic Directives) – NE-3.01, and two specific standards on licensing of mines and mills of uranium ores, named NE-1.13 – Licenciamento de Minas e Usinas de Beneficiamento de Minérios de Urânio ou Tório, and on tailings ponds decommissioning: Segurança de Sistema de Barragem de Rejeito Contendo Radionuclídeos (Safety of Radionuclide Bearing Tailings Pond Systems) NE-1.10, and a standard for conventional mining and millings industry with U and Th associated (NORM and TENORM), Requisitos de Segurança e Proteção Radiológica para Instalações Mínero-Industriais – NM-4.01. In the absence of specific norm ICRP and IAEA recommendations are used.

Licenses are issued by the "Institute of the Environment and Renewable Natural Resources" – IBAMA, according to Brazilian environment law and CNEN regulations.

The closure of Poços de Caldas Unit in 1997 brought to an end the exploitation of a low-grade ore deposit, which produced vast amounts of waste rock. The closure, remediation and restoration actions are still under development. Several studies have been carried out to characterise geochemical

and hydrochemical aspects of the effects that waste rock and tailings dam may have had on the environment to establish the necessary mitigation measures.

The licensing of St. Quitéria project is split into a non nuclear part involving milling and phosphate production which has a construction permit issued in 2005. Regarding the nuclear part, INB is discussing its terms with the federal regulatory body IBAMA/CNEN.

URANIUM REQUIREMENTS

Brazil's present uranium requirements for the Angra I nuclear power plant, a 630 MWe PWR, are about 150 tU/yr. The Angra II nuclear power plant, a 1.245 MWe PWR, requires 300 tU/yr. In addition, start-up of Angra III (similar to the Angra II nuclear power plant), expected around 2014, will add another 300 tU/year to the annual demand.

The long term electric energy supply plan includes the construction of four new 1 000 MWe nuclear power plants by 2030.

Supply and procurement strategy

All domestic production is destined for internal requirements. The shortfall between demand and production is met through purchases.

The planned production increase is intended to meet all reactor requirements, including the Angra III unit and the planned expansion of nuclear energy electricity generation.

NATIONAL POLICIES RELATING TO URANIUM

INB, a 100% government-owned company, is in charge of fuel cycle activities and working to increase its production so as to meet the future uranium demand.

Besides the expansion of Caetité/Lagoa Real centre, INB's focus is on the St. Quitéria project, Ceará State.

URANIUM STOCKS

None reported.

URANIUM PRICES

None reported.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in thousand BRL	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	0	0	0	1 200
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	9 000
Total expenditures	0	0	0	10 200
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	1000
Government development holes drilled	0	0	0	NA
Subtotal exploration drilling (m)	0	0	0	0
Subtotal exploration holes drilled	0	0	0	0
Subtotal development drilling (m)	0	0	0	1 000
Subtotal development holes drilled	0	0	0	NA
Total drilling (m)	0	0	0	1 000
Total holes drilled	0	0	0	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	58 300	58 300	58 300	58 300	80
Open-pit mining	10 500	10 500	10 500	10 500	80
In situ leaching	0	0	0	0	
Co-product and by-product*	71 100	88 900	88 900	88 900	70
Unspecified	0	0	0	0	
Total	139 900	157 700	157 700	157 700	

* Recovery from phosphoric acid.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	64 800	64 800	65 800	64 800	80
In-place leaching*	0	0	0	0	
Heap leaching**	4 000	4 000	4 000	4 000	80
Unconventional***	71 100	88 900	88 900	88 900	70
Total	139 900	157 700	157 700	157 700	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** A co-product from phosphoric acid production from a specific deposit – St. Quitéria (metamorphic – metasomatic/phosphorite).

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	86 300	104 100	104 100	104 100
Other*	53 600	53 600	53 600	53 600
Total	139 900	157 700	157 700	157 700

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	2 400	2 400	2 400	70
In situ leaching	0				
Co-product and by-product	0	31 200	78 600	78 600	70
Unspecified	0	40 000	40 000	40 000	70
Total	0	73 600	121 000	121 000	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	2 400	2 400	2 400	70
In-place leaching*	0	0	0	0	0
Heap leaching**	0	0	0	0	0
Unconventional***	0	31 200	78 600	78 600	70
Unspecified	0	40 000	40 000	40 000	70
Total	0	73 600	121 000	121 000	70

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** A co-product from phosphoric acid production from a specific deposit – St. Quitéria (metamorphic – metasomatic/phosphorite).

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	7 600	7 600	7 600
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	8 900	8 900	8 900
Vein	0	600	600	600
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	6 000	53 400	53 400
Other*	0	50 500	50 500	50 500
Total	0	73 600	121 000	121 000

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
300 000	300 000	300 000

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
NA	NA	500 000

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining *	2 009	200	300	330	2 839	340
Underground mining *	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	2 009	200	300	330	2 839	340

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	1 097	0	0	0	1 097	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	912	200	300	330	1 742	340
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	2 009	200	300	330	2 839	340

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	1 097	0	0	0	1 097	0
Metasomatite	912	200	300	330	1 742	340
Other*	0	0	0	0	0	0
Total	2 009	200	300	330	2 839	340

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Brazil

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
330	100	0	0					330	100

Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres	580	580	640	640
Employment directly related to uranium production	340	340	340	340

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	A-I	B-I	A-II	A-I	B-I	A-II	A-I	B-I	A-II
340	340	340	340	1 600	1 600	1 600	1 600	2 000	2 000	2 000	2 000

2025				2030				2035			
A-I	B-I	A-II	A-I	B-I	A-II	A-I	B-I	A-II	A-I	B-I	A-II
2 000	2 000	2 000	2 000	NA	NA	NA	NA	NA	NA	NA	NA

Net nuclear electricity generation

	2007	**2008**
Nuclear electricity generated (TWh net)	12.365	14.003

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 875	1 875	1 875	1 875	1 875	3 120

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 120	4 120	3 120	5 120	3 120	7 120	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
450	450	450	450	450	750

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
750	1 000	750	1 250	750	1 750	NA	NA

• Bulgaria •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration activities

Uranium exploration activities were terminated in 1990.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Identified Conventional Resources as of 1 January 1991 amounted to 20 565 tU. It should be mentioned that they were categorised at that time as economically and ecologically unprofitable.

For some of these deposits, resources have been recalculated following reports submitted to the Specialised Expert Committee on reserves and resources (SEC) within the Ministry of Environment and Waters. The balance of uranium resources as of 1 January 2009 was compiled based on data included in these reports and the last report of Redki Metali (as of 1 January 1991). Recalculated Identified Conventional Resources of uranium in Bulgaria amount at 19 809 tU, 11 908 tU of which are in the underground production category and 7 901 tU are amenable to *in situ* leach (ISL) production.

The portion amenable to underground mining refers to 67 different sites (locations) where insignificant quantities were detected. Therefore, these are considered non-technological and uneconomic for production.

Again, based on data from SEC, resources amenable to ISL amount to 7 901 tU. During production in 1991 the mean recovery factor of 65% was achieved based on experience in 16 sites. To date, no official estimates of the cost of production have been performed.

Undiscovered Conventional Resources (Prognosticated & SR)

Prognosticated Conventional Resources are estimated to amount to about 25 000 tU.

Unconventional Resources and other materials

No Unconventional Resources have been identified.

URANIUM PRODUCTION

Historical review

Up to 1990, 60 000 tonnes of uranium deposits were discovered and about 16 500 tU was produced. The production followed an ascending rate from 150-200 tU/year in the 1950s to 430 tU/year in 1975. The adoption of ISL mining of the Upper Thracian deposits raised the production to 660 tU in 1989, when 70% of the uranium was produced by ISL. Ores were processed in two hydro-metallurgical plants. Uranium extraction and processing of pregnant ISL resins was done at the Zvezda plant near Eleshnitsa, where U_3O_8 (80-82% concentration; 68-70% U) was produced.

The main ore deposits for underground mining were: Buhovo near Sofia; Eleshnitsa, Senokos and Simitli in South-western Bulgaria; Vinishte and Smolyanovtsi in North-western Bulgaria; Sliven in Central Bulgaria; and Smolyan, Dospat and Selishte in the Rhodopa Moutains. Ore bodies vary from 50 m to 600 m in length and from 2 m to 100 m in width. Uranium grades vary from 0.03%U to 0.3%U. Heap leaching was used in these underground mines.

ISL mining has been used in favourable conditions since 1969. Deposits suited for ISL mining are located in regions of the Upper Thracian, the Struma and the Dospat River valleys, where ore deposits occur at a depth of 30 to 250 m below surface and thicknesses vary between 10 m to 80 m. Uranium mineralisation is also situated in mainly Pliocene sands, clayey in places, where thicknesses vary from 0.4 m to 8 m. Ore grades are variable, but the mean value is about 0.03% U.

All production activities were conducted by state-owned entities.

Production of uranium ores and uranium in Bulgaria for the period 1946-1990

Year	Ore (tU)	U (%)	Uranium (kg)				
			Classic production	Combination method *	*In situ*	U from water	Total
1946	12 800	0.227	29 100	0	0	0	29 100
1947	36 000	0.081	29 100	0	0	0	29 100
1948	21 600	0.119	25 600	0	0	0	25 600
1949	28 300	0.122	34 400	0	0	0	34 400
1950	36 900	0.213	78 600	0	0	0	78 600
1951	66 400	0.193	128 100	0	0	0	128 100
1952	105 800	0.159	168 100	0	0	0	168 100
1953	119 500	0.141	167 900	0	0	0	167 900
1954	158 000	0.099	157 200	0	0	0	157 200
1955	180 900	0.116	209 200	0	0	0	209 200
1956	236 600	0.124	294 290	0	0	0	294 290
1957	271 900	0.118	321 450	0	0	0	321 450

Production of uranium ores and uranium in Bulgaria for the period 1946-1990 (contd.)

1958	245 200	0.107	263 150	0	0	0	263 150
1959	259 900	0.110	285 860	0	0	0	285 860
1960	308 800	0.105	324 620	0	0	0	324 620
1961	378 900	0.101	382 220	0	0	0	382 220
1962	437 200	0.098	430 620	0	0	0	430 620
1963	463 800	0.094	435 220	0	0	0	435 220
1964	527 800	0.088	464 180	0	0	0	464 180
1965	541 200	0.074	402 830	0	0	0	402 830
1966	541 700	0.067	363 910	0	0	0	363 910
1967	578 000	0.066	380 140	0	0	0	380 140
1968	557 900	0.064	356 480	0	0	0	356 480
1969	550 400	0.063	349 460	0	7 650	0	357 110
1970	485 400	0.060	291 450	880	17 460	0	309 790
1971	438 700	0.055	240 290	10 170	63 850	0	314 310
1972	387 500	0.061	234 770	18 960	87 080	0	340 810
1973	460 800	0.059	272 620	21 210	87 130	0	380 960
1974	521 000	0.057	296 870	21 440	88 810	0	407 120
1975	549 100	0.056	307 440	19 330	106 580	0	433 350
1976	566 300	0.053	300 920	19 070	118 900	0	438 890
1977	600 000	0.050	297 790	18 580	140 770	0	457 140
1978	623 152	0.047	295 746	18 380	167 350	1 760	483 236
1979	621 450	0.047	295 040	18 070	180 260	2 420	495 790
1980	614 400	0.050	308 000	19 060	194 970	2 450	524 480
1981	575 500	0.049	284 260	30 560	201 910	0	516 730
1982	532 000	0.049	260 140	32 270	221 010	1 110	514 530
1983	582 600	0.043	250 090	35 440	243 430	1 360	530 320
1984	590 000	0.043	252 580	28 690	261 760	770	543 800
1985	584 300	0.040	235 630	34 710	274 370	60	544 770
1986	578 200	0.039	224 140	49 340	312 390	0	585 870
1987	645 900	0.039	249 850	38 710	360 280	0	648 840
1988	601 100	0.037	224 000	47 220	396 430	0	667 650
1989	470 600	0.041	192 400	36 920	415 610	0	644 930
1990	342 100	0.038	130 380	29 850	323 770	0	484 000
Total	18 035 602	0.064	11 526 136	548 860	4 271 770	9 930	16 356 696

* In place or heap leaching.

Status of production facilities

At present no uranium production centres exist. If uranium production plans are re-considered, all processes and facilities will have to be built by private operators.

On the territory of the former uranium ore processing plant, Zvezda, an installation for ion-exchange resins, used to purify uranium contaminated mining waters, is in operation. It is a small capacity installation that can process about 742 m^3 of resins per year.

As a result of the purification from uranium of mining waters released to the surface, the final product yellow cake is obtained (ammonium uranium-3-carbonate (AUTC) $NH_4UO_2(CO_3)_3$).

The obtained quantities amounted to:

Period of production	Net quantity $NH_4UO_2(CO_3)_3$. [kg]	U content [%]	U content [kg]
Until 31.12.2006	5 707	42.4	2 408.1325
For 2007	3 850	46.35	1 785.6385
For 2008	1 526	45.93	700.9003
For 2009	3 814	44.16	1 684.2318
Until 04.12.2009 (total)	14 897	44.71	6 578.9031

The quantities of final product (yellow cake) obtained are stored at the site, with appropriate measures for physical protection. Bulgaria is in the process of seeking a customer interested in purchasing these quantities.

Since 1992, only activities concerning dismantling facilities, closing mining works, re-cultivation of contaminated areas, purification of uranium contaminated mining waters and environmental monitoring have been conducted.

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

Uranium production and processing in the Republic of Bulgaria was ceased by government decree No. 163 of 20 August 1992.

Remediation activities of uranium production and processing facilities include: technical liquidation, technical and biological re-cultivation, purification of uranium contaminated mining waters and environmental monitoring of areas affected by mining.

At this time, technical remediation of all sites mentioned in the governmental decree (54 in total) has been completed. Following 37 re-cultivation projects, 1 172.7 ha of agricultural lands were returned to their owners after remediation was approved by the appropriate land property commissions. Risk assessment and categorisation has been completed for 48 facilities.

The total financial resources spent on the implementation of the government decrees No. 163 of 20 August 1992, No. 56 of 29 March 1994, No. 213 of 9 September 1995 and No. 74 of 27 March 1998 on ending uranium production and processing, according to the Ministry of Financial Affairs amounted to BGN 35 653 200 as shown below:

Year	Bulgarian levs (BGN)
1992	317 324
1993	408 398
1994	497 175
1995	442 300
1996	400 745
1997	1 702 465
1998	1 888 558
1999	3 765 522
2000	4 365 059
2001	3 479 790
2002	1 800 090
2003	1 733 632
2004	3 676 429
2005	2 101 131
2006	2 718 358
2007	3 354 010
2008	3 002 214
TOTAL	35 653 200

At this time, the majority of the environment remediation of uranium mining impacts is considered complete. However, a project on sealing and re-cultivation of the tailings facilities and adjoining areas in Buhovo is forthcoming. Similar projects at other sites where geological exploration activities were conducted and small quantities of uranium were produced are also forthcoming. The total price of these remaining projects is expected to amount to BGN 6 million.

URANIUM REQUIREMENTS

Nuclear power in Bulgaria contributes significantly to meeting the required electricity energy of the country and the surrounding regions. For the last ten years, Kozloduy nuclear power plant (KNPP) has been providing 40-47% of the average annual electricity production in the Republic of Bulgaria.

The energy strategy of Bulgaria adopted in 2002 envisages maintaining the share of nuclear electricity at this level. This strategy will be implemented through lifetime extension of the nuclear units in operation and construction of new nuclear power plants. Nuclear energy is – and will continue to be – part of the solution to meet Bulgaria's energy needs while reducing greenhouse gas emissions.

On 31 December 2006, Bulgaria shut down Units 3 and 4 of KNPP as part of Bulgaria's EU Accession Treaty.

The country plans to launch the construction of new reactors. The public opinion in Bulgaria is favourable, with more than 70% of the population supporting further development of nuclear energy. Planning analysis concludes that an additional 1 000 to 2 000 MWe of base load electrical generation will be required to meet projected demand between 2010 and 2015.

In April 2004, the Bulgarian Government approved in principle the continuation of the construction activities at the Belene site, based on the conclusion that nuclear energy is the main and most efficient way to meet Bulgaria's future electricity needs. Nuclear power also provides high reliability and economic electricity generation, security of supply and implementation of international agreements on environmental protection.

On 21 December 2004, the Nuclear Regulatory Agency (NRA) Chairman signed a permit to the NEC for selection of a site for construction of a new NPP.

In April 2005, the Council of Ministers by Decision No. 260 approved the construction of a new NPP at Belene site.

On 30 October 2006, following a decision of the Board of Directors of NEK EAD, Atomstroyexport JSC was selected as the winning bid in the tender for the construction of two 1 000 MW units B 466 type, with a total price up to EUR 3 997 260 billion and term of construction of six and a half years for Unit 1 and seven and a half years for Unit 2.

On 29 November 2006, Atomstroyexport JSC and NEC EAD, signed an Agreement for construction of Belene NPP. Preparation works for the construction of both reactors started in 2008 (Demolition of the former 1st unit building, construction of administrative buildings). Expected commissioning of the first unit was planned for 2013-2014. On 21 December 2006 the NRA Chairman approved the Belene site for construction of a new NPP.

By the end of 2009 the Belene NPP project is under review. It is expected that this process will result in a delay of construction and the respective commissioning of Belene NPP units.

Since the end of 2004, when Units 1 and 2 of Kozloduy NPP were shut down, Bulgaria's uranium requirements diminished by about 250 tU/yr. This trend continues after the shutdown of Units 3 and 4 of KNPP on 31 December 2006. From 2007 to 2010, the country's uranium requirements are expected to remain unchanged, related only to fuel supply for Units 5 and 6 of KNPP (253 tU/yr). For the commissioning of Unit 1 of Belene NPP uranium requirements will rise to about 814 tU for the first core load. After the commissioning of the second 1 000 MW unit, uranium requirements will rise by 75% compared to 2007-2008, according to the fuel needs specified for WWER 1000/B446.

Supply and procurement strategy

Bulgaria imports nuclear fuel needed for the operation of KNPP. The Kozloduy NPP fuel cycle includes all stages (uranium purchase, conversion, enrichment, fabrication, interim storage, spent fuel transportation, reprocessing and used fuel disposal) based on the agreement between the Republic of Bulgaria and the Russian Federation according to long term commercial contracts for fuel supply and spent fuel reprocessing.

The contract was concluded after a tender procedure in 2002 with the Russian company TVEL as the supplier. The quantities and terms of delivery are contracted on annual basis.

Bulgarian nuclear power plant Kozloduy has signed an Annex in 2006 to its existing long-term contract from 2002 for supply of nuclear fuel for Units 5 and 6 with TVEL until 2020, providing added security of supply assurance.

Bulgaria

NATIONAL POLICIES RELATING TO URANIUM

No changes of the legal basis related to uranium have occurred in the last two years.

At this time, Bulgaria does not intend to renew uranium mining activities but, considering the construction of the Belene NPP project, this policy may be altered.

URANIUM STOCKS

No changes in the uranium stock levels.

URANIUM PRICES

Following the Annex to the contract for fuel supply signed in 2006, from 2008 the prices of the spent fuel will be negotiated in three-year intervals.

Prognosticated Conventional Resources (tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	25 000	25 000

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	15 798	0	0	0	15 798	0
In-place leaching*	549	0	0	0	549	0
Heap leaching**	NA	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	10	2	2	1	10	2
Total	16 357	2	2	1	16 362	2

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	13.693	14.742

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
2 000	2 000	2 000	NA	NA	4 000*

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
4 000	NA	4 000	NA	4 000	NA	4 000	NA

* Due to the delay in construction of the two 1 000 MWe units, the indicated installed capacity in 2015 may be lower.

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
253	253	253	NA	1 067*	NA

* If first unit of Belene now under construction is commissioned.

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
443	NA	443	NA	443	NA	443	NA

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	0	0	0	0	0
Utility	0	80.7	0	0	80.7
Total	0	80.7	0	0	80.7

• Canada •

URANIUM EXPLORATION

Historical review

See the 2007 Red Book for a short historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

During 2007 and 2008, exploration efforts continued to focus on areas favourable for the occurrence of deposits associated with Proterozoic unconformities in the Athabasca Basin of Saskatchewan, and to a lesser extent, similar geologic settings in the Thelon and Hornby Bay Basins of Nunavut and the Northwest Territories. Uranium exploration also remained very active in the Otish Mountains of Quebec where Strateco Resources Inc. has applied for a licence to conduct underground exploration on the Matoush deposit. Exploration activity in the Central Mineral Belt of Labrador, where Aurora Energy Resources Inc. is proposing to develop the Michelin and Jacques Lake deposits, reduced significantly after April 2008 when the regional aboriginal government imposed a three-year moratorium on uranium mining on their lands. The significant drop in the uranium spot price in the second half of 2007 triggered a decrease in exploration activity in other areas of Canada.

Surface drilling, geophysical surveys and geochemical surveys continued to be the main tools used to identify new uranium occurrences, define extensions of known mineralised zones and to reassess deposits which were last examined in the 1970s and 1980s.

The recent increased exploration activity has led to new uranium discoveries in the Athabasca Basin. Notable high-grade uranium mineralisation discoveries include Centennial (UEM Inc.), Shea Creek (AREVA Resources Canada Inc., or AREVA), Wheeler River (Denison Mines Inc.), Midwest (AREVA) and Roughrider (Hathor Exploration Ltd.).

Domestic uranium exploration expenditures were CAD 378 million in 2008, down 8.5% from the peak in exploration expenditures of CAD 413 million that occurred in 2007. Uranium exploration and development drilling totalled 821 300 m in 2008, compared to the record 853 200 m that was reported in 2007. Over 60% of the combined exploration and development drilling in 2007 took place in Saskatchewan.

In 2008, overall Canadian uranium exploration and development expenditures amounted to CAD 506 million. Less than one-third of the overall exploration and development expenditures in 2008 can be attributed to advanced underground exploration, deposit appraisal activities, and care and maintenance expenditures associated with projects awaiting production approvals.

URANIUM RESOURCES

Identified Conventional Resources (RAR &Inferred)

As of 1 January 2009, Canada's total identified conventional uranium resources recoverable at a cost of <USD 80/kgU amounted to 447 400 tU, an increase of 5% from the 2007 estimate of 423 200 tU. Canada's total identified uranium resources recoverable at a cost of <USD 130/kgU amounted to 485 300 tU as of 1 January 2009, an increase of 15% compared to 2007 (423 200 tU). This increase in identified uranium resources is primarily due to junior mining companies reporting National Instrument (NI) 43-101 compliant resource assessments for deposits which were discovered in the 1970s and 1980s and are being re-examined as a result of higher uranium prices. Most of Canada's identified uranium resources are re-evaluated annually by the uranium mining companies.

The bulk of Canada's identified conventional uranium resources occur in Proterozoic unconformity-related deposits in the Athabasca Basin of Saskatchewan and the Thelon Basin of Nunavut. These deposits host their mineralisation near the unconformity boundary in either monometallic or polymetallic mineral assemblages. Pitchblende prevails in the monometallic deposits, whereas uranium-nickel-cobalt assemblages prevail in the polymetallic assemblages. The average grade varies from 1%U to over 15%U. None of the uranium resources referred to or quantified herein are a co-product or by-product output of any other mineral of economic importance. Mining losses (~20%) and ore processing losses (~3%) were used to calculate known conventional resources.

All of Canada's identified conventional uranium resources recoverable at <USD 40/kgU are in existing or committed production centres. The percentage of identified conventional uranium resources in existing or committed production centres that are recoverable at <USD 80/kgU, <USD 130/kgU and <USD 260/kgU are 82%, 75% and 69%, respectively. Less than 8% of the identified conventional uranium resources recoverable at <USD 260/kgU are currently not available for mining due to a temporary three-year moratorium that was enacted in 2008 by the Nunatsiavut Assembly, the legislative branch of Labrador's regional aboriginal government.

Undiscovered Conventional Resources (Prognosticated and SR)

Prognosticated and Speculative Resources have not been a part of recent resource assessments; hence there are no changes to report in these categories since 1993.

URANIUM PRODUCTION

Historical review

See the 2007 Red Book for a short historical review of uranium production.

Status of production capability and recent and ongoing activities

Overview

Since the last Elliot Lake production facility closed in 1996, all active uranium production centres are located in northern Saskatchewan. Current Canadian uranium production remains below full production capability. In 2008, production was 9 000 tU, 5% below 2007 production,

owingprimarily to a 10% reduction in output from the McArthur River mine. In 2009, Canadian uranium production is expected to increase to 9 900 tU.

Cameco Corporation is the operator of the McArthur River mine, a Cameco (70%), AREVA (30%) joint venture. Production at this, the world's largest high-grade uranium mine, was 7 085 tU and 6 313 tU in 2007 and 2008, respectively. After raise bore mining of the high-grade ore behind a freeze curtain created to control groundwater inflow, high-grade ore slurry is produced by underground crushing, grinding and mixing. The slurry is then pumped to the surface and loaded on specially-designed containers that are trucked 80 km to Key Lake, where all McArthur River ore is milled.

The Key Lake mill is a Cameco (83%) and AREVA (17%) joint venture operated by Cameco. Although mining at Key Lake was completed in 1997, the mill maintained its standing as the world's largest uranium production centre by producing 7 199 tU and 6 383 tU in 2007 and 2008, respectively. These totals represent a combination of high-grade McArthur River ore slurry and stockpiled, mineralised Key Lake special waste rock that is blended to produce a mill feed grade of about 3.4% U. A proposal to increase production at McArthur River and Key Lake by some 18% annually (from 7 200 tU/yr to 8 500 tU/yr) is currently being reviewed by the federal nuclear regulator, the Canadian Nuclear Safety Commission (CNSC).

The McClean Lake production centre, operated by AREVA, is a joint venture between AREVA (70%), Denison Mines Inc. (22.5%), and OURD (Canada) Co. Ltd., a subsidiary of Overseas Uranium Resources Development Corporation of Japan (7.5%). Production in 2007 and 2008 amounted to 734 tU and 1 249 tU, respectively. The increase in production is a result of higher grade ore being milled. Modifications to the mill to increase capacity to 4 600 tU/yr and to process ore from the Cigar Lake mine are nearing completion. Mining at the Sue E and B pits was completed in 2008 and about 375 600 t of ore containing 2 500 tU was stockpiled to provide mill feed for the next few years. Mining of the Caribou deposit, which was expected to commence in 2009 and is undergoing an environmental assessment, will be delayed for at least a year due weakening uranium prices affecting the economic viability of the deposit.

The Rabbit Lake production centre, wholly-owned and operated by Cameco, produced 1 544 tU and 1 368 tU in 2007 and 2008, respectively. The decline in 2008 production was due to the milling of lower grade ore. Exploratory drilling in the Eagle Point mine during 2007 and 2008 delineated additional assured resources, extending the life of the mine. Cameco has indicated that it intends to continue the exploratory drilling at the Eagle Point mine in 2009.

Cigar Lake, with identified resources of 88 200 tU at an average grade of approximately 16%U, is the world's second-largest high-grade uranium deposit. The mine is a Cameco (50.025%), AREVA (37.1%), Idemitsu (7.875%) and TEPCO (5%) joint venture operated by Cameco. When completed, the mine is expected to have a full annual production capacity of 6 900 tU. About half of the first phase of Cigar Lake ore will be shipped as a uranium-rich solution from the McClean Lake mill to the Rabbit Lake mill for final processing.

Construction of the Cigar Lake mine began on 1 January 2005, with completion originally expected in 2007. During October 2006, construction was halted due to a major inflow of groundwater that could not be controlled and the mine became flooded. Remediation of the mine is progressing slowly. Cameco conducted work to seal off the breach, however when de-watering the mine in 2008, a second inflow of groundwater occurred and operations were halted. Cameco is conducting investigations into the cause of the latest inflow before continuing with remediation. Production from the mine is not expected until 2012 at the earliest.

Uranium production centre technical details
(as of 1 January 2009)

	Centre # 1	Centre # 2	Centre # 3	Centre # 4	Centre # 5
Name of production centre	McArthur River/ Key Lake	McClean Lake	Rabbit Lake	Cigar Lake	Midwest
Production centre classification	Existing	Existing	Existing	Committed	Planned
Start-up date	1999/1983	1999	1975	2012	NA
Source of ore:					
• Deposit name	P2N *et al.*	JEB, McClean, Sue A-E, Caribou	Eagle Point	Cigar Lake	Midwest
• Deposit type	Unconformity	Unconformity	Unconformity	Unconformity	Unconformity
• Resources	145 200 tU	8 900 tU	8 000 tU	88 200 tU	16 700 tU
• Grade (% U)	15.0	1.22	0.79	16.0	4.4
Mining operation:					
• Type (OP/UG/ISL)	UG	OP/UG	UG	UG	OP
• Size (t ore/day)	NA	NA	NA	NA	NA
• Average mining recovery (%)	NA	NA	NA	NA	NA
Processing plant (acid/alkaline):				to be processed at McClean Lake and Rabbit Lake	to be processed at McClean Lake
• Acid/Alkaline	Acid	Acid	Acid		
• Type (IX/SX/AL)	SX	SX	SX		
• Size (t ore/day)	750	300	2 300		NA
• Average process recovery (%)	98	97	97	NA	NA
Nominal production capacity (tU/year	7 200	3 077	4 615	6 294	2 300 (est)
Plans for expansion		relates to Cigar Lake	relates to Cigar Lake		

Ownership structure of the uranium industry

As noted above, Cameco Corporation and AREVA Canada Resources Inc. (AREVA) are the majority owners and operators of the uranium production centres now in operation. Denison Mines Inc. and OURD (Canada) Co. Ltd. are minority owners of the McClean Lake production centre, while Idemitsu and TEPCO are joint venture partners of the Cigar Lake mine.

Employment in the uranium industry

Direct employment in Canada's uranium industry totalled 1 294 in 2007 and 1 316 in 2008. Total employment, including head office and contract employees, was 1 873 in 2007 and 1 984 in 2008.

Future production centres

Two uranium mining projects in Saskatchewan could enter into production within a few years, extending the lives of existing production centres. Cigar Lake ore will provide feed for the McClean Lake and Rabbit Lake mills and Midwest ore will provide additional feed for the McClean Lake mill. In addition, several exploration projects in the Athabasca Basin have resulted in the identification of significant high-grade uranium mineralisation that may develop into proposals for new mines.

There is also the possibility of mines being developed outside of Saskatchewan. A proposal by AREVA to develop the Kiggavik and Sissons deposits in Nunavut is currently undergoing an environmental assessment as well as a feasibility study. Strateco Resources Inc. has applied for a licence to conduct underground exploration at the Matoush deposit in Quebec. In Labrador, Aurora Energy Resources Inc. is proposing to develop the Michelin and Jacques Lake deposits and is currently consulting with the community to gain support for the project.

Secondary sources of uranium

Canada reported that there was no production or use of mixed acid fuels nor any production or use of re-enriched tailings.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Environmental Impact Assessments

On August 21, 2009 an environmental assessment of the Millennium Mine Project, which is located in the Athabasca Basin of northern Saskatchewan, began. Cameco Corporation is proposing to develop the deposit, which contains 18 000 tU at an average grade of 3.85% U, as an underground mine. The proposed mine would produce 150 000 to 200 000 tonnes of ore annually for six to seven years. Ore and associated waste materials would be transported to the Key Lake mill along a new 21 km access road that would connect to the existing road network. Clean waste rock would be stored on-site.

The environmental assessment for the Midwest project, a joint venture between AREVA (69.16%), Denison Mines Inc. (25.17%) and OURD (Canada) Co. Ltd. (5.67%), began on 2 March 2006. The proposal is to mine the Midwest deposit (16 700 tU averaging 4.4% U) by open pit and to transport the ore to McClean Lake for milling. In 2008, AREVA announced a decision to

postponedevelopment of the project, due to low uranium prices, but to continue with the environmental assessment process. If the project receives regulatory approval, and the economics of the project improve, it would take two years to develop the mine and a further two years to mine the ore. Milling of the Midwest ore is expected to take from five to seven years.

On 3 December 2007, AREVA announced a decision to proceed with a two-year feasibility study and to commence the regulatory process to obtain approval for the development of the Kiggavik-Sissons project in Nunavut. Combined, the two deposits contain an estimated 57 000 tU with an average grade of 0.2%U. An environmental assessment of the project will be submitted to the Nunavut Impact Review Board as part of the Canadian Nuclear Safety Commission (CNSC) licensing process.

On 24 October 2008, the CNSC received an application from Strateco Resources Inc., for a licence to conduct underground exploration on the Matoush Project in the Otish Mountains of Quebec. The Matoush deposit has identified resources of 6 500 tU with an average grade of 0.42%U. An environmental assessment of the proposed underground exploration is expected to commence in 2009.

A proposal to increase production at McArthur River and Key Lake by some 18% annually (from 7 200 tU/yr to 8 500 tU/yr) is the subject of an environmental assessment that was initiated in January 2003. Increased production at McArthur River requires changes to manage additional waste rock, mineralised waste and mine water flow. The means to address the associated increased rate of tailings accumulation and treated effluent at the Key Lake mill also will be considered in this assessment.

On 4 July 2005, Cameco applied for an amendment to an existing licence to authorise an increase in the production capacity of the Blind River Refinery from 18 000 tU/yr to 24 000 tU/yr as uranium trioxide. On 24 October 2008, the environmental assessment was completed and the proposal is currently undergoing licensing.

Regulatory activities

On 1 October 2007, the Government of Canada announced the establishment of the Major Projects Management Office (MPMO). The role of the MPMO is to provide overarching project management and accountability for major resource projects in the federal regulatory review process, including uranium mines and mills, and to facilitate improvements to the regulatory system for major resource projects.

Decommissioning

Elliot Lake, Ontario was the major uranium mining centre in Canada for over 40 years. After mining operations ended in the 1990s, the companies that conducted the mining have committed well over CAD 75 million to decommission all mines, mills and waste management areas. These same companies continue to commit some CAD 2 million each year for treatment and monitoring activities.

In 2007 and 2008, water treatment and minor engineering works continued to be the main activities at the closed Elliot Lake area uranium mine and mill sites. In October 2008, the State of Environment (SOE) report noted that water quality within the Serpent River Watershed has improved since the closure and decommissioning of the mines and that it currently meets Ontario Drinking Water Standards.

The Cluff Lake mine, located in the western Athabasca Basin of Saskatchewan, ceased mining and milling operations in May 2002. A two-year decommissioning program was initiated in 2004, following a five year comprehensive study environmental assessment. Decommissioning was essentially completed by 2006 and AREVA continues to work on site restoration activities, such as the planting of tree seedlings. A follow-up monitoring program is in place to confirm that the objectives of the decommissioning plan are met.

On 2 April 2007, the Government of Canada and the Government of Saskatchewan announced a shared funding commitment for the first phase of the cleanup of closed uranium mines in northern Saskatchewan (principally the Gunnar and Lorado mines). The total cost of the cleanup, which the Governments of Canada and Saskatchewan will share equally, is expected to be CAD 24.6 million.

Although these mines were operated by the private sector from the 1950s until the early 1960s, the companies no longer exist. When the sites were closed, there was no regulatory framework in place to appropriately contain and treat the waste, which has led to environmental impacts on local soils and lakes. The project is now undergoing an environmental assessment.

URANIUM REQUIREMENTS

Canada has 22 CANDU reactors operated by public utilities and private companies in Ontario (20), Quebec (1) and New Brunswick (1). Of these 22 reactors, 17 were in full commercial operation in 2008, generating about 15% of Canada´s total electricity production. Of the 5 reactors which were not operating, two are shut down and three are being refurbished.

Refurbishment projects estimated at over CDN 9 billion are currently underway or have been announced in Ontario (~CDN 6 billion), New Brunswick (~CDN 1.4 billion) and Quebec (~CDN 1.9 billion). Bruce Power's restart and refurbishment program of Bruce A units 1 and 2 has been underway for a few years now. New Brunswick Power began the refurbishment of its sole nuclear reactor in March 2008. These refurbishment projects are progressing, although they have encountered some delays and cost overruns. In 2008, Hydro-Quebec announced that it will proceed with the refurbishment of its nuclear power plant (Gentilly 2) in 2011-2012. Decisions on the refurbishment of additional units are also pending.

New nuclear build projects are also being considered by some public and private companies in Canada. The actual number of new reactor units to be built hinges largely on refurbishment plans for existing units. Although the Government of Ontario had launched a competitive Request for Proposals (RFP) process to build two new reactors at the Darlington site, it decided in June 2009, after receiving a single bid conforming to the RFP, to suspend the process because of pricing concerns. Moreover, in July 2009, Bruce Power withdrew its applications to build new reactors at the Bruce and Nanticoke sites given the decline in the electricity demand in Ontario due to the economic recession. Bruce Power indicated that it will investigate the feasibility of refurbishing Units 3-8 instead. The Government of New Brunswick is examining the feasibility of building a second reactor in the province, while the Government of Alberta and the Government of Saskatchewan are both considering the potential use of nuclear power to meet their future electricity requirements.

Supply and procurement strategy

Ontario Power Generation fills its uranium requirements through long-term contracts with a variety of suppliers, as well as periodic spot market purchases. Since becoming a partner in BrucePower in 2001, Cameco provides all uranium and uranium conversion services, and contracts all required fuel fabrication services, for all of Bruce Power's fuel procurement needs.

NATIONAL POLICIES RELATING TO URANIUM

The *Nuclear Fuel Waste (NFW) Act*, which came into force on 15 November 2002, requires nuclear energy corporations to establish a Nuclear Waste Management Organisation (NWMO) to manage nuclear fuel waste over the long-term. Under the *NFW Act*, the NWMO is required to submit a study of the options for the long-term management of nuclear fuel waste.

On 3 November 2005, the NWMO submitted its report to the federal government for review and consideration. The NWMO recommended an Adaptive Phased Management (APM) which involves centralised containment and isolation of used nuclear fuel in a deep geological repository with the potential to retrieve used fuel until and if a decision is made in the future to seal the facility. The federal government announced its acceptance of the recommendation of the NWMO and selected APM as the preferred approach on 14 June 2007.

The *Nuclear Liability Act (NLA)* sets out a comprehensive scheme of liability for third-party injury and damage arising from nuclear accidents, and a compensation system for victims. It embodies the principles of absolute and exclusive liability of the operator, mandatory insurance, and limitations on the operator's liability in both time and amount. Under the *NLA*, operators of nuclear installations are absolutely liable for third-party liabilities to a limit of CAD 75 million. All other contractors or suppliers are thereby indemnified. A bill to amend the *NLA* has been tabled in Parliament. If passed, these amendments will overhaul the current legislation to better addresses public interests and reflect international standards. Key among the proposed amendments is an increase in the operator liability limit to CAD 650 million.

URANIUM STOCKS

The Canadian government does not maintain any stocks of natural uranium. Producers and utilities do not provide this information as they consider it to be commercially confidential. Since Canada has no enrichment or reprocessing facilities, there are no stocks of enriched or reprocessed material in Canada. Although Canadian reactors use natural uranium fuel, small amounts of enriched uranium are used for experimental purposes and in booster rods in certain CANDU reactors.

URANIUM PRICES

In 2002, Natural Resources Canada suspended the publication of the Average Price of Deliveries under Export Contracts for uranium.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million CAD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	214	413	378	207
Government exploration expenditures	0	0	0	0
Industry* development expenditures	134	157	128	67
Government development expenditures	0	0	0	0
Total expenditures	348	570	506	274
Industry* exploration drilling (m)	424 100	654 900	725 400	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	228 900	198 200	95 900	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	424 100	654 900	725 400	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	228 900	198 200	95 900	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	653 000	853 100	821 300	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	249 536	282 086	285 847	304 732	NA
Open-pit mining	17 542	54 729	75 215	82 710	NA
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	267 078	336 815	361 062	387 442	

Reasonably Assured Conventional Resources by processing method*
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	267 078	336 815	358 601	384 981	98
In-place leaching*			1 461	1 461	70
Heap leaching**			1 000	1 000	70
Total	267 078	336 815	361 062	387 442	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	267 078	336 815	347 141	352 026
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	2 461	2 461
Vein	0	0	1 300	1 300
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	10 160	31 655
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	267 078	336 815	361 062	387 442

* Includes surficial, Collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	99 670	110 560	120 200	145 978	NA
Open-pit mining	0	0	3 993	11 235	NA
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	99 670	110 560	124 193	157 213	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	99 670	110 560	122 818	143 288	NA
In-place leaching*	0	0	831	8 355	NA
Heap leaching**	0	0	544	5 570	NA
Total	99 670	110 560	124 193	157 213	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	99 670	110 560	111 475	115 417
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	1 385	13 925
Vein	0	0	7 340	7 340
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	3 993	20 531
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	99 670	110 560	124 193	157 213

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
50 000	150 000	150 000

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
700 000	700 000	0

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining[1]	113 469	886	848	1 307	116 510	1 300
Underground mining[1]	284 863	8 976	8 628	7 693	310 160	8 600
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	398 332	9 862	9 476	9 000	426 670	9 900

(1) Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	397 332	9 862	9 476	9 000	425 670	9 900
In-place leaching*	1 000	0	0	0	1 000	0
Heap leaching**	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	398 332	9 862	9 476	9 000	426 670	9 900

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	219 236	9 862	9 476	9 000	247 574	9 900
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	144 182	0	0	0	144 182	0
Vein	26 630	0	0	0	26 630	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	8 284	0	0	0	8 284	0
Other*	0	0	0	0	0	0
Total	398 332	9 862	9 476	9 000	426 670	9 900

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
0	0	6 126	68	2 780	31	94	1	9 000	100

Canada

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	1 665	1 873	1 984	1 600
Employment directly related to uranium production	1 152	1 294	1 416	1 200

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
16 430	16 430	16 430	16 430	17 730	17 730	17 730	17 730	17 730	19 000	17 730	19 000

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
17 730	19 000	17 730	19 000	17 730	19 000	17 730	19 000	17 730	19 000	17 730	2 000

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	88.2	88.6

Installed nuclear generating capacity to 2035
(MWe net)*

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
12 700	12 700	11 400	14 300	10 500	14 300

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
11 400	15 300	NA	NA	NA	NA	NA	NA

* *Source*: *Nuclear Energy Data*, OECD, Paris 2009.

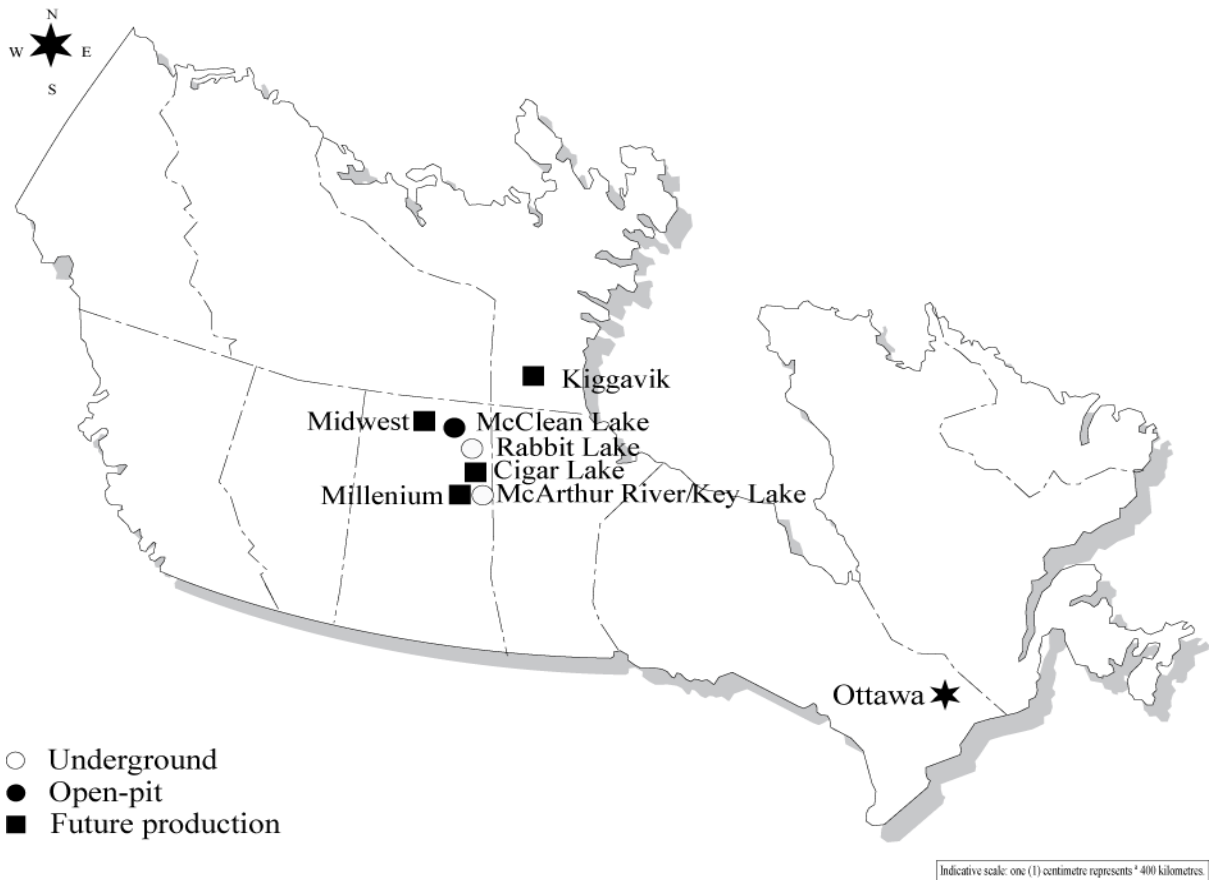
Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 600	1 600	1 800	2 000	1 800	2 000

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
2 000	2 300	2 100	2 500	NA	NA	NA	NA

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	NA	0	0	0	NA
Utility	NA	0	0	0	NA
Total	NA	0	0	0	NA



• China •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

The domestic uranium prospecting and exploration has been intensified and increased due to the more financial input and an increase of actual works accomplished during 2007-2008. The working areas have been expanded to the potential prospects selected after the regional prognosis and assessment apart from the continued prospecting and exploration on the mineralisation areas and belts related to the previous discovered uranium deposits. The exploration focus is given to the sedimentary basins in the northern and western China, although several exploration projects are investigating depth and extension of orebodies on the known uranium deposits in the southern China are being carried out at the same time.

The exploration including the regional uranium potential assessment and the further works on the discovered mineralisation and deposits in the northern China are carried out in Yili, Turpan-Hami, Junggar and Tarim basins of Xinjiang Autonomous Region, Erdos, Erlian, Songliang, Badanjilin and Bayingebi basins of Inner Mongolia, Caidamu basin in Qinghai province and Jiuquan Basin in Gansu province, etc. The different methods, such as EH-4, CSAMT and some drilling are used for the assessment, and further drilling is applied to the mineralised areas in order to find the ISL amendable sandstone deposits and conventional hard rock sandstone and mudstone uranium deposits.

The exploration works in the southern China looking for hydrothermal vein type uranium deposits related to volcanic and granite have been carried out in Xiangshan, Taoshan uranium field in Jiangxi province of the southern China, Xiazhuang, Zhuguang uranium field in Guangdong province, Ziyuan field of Guangxi Autonomous Region, Lujing filed and Daqiaowu field of Zhejiang province, respectively.

The total drilling footage finished in last two years amounted to 950 000 m (450 000 m in 2007 and 500 000 m in 2008), including 700 000 m focused on the sedimentary basins in the northern China. As a result, uranium resources in the northern China have dramatically increased. The new discoveries are three large uranium deposits named Mengqiguer (located in the southern margin of Yili basin in Xinjiang), Sunjialiang (located in the northern part of Erdos basin) and Nuheting (in the Erlain basin of Inner Mongolia), two medium size deposits called Subeng (located in the Erlain basin) and Baixingtu (located in Songliao basin of Inner Mongolia) and the identification potential areas such as Ciyaobo (Erdos basin), Shazhaoquan (Badanjilin basin in Inner Mongolia) and Honghaigou (Yili basin) for future targets and prospects. These results show that the future exploration focus will be given to the basins located in the northern China in order to discover more uranium resources.

Meanwhile, the progress achieved in southern China led to the discovery of four large scale uranium deposits called Julongan (in the Xiangshan uranium field), Baimianshi (in the Gannan uranium field in Jiangxi province), Mianhuakeng (in the Zhuguannanbu uranium field in Guangdong province) Shazijiang (in the Ziyuan uranium field in Guangxi) and two medium sized deposits named Heshang (in the Xiangshan field) and Xiangyangping (in the Ziyuan field in Guangxi Autonomous Region).

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The new discovered uranium resources during 2007 and 2008 amount to a total of about 71 400 tU categorised RAR and IR. These are distributed in the following way: 10 000 tU in Mengqiguer, 6 000 tU in Shihongtan of Xinjiang; 17 000tU in Nuheting, 2 400 tU in Subeng, 4 600 tU in Sunjialiang of Inner Mongolia; 12 000 tU in Baimianshi of Gannan uranium orefield, 3 000 tU in Julongan of Xiangshan in Jiangxi; 11 400 tU in Mianhuakeng of Zhuguangnanbu in Guangdong and 5 000 tU in Xiangyangping of Guangxi. Among them, 45 200 tU is categorised as RAR and the rest (26 200 tU) as IR. Uranium resources in China totalled 171 400 tU according to the latest data, as listed in the following table.

Distribution of Uranium Resources in China

No.	Location (Provinces + places/names)		tU
1	Jiangxi	Xiangshan	29 000
2		Gannan	12 000
3	Guangdong	Xiazhuang	12 000
4		Zhuguangnanbu	11 400
5	Hunan	Lujing	5 000
6	Guangxi	Ziyuan	10 000
7	Xinjiang	Yili	26 000
8		Turp-Hame	9 000
9	Inner Mongolia	Erdos	21 600
10		Erlian	19 400
11	Liaoning	Qinglong	8 000
12	Yunnan	Tengchong	6 000
13	Shanxi	Lantian	2 000
Total			171 400

Undiscovered Conventional Resources (Prognosticated & SR)

China has great potential for uranium resources. According to the study of math statistic conducted by the several institutes in China, 1.2 – 1.7 million tonnes of potential uranium resources are predicted. Favourable areas in the Er'lian Basin, Erdos basin, Inner Mongolia Autonomous Region have been identified in the last two years and other areas such as the Tarim Basin, Junggar Basin in Xinjiang Autonomous Region and the Songliao Basin in northeast China are regarded as favourable potential target areas. More uranium resources may be added to the known uranium deposits in southern China as prospecting and exploration works have been re-started.

Unconventional Resources and other materials

No systematic appraisal has been made.

URANIUM PRODUCTION

Historical review

The 50 year history of China's uranium industry has experienced both a boom in activity during the first two decades followed by a decline in late 1980s and 1990s. In the early years of the new century resurgence has taken place, driven principally by the ambitious new nuclear power programme announced by Chinese Government and increasing uranium spot prices. As a result, uranium production has once again been a focus of attention in China. Several production centres are under construction, such as Fuzhou and Chongyi Uranium mines. The new Chongyi production centre will be situated in a different location, subject to the result of ongoing pilot tests. In addition, the former Qinglong uranium mine has been rebuilt and brought back into operation. Feasibility studies are also being carried out on other select uranium deposits.

Status of production capability

Two new production centres have been put into the operation after the end of construction and the final approval received from the relative authorities. But the Qinglong uranium mine, a conventional underground mine associated with the Benxi uranium mine, has not yet reached design capability due to longer than expected heap leach cycles, especially in the winter. For Yining ISL mine, pilot tests and hydro-geological tests are being carried out in order to achieve the designed capability.

A new production centre has been built and put into operation in Shaoguan of Guangdong province, South China. The process technologies used in the Shaoguan production centre are conventional underground mining and heap leaching.

The status of other production centres in China remains the same. No production centres have been shut down or closed in the last two years.

Ownership structure of the uranium industry

The uranium industry in China is 100% owned by state companies.

Employment in the uranium industry

With the new production centres put into production, new employees are needed. The future employees in this industry are expected increase slightly.

Future production centres

New production centres at Fuzhou uranium mine and Chongyi uranium mine remain under construction.

In situ leach (ISL) pilot tests at the Shihongtan deposit of Yining production centre are ongoing. Pilot tests in Dongsheng uranium deposit are also ongoing, but only in the western portion of the field. Owing to low permeability, it is proved to be unsuitable for ISL extraction in the eastern part of the deposit. As a result, pilot tests of conventional underground mining are being considered.

Pilot tests and construction are being carried out on several other deposits, such as Liaohe sandstone type uranium deposit and the Guyuan granite uranium deposit.

Secondary Sources of Uranium

No MOX fuel, re-enriched tails or reprocessed uranium are used or produced in China.

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2	Centre #3	Centre #4
Name of production centre	Fuzhou	Chongyi	Yining	Lantian
Production centre classification	Existing	Existing	Existing	Existing
Start-up date	1966	1979	1993	1993
Source of ore: • Deposit name • Deposit type • Reserves (tU) • Grade (% U)	Volcanic	Granite	Dep.512 Sandstone	Lantian Granite
Mining operation: • Type (OP/UG/ISL) • Size (t ore/day) • Average mining recovery (%)	UG 700 92	UG 350 90	ISL NA NA	UG 200 80
Processing plant (acid/alkaline): • Acid/Alkaline • Type (IX/SX) • Size (t ore/day) For ISL (kilolitre/hour) • Average process recovery (%)	Conventional Acid IX 700 90	Heap leach Acid IX 350 84	ISL Acid IX NA NA	Heap leach Acid IX 200 90
Nominal production capacity (tU/year)	300 200 (committed)	120	300	100
Plans for expansion	NA	Expansion to 270tU/yr		NA
Other remarks				

Uranium production centre technical details (contd.**)**
(as of 1 January 2009)

	Centre #5		Centre #6
Name of production centre	Benxi	Qinglong	Shaoguan
Production centre classification	Existing	Existing	Existing
Start-up date	1996	2007	NA
Source of ore: • Deposit name • Deposit type • Reserves (tU) • Grade (% U)	 Benxi Granite	 Qinglong Volcanic	 Granite
Mining operation: • Type (OP/UG/ISL) • Size (t ore/day) • Average mining recovery (%)	 UG 100 85	 UG 200 85	 UG 400 90
Processing plant (acid/alkaline): • Acid/Alkaline • Type (IX/SX) • Size (t ore/day) For ISL (kilolitre/hour) • Average process recovery (%)	Heap leach Acid SX NA 90	Heap leach Acid IX NA 96	Heap leach Acid SX NA 90
Nominal production capacity (tU/year)	120	100	160
Plans for expansion	NA	NA	NA
Other remarks			

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Owing to the new environmental regulations put in place recently, new technologies are widely used in uranium mines in China. Mine liquids are collected, treated and recycled. Only very small amounts of waste water are discharged after treatment to meet the regulatory requirements and standards. The treated water is not discharged directly, but instead is kept in a storage pond for a period of time before being checked again to verify that it meets discharge standards according to the new regulations in last two years.

The regulation for the radiation protection of uranium mine and mill (EJ 993-2008) was put into place in 2008. All the workers in uranium mines and mills are required to be equipped with radiation monitors during working hours.

A total of three closed mines have been rehabilitated. One has been approved by the responsible government authority and approvals for the other two are expected in 2009.

URANIUM REQUIREMENTS

Uranium Requirements

As of 1 January 2009, the total installed capacity of Nuclear Power Plants is 9 070 MWe. The annual uranium requirement amounts to about 3 300 t uranium.

According to the government's nuclear power program, the total capacity of NNP will reach as high as 58 GWe by the end of 2020.

Based on the preliminary calculation, the uranium requirements will be 4 600 tU, 6 450 tU, 8 200 tU in the years 2010, 2015 and 2020, respectively. The projection for lower and high uranium requirement for the year of 2020, 2025, 2030 and 2035 will range from 10 100-12 000 tU, 12 300-16 200 tU, 12 300-16 200 tU and 14 400-20 500 tU, respectively.

Supply and Procurement Strategy

In order to meet the demand of nuclear power plants with the development program approved by the central government, additional production capability needs to be developed. The central government has adopted the policy "Facing Two Markets and Using of Two kind of Resources", meaning that uranium resources will be actively developed in China, making full use of non-domestic resources and development in advance of requirements. Uranium supply will be guaranteed through domestic production, development of non-domestic resources and international trade to ensure a stable supply of nuclear fuel to domestic nuclear power plants.

As a supplement to balance of uranium supply, international supplies will be made through different channels in order to lower the market risks, provide supply stability and realise reasonable prices.

NATIONAL POLICIES RELATING TO URANIUM

In order to meet the demand droved by faster growing of nuclear power in China, The Chinese government has taken the importance of uranium fuel supply, The measures taken by the central government include intensification of uranium exploration in China, promotion of domestic production, introduction of regulations to allow non government organisation for uranium exploration in China, and use of "two market and two resource" meaning overseas purchase and production as well.

URANIUM STOCKS

Not Available.

URANIUM PRICES

The domestic uranium price is gradually streamlined with the international market price in order to follow the trend of the development of uranium prices in the world, so it is purchased in China following the fluctuations of the international market accordingly.

China

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million USD (as of November 2009)	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	28	38	44	46
Industry* development expenditures	0	0	0	0
Government development expenditures	28	38	44	46
Total expenditures	28	38	44	46
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	400 000	450 000	500 000	500 000
Government exploration holes drilled	1 230	1 410	1 590	1 590
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	400 000	450 000	500 000	500 000
Subtotal exploration holes drilled	1 230	1 410	1 590	1 590
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	400 000	450 000	500 000	500 000
Total holes drilled	1 230	1 410	1 590	1 590

* Non-government.

Uranium exploration and development expenditures (non-domestic)

Expenses in USD millions (as of November 2009)	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	NA	NA	NA	NA
Industry* development expenditures	0	0	0	0
Government development expenditures	NA	160	220	NA
Total expenditures	NA	160	220	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	15 000	34 900	49 900	49 900	
Open-pit mining	0	0	0	0	
In situ leaching	37 000	66 000	66 000	66 000	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	52 000	100 900	115 900	115 900	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	52 000	100 900	115 900	115 900	
In-place leaching*	0	0	0	0	
Heap leaching**	NA	NA	NA	NA	
Total	52 000	100 900	115 900	115 900	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	NA	NA	NA	NA
Sandstone	NA	NA	NA	NA
Hematite breccia complex	NA	NA	NA	NA
Quartz-pebble conglomerate	NA	NA	NA	NA
Vein	NA	NA	NA	NA
Intrusive	NA	NA	NA	NA
Volcanic and caldera-related	NA	NA	NA	NA
Metasomatite	NA	NA	NA	NA
Other*	NA	NA	NA	NA
Total	NA	NA	NA	NA

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	3 400	36 100	39 500	39 500	
Open-pit mining	0	0	0	0	
In situ leaching	12 000	13 000	16 000	16 000	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	15 400	49 100	55 500	55 500	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	15 400	49 100	55 500	55 500	
In-place leaching*	0	0	0	0	
Heap leaching**	NA	NA	NA	NA	
Total	15 400	49 100	55 500	55 500	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	NA	NA	NA	NA
Sandstone	NA	NA	NA	NA
Hematite breccia complex	NA	NA	NA	NA
Quartz-pebble conglomerate	NA	NA	NA	NA
Vein	NA	NA	NA	NA
Intrusive	NA	NA	NA	NA
Volcanic and caldera-related	NA	NA	NA	NA
Metasomatite	NA	NA	NA	NA
Other*	NA	NA	NA	NA
Total	NA	NA	NA	NA

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

ognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
3 600	3 600	3 600

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
4 100	4 100	NA

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
	100							**NA**	

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	7 300	7 400	7 450	7 500
Employment directly related to uranium production	6 700	6 720	6 740	6 800

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	59.3	65.3

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
9 070	9 070	13 000	20 000	25 000	35 000

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
40 000	58 000	58 000	71 300	71 300	83 800	83 800	108 800

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 800	3 300	2 340	4 600	4 600	6 450

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
6 450	8 200	10 100	12 000	12 300	16 200	14 400	20 500

China

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	NA	NA	NA	NA	NA
Producer	NA	NA	NA	NA	NA
Utility	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

• Czech Republic •

URANIUM EXPLORATION

Historical review

A brief historical review of exploration in the Czech Republic, including the former Czechoslovakia, was provided in the 2001 edition of the Red Book.

Recent and ongoing uranium exploration and mine development activities

No field exploration has been carried out since the beginning of 1994. Drilling has been carried out in the deeper part of depleted Rozná deposit to specify and verify resources in 2008. Activities have been focused on the conservation and processing of previously collected exploration data. Advanced processing the exploration data and building the exploration database will continue in 2009.

URANIUM RESOURCES

Historically, most of the known uranium resources of the Czech Republic occurred in 23 deposits, of which 20 have been mined out or closed. Of the three remaining deposits, one is being mined (Rozná), and two, (Osecná-Kotel and Brzkov) have resources that are not recoverable because of environment protection. Undiscovered uranium resources are believed to occur in the Rozná and Brzkov vein deposits in the metamorphic complex of western Moravia, as well as in the sandstone deposits of the Stráz block, Tlustec block and Hermánky region in the Northern Bohemian Cretaceous basin.

Identified Conventional Resources (RAR & Inferred)

Identified Conventional Resources as of 1 January 2009 decreased by 178 tU in comparison with the previous estimate.

In detail, the Reasonably Assured Conventional Resources recoverable at cost of less than USD 80/kgU decreased by 128 tU, and the RAR recoverable at costs >USD 80/kgU are no longer registered. The decrease in RAR was the combined result of mining depletion (533 tU) and the specification and re-evaluation of resources at the Rozna deposit during 2007 and 2008 (adding 405 tU).

Inferred Conventional Resources at cost of less than USD 80/kgU decreased by 50 tU from the same reason as RAR (i.e. as a combined result of the depletion and re-evaluation and specification of the resources at the Rozna production centre). Inferred Conventional Resources above USD 80/kgU are no longer reported. All the Identified Conventional Resources recoverable at <USD 80/kgU are tributary to the existing Rozna and Straz production centres. Mining losses of 5% have been accounted for in estimating RAR & IR.

Undiscovered Conventional Resources (Prognosticated and SR)

12No new areas favourable for the discovery of resources have been identified in the last years; hence there are no changes to report in these categories (see details in the 2001 Red Book).

The Speculative Conventional Resources at a cost of about or more than USD 260/kgU are estimated to be 179 000 tU and reported as Unassigned. These resources are situated in the sandstone deposits of the Northern Bohemian Cretaceous basin.

URANIUM PRODUCTION

Historical review

A review of historical uranium production was provided in the 2001 Red Book.

A cumulative total of 110 427 tU was produced in the Czech Republic during the period 1946-2008.

Status of production capability

Two production centres remain in the Czech Republic. One is a conventional deep mine Rozna (stoping c. 1100 m underground) in the Dolni Rozinka uranium production centre and the second is a chemical mining centre currently under remediation in Straz pod Ralskem (*in situ* leaching c. 180 m underground). Both the Dolni Rozinka and Straz pod Ralskem production centres are capable of producing uranium. On the basis of the positive development in uranium prices and existing uranium resources at the Rozna deposit the Government decided (by Decree in May 2007) to continue mining activities as long as they are profitable. Expected production is 255 tU in 2009.

Uranium from the ISL facility in Straz pod Ralskem has been produced as a part of environmental remediation since 1996. Production capability during remediation has decreased due to low uranium concentration in solutions. Expected production is 25 tU in 2009, and it is expected to decrease continuously thereafter.

Uranium is also obtained from mine water treatment, with total expected production of 12 tU in 2009.

Ownership Structure of the Uranium Industry

With respect to ownership of the uranium producing operations there are no changes to report. All uranium related activities, including exploration and production are being carried out by the government-owned enterprise, DIAMO, s.p., based in Straz pod Ralskem.

Employment in the Uranium Industry

With respect to recent and ongoing uranium production and related environmental activities, employment in the Czech uranium production centres has settled at 2 287 workers, as of the end 2008. These employees are engaged in uranium production, decommissioning and restoration activities in Dolni Rozinka and Straz pod Ralskem centres.

Future Production Centres

No other production centres are committed or planned in the near future.

Production and/or use of mixed-oxide fuels, Re-enriched Tails and Reprocessed Uranium

The Czech power company CEZ, a.s. does not use MOX fuel, re-enriched tails or RepU in its reactors.

Uranium production centre technical details
(as of 1 January 2007)

	Centre #1	Centre #2
Name of production centre	Dolní Rozínka	Stráz pod Ralskem
Production centre classification	Existing	Existing
Start-up date	1957	1967
Source of ore:		
• Deposit name	Rozná	Stráz
• Deposit type	Vein	Sandstone
• Reserves (tU)	680	1 320
• Grade (% U)	0.378	0.030
Mining operation:		
• Type (OP/UG/ISL)	UG	ISL
• Size (t ore/day)	550	
• Average mining recovery (%)	95	50 (estimated)
Processing plant (acid/alkaline):		
• Acid/Alkaline	Alkaline	Acid
• Type (IX/SX)	IX/CWG	IX
• Size (t ore/day) For ISL (kl/day)	530	20 000 kl/day
• Average process recovery (%)	92.5	
Nominal production capacity (tU/year)	400	100
Plans for expansion	No	No
Other remarks		production under remediation process

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

Both environmental activities and the resolution of social issues are main parts of contraction programme of the Czech uranium industry, which started in 1989. The environmental remediation activities include planning, administration, environmental impact assessment, decommissioning, waste rock management, remediation of tailings impoundments, site rehabilitation, water treatment and long term monitoring. These activities are completely provided at the existing production centres as well as at the sites of former uranium facilities.

The fundamental uranium environmental projects are as follows:

- Remediation of the after-effects of the *in situ* leaching in Straz pod Ralskem (affected in sum 266 million m^3 groundwater, enclosure 600 ha surface area).
- Rehabilitation of the tailings impoundments in Mydlovary, Pribram, Straz pod Ralskem, Rozna (in sum 19 ponds, total area 576 ha).
- Rehabilitation of the waste rock dumps in Pribram, Hamr, Krizany, Licomerice, Rozna, Olsi and others (in sum 406 dumps, capacity 46 million m3).
- Mine water treatment from uranium facilities in Pribram, Straz, Horni Slavkov, Licomerice, Olsi, and others (approx.11 million m3 per year, gained an the average 14 tU).

The major part of environmental projects (more than 90%) is being funded by the state budget. The projects will continue until approximately 2040 and should cost more than CZK 60 000 million.

The contraction programme of the uranium industry consists in gradually decreasing employment related to uranium production and developing of alternative projects to resolve social issues. The social part of the contraction programme (compensations, damages, rents etc.) is financed by the state budget. The Czech uranium industry is carried out by the state-owned enterprise DIAMO, as an environmental engineering company.

Expenditures Related to Environmental Activities and Social Issues
(Million CZK)

	Total through end of 2005	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Uranium environmental remediation	21 122	1 300	1 462	1 416	25 300	2 095
Social programme and social security	5 936	488	466	446	7 336	462
Total	27 058	1 788	1 928	1 862	32 636	2 557

URANIUM REQUIREMENTS

There are two nuclear power stations (NPS) in the Czech Republic operated by Czech power company CEZ, a.s: Dukovany NPS (4 Units of VVER 440 MWe) and the Temelin NPS (2 Units of VVER 1 000 MWe). Total annual uranium needs for these power plants have been fluctuating in the range of 690-700 tU in the long term, assuming tails assay 0.3%. The transition to a new fabricator TVEL at the Temelin NPS will see (i) a temporary decrease in the total uranium needs in 2008 and 2009 as fuel of lower energy content (i.e., of lower assays) is ordered for the Temelin NPS, and (ii) a temporary increase in uranium needs in the period 2010-2013, as an entire core replacement will be performed at Unit 1 and a faster pace of fuel reloading will be exercised at Unit 2. However, in the total balance, that increase will be partly offset by specifying lower tails assays at enrichment facilities.

Increased uranium needs after 2020 onwards reflect an assumption that two additional reactors will be put in operation in the period from 2020 to 2022 at the Temelin site. Preliminary considerations include alternatives of possible capacities in the range of 1 000-1 600 MWe each.

Supply and Procurement Strategy

CEZ, a.s. has been maintaining a diversified portfolio of uranium suppliers and uranium processing companies (converters and enrichers) concerning the Temelin NPS. A different approach has been exercised for the Dukovany NPS whereby a portion of the required fuel has been purchased from the Russian supplier TVEL and for the remaining portion CEZ, a.s. has been supplying its uranium concentrates of Czech origin to TVEL. Almost all these needs have been covered on the basis of long-term contracts.

NATIONAL POLICIES RELATING TO URANIUM

The continuation of the contraction programme of the Czech uranium industry has been decided and started at the end of the 1980s. However, according to government decree the remaining deposits at Rozna and Straz will be mined out (without financial assistance from the government). Future uranium mining will depend on technical and economic conditions at the deposits considered for development and uranium prices.

The Government of the Czech Republic maintains a positive nuclear policy in the field of the power industry for the future.

URANIUM STOCKS

The Czech power company CEZ, a.s. maintains uranium stocks (pipeline and strategic) on a level of about two years of annual needs. Such stocks are held in all forms of processed uranium: U-concentrates (U_3O_8), UF_6, EUP and fabricated fuel.

URANIUM PRICES

Uranium prices are not available as they are commercially confidential. In general, uranium prices in supply contracts between the domestic producer DIAMO, s.p. and CEZ, a.s. reflect price indicators of the world market (i.e. Long-term & Spot Prices are incorporated according to agreed upon formulas).

Uranium exploration and development expenditures and drilling effort – domestic

Currency reported: million CZK	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0.1	0.1	5.2	2.0
Government exploration expenditures	2.8	0.6	0.8	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	2.9	0.7	6.0	2.0
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	0	0	0	0
Subtotal exploration holes drilled	0	0	0	0
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	0	0	0	0
Total holes drilled	0	0	0	0

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	432	432	432	90
Open-pit mining	0	0	0	0	0
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	432	432	432	90

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	432	432	432	90
In-place leaching*	0	0	0	0	0
Heap leaching**	0	0	0	0	0
Total	0	432	432	432	90

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	432	432	432
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	432	432	432

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	70	70	70	90
Open-pit mining	0	0	0	0	0
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	70	70	70	90

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	70	70	70	90
In place leaching*	0	0	0	0	0
Heap leaching**	0	0	0	0	0
Total	0	70	70	70	90

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	70	70	70
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	70	70	70

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
180	180	180

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	0	179 000

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	0	0	0	0	0	0
Underground mining*	92 131	327	279	240	92 977	230
In situ leaching	17 339	48	28	35	17 450	25
Co-product/by-product	0	0	0	0	0	0
Total	109 470	375	307	275	110 427	255

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	107 067	310	263	226	107 866	218
In-place leaching*	3	0	0	0	3	0
Heap leaching**	125	0	0	0	125	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	2 275	65	44	49	2 433	37
Total	109 470	375	307	275	110 427	255

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	32 673	48	28	35	32 784	25
Hematite breccia complex	0	0	0	0	0	0
Quartz - pebble conglomerate	0	0	0	0	0	0
Vein	76 797	327	279	240	77 643	230
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	109 470	375	307	275	110 427	255

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
275	100	0	0	0	0	0	0	275	100

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	2 251	2 294	2 287	2 261
Employment directly related to uranium production	1 213	1 106	1 122	1 125

Czech Republic

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	500	500	0	0	50	50	0	0	50	50

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	50	50	0	0	50	50	0	0	30	30

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	24.6	25.0

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
3 550	3 550	3 550	3 800	3 700	3 800

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 800	4 900	4 900	6 000	6 000	6 200	6 000	6 200

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
637	880	860	870	670	680

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
675	880	830	1 000	830	1 000	980	1 000

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	<200	0	0	0	<200
Utility	NA	NA	0	0	NA
Total	<200	NA	0	0	<200

• Denmark (Greenland) •

URANIUM EXPLORATION

Historical review

See the 2003 Red Book for a brief historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

A new JORC compliant estimate from the exploration company Greenland Minerals and Energy Ltd. was produced in 2008. The estimate is based on data gathered during exploration targeted at other minerals (the Kvanefjeld deposit), as exploration and exploitation of radioactive elements is prohibited in Greenland. The result for uranium is 334 289 000 tonnes of ore at cut-off grade 302 ppm U_3O_8 (256 ppm U, or 0.0256% U), equivalent to 100 960 tonnes U_3O_8 (85 614 tU). No cost of production is included with this resource estimate.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Following an exploration campaign Greenland Minerals and Energy Ltd. reported 100 960 t U_3O_8 (85 614 tU) of re-evaluated previously known inferred resources at the deposit of Kvanefjeld in mid 2008. These results were placed in the high cost category (<260 USD/kgU), because the ore is of a complex composition and processing is expected to be complicated. For these reasons, a recoverability ratio of 65% was used.

Undiscovered Conventional Resources (Prognosticated and SR)

Unknown.

Unconventional Resources and other materials

Unknown.

URANIUM PRODUCTION, REQUIREMENTS AND POLICIES RELATING TO URANIUM

Denmark has no uranium production or requirements. Denmark reported no information on national policies relating to uranium, uranium stocks or uranium prices. In November 2008, citizens of

in Greenland voted decisively in support of a plan to give it greater autonomy from Denmark. As of July 2009, discussion on the issue of producing uranium as a by-product was under discussion in the Government of Greenland parliament but no decision had been taken.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in EUR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	NA	NA
Industry* exploration drilling (m)	NA	10 000	15 000	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	NA	10 000	15 000	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	NA	10 000	15 000	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Uranium exploration and development expenditures – non-domestic

Expenses in EUR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	NA	NA	NA	NA
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	NA	NA	NA	NA
Total expenditures	NA	NA	NA	NA

* Non-government.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	85 614
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	85 614

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
NA	NA	NA

Speculative Conventional Resources
(tonnes U)

1		
<USD 80/kgU	<USD 130/kgU	Unassigned
50 000	50 000	50 000

• Egypt •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

During the last two years (2007 and 2008) the Nuclear Materials Authority of Egypt (NMA) concentrated its exploration and development activities in four of its uranium prospects in the southern

and northern parts of the Eastern Desert and southwest Sinai Peninsula. These activities mainly included exploratory deep trenching and shallow drilling works supported by ground integrated geophysical and geochemical investigations to follow-up subsurface extensions of the tectonic structures and geologic formations hosting the uranium mineralisation in these occurrences which displayed good uranium resources. Intensive underground exploratory works supported by deep drilling facilities are still urgently required to reach a reliable evaluation of these uranium resources.

Early 2009 Egypt started a comprehensive geological, geophysical, and geochemical exploration works in the southern part of the Eastern Desert and Red Sea region. These activities are currently concentrated on exploring potential uranium resources in new target environments mainly include the Cretaceous volcanic rocks (e.g. Natash Volcanics) and Cretaceous Nubia sandstone basins (e.g. Kom Ombo Basin) located in the southern part of the Eastern Desert in addition to the unconformity contacts between the younger granites and Miocene sediments extending along the Red Sea coast. These recent exploration activities represent the first step in a long-term future plan aiming at diversifying and maximising Egypt uranium resources, urgently required to support its national program of peaceful uses of nuclear energy needed to secure its energy resources for development projects.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Limited uranium resources evaluation works have been recently conducted in two of the known Egyptian uranium prospects namely; Gabal Gattar prospect-located in the northern part of the Eastern Desert – and Abu Zenima prospect-located in the southwestern part of Sinai peninsula.

In Gabal Gattar prospect, about 27 000 tonnes ore of inferred uranium resources have been identified will an ore grade ranging between 0.19-0.24% U_3O_8 (16-0.20% U). In this prospect rocks hosting the uranium mineralisation are mainly represented by the Precambrian Calc-Alkaline granites (Late Orogenic Plutonites) referred to in Egypt as the younger granites. Distribution of this mineralisation is mainly controlled by the shear structures cutting across the granitic masses.

In Abu Zenima prospect about 38 000 tonnes ore of inferred uranium resource has been identified with an average ore grade 0.07% U_3O_8 (0.06% U). The uranium hosting rocks are mainly represented by the Carboniferous sandstones.

Undiscovered Conventional Resources (Prognosticated and SR)

In the last two years two areas (the: Abu Rushied-Seikat area and Sella area) have been identified in the extreme southeastern part of the Eastern Desert as geologically favourable environments for prognosticated uranium resources. Integrated geological, geophysical and geochemical exploration and development works carried out in these two areas indicated promising potential for uranium resources associated with REE mineralisations.

In the Abu Rushied-Seikat area, uranium mineralisation associated with REE were discovered in the Para-geneises and metamorphosed sandstones of Precambrian age, whereas in Sella area structurally-controlled uranium mineralisations have been discovered along the shear structures cutting across the Precambrian granitic masses. In the two areas some subsurface exploratory works, mainly represented by deep trenching and shallow drilling, are underway to follow-up potential subsurface extensions and configuration of the discovered surface mineralisation. So far no resource estimates have been made in these two areas.

Unconventional Resources and Other Materials

The upper Cretaceous phosphate deposits represent one of the promising unconventional uranium resources in Egypt. Confirmed estimates of these phosphate ore deposits amount to about 700 million tonnes. Uranium content in these deposits ranges between 50-200 ppm, with an average value 60 ppm. Although no reliable estimate of the uranium resources in Egyptian phosphate ores has been made, it is possible that the deposits contain up to 42 000 tU.

URANIUM PRODUCTION

Egypt has no uranium production centres, no exploitation mines and no mills.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

All experimental mining, trenching, drilling tasks and laboratory units are under environmental control and radiation safety regulations according to the international standards of the International Atomic Energy Agency.

The NMA is responsible for studies to assess and manage the radioactive wastes that are expected to arise during the black sand exploitation and mineral separation. This task will be performed in collaboration with the IAEA (TC project EGY/9/037).

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in EGP	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	10 000 000	10 000 000	10 000 000	10 000 000
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	2 700 000	5 300 000
Total expenditures	10 000 000	10 000 000	12 700 000	15 300 000
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	NA	NA	600	1 000
Government exploration holes drilled	NA	NA	10	20
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	NA
Government development holes drilled	0	0	0	NA
Subtotal exploration drilling (m)	0	0	600	1 000
Subtotal exploration holes drilled	0	0	10	20
Subtotal development drilling (m)	0	0	0	NA
Subtotal development holes drilled	0	0	0	NA
Total drilling (m)	0	0	600	1 000
Total holes drilled	0	0	10	20

* Non-government.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	2 000	0	90
Open-pit mining	0	0	103	0	85
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	0	2 103	0	89.8

* Resources reported *in situ* with recovery factors provided.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	103	103
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	2 000
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	2 103

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

• Finland•

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration activities

The authority responsible for mining and exploration, Ministry of Trade and Industry, was merged with Ministry of Labour to form Ministry of Employment and the Economy (MEE) from 1 January 2008. MEE promotes the use of mineral resources by securing a favourable operating environment for mineral exploration and mining activities. The Ministry's actions are based on the

Mining Act and the Mining Decree of 1965. A revision of the Finnish mining law is currently under way.

In October 2006 the Ministry granted a claim to AREVA in eastern Finland for five years. Following stakeholders' appeals to the Supreme Administrative Court, the claim came into force after the favourable decision of the court in February 2008. Another claim was granted in January 2007 to Namura Finland in northern Finland for one year. Respectively, this claim came into force after court's decision in October 2007. Since the extension granted by MEE for this claim expired in October 2008, the company has applied for a new extension based on the radon survey carried out on this property in summer 2008.

The Ministry rejected four claim applications in southern and northern Finland in January 2007. Filed between December 2006 and September 2008, other claim applications are pending at the Ministry. Three of these applications were filed in 2006, 13 in 2007 and two in 2008. The companies involved are Agricola Resources, AREVA, Karelian Resource Services, Mawson Resources and Namura Finland (Cooper Minerals).

Because of the difficulties and delays in licensing, the activities in Finland have mainly been limited to grass roots exploration first in claim reservation and then in claim application areas from 2006 to 2008. AREVA carried out an aerogeophysical survey on its target in eastern Finland in 2007 and – after the court decision – trenching and diamond drilling in 2008.

Almost all known occurrences of uranium were staked as claim reservations during 2005 and 2006. These reservations have now expired and are under a moratorium of three years. Exploration for new occurrences has been done only by AREVA which managed to find a promising gold-uranium prospect of a new type in Paleoproterozoic rocks in northern Finland, west of Rovaniemi, during the field season of 2008.

Prolonged licensing, probable appeals of the claim decisions and the general decline in funding of exploration may cause the companies to reduce their activities in Finland during the year 2009.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Finland reports 1 500 tU of Reasonably Assured Conventional Resources recoverable at costs of USD 80-130/kgU, included in the deposits of Palmottu and Pahtavuoma-U. No Inferred Conventional Resources are reported.

Undiscovered Conventional Resources (Prognosticated and SR)

None reported.

Unconventional Resources and Other Materials

Finland has previously estimated that between 3 000 and 9 000 tU could be recovered from the Paleoproterozoic Talvivaara black shales, in central Finland, and another 2 500 tU from the Paleozoic Sokli carbonatite, in northern Finland, as by-product resources. Additional 1 000 tU is included in a Paleoproterozoic phosphorite deposit in middle Finland.

With bioheapleaching as the method, the 640 Mt of measured and indicated low-grade polymetallic (nickel, zinc, copper and cobalt) sulphide ores in the Talvivaara black shales are in

commercial production by the Talvivaara Mining Company since October 2008. Uranium recovery is not included in the extraction of metals. The uranium content of the ore is 0.001-0.004% U (IUREP 1981).

In 2007, the Ministry granted a two-year extension of the Sokli mining concession (phosphate & niobium) to the holder, Kemira GrowHow. In the same year Yara International acquired 30 % of the shares in Kemira GrowHow from the state of Finland and subsequently became the owner of this company. Yara launched a development project at Sokli, including environmental impact assessment.

The phosphate ore is a soft regolith lying on top of a hardrock magmatic carbonatite. The phosphate ore contains niobium, thorium and uranium derived from the primary pyrochlore mineral in the carbonatite. The EIA programme includes an option for uranium production. As part of the programme, a radiological survey is under way at Sokli.

Finland reported previously 2 900 tU of Reasonably Assured Conventional Resources in the cost range USD 130 or more/kgU, included in several deposits. This cost category was not used in the Red Book for a long time, and these resources were excluded from the estimates. Extensions of national parks, mine closure and other such reasons still exclude most of these resources from mineable deposits. However, as a target of recent claim applications by Mawson Resources and Namura Finland, the Nuottijärvi deposit with its historic resource of 1 000 tU can be reported in the cost category USD 130-260/kgU. Because the ore is of low-grade uraniferous phosphorite, this deposit is classified as an unconventional resource.

URANIUM PRODUCTION

Historical review

Uranium production in Finland has been confined only to the now restored Paukkajanvaara mine that operated as a pilot plant between 1958 and 1961. A total of 40 000 tonnes of ore was hoisted, and the concentrates produced amounted to about 30 tU. As listed in the Red Book Retrospective, the total historical production calculated from the Mining Register statistics is no more than 41 tU from 1958 to 1961. Currently, Finland has no production capability and no plans to develop any.

Secondary sources of uranium

Finland does not produce or use mixed-oxide fuels. Since 2000, Teollisuuden Voima Oyj (TVO) has used re-enriched tails for fuel, totalling 843 tU (natural equivalent) by the end of 2008.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

The Paukkajanvaara uranium mine area was restored in the 1990s. After the final field measurements in 1999, the Finnish Centre for Radiation and Nuclear Safety gave the certificate of accomplished environmental restoration to the landowner in 2001.

According to legislation in Finland, export and import of spent nuclear fuel are not permitted. Since the beginning of the 1980s, investigations have been made to solve the problem of geologic disposal. In 1996, Posiva Oy was established by Teollisuuden Voima Oyj (TVO) and Fortum Power and Heat Oy, the power companies responsible for nuclear waste management.

In 1999, Posiva filed an application for a decision-in-principle (DIP) on building a disposal facility. In December 2000, the government made a positive DIP and in May 2001 the Finnish Parliament ratified it. The disposal facility will be built in Olkiluoto, at Eurajoki municipality. The DIP applies to the spent fuel from Finland´s present four nuclear power plant units. In May 2002, in parallel with the DIP ratification of the Olkiluoto 3 nuclear unit, the Parliament also ratified a DIP on the disposal of the spent nuclear fuel from this unit. In summer of 2004, Posiva Oy started the construction of the underground research and characterisation facility named ONKALO for disposal of spent fuel. The access tunnel of ONKALO is now 3.5 kilometres long down to the depth of 330 metres, and two shafts have been bored to the depth of 290 metres. Posiva is preparing to submit an application for the construction license in 2012. Construction of the encapsulation plant and geologic repository is expected to commence in 2015 and the disposal operations are planned to start in 2020.

URANIUM REQUIREMENTS

At the beginning of 2009, four reactors were in operation: Olkiluoto 1 and 2, owned by the Finnish private utility TVO (Teollisuuden Voima Oyj) and Loviisa 1 and 2, owned by Fortum Power and Heat Oy (the former IVO). The installed capacity totals about 2.7 Gwe net. Uranium requirements are 460 tU/year for the four reactors.

In October 2003, TVO selected Olkiluoto as the location of the new unit and the consortium Framatome ANP – Siemens, now AREVA, was selected as the main supplier. The construction license for Olkiluoto 3 pressurised water reactor (type EPR, European Pressurised Water Reactor) was granted in 2005. The reactor's thermal output is 4 300 MW and electric output about 1 600 MW. The construction of the plant has been delayed approximately three years. The new unit is planned to start commercial operation in 2012. The uranium requirements for this new unit will range from 200 to 300 tU/year.

There are now three applications for a new nuclear power plant in Finland made by the companies TVO, Fortum and Fennovoima. A DIP will probably be made in 2010 and a possible new plant could be in operation before year 2020.

Supply and procurement strategy

TVO procures natural uranium, enrichment services and fuel fabrication from several countries. Fortum Power and Heat Oy purchases fuel assemblies from Russia and until now, all the uranium.

NATIONAL POLICIES RELATING TO URANIUM

Licenses for mining, enrichment, possession, fabrication, production, transfer, handling, use and transport of nuclear materials and nuclear wastes may be granted only to natural persons, corporations or authorities under the jurisdiction of a Member State of the European Union. However, under special circumstances, foreign organisations or authorities may be granted a license to transport nuclear material or nuclear waste within Finland. No significant changes to Finnish uranium policy are reported.

Since September 2006, an environmental impact assessment procedure will be applied to all uranium mining projects, without any limitations on the annual amount of the extracted resource or on

the area of an opencast mine. In addition to the licensing based on the *Mining Act* and on the environmental and radiation legislation, production of uranium or thorium also needs a license from the government according to the *Nuclear Energy Act*.

In 2009 there will be a new draft for the ongoing revision of the *Mining Act*. In the first draft circulated in 2008 there is a veto right for the municipality where a possible uranium mine would be located. This is an analogy from the *Nuclear Energy Act* for all nuclear facilities where the site municipality has a definite veto right. The revised *Mining Act* is expected to be in force in early 2011.

URANIUM STOCKS

The nuclear power utilities maintain reserves of fuel assemblies from seven months to one year's use, although the legislation demands only five months use.

URANIUM PRICES

Due to commercial confidentiality price data are not available.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in EUR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	1 399 000	1 124 000	1 555 000	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	1 399 000	1 124 000	1 555 000	NA
Industry* exploration drilling (m)	0	0	1 060	0
Industry* exploration holes drilled	0	0	10	0
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	0	0	1 060	0
Subtotal exploration holes drilled	0	0	10	0
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	0	0	1 060	0
Total holes drilled	0	0	10	0

* Non-government.

Finland

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	1 500	1 500	
Total	0	0	1 500	1 500	

* *In situ* resources.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	1 500	1 500	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	1 500	1 500	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	500	500
Intrusive	0	0	1 000	1 000
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	1 500	1 500

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	15	0	0	0	15	0
Underground mining*	15	0	0	0	15	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	30	0	0	0	30	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	30	0	0	0	30	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	30	0	0	0	30	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	30	0	0	0	30	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	30	0	0	0	30	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Re-enriched tails production and use
(tonnes of natural U equivalent)

Re-enriched tails	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Production	0	0	0	0	0	0
Use	718	NA	125	0	843	0

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	22.5	22.1

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
2 680	2 680	2 680	2 680	4 280	4 280

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
4 280	4 280	4 280	4 280	3 800	3 800	3 320	3 320

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
460	460	440	470	640	700

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
640	700	640	700	470	605	470	505

• France •

URANIUM EXPLORATION

Uranium exploration in France began in 1946, focusing on already known uranium ore deposits and the few mineralisation occurrences discovered during radium exploration. In 1948, exploration work led to the discovery of the La Crouzille deposit, formerly of major importance. By 1955, deposits had been identified in the granite areas of Limousin, Forez, Vendée and Morvan.

Prospecting activities were subsequently extended to sedimentary formations in small intra-granitic basins and terrigeneous formations, arising from eroded granite mountains and mainly located north and south of the Massif Central.

Recent and ongoing uranium exploration and mine development activities

No domestic activities have been carried out in France since 1999.

Abroad, AREVA has been focusing on targets aimed at the discovery of exploitable resources in Australia, Canada, Finland, Kazakhstan, Mongolia and Niger. AREVA is also directly or indirectly involved in uranium exploration or development activities through subsidiaries. In Canada, Namibia, South Africa, the Central Africa Republic, Niger and Kazakhstan, it is involved in uranium mining operations and projects. In addition, without being an operator, it holds shares in several mining operations and research projects in different countries.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The last uranium mine (Le Bernardan) was closed in 2001, but the resources associated with it were re-assessed in 2009. This re-assessment produced new figures of 11 451 tU RAR and 139 tU Inferred, all above the USD 130/kgU, of which 9 000 tU are recoverable by open-pit mining.

Undiscovered Conventional Resources (Prognosticated and SR)

No systematic appraisal is made of undiscovered resources.

URANIUM PRODUCTION

Historical review

As a result of the mine closures French uranium production has declined since 1990. With the closure of the Lodève mining site in 1997 and of Le Bernardan in 2001, there remain no active uranium operations in France.

Status of production capability

Following the closure of all uranium mines in 2001, all the ore processing plants were shut down, dismantled and the sites reclaimed.

Only one or two tonnes of uranium per year are still recovered on resins during water cleaning process of the outflow from the former Lodève mine, in the South of France. The resins are eluted at the Malvesi refinery, and the uranium is recovered.

Future production centres

There are no plans to develop new production centres in the near future.

Secondary sources of uranium

Production and/or use of mixed-oxide fuels

The annual production of MOX fuel in France is about 145 tHM, roughly corresponding to 1 160 tU equivalent using the Red Book recommended conversion factor. This corresponds to the total amount of MOX fuel contained in fuel elements produced in France. Most of the French MOX production (about 100 t yearly or 800 tNatU equivalent) is used to fuel French NPPs, the remaining is sent abroad under LT contracts.

The Cadarache MOX fuel factory ceased commercial production in 2003. The production of a few fuel elements from United States excess military plutonium was achieved in 2004-2005 and these lead-test assemblies returned to Duke Power Catawba power station where they were burnt in preparation of a larger recycling of the United States excess military plutonium.

In 2007, the Melox plant in Marcoule has been awarded a licence upgrade to produce up to 195 tonnes of MOX/year (from previously 145 tonnes).

Production and/or use of re-enriched tails

A fraction of the depleted UF_6 flow generated through the enrichment activities is currently sent to the Russian Federation for re-enrichment. This fraction is limited to materials with mining origin allowing their transfer (according to international and bilateral agreements dealing with the exchange of nuclear materials). The return flow is exclusively used to over-feed the enrichment plant in France (Georges Besse gaseous diffusion plant run by EURODIF, an AREVA subsidiary).

In addition, in 2008 and 2009, a few thousand tonnes of depleted uranium were removed from storage, converted in UF_6 and enriched to natural uranium grade at Georges Besse gaseous diffusion plant, thanks to the then prevailing economic conditions, primarily high uranium spot prices.

Production and/or use of reprocessed uranium

Production of reprocessed uranium in France results from the activity of the la Hague reprocessing plant. The annual production was slightly below 1 000 tU in 2008. This RepU production will increase to 1 050 tU from 2010.

In France, 300 tNatU equivalent are recycled every year in two reactors (EDF reactors of Cruas power plant). Starting from 2010, 600 tNatU equivalent will be recycled in the four Cruas NPP's reactors.

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

None reported.

URANIUM REQUIREMENTS

The total number of nuclear power reactors is expected to increase slightly with the addition of one EPR1 600 MWe, expected to be put into operation at Flamanville before 2015, and another one at Penly before 2020. Starting from 2015, EDF intends to increase the nuclear generating capacity from some of the existing nuclear power plants. Still, uranium requirements should not change significantly since no reactor is expected to be shut down in the near future.

Supply and procurement strategy

Since France is a net importer of uranium, its policy towards procurement is one of supply diversification. French operators participate in uranium exploration and exploitation outside France within the regulatory framework of the host countries. Uranium is also purchased under short or long-term contracts, either from mines in which French operators have shareholdings or from mines operated by third parties.

Beginning in 2010, it is expected that the use of recycled materials will be increased.

URANIUM STOCKS

Électricité de France (EDF) possesses strategic uranium inventories, the minimum level of which has been fixed at the equivalent of three years' forward consumption to offset possible supply interruptions.

URANIUM PRICES

Information on uranium prices is not available.

Uranium exploration and development expenditures – non-domestic

Expenses in million Euros	2006**	2007	2008	2009 (expected)
Industry exploration expenditures*	31.1	42	56	59
Government exploration expenditures				
Industry development expenditures*	35			
Government development expenditures				
Total expenditures	66.1	42	56	59

* Non-government.
** *Uranium 2007: Resources, Production and Demand.*

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	9 000	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	2 451	
Total	0	0	0	11 451	

* *In situ* resources.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	0
Open-pit mining	0	0	0	0	0
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	139	0
Total	0	0	0	139	0

* *In situ* resources.

Mixed-oxide fuel production and use
(tonnes of natural U equivalent)

Mixed-oxide (MOX) fuels	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	10 870	1 160	1 000	1 008	14 038	1 160
Use	NA	NA	NA	NA	NA	NA
Number of commercial reactors using MOX	NA	NA	NA	NA	NA	NA

Net nuclear electricity generation

	2007	**2008**
Nuclear electricity generated (TWh net)	418	417.6

Installed nuclear generating capacity to 2035
(MWe net)

2008	**2009**	**2010**		**2015**	
63 130	63 130	*Low*	*High*	*Low*	*High*
		63 130	63 130	64 730	64 730

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
66 030	67 630	66 030	67 630	66 030	67 630	66 030	67 630

Annual Reactor-related Uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	**2009**	**2010**		**2015**	
9 000	9 000	*Low*	*High*	*Low*	*High*
		8 500	9 500	8 000	9 000

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
8 000	9 000	8 000	9 000	8 000	9 000	8 000	9 000

• Germany •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

There are no actual exploration activities in Germany. In recent times, there have been several inquiries for the Großschloppen deposit by national and international consultants and junior mining companies. No reports or plans exist thus far for exploration or drilling. Renewed exploration activities in the uraniferous Pöhla mine, Erzgebirge, focused on the commodities tungsten and tin.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Identified conventional resources were last assessed in 1993. These identified conventional resources occur mainly in the closed mines which are in the process of being decommissioned. Their future availability remains uncertain.

Undiscovered Conventional Resources (Prognosticated & SR)

All undiscovered conventional resources are reported as speculative resources in the cost category above USD 260/kgU.

Unconventional Resources and other materials

None.

URANIUM PRODUCTION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium production.

Status of production capability

There is no commercial production of uranium in Germany. Decommissioning of the German production facilities started in 1989 (Western Germany) and 1990 (Eastern Germany). Since 1991 uranium is recovered from clean-up activities in previous mines. Between 1991 and 2008, the recovery from mine water treatment and environmental restoration totalled 2 431 tU. Since 1992, all uranium production in Germany has been derived from the clean-up operations at the Königstein mine.

Ownership structure of the uranium industry

The production facilities in the former German Democratic Republic were in the ownership of the Soviet-German stock company Wismut (SDAG Wismut). After reunification, the German Ministry of Economy succeeded the ownership from SDAG Wismut. The German Federal government through Wismut GmbH took the responsibilities for the decommissioning of the production facilities and remediation activities. The government retains ownership of all uranium recovered in clean up operations.

In August 1998, Cameco completed its acquisition of Uranerz Exploration and Mining Ltd. (UEM), Canada, and Uranerz USA Inc. (UUS), from their German parent company Uranerzbergbau GmbH (Preussag and Rheinbraun, 50% each). As a result, there remains no commercial uranium industry in Germany.

Employment in the uranium industry

All employment is engaged in decommissioning and rehabilitation of former production facilities. Employment decreased within the last five years from 2 230 (2004) to 1 770 (2008).

Future production centres

None reported.

NATIONAL POLICIES RELATING TO URANIUM

According to the agreement between the Federal Government of Germany and the utility companies dated 14 June 2000, the future utilisation of nuclear power plants shall be restricted. For each plant the residual operating life remaining after 1 January 2000 shall be calculated on the basis of a standard operating life of 32 calendar years from the commencement of commercial power operation. Accordingly, the future uranium requirements will decrease, however, details of the annual requirements for the period after 2020 cannot be provided.

URANIUM STOCKS

Germany reported no information on national policies relating to uranium, uranium stocks, or uranium prices.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	3 000	
Total	0	0	0	3 000	

Germany

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	4 000	
Total	0	0	0	4 000	

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	0	74 000

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	NA	0	0	0	NA	0
Underground mining*	NA	0	0	0	NA	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	0	0	0	0	0	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	NA	0	0	0	0	0
In-place leaching*	NA	0	0	0	0	0
Heap leaching**	NA	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	2 325	65	41	0	2 431	50
Total	219 411	65	41	0	219 517	50

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres	1 835	1 775	1 770	1 638
Employment directly related to uranium production	NA	NA	NA	NA

Mixed-oxide fuel production and use
(tonnes of natural U equivalent)

Mixed-oxide (MOX) fuels	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	0	0	0			
Use	5 520	330	220	250	6 320	210
Number of commercial reactors using MOX	16	6	4	4	16	5

Re-enriched tails production and use
(tonnes of natural U equivalent)

Re-enriched tails	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	NA	NA	NA	NA	NA	NA
Use	NA	NA	NA	NA	NA	NA

Reprocessed uranium use
(tonnes of natural U equivalent)

Reprocessed uranium	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	NA	NA	NA	NA	NA	NA
Use	NA	1 250	370	950	NA	700

Germany

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	133.2	140.9

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
20 470	20 470	20 470	20 470	12 100	13 400

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 500	3 500	0	0	0	0	0	0

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
2 300	2 600	2 500	2 500	2 000	2 200

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
200	350	0	0	0	0	0	0

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	NA	NA	NA	NA	NA
Producer	NA	NA	NA	NA	NA
Utility	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

• Hungary •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

From 2006, there are four uranium ore exploration projects areas covered by seven exploration licenses, namely: 1) Mecsek, 2) Bátaszék, 3) Dinnyeberki and 4) Máriakéménd. The main features of areas and the activities performed during the years 2007 and 2008 are as follows:

The Mecsek exploration project area includes some non-mined parts of the Mecsek sandstone-type deposit of Upper Permian age which were the subject of historic mining activities. The total exploration area is 42.9 km^2. The digitisation and computer-based processing of the data from historic exploration activities has been done and mostly completed. Based on these data, a new geological model of the deposit has been established and resource estimates have been developed.

Bátaszék is a roll-front type deposit in Pliocene sediments (area of 188.07 km^2) discovered in 1989. In 2007, an airborne radiometric survey was performed, including spectral gamma-radiation, magnetic and electromagnetic methods. In 2008, four holes were drilled, logged and the cores tested. The next phase of drilling is in preparation.

The Dinnyeberki deposit was discovered in 1982. It represents a palaeogeography (alluvial facies rich in organic matter) controlled mineralisation in Miocene sediments. The exploration area encompasses 10.5 km^2. In 2008, one hole was drilled, logged and the cores tested.

The Máriakéménd: exploration area (177.3 km^2) includes the extension of the Mecsek deposit, displaced along a strike-slip fault. No field activity has been performed in this area to date.

In addition, a uranium ore exploration project licence has been granted for a 97 km^2 area on the north western portion of the Mecsek-mountain. No field activity has been performed yet on this area.

URANIUM RESOURCES

Hungary's reported uranium resources are limited to those of the Mecsek deposit.

The ore deposit occurs in Upper Permian sandstones that may be as thick as 600 m. The sandstones were folded into the Permian-Triassic anticline of the Mecsek Mountains. The ore-bearing sandstone occurs in the upper 200 m of the unit. It is underlain by a very thick Permian siltstone and covered by Lower Triassic sandstone. The thickness of the green-grey ore-bearing sandstone, locally referred to as the productive complex, varies from 15 to 90 m. The ore minerals include uranium oxides and silicates associated with pyrite and marcasite.

Identified Conventional Resources (RAR & Inferred)

Parallel the recent Mecsek exploration program, resources were re-estimated and re-categorised. As a result, 11 500 tU is now reported as *in situ* high-cost Inferred resources.

Undiscovered Conventional Resources (Prognosticated & SR)

Speculative Resources are not estimated. Uranium resources classified as prognosticated amount to a total of 12 800 tU recoverable at costs of USD 130-260/kgU. These resources are tributary to the former Mecsek production centre.

URANIUM PRODUCTION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium production.

Status of production capability

In 1998 and 1999 the only uranium production was 7 tU/year and 4 tU/year as a by-product of water treatment activities. Since 2000 this has been 1-3 tU/year.

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

In 1998, after the closure of the mines, the stabilisation and remediation work was begun, following a conceptual plan developed by the staff and accepted by the competent authorities of Hungary. The government accepted the financial requirement and determined the time of completion to be the end of 2002. This deadline was modified several times because of financial issues. The final deadline was the end of 2008, when the project finished successfully. The projects include:

- Closing down underground mines.
- Remediating waste rock piles, heap-leaching sites, tailings ponds and contaminated water flows.
- Decommissioning the milling plant and open-pit sites.

After the successful remediation programme the following activities have to be continued:

- Operating a monitoring system on the uranium-mining legacy sites.
- Treating contaminated water both on the mining and the tailings ponds area.

The legal successor of the former Mecsek mine (as a state-owned company) is also responsible for paying compensation including damages for occupational disease, income and pension supplements, reimbursements of certified costs and dependent expenses to people formerly engaged in uranium mining.

Costs of environmental management
(HUF thousands)

	Pre 1998	1998 to 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Closing of underground spaces	NA	2 107 897	281 992	0	0	0	0	0	0	0	0
Reclamation of surficial establishments and areas	NA	459 447	589 728	651 766	320 519	67 895	31 610	6 190	23 232	21 944	0
Reclamation of waste rock piles and their environment	NA	222 943	141 253	286 930	82 543	37 209	0	1 868	0	0	217 678
Reclamation of heap-leaching piles and their environment	NA	900 941	608 231	115 936	18 938	0	0	0	0	0	0
Reclamation of tailings ponds and their environment	NA	538 203	741 195	1 304 629	1 869 523	941 816	274 807	995 821	312 749	445 681	975 507
Water treatment	NA	626 649	383 436	243 941	241 686	496 783	447 249	398 192	452 287	474 663	510 750
Reconstruction of electric network	NA	0	98 361	20 790	0	0	0	0	0	0	0
Reconstruction of water and sewage system	NA	1 000	0	0	0	0	0	0	0	0	0
Other infrastructural service	NA	342 000	93 193	42 651	47 329	0	0	0	0	0	0
Other activities including monitoring, staff, etc.	NA	581 197	431 678	461 512	367 677	101 229	38 045	139 865	157 424	164 938	218 624
Subtotal	5 406 468	5 780 277	3 369 067	3 128 155	2 948 275	1 644 932	791 711	1 541 936	945 692	1 107 226	1 922 559
Reserves for the amount of 1998-2000		139 120	0	0	0	0	0	0	0	0	0
Total	**5 406 408**	**5 919 397**	**3 369 067**	**3 128 155**	**2 948 275**	**1 644 932**	**791 711**	**1 541 936**	**945 692**	**1 107 226**	**1 922 559**

NA: Not available

URANIUM REQUIREMENTS

The Paks Nuclear Power Plant generated 14 818.5 GWh (gross) in 2008 providing 37.2% of the total gross Hungarian electricity production. This amount was generated by four units as follows: Unit 1: 3 961.3 GWh; Unit 2: 3 164.8 GWh; Unit 3: 3 735.8 GWh; Unit 4: 3 956.7 GWh. Since the date of the first connection to the grid of Unit 1, the quantity of all electricity produced by the Paks NPP exceeded 320 TWh by the end of 2008.

In order to enhance its economic and operational effectiveness and to improve its market position, the Paks Nuclear Power Plant commenced an Economical Effectiveness Enhancement Programme (EEP) in 2005, the principal elements of which are as follows: power uprating, maintenance optimisation, operating lifetime extension. The objectives of the EEP were accomplished as planned in 2008.

According to the schedule of the program, the power uprating of Units 2 and 3 was performed in 2008. During the annual outage of the units the required modifications were performed according to the licence issued by the Hungarian Atomic Energy Authority. After the outage, the power of Unit 2 was increased step by step and it reached the licensed value of 108% on 5 December 2008. Thus the nominal electric capacity of Unit 2 reached 500 MWe.

The electrical capacity of Unit 3 reached the value of 104% on 31 October 2008. Following further modifications the total power uprating of Unit 3 will be completed after a planned outage in 2009.

There is an ongoing activity to apply a new type of fuel elements. It is expected that from 2010 the new type of fuel elements with moderately higher enrichment containing gadolinium burnable poison will be used resulting in a decrease in the required amount of fresh fuel and in the amount of spent fuel.

Preparation of the lifetime extension program was continued in 2008. On 14 November the Paks NPP submitted the Lifetime Extension Program (LEP) to the Nuclear Safety Directorate of the Hungarian Atomic Energy Authority. The LEP presents the foundation of the conditions for operation 20 years beyond the planned lifetime (30 years) of Paks NPP as well as the planned further activities and tasks.

The annual uranium requirements for the Paks NPP are about 360 tU. Until 1997, the requirements could be met by uranium mined domestically. Since that time, uranium requirements are solely satisfied by imports from Russia.

NATIONAL POLICIES RELATING TO URANIUM

Since the shutdown of the Hungarian uranium mining industry in 1997, there are no uranium related policies.

URANIUM STOCKS

The by-product of the water treatment activities (UO_4 $2H_2O$) – until the exportation – is stored in the mine water treatment facility. At the end of 2008 the inventory was 5 189 kg.

URANIUM PRICES

Uranium prices are not available as they are commercially confidential.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million HUF	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	NA	20.79	37.087	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	NA	20.79	37.087	NA
Industry* exploration drilling (m)	NA	NA	950	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	NA	NA	NA	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	NA	NA	950	NA
Subtotal exploration holes drilled	NA	NA	5	NA
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	NA	NA	950	NA
Total holes drilled	NA	NA	5	NA

* Non-government.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	11 500	
Total	0	0	0	11 500	

* *In-situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	11 500	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	0	11 500	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	11 500
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	11 500

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	0	12 800

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	0	0	0	0	0	0
Underground mining*	21 000	0	0	0	21 000	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	48	2	1	1	52	1
Total	21 048	2	1	1	21 052	1

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	20 475	0	0	0	20 475	
In-place leaching*	0	0	0	0	0	
Heap leaching**	525	0	0	0	525	
U recovered from phosphates	0	0	0	0	0	
Other methods***	48	2	1	1	52	1
Total	21 048	2	1	1	21 052	1

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Hungary

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	21 048	0	0	0	21 048	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	21 048	0	0	0	21 048	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
1	100	0	0	0	0	0	0	1	100

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	13.8	14.0+

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 860	1 860	1 890	1 890	1 890	1 890

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1 890	1 890	1 890	1 890	1 890	1 890	950	1 890

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
422	423	360	360	360	360

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
360	360	360	360	360	360	180	360

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	5	0	0	0	5
Utility	0	0	0	0	0
Total	5	0	0	0	5

• India •

URANIUM EXPLORATION

Historical review

Uranium exploration in India dates back to the early 1950s, since the discovery of Jaduguda uranium deposit in the year 1951. India has progressed a long way with the identification of many deposits and potential provinces. A summary of past exploration activities, including major discoveries, exploration methods used and areas covered has been described in the Red Book 2007.

Recent and ongoing uranium exploration and mine development activities

Uranium exploration activities in India have been concentrated in the following provinces:

- Meso-proterozoic Delhi basin, Rajasthan.
- Meso-neoproterozoic Cuddapah and Kurnool basin, Andhra Pradesh.
- Neoproterozoic Bhima basin, Karnataka.
- Neoproterozoic Kaladgi basin, Karnataka.
- Cretaceous sedimentary basin, Meghalaya.

Proterozoic Delhi basin, Rajasthan

The Meso-proterozoic Delhi Group of metasediments in the northeastern part of Rajasthan holds potential for albitite and unconformity types of uranium mineralisation.

A zone of albitite-microclinite-pyroxinite (referred to as albitite line) with varying width occurs over 320 km in length, between Raghunathpura in Haryana and Tal in Rajasthan. A number of uranium and uranium-thorium anomalies were reported along this zone. At Ghateshwar-Rohil uranium mineralisation is associated with albitites in association with carbonaceous phyllite and mica schist of Delhi Supergroup. At Rohil, a relatively small – low grade deposit has been established. Currently the area is under exploration for augmentation of resources.

Cuddapah and Kurnool basin, Andhra Pradesh

The crescent shaped Meso-Neoproterozoic Cuddapah & Kurnool basins are spread over an area of 44 000 km^2 and incorporates Papaghni, Nallamalai, Srisailam, Kurnool and Palnad sub-basins. Three types of uranium mineralisation/deposits have been identified in the Cuddapah basin. These are unconformity related, fracture controlled and stratabound type of mineralisation.

Unconformity-related deposits

Reconnaissance/exploratory drilling in a small portion of the Chitrial outlier in the Srisailam sub-basin of the Cuddapah basin has resulted in establishing a medium tonnage low grade deposit associated with the unconformity between Basement Granitoids and Srisailam Formation. Exploration has been planned over a large area in the contiguous geological settings.

Evaluation and exploratory drilling of the mineralised unconformity between the basement granitoids and the overlying Srisailam Formation in the Srisailam sub-basin have further enlarged the resource position of Peddagattu deposit located in the northern part of the basin.

A small, low grade deposit has been established around Koppunuru at the unconformity between basement granitoids and overlying quartzite of Banganapalle Formation of Kurnool Group in Palnad sub-basin of Cuddapah basin. Exploration is being actively pursued in this area.

Surveys carried out in the northern part of the Palnad sub-basin, have indicated the presence of uranium anomalies in basement granitoids, basic dykes and overlying quartzite of Banganapalle Formation over an area of 7 km^2 around Rallavagu Tanda, Damarchela and Mathampalle, Nalgonda district.

Fracture controlled uranium mineralisation

The Gulcheru quartzite exposed in the southern part of the basin is fractured, faulted and intruded by basic dykes. Uranium mineralisation is associated with the quartz-chlorite breccia and is intermittently spread over an area of 35 km^2 along Madyalabodu-Gandi-Rachakuntapalle-Kannampalle tract and at Idupulapaya in Cuddapah district.

Stratabound Uranium Deposits

A dolostone hosted stratabound uranium deposit at Tummallapalle-Rachakuntapalle in the Vempalle Formation of Papaghni Group in the southern parts of Cuddapah basin was established in the early nineties. Due to high uranium extraction costs, the deposit was under constant study to develop low cost extraction methods. As a consequence of the development of an innovative alkali route beneficiation process for the ore and prevailing high uranium cost the deposit became economic and a mine is being constructed in Tummalapalle. Extension areas along the strike and dip are being probed for additional resources.

Neoproterozoic Bhima basin, Karnataka

The Bhima basin consists of arenaceous, calcareous and argillaceous sediments of Bhima Group and is affected by a number of E-W and NW-SE trending major faults. The exploration carried out so far in this area has established a small size, medium grade deposit associated with limestone and basement granite at Gogi. The ore is amenable to conventional alkaline leaching. Areas adjoining Gogi uranium deposit are being intensively explored for mineralised extensions.

Two cross faults on the south-eastern margin of Bhima Basin, viz., Ukinal-Kurlagere and Wadi fault zones are being investigated by exploratory drilling for possible unconformity/vein type uranium mineralisation. Geologically, these two fault zones are analogous to the Gogi area in which a small deposit has already been established.

Neoproterozoic Kaladgi basin, Karnataka

The Proterozoic Kaladgi basin is emerging as a potential host for uranium mineralisation associated with arenites. Surface and subsurface investigations in the Deshnur area indicate the presence of extensive potential for medium grade unconformity related uranium mineralisation. Only 8 300 km^2 of the basin is exposed, whereas vast areas of the basin seem to be covered by variable thickness of trap rocks of Cretaceous age.

One of the boreholes drilled in Deshnur area returned with a grade and thickness of 0.13% eU_3O_8 over 63.20 m. Further exploration is in progress. Similar contiguous environments in Kaladgi basin are being explored.

Cretaceous sedimentary basin, Meghalaya

Evaluation and exploratory drilling of the mineralised Mahadek sandstone has further strengthened the resource position of Wahkyn deposit located about 10 km SW of Domiasiat in West Khasi Hills district, where a medium-grade, mid-sized deposit has already been established.

A low-grade, low-tonnage deposit at Lostoin has been established to the west of Wahkyn deposit in the same geological environment.

Reconnaissance radiometric surveys have brought to light significant new uranium anomalies in the Cretaceous Mahadek sandstones, about 20 km west of Wahkyn deposit near Umthongkut in theWest Khasi Hills district and further about 30 km west of Umthongkut at Balphakram in the Garo Hills district and the Khonglah-Mawngap area in the Jaintia Hills district.

Other potential areas

Uranium exploration for locating unconformity related deposits has been taken up in the Mesoproterozoic Gwalior Basin, Madhya Pradesh, and Indravati basin, Chhattisgarh.

Some of the earlier located uranium occurrences associated with quartz pebble conglomerates (QPC) in the Sundargarh and Jajpur districts of Orissa are now being re-assessed to establish their potential.

Future strategies

Airborne Time Domain Electromagnetic surveys have been introduced in a big way in the uranium exploration programme of the country. More than 400 000 km of airborne geophysical surveys, including TDEM, Gamma-ray spectrometric and magnetic surveys, are proposed to be carried out over potential Proterozoic Basins of India.

An ambitious programme to drill about 700 000 m in potential target areas of the country has already been formulated in order to augment national uranium resources.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

India's identified conventional uranium resources (RAR and Inferred) are estimated to amount to 105 900 tU and are hosted by the following type of deposits:

Vein type	49.06%
Sandstone type	14.57%
Unconformity type	12.92%
Metasomatite	0.63%

QPC	0.33%
Others (Stratabound)	22.49%

As of 1st January 2009, the identified conventional *in situ* resources established so far include 72 800 tU of Reasonably Assured Resources (RAR) and 33 100 tU of Inferred Resource (IR). The substantial increase in the RAR is mainly due to the re-assessment of some deposits, which were earlier classified as IR. Although appreciable amounts of resources have been added in the extension areas of one of the deposits, there is only a marginal increase compared to the 2007 figure in respect of IR. This is mainly due to the firming up of the few deposits based on additional data accrued and subsequently upgrading resources from IR to RAR.

Undiscovered Conventional Resources (Prognosticated & SR)

In parts of Andhra Pradesh, Meghalaya, Rajasthan, and Karnataka, potential areas for uranium resources were firmed up with enhanced degrees of confidence. Due to the re-assessment and identification of many new areas in Srisailam sub-basin, Andhra Pradesh, Mahadek basin, Meghalaya, North Delhi Fold Belt of Haryana & Rajasthan and Bhima & Kaladgi basins and Karnataka, a substantial increase has been observed under Prognosticated Resource category (PR) while no change has occurred under the Speculative Resource category (SR). As of 1 January 2009, the undiscovered resources include 63 600 tU under the PR category and 17 000 tU under the SR category as *in situ* resources.

URANIUM PRODUCTION

Historical Review

The Uranium Corporation of India Limited (UCIL) was formed in October 1967 under the administrative control of the Department of Atomic Energy, Government of India. UCIL is now operating five underground uranium mines at Jaduguda, Bhatin, Narwapahar, Turamdih and Bagjata and one opencast mine at Banduhurang in the district of Singhbhum East, Jharkhand State. The ore produced from these mines is processed in two plants located at Jaduguda and Turamdih. All these units fall within a multi-metal mineralised sector called the Singhbhum Shear Zone in the eastern part of India.

Status of production capability

The total installed capacity of Jaduguda plant is about 2 100 t ore/day and capacity of Turamdih plant is about 3 000 t ore/day.

Recent and Ongoing Activities

Jaduguda Mine: The Jaduguda uranium deposit lies within meta-sediments of Singhbhum Shear Zonein in Proterozoic age host rock. There are two prominent parallel ore lenses: the Footwall lode (FWL) and Hangwall lode (HWL). These lodes are separated by a barren zone of 100 m

thickness. The FWL extends over a strike length of about 600 m in the southeast-northwest direction. The strike length of HWL is about 250 m and is confined to the eastern part of the deposit. Both the lodes have an average dip of 40 degrees towards the north-east. Of the two lodes, the FWL is better mineralised. The Jaduguda deposit has been explored up to a depth of 880 m.

Jaduguda Mine was commissioned in October 1967. The entry into the mine is through a 640 m vertical shaft. An underground auxiliary vertical shaft, sunk from 555 m to 905 m, provides access to deeper levels. The cut-and-fill stopping method is practiced in this mine, which yields about 80% ore recovery. De-slimed mill tailings are used as backfill material. Broken ore is hoisted by a skip in stages through shafts to the surface and sent to the Jaduguda mill by conveyor for further processing.

Bhatin Mine: The Bhatin uranium deposit is located 4 km north-west of Jaduguda. A major strike-slip fault lies between these two deposits. The Bhatin mine came into production in 1986. The ore lens in this mine has a thickness of 2 m to 10 m with an average dip of 35 degrees. The geological setting of Bhatin is similar to that of the Jaduguda deposit. The entry into the mine is through an adit and deeper levels are accessed by inclines. The cut and fill method of stoping is followed at Bhatin using deslimed mill tailings from Jaduguda mill. Broken ore is sent to Jaduguda mill by truck.

Narwapahar Mine: Narwapahar deposit, located about 12 km west of Jaduguda has been in operation since 1995. In this deposit, discrete uraninite grains occur within chlorite-quartz schists with associated magnetite. There are several ore lenses in this deposit extending over a strike length of about 2 100 m. The ore shoots are lenticular in shape, with an average north-easterly dip of 30 to 40 degrees. The thickness of individual ore shoots varies from 2.5 m to 20 m. The deposit is accessed by a 355 m vertical shaft and a 7 degree decline from the surface. The cut-and-fill stoping method is also practiced in this mine using deslimed mill tailings of Jaduguda plant as back fill material. Ore of Narwapahar mine is sent to the Jaduguda plant by truck for processing.

Turamdih Mine: The Turamdih deposit is located about 12 km west of Narwapahar. This mine was commissioned in 2003. Discrete uraninite grains within feldspathic-chlorite schists form a number of ore lenses with very erratic configuration. Two levels at 70 m and 100 m depth have been opened and are accessed by a 8 degree decline from surface. A vertical shaft is being sunk to provide access to deeper levels. Ore of this mine is processed at the Turamdih plant.

Bagjata Mine: The deposit at Bagjata, about 26 km east of Jaduguda has been developed as an underground mine with a 7 degree decline as entry and vertical shaft to access deeper levels. This mine was commissioned in 2008. Ore from the Bagjata mine is sent to the Jaduguda plant by truck for processing.

Banduhurang Mine: The deposit located at Banduhurang has been developed as a large opencast mine. The ore body at Banduhurang is the western extension of ore lenses at Turamdih. This mine was commissioned in 2007. Ore from Banduhurang is sent to the Turamdih plant by truck for processing.

Jaduguda Mill: Uranium ore produced at the Jaduguda, Bhatin, Narwapahar and Bagjata mines is being processed in the mill located at Jaduguda. The mill was commissioned in 1968.

Following the crushing and grinding to 60% passing 200 mesh, ore is leached in pachuca tanks using sulphuric acid under controlled pH and temperature conditions. After the filtration of the pulp, ion exchange resin is used to recover uranium. After elution, the product is precipitated using

magnesia to produce magnesium di-uranate containing 70% U_3O_8 (59% U).The treatment of mine water and the reclaiming of tailings water has resulted in the reduction of fresh water requirements, as well as increasing the purity of the final effluent.

A magnetite recovery plant is also in operation at Jaduguda producing very fine grained magnetite as by-product.

Turamdih Mill: Uranium ore produced at the Turamdih, and Banduhurang mines is being processed at the Turamdih mill, commissioned in 2009.

Ownership Structure of the Uranium Industry

The uranium industry is wholly owned by the Department of Atomic Energy, Government of India.

The Atomic Minerals Directorate for Exploration and Research under the Department of Atomic Energy is responsible for uranium exploration programmes in India. Following discovery and deposit delineation, the economic viability is assessed. The evaluation stage may also include exploratory mining. Once a deposit of sufficient tonnage and grade is established, UCIL initiates activities for commercial mining and production of uranium concentrates.

Employment in the Uranium Industry

Uranium mining and milling activities in India provide employment for 4 643 people.

Future Production Centres

The Jharkhand uranium deposit located at Mohuldih in the Seraikela-Kharswan district is under development as an underground mine. This deposit is about 2.5 km west of Banduhurang. The ore of the mine shall be treated in Turamdih plant.

Another uranium deposit in carbonate hosted rock at Tummalapalle in the Cuddapah district of Andhra Pradesh has also been taken up for development. This underground mine is to be accessed by three declines along the apparent dip of the ore body. The central decline will be equipped with a conveyor for ore transport and other two declines shall be used as service paths. The ore will be treated in a pressurised alkali leaching plant under construction near the mine.

A sandstone hosted uranium deposit at Kylleng-Pyndengsohiong, Mawthabah (former name Domiasiat) in the West Khasi Hills District, Meghalaya State, is planned for development by open-pit mining with a processing plant near the site.

Uranium deposits located at Lambapur-Peddagattu in the Nalgonda district, Andhra Pradesh, are also planned for development. One open-pit mine and three underground mines are proposed at this site. The uranium ore processing plant is being proposed to be constructed at Seripally, 50 km away from the mine site. Pre-project activities are in an advanced stage of completion.

The uranium deposit located at Gogi in the Gulbarga district, Karnataka, is planned for development as an underground mine. It is about 12 km west of Shahapur. Exploratory mining is in progress at site to establish the configuration of ore body. Laboratory and pilot plant tests are in progress to establish a process flow sheet.

India

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2	Centre #3	Centre #4
Name of production centre	Jaduguda	Bhatin	Narwapahar	Bagjata
Production centre classification	Existing	Existing	Existing	Existing
Start-up date	1967	1986	1995	2008
Source of ore: • Deposit name • Deposit type • Reserves (tU) • Grade (% U)	Uranium Ore Jaduguda Vein	Uranium Ore Bhatin Vein	Uranium Ore Narwapahar Vein	Uranium Ore Bagjata Vein
Mining operation: • Type (OP/UG/ISL) • Size (t ore/day) • Average mining recovery (%)	 UG 650 80	 UG 150 75	 UG 1000 80	 UG 500 80
Processing plant (acid/alkaline): • Acid/Alkaline • Type (IX/SX) • Size (t ore/day) • Average process recovery (%)	Jaduguda Acid IX 2100 80			
Nominal production capacity (tU/year)	175			
Plans for expansion	Undergoing expansion to treat 2 500 tonnes ore / day			
Other remarks	Ore being processed in Jaduguda plant			

	Centre #5	Centre #6	Centre #7
Name of production centre	Turamdih	Banduhurang	Mohuldih
Production centre classification	Existing	Existing	Committed
Start-up date	2003	2007	2011
Source of ore: • Deposit name • Deposit type • Reserves (tU) • Grade (% U)	Uranium Ore Turamdih Vein	Uranium Ore Banduhurang Vein	Uranium Ore Mohuldih Vein
Mining operation: • Type (OP/UG/ISL) • Size (t ore/day)	 UG 750	 OP 3500	 UG 500
• Average mining recovery (%)	75	65	80
Processing plant • Acid/Alkaline • Type (IX/SX) • Size (t ore/day) • Average process recovery (%)	Turamdih Acid IX 3000 80		
Nominal production capacity (tU/year)	190		
Plans for expansion	Turamdih mine (1 000 TPD) and Turamdih plant (4 500 TPD) are under expansion		
Other remarks	Ore being processed in Turamdih plant		Ore to be processed after the expansion of Turamdih plant

Uranium production centre technical details (contd.)
(as of 1 January 2009)

	Centre #8	Centre #9	Centre #10
Name of production centre	Tummalapalle	Kylleng-Pyndengsohiong, Mawthabah	Lambapur-Peddagattu
Production centre classification	Committed	Planned	Planned
Start-up date	2010	2012	2012
Source of ore:	Uranium Ore	Uranium Ore	Uranium Ore
• Deposit name	Tummalapalle	KPM	Lambapur-Peddagattu
• Deposit type	Strata bound	Sandstone	Unconformity
• Reserves (tU)			
• Grade (% U)			
Mining operation:			
• Type (OP/UG/ISL)	UG	OP	UG/OP
• Size (t ore/day)	3000	2 000 (275 days/y working)	1 250
• Average mining recovery (%)	60	90	75
Processing plant (acid/alkaline):	Tummalapalle	KPM	Seripally
• Acid/Alkaline	Alkaline pressurised	Acid	Acid
• Type (IX/SX)	IX	IX	IX
• Size (t ore/day)	3 000	2 000 (275 days/y working)	1 250
• Average process recovery (%)	70	87	77
Nominal production capacity (tU/year)	217	340	130
Plans for expansion			
Other remarks			

NA Not available.

Secondary sources of uranium

See relevant table for India's production and use of mixed-oxide fuels. India reported no information on the production and use of re-enriched tails or reprocessed uranium.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Environmental Aspects

There are no environmental issue related to existing uranium mines and processing plants operated by UCIL. However, provisions are made for the management of environmental impacts. The

organisation responsible for this task is the Health Physics Group of the Bhabha Atomic Research Centre, located in Mumbai. It carries out environmental health monitoring of radiation, radon and dust at uranium production facilities. The Health Physics Group operates an Environmental Survey Laboratory at Jaduguda.

URANIUM REQUIREMENTS

As of 1 January 2009, total installed nuclear capacity in India was 4 120 MWe (gross), comprised of 15 pressurised heavy water reactors (PHWRs) and two boiling water reactors (BWRs). Construction of 3 PHWRs (Kaiga 4 – 1 x 220 MWe and RAPP 5&6 – 2 x 220 MWe), 2 light water reactors (KKNPP 1&2 – 2 x 1 000 MWe) and one prototype fast breeder reactor (1 x 500 MWe) is in progress. The total nuclear power generating capacity is expected to grow to about 7 280 MWe (gross) – 6 700 MWe (net) by 2011, with progressive completion of projects under construction.

The present plan is to increase the nuclear installed capacity to about 20 000 MWe by the year 2020, comprised of 10 000 MWe of PHWRs, 8 320 MWe of Light Water Reactors (LWRs), 2 500 MWe of FBRs and 300 MWe of advanced heavy water reactor (AHWR).

Annual uranium requirement for the year 2009 is about 930 tU which would gradually increase to about 4 070 tU in 2020. Identified Conventional uranium resources can support 10 GWe installed capacity of PHWRs operating at a lifetime capacity factor of 80% for 40 years.

With the opening of international cooperation in peaceful nuclear programme, India's installed nuclear capacity is expected to grow significantly. More projects are envisaged to be taken up. However, the exact programme to be adopted based on technical cooperation with other countries is yet to be finalised.

Supply and procurement strategy

Uranium requirement for PHWRs is met so far from indigenous sources. In future, uranium requirements for PHWRs will be met from both indigenous and imported sources. Two operating BWRs and two LWRs (VVER type) under construction require enriched uranium and are fuelled by imported uranium. Future LWRs would also be fuelled by imported uranium.

NATIONAL POLICIES RELATING TO URANIUM

Uranium exploration, mining, production, fuel fabrication and operation of nuclear power reactors is controlled by the Government of India. National policies relating to uranium are governed by the *Atomic Energy Act* 1962 and provisions made thereunder.

Any future imported LWRs would be purchased on the basis of an assured fuel supply for the lifetime of the reactor.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million INR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	742.10	801.60	1074.50	1503.20
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	742.10	801.60	1074.50	1503.20
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	42 620	60 456	117 747	321 700
Government exploration holes drilled	NA	NA	NA	NA
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	42 620	60 456	117 747	321 700
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	42 620	60 456	117 747	321 700
Total holes drilled	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost Range unassigned	Recovery factor (%)
Underground mining	NA	NA	NA	60 200	
Open-pit mining	NA	NA	NA	12 600	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	NA	NA	NA	72 800	

* *In situ* resources.

India

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost Range unassigned	Recovery factor (%)
Conventional	NA	NA	NA	72 800	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	NA	NA	NA	72 800	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost Range unassigned
Unconformity-related	NA	NA	NA	13 700
Sandstone	NA	NA	NA	12 600
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	NA	NA	NA	34 300
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	NA	NA	NA	12 200
Total				72 800

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost Range unassigned	Recovery factor (%)
Underground mining	NA	NA	NA	31 100	
Open-pit mining	NA	NA	NA	2 000	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total				33 100	

* *In situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost Range unassigned	Recovery factor (%)
Conventional	NA	NA	NA	33 100	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total				33 100	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Unassigned
Unconformity-related	0	0	0	0
Sandstone	NA	NA	NA	2 800
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	NA	NA	NA	400
Vein	NA	NA	NA	17 600
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	NA	NA	NA	700
Other*	NA	NA	NA	11 600
Total	NA	NA	NA	33 100

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
NA	NA	63 600

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
NA	NA	17 000

India

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
NA	100	0	0	0	0	0	0	NA	100

Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres	4 300	4 300	4 643	4 643
Employment directly related to uranium production	4 300	4 300	4 643	4 643

Net nuclear electricity generation

	2007	**2008**
Nuclear electricity generated (TWh net)	18.00	15.43

Installed nuclear generating capacity to 2035
(MWe net)

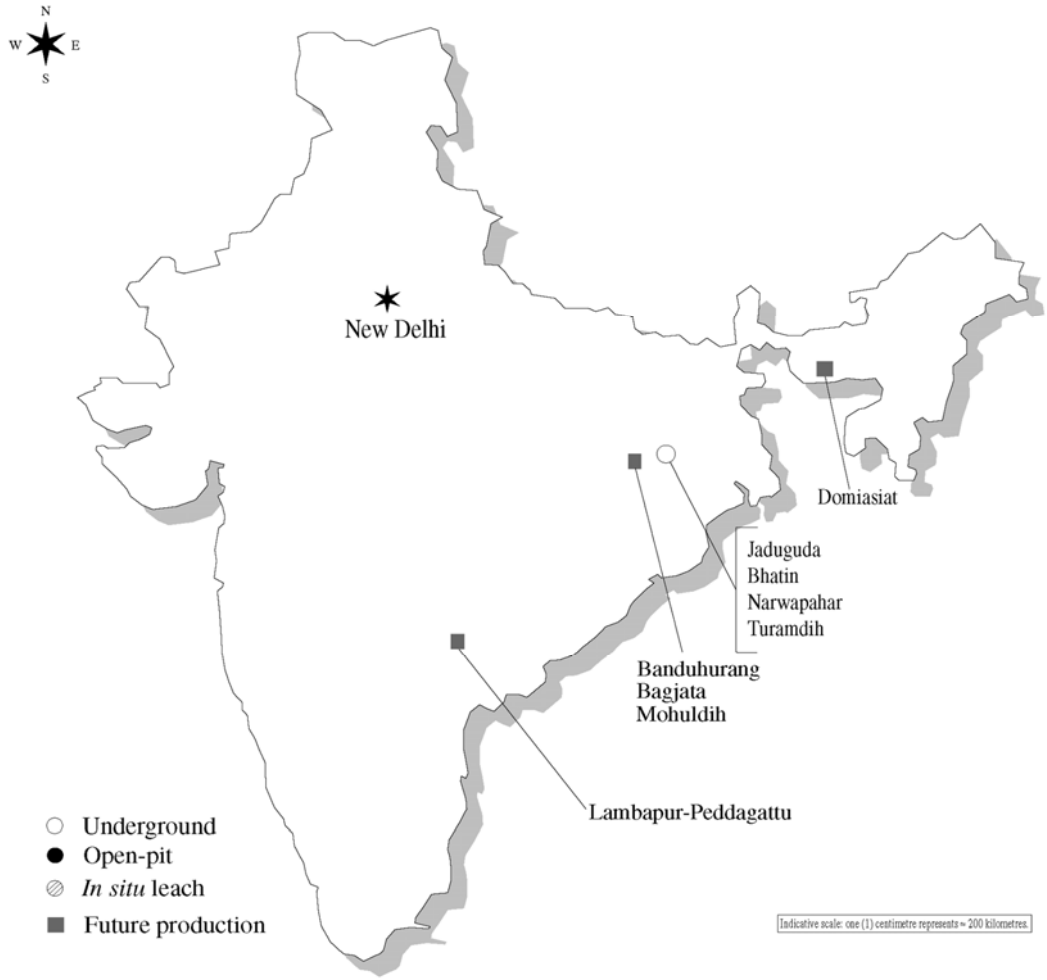
2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
4 120	4 780		6 780		14 380

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
	23 180	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
750	930		1 260		2 530

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
	4 060		NA		NA		NA



•Indonesia •

URANIUM EXPLORATION

Historical review

See the 2005 edition of the Red Book for a short historical review of uranium exploration.

In 2005, exploration drilling was carried out at Jumbang 3 (45 m) and at Mentawa (45 m); in 2006 at Semut (454 m) and Mentawa (45 m). In 2007, exploration drilling was carried out at Semut (174 m). In 2008, no exploration drilling was undertaken.

Recent and ongoing uranium exploration and mine development activities

In 2009, exploration drilling is planned to be continued in the Kalan Sector (expected 450-550 m), and to carry out detailed, systematic prospection in the Kawat area and its surroundings. Besides this, general prospection in Bangka Belitung Province will be conducted. No mine development activity is currently under consideration.

The policy of organisation now for the next two years is to extend exploration in Kalimantan and Sumatera by doing prospection from the general reconnaissance to systematic stages in order to discover new uranium deposits.

URANIUM RESOURCES

Identified Conventional Resources (RAR &Inferred)

Indonesia reports no changes in the amounts of RAR and Inferred resources. In 2010, evaluation drilling in the Kawat Sector and the surrounding area is planned with the goal of upgrading Speculative resources to Inferred and RAR.

Undiscovered Conventional Resources (Prognosticated & SR)

Following the policy of extending the area of exploration in order to discover new uranium deposits, investigations resulted in an 11 000tU increase in Speculative resources, in the Kawat sector during 2006 and 2007. The Kawat sector had been identified as an area of favourable geological criteria for hosting uranium mineralisation. Based on these positive results, systematic prospection stages will be continued in 2009 in the neighborhood of Kawat with the same geological characteristics. Kawat and surrounding districts are prospective areas for rhyolite bearing uranium, containing from 60 ppm to 13 000 ppm U_3O_8 (51 ppm to 11 025 ppm U, or 0.0051% to 1.125%U)

On 2010 exploration drilling in the Kawat Sector is planned in order to obtain more information on uranium bearing rock, such as depth, grade, and thickness of the ore.

Unconventional Resources and Other Materials

In 2009, general prospection in Bangka Belitung Province will also be carried out. The result of the previous investigation which was done by the local government provided information strong indications of monazite mineralisation, containing uranium and thorium from 0.3% up to 2.4%, phosphate and rare earths. In this area, monazite has previously been found as a by product of tin mining.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

No significant environmental issues relating to uranium exploration and resource development have been identified. Indonesia reported no information on national policies relating to uranium, uranium stocks, or uranium prices.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in millions IDR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	1 104.98	1 060. 83	0	2 400
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	1 104.98	1 060.83	0	2 400
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	531	173.70	0	500
Government exploration holes drilled	10	4	0	3
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	531	173.70	0	500
Subtotal exploration holes drilled	10	4	0	3
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	531	173.70	0	500
Total holes drilled	10	4	0	3

* Non-government.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	900	6 797	6 797	6 797	70
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	900	6 797	6 797	6 797	70

* *In situ* resources.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	900	6 797	6 797	6 797	70
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	900	6 797	6 797	6 797	70

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	900	6 797	6 797	6 797
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	900	6 797	6 797	6 797

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	1 734	1 734	1 734	70
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	1 734	1 734	1 734	70

* *In situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	1 734	1 734	1 734	70
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	1 734	1 734	1 734	70

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	1 734	1 734	1 734
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	1 734	1 734	1 734

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
16 100	16 100	16 100

• Islamic Republic of Iran •

URANIUM EXPLORATION AND MINE DEVELOPMENT

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

In the past two years, besides the previous projects that are still under study, exploration has begun in new areas in the Kerman, Sistan-va-Baluchstan, South Khorasan and Razavi Khorasan provinces, in the southeast and east of Iran.

In the current year (2009), structural regional studies will continue covering almost the entire eastern part of Iran.

Reconnaissance of sedimentary type uranium deposits by modern procedures is an on-going exploration programme over the entire country, in order to evaluate the potential of favourable sedimentary basins for uranium mineralisation.

Exploration areas

Exploration studies on Saghand Orefield

Areas close to deposits number 1 and 2 of Saghand (the Saghand uranium mine), which consist of many anomalies, are under exploration in different phases of operations. Mineralisation in this area is metasomatite and hydrothermal type, generated by an alkaline granite mass intrusion into volcanic rocks. Exploration of some anomalies of this exploration area has been completed, and exploration in other anomalies is continued by trenching, exploratory drillings and logging.

Markesheh-Ravar exploration area

Sedimentary complexes of Upper Jurassic-Lower Triassic age host uranium mineralisation associated with silver and copper mineralisation within an arkose coalferous sandstone in this exploration area. A combination of geological and geophysical exploratory operations is being carried out in addition to exploratory drilling and logging. This sandstone unit is situated within a sequence of red sediments.

Narigan exploration area

This area hosts hydrothermal type uranium mineralisation and different anomalies which are under exploratory operations in different stages.

Koshumi exploration area

Metasomatite mineralisation within various anomalies in this area is the major mineralisation type. Analytical and logging data are being interpreted in some of the anomalies.

Gachin Salt Plug (Bandar-Abbas)

Exploration operations in adjacent areas are planned in order to identify new uranium resources and to develop existing Gachin resources.

The Lut and Jazmurian regions

The Lut and Jazmurian regions in southeastern Iran are under exploratory studies in the reconnaissance phase. These depression zones could have suitable conditions for sedimentary basins with uranium mineralisation potential.

Mine development activities in Saghand

Sinking and equipping two cylindrical shafts (4 m in diameter and 350 m deep each) has been completed and the overall progress of the entire mine development project is about 56% complete. These development activities have been defined in the frame of six projects and the rest will be implemented up to 2012. The tunnelling operation has reached about 1 300 m until now.

Underground mining methods are going to be used for 90% of the exploitation operation (Room Mining 42%, Room and Pillar 28% and other methods such as Long Wall, Cut and Fill and Sub-level Stopping for the remaining 20%).

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2
Name of production centre	Gachin	Ardakan
Production centre classification	Existing	Committed
Start-up date	2006	2012
Source of ore:		
• Deposit name	Gachin	Saghand
• Deposit type	Salt Plug	Metasomatite
• Reserves (tU)	100	900
• Grade (% U)	0.2	0.0553
Mining operation:		
• Type (OP/UG/ISL)	OP	10% OP, 90% UG
• Size (t ore/day)	50	500
• Average mining recovery (%)	80	80
Processing plant (acid/alkaline):		
• Acid/Alkaline	Acid	Acid
• Type (IX/SX)	SX	IX
• Size (t ore/day)	50	400
• Average process recovery (%)	90	90
Nominal production capacity (tU/year)	21	50
Plans for expansion		
Other remarks		

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in millions IRR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	19 913	16 227	49 500	67 900
Industry* development expenditures	0	0	0	0
Government development expenditures	24 270	20 243	24 170	92 070
Total expenditures	44 183	36 470	73 670	159 970
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	10 800	13 850	16 645	40 000
Government exploration holes drilled	130	162	178	210
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	0	0	0	0
Subtotal exploration holes drilled	0	0	0	0
Subtotal development drilling (m)	10 800	13 850	16 645	40 000
Subtotal development holes drilled	130	162	178	210
Total drilling (m)	10 800	13 850	16 645	40 000
Total holes drilled	130	162	178	210

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	491	491	85-90
Open-pit mining	0	0	100	100	85-90
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	136	136	
Total	0	0	727	727	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	727	727	85-90
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	727	727	85-90

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	491	0
Other*	0	0	236	0
Total	0	0	727	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	876	876	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	554	554	
Total	0	0	1 430	1 430	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	1 430	1 430	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	1 430	1 430	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	522	522
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	876	876
Other*	0	0	32	32
Total	0	0	1 430	1 430

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	4 190	4 190

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	14 000	14 000

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	0.134	6.304	4.7	6.264	17.4	10
Underground mining*	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	0.134	6.304	4.7	6.264	17.4	10

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	0.134	6.304	4.7	6.264	17.4	10
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	0.134	6.304	4.7	6.264	17.4	10

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other	0.134	6.304	4.7	6.264	17.4	10
Total	0.134	6.304	4.7	6.264	17.4	10

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
6.264	100	0	0	0	0	0	0	6.264	100

Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres	285	285	285	300
Employment directly related to uranium production				

Installed nuclear generating capacity to 2035
(MWe net)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
0	0	915	915	915	915

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 175	5 075	6 975	7 925	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
0	0	160	160	160	160

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
590	910	1 230	1 390	NA	NA	NA	NA

• Japan •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

Japan-Canada Uranium Co. Ltd., which took over JNC's mining interests in Canada, is carrying out exploration activities in Canada. Japanese private companies hold shares in developing and mining operations in Canada, Niger, Kazakhstan and elsewhere.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

About 6 600 tU of Reasonably Assured Resources have been identified and classified as recoverable at <USD 130/kgU.

URANIUM PRODUCTION

Historical review

A test pilot plant with a capacity of 50 tonnes ore per day was established at the Ningyo-toge mine in 1969 by PNC. The operation ceased in 1982 with a total production of 84 tU. In 1978, the vat leaching test of the Ningyo-toge ore began on a small scale with a maximum capacity of 12 000 tonnes ore per year, consisting of three 500-tonne ore vats. The vat leaching test was terminated at the end of 1987.

Secondary sources of uranium

Production of mixed-oxide fuels

Production facilities

The plutonium fuel plant of JAEA consists of three facilities, the plutonium fuel development facility (PFDF), the plutonium fuel fabrication facility (PFFF), and the plutonium fuel production facility (PFPF).

- The PFDF was constructed for basic research and fabrication of test fuels and started operation in 1966. As of March 2008, approximately two tonnes of MOX fuels have been fabricated in the PFDF.

Japan

- In the PFFF, there are two MOX fuel fabrication lines, one for the experimental fast breeder reactor Joyo (FBR line) with one-tonne MOX/year of fabrication capability and the other for the prototype advanced thermal reactor Fugen (ATR line) with 10 tonnes MOX/year fabrication capability. The FBR line started its operation in 1973 with Joyo initial load fuel fabrication. The fuel fabrication for the Joyo in the FBR line was finished in 1988, and the role of the fuel fabrication for Joyo was switched to the PFPF. The ATR line started its operation in 1972 with MOX fuel fabrication for the Deuterium Critical Assembly (DCA) in O-arai Research and Development Center of JAEA. The fuel fabrication for ATR Fugen was started in 1975 and was finished in 2001. The total amount of MOX fuel fabricated by both lines was approximately 155 tonnes.

- PFPF FBR line was constructed to supply MOX fuels to the prototype FBR Monju and the experimental FBR Joyo with five tonnes MOX/year of fabrication capability. The PFPF FBR line started its operation in 1988 with Joyo reload fuel fabrication and fuel fabrication for the FBR Monju was started in 1989. As of March 2008, approximately 13 tonnes of MOX fuels had been fabricated in the PFPF.

Use of mixed-oxide fuels

- Prototype Fast Breeder Reactor Monju

Monju achieved its initial criticality in April 1994, and supplied electricity to the grid initially in August 1995. However, the pre-operational test of the plant was interrupted by a sodium leak accident in the secondary heat transport system in December 1995 during a 40% power operation test. After carrying out the cause investigation and the comprehensive safety review for two years and the necessary licensing procedure, the permit for plant modification (countermeasure against potential sodium leak etc.) was issued in December 2002 by METI. JAEA completed a series of modifications in order to reinforce countermeasures against potential sodium leak accidents in May 2007, followed by the modified system function test till August 2007 and the succeeding entire system function test (ESFT). All the already-existing aged but fresh 78 fuel assemblies and 6 newly-fabricated fuel assemblies were transported to Monju by 16 December 2008. The fresh fuel assemblies wait ready outside the core. Monju is in the course of sodium leak detector re-inspection and repair work on the exterior ventilation duct connecting to the stack, after finishing 133 of a total of 141 test items of the ESFT. A revision of design-bases on earthquake-acceleration instructed by the Japanese regulatory body required a detailed review of the final report on the seismic safety of Monju plant submitted on March 2008. This review is still ongoing as of May 2009.

- Experimental Fast Reactor JOYO

The experimental fast reactor JOYO attained its initial criticality in April 1977 with the MK-I breeder core. As an irradiation test bed, the JOYO MK-II core achieved the maximum design output of 100 MWt in March 1983. By June 2000, 35 duty cycle operations and thirteen special tests with the MK-II core had been completed. The MK-III high performance irradiation core, of which maximum design output increases to 140 MWt, achieved its initial criticality in July 2003. By March 2009, six duty cycle operations and four special tests with MK-III core had been completed. The JOYO net operation time reached around 70 000 hours and 588 fuel subassemblies were irradiated during the MK-I, MK-II and MK-III core operations.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

None reported.

URANIUM REQUIREMENTS

Uranium Requirements

As of the end January 2009, Japan had 53 operating commercial nuclear power reactors. Total electric generating capacity was 48 087 MWe, providing approximately one third of the electricity generated in Japan. Three additional commercial nuclear power reactors (Tomari-3, Shimane-3, Ohma) and one prototype fast breeder reactor MONJU are under construction. Two reactors (Hamaoka-1 and Hamaoka-2) were shut down and operations were terminated on 30 January 2009.

Supply and procurement strategy

Japan has relatively scarce domestic uranium resources and, therefore, must depend to a great extent on overseas supply of uranium. A stable supply of uranium resources is to be ensured through long-term purchase contracts with overseas uranium suppliers, direct participation in mining development and diversification of suppliers and countries.

NATIONAL POLICIES RELATING TO URANIUM

There is no special legislation for uranium exploration and exploitation under the Japanese Mining Laws and Regulations. Uranium exploration and exploitation is open to private companies incorporated in Japan. However, no private company has pursued uranium exploitation in Japan.

URANIUM PRICES

Uranium import prices are contracted by private companies. Government information is not available for these data.

Uranium exploration and development expenditures – non-domestic

Expenses in million JPY	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	0	190	400	400
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	6 600	6 600	85
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	6 600	6 600	85

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	6 600	6 600	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	6 600	6 600	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	6 600	6 600
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	6 600	6 600

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	39	0	0	0	39	0
Underground mining*	45	0	0	0	45	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	84	0	0	0	84	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	45	0	0	0	45	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	39	0	0	0	39	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	84	0	0	0	84	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	84	0	0	0	84	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	84	0	0	0	84	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Japan

Mixed-oxide fuel production and use
(tonnes of natural U equivalent)

Mixed-oxide (MOX) fuels	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	598	0	9	4	611	36
Use	521.3	10.3	0	0	531.6	64.1
Number of commercial reactors using MOX	NA	0	0	0	NA	0

Reprocessed uranium use
(tonnes of natural U equivalent)

Reprocessed uranium	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	645	0	0	0	645	0
Use	138	27	30	0	195	12

Net nuclear electricity generation (Fiscal year)

	2007	**2008**
Nuclear electricity generated (TWh net)	263.8	258.1

Installed nuclear generating capacity to 2035
(MWe net) (Fiscal year)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
47 940	NA	NA	NA	NA	NA

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
6 914	NA	7 901	7 901	14 214	14 214

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
NA	NA	NA	NA	NA	NA	NA	NA

• Jordan •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review of uranium exploration.

During the 1990's reconnaissance and exploration studies revealed surficial uranium deposits distributed in several areas of the country, as described below:

- Central Jordan: exploration, including 1 700 trenches and over 2 000 boreholes, was carried out revealing the occurrence of uranium deposits as minute mineral grains disseminated within fine calcareous Pleistocene sediments and as yellowish films of carnotite and other uranium minerals coating fractures of fragmented chalk or marl of Mastrichtian -Paleocene age. The results of channel sampling in three areas in central Jordan indicate uranium contents ranging from 140 to 2 200 ppm U (0.140% to 2.2% U) over an average thickness of about 1.3 m, with an average thickness of the overburden about 0.5 m.
- Three uranium anomalous areas (Mafraq, Wadi Al-Bahiyyah, and Wadi Sahb alabiadh) with promise for hosting uranium deposits were also covered by the reconnaissance studies.

Recent and ongoing uranium exploration and mine development activities

In 2008, the Jordan Atomic Energy Commission (JAEC) was established, in accordance with the newly enacted *Nuclear Energy Law* (Law No. 42 of 2007) and its Amendments of 2008. The JAEC is the official entity entrusted with the development and execution of the Jordanian nuclear power programme. The exploration, extraction and mining of all nuclear materials; including uranium, thorium, zirconium and vanadium is now under the authority of JAEC.

The Nuclear Fuel Cycle Commission of JAEC is in charge of developing and managing all aspects of the nuclear fuel cycle; including uranium exploration, extraction, production, securing fuel supply and services, nuclear fuel management and radioactive waste management. The JAEC uranium policy is to maximise sovereignty while creating value from resources, and to avoid concessions to foreign companies. To attract investors and operate on commercial basis, JAEC created Jordan Energy Resources Inc as its commercial arm.

In September 2008, JAEC signed an exploration agreement with Areva and created the Jordanian French uranium mining company (JFMUC), a joint venture that will carry out all exploration activities leading to a feasibility study of developing resources in Central Jordan. A complete exploration program is being carried out in the 1 400 km^2 area of Central Jordan, pending positive results JFMUC will develop and construct a mine. Based on the available preliminary data, it is expected that production will start in 2012 with an estimated annual output of 2 000 tU.

At the end of 2008, JAEC reached an agreement with Rio-Tinto, and an MOU was signed in January 2009 entitling Rio-Tinto to carry out reconnaissance and prospecting in three areas (north of Al-Bahiyyah, Wadi Sahb alabiadh, and Rewashid). Reconnaissance activities have started, and

pending positive results Rio-Tinto will move into an exploration and mine development phases through a joint venture with JAEC.

Exploration activities by Jordanian teams in co-operation with the Chinese SinoU are being carried out in two other areas (Mafraq and Wadi Al-Bahiyyah).

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in millions JOD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	7.2
Government exploration expenditures	0	0	0.25	1.0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	NA	NA
Total expenditures	0	0	0.25	8.2
Industry* exploration drilling (m)	0	0	NA	30 000
Industry* exploration holes drilled	0	0	NA	NA
Government exploration drilling (m)	0	0	NA	5 000
Government exploration holes drilled	0	0	NA	NA
Industry* development drilling (m)	0	0	NA	NA
Industry* development holes drilled	0	0	NA	NA
Government development drilling (m)	0	0	NA	NA
Government development holes drilled	0	0	NA	NA
Subtotal exploration drilling (m)	0	0	NA	35 000
Subtotal exploration holes drilled	0	0	NA	NA
Subtotal development drilling (m)	0	0	NA	NA
Subtotal development holes drilled	0	0	NA	NA
Total drilling (m)	0	0	NA	35 000
Total holes drilled	0	0	NA	NA

* Non-government.

Uranium exploration and development expenditures – non-domestic

Expenses in millions JOD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	NA	NA	NA	NA
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	NA	NA	NA	NA
Total expenditures	NA	NA	NA	NA

* Non-government.

• Kazakhstan •

URANIUM EXPLORATION

Historical Review

A historical review of uranium exploration and mine development in Kazakhstan is provided in the Red Book 2007.

Recent and Ongoing Uranium Exploration and Mine Development Activities

Uranium exploration expenditure in Kazakhstan increased from KZT 1 037 million in 2006, to KZT 4 125 million in 2007 and to KZT 9 402 million in 2008. The number of holes drilled was 1 036 in 2007 and 1 693 in 2008, with a total of 514 783 m drilled in 2007 and 853 862 m drilled in 2008.

In 2005-2008 exploration of sandstone-type deposits was performed at Moinkum, Inkai, Mynkuduk and Buddenovskoye in the Shu-Sarysu Uranium Province and at Northern Kharassan in the Syrdaria Uranium Province. A geological and economic re-estimation of vein-type deposits in the Northern Kazakhstan Uranium Province was conducted in 2007-2008.

The JV Inkai has completed exploration and ISL pilot project works at site No. 2, and continues exploration at site No. 3 of the Inkai deposit. The Karatau Limited Liability Partnership (LLP) has completed the first stage of exploration with ISL pilot production at site No. 2 of the Buddenovskoye deposit and commenced commercial production and the second stage of exploration. A geological and economic re-evaluation of uranium resources was made of the Vostok and Zvezdnoye deposits (vein mineralization) in 2007.

Exploration in 2007-2008 resulted in an increase in Identified Resources by 23 592 tU, including an increase in Reasonably Assured Resources of 51 714 tU.

The JV Katco continues uranium exploration at site No. 3 (central) of the Moinkum deposit. The Kyzylkum LLP and the Baiken-U LLP perform uranium exploration at the Northern Kharassan deposit.

In 2009, exploration and ISL pilot production will be completed: on the western site of the Mynkuduk deposit by the Appak LLP; at site No. 4 of the Inkai deposit by the Betpak-Dala LLP and at the central site of the Mynkuduk deposit by the Ken Dala.kz JSC.

The Akbastau JSC will start exploration at sites No. 1, 3 and 4 of the Buddenovskoye deposit in 2009-2010. It is planned to fulfill ISL pilot production at all these sites. In 2009, the Zarechnoye JSC will commence exploration of the South Zarechnoye deposit.

In 2010, the Volkovgeology JSC is planning to renew geological exploration of sandstone-type deposits in new perspective areas of the Shu-Sarysu and the Syrdaria Uranium Provinces at the expense of the state budget.

No new deposits were discovered during the reporting period.

Uranium exploration and development expenditures (non-domestic)

No uranium exploration and development was performed by Kazatomprom beyond the limits of the Republic of Kazakhstan.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

As of 1 January 2009, identified *in situ* uranium resources amounted to 950 056 tU (recoverable at <USD$260/kgU), including 637 405 tU of resources amenable for ISL mining.

In 2007 and 2008, 15 147 tU were mined. Considering the losses during mining (1 766 tU or 10.4%), 16 913 tU of resources were depleted. Whereas 14 250 tU (94.1%) were produced by ISL method, 895 tU were produced by underground mining at the Vostok and Zvezdnoye deposits.

Inferred Resources were increased by 23 592 tU (transfered from Prognosticated Resources) as a result of geological exploration in 2007-2008, including 852 tU at the Vostok and Zvezdnoye deposits and 22 740 tU at the Inkai and Buddenovskoye deposits. Reasonably Assured Resources were increased by 51 714 tU (transfered from Inferred Resources), including 3 595 tU at the Vostok and Zvezdnoye deposits amenable for underground mining and 48 119 tU at the Inkai deposit (sites No. 2 and 4) and the Buddenovskoye deposit (site No. 2) amenable for ISL.

There have been significant changes in the cost categories assigned to resources due to the introduction of a new Tax Code in Kazakhstan effective from 1 January 2009, which replaced Royalty by “Tax on a mineral wealth.” Thus the cost of production has increased. The cost of production is shown in 2009 prices.

As a result of a geological and economic re-estimation of the north Kazakhstan Uranium Province deposits, corrections were made in the distribution of resources amenable to open-pit and underground mining.

Undiscovered Conventional Resources (Prognosticated & SR)

A re-evaluation of Prognosticated and Speculative Resources was made within the reporting period. Out of 500 000 tU of Prognosticated Resources, 498 000 tU are related to sandstone deposits and 2 000 tU to vein deposits. Out of 300 000 tU of Speculative Resources, 90% are related to sandstone deposits, 10% to unconformity-related deposits.

Unconventional Resources and Other Materials

Estimates are not made of Kazakhstan’s uranium resources in the categories of Unconventional Resources and other materials.

URANIUM PRODUCTION

Historical Review

A historical overview of uranium production in Kazakhstan is provided in the 2007 Red Book.

Production Capability and Recent and Ongoing Activities

In 2007 and 2008, uranium was mined in 15 production centers at the following deposits: Kanzhugan, Moinkum, Akdala, Uvanas, Mynkuduk, Inkai, Buddenovskoye, North Karamurun, South Karamurun, Irkol, Zarechnoye, Vostok and Zvezdnoye. All deposits are being mined by ISL, with the exception of Vostok and Zvezdnoye, where underground mining methods are being used.

The Uvanas, Mynkuduk (eastern site), Kanzhugan, Moinkum (southern part of site No. 1), North Karamurun, South Karamurun and Irkol (until October 2008) deposits are operated by the Mining Company LLP. The Akdala and Inkai (site No. 4) deposits are operated by the JV Betpak Dala LLP. The JV KATCO LLP takes part in the operation of the Moinkum deposit (northern part of site No. 1 and site No. 2). The Inkai deposit (sites No. 1 and 2) is operated by the JV Inkai LLP; the Buddenovskoye deposit (site No. 2) by Karatau LLP; the Zarechnoye deposit by JV Zarechnoye JSC; the central site of the Mynkuduk deposit by Ken Dala.kz JSC; and the western site of the Mynkuduk deposit by Appak LLP. The Vostok and Zvezdnoye deposits are operated by the Stepnogorskiy Mining and Chemical Complex LLP using underground mining and heap leaching methods.

In October 2008, the Irkol deposit, with plans to achieve a mine design capacity of 750 tU/yr by 2010, was transferred to the Semizbai-U LLP. The Semizbai-U LLP plans to begin commercial ISL production at Semizbai deposit in the North-Kazakhstani Uranium Province in 2009, achieving a capacity of 500 tU/yr by 2012.

Since 2008, the Kyzylkum LLP started ISL pilot production at the Northern Kharassan deposit (Kharasan-1 site), working toward commercial production of 1 000 tU/yr in 2010-2012, and a further expansion to 3 000 tU/yr thereafter. In 2009, the Baiken-U LLP plans to start ISL pilot production at the Northern Kharassan deposit (Kharassan-2), working toward commercial production in 2010-2012 and a design capacity of 2 000 tU/yr in 2014-2016.

In 2009, the JV Akbastau JSC plans to start pilot production by ISL at site No. 1 and from 2011 at sites No. 3 and 4 of the Buddenovskoye deposit to reach a combined capacity of 3 000 tU/yr.

In the period 2007-2008, uranium production in Kazakhstan amounted to 15 145 tU, of which 895 tU were produced be traditional underground mining methods (including 123 tU by heap leaching), and 14 250 by ISL (94.1% of total production).

As of 1 January2009, the total capacity of uranium production centers in Kazakhstan is 12 000 tU/yr. It is planned to expand production capacity to 19 000-28 000 tU/yr by 2015.

Uranium production at ISL mines in Kazakhstan is carried out using sulphuric-acid to produce pregnant uraniferous solutions. Further processing of pregnant uraniferous solutions is based on ion-exchange sorption-elution technologies with uranil salts precipitation and/or further extraction or refining to produce natural uranium concentrate.

During the production of natural uranium concentrate from the Vostok and Zvezdnoye deposits, the technique of autoclave soda leaching is also used at the hydrometallurgical plant.

Kazakhstan

Ownership Structure of the Uranium Industry

In 2008, the State share of uranium production in Kazakhstan was 60.3%, including 19.8% from NAC Kazatomprom owing to its partnership in joint-ventures and 40.5% from the Mining Company LLP, which belongs to NAC Kazatomprom, a 100% state-owned company.

Mining Company LLP includes the following production centers: the Taukentskiy Mining and Chemical Plant LLP, the Stepnoye Mining Group LLP and Mining Group-6 LLP.

As of 1 January 2009, NAC Kazatomprom held shares in joint ventures with companies from Canada, France, Japan and Kyrgyzstan (JV Betpak Dala LLP, JV Inkai LLP, JV Katco LLP, Appak LLP, Kyzylkum LLP, Baiken-U LLP, JV Zarechnoye JSC) and with foreign state companies of Russia and China (JV Zarechnoye JSC , JV Akbastau JSC, Karatau LLP, Semizbai-U LLP).

The Stepnogorskiy Mining-Chemical Complex LLP (SMCC LLP) is under the trust management of JSC NAC Kazatomprom. This Mining-Chemical Complex mines deposits by the underground method and also wholly-owns the Ken Dala.kz LLP, where mining is conducted using the ISL method.

In 2008, the production share of foreign companies in Kazakhstan amounted to 34.4% of total production and the share of state foreign companies amounted to 5.3% of total production.

Employment in the Uranium Industry

Total employment in uranium producing companies in Kazakhstan increased from 6 941employees in 2006 to 7 940 in 2008.

In 2007 and 2008, due to the establishment of new uranium production centers and the development of existing ones, Kazakhstan continued to suffer from a shortage of qualified personnel. Training was conducted in two educational centers to prepare qualified personnel among local citizens. The Kazakhstan Nuclear University and the Regional Geotechnology Training Center were involved in retraining and raising skill levels of personnel.

According to subsoil use contracts, annual obligatory training expenses comprised about 1% of the uranium production cost.

Future Production Centres

In 2009, it is expected to conclude two contracts for uranium exploration and production at two sandstone deposits: Zhalpak and Moinkum (site No. 3).

In the Zhalpak deposit, RAR and Inferred Resources total 14 525 tU with an average grade of 0.035% U. ISL pilot production is scheduled to begin by 2011 and it is planned to reach a total mine design capacity of 750 tU/yr by 2015. It has not been decided yet which production centre will develop this deposit.

In the Moinkum deposit, northern part of site no. 3 (Central), Inferred Resources total 10 091 tU with an average grade of 0.052% U. In 2011, exploration and ISL uranium production will be developed by the Taukentskiy Mining Chemical Plant LLP, reaching a total design capacity of 500 tU/yr by 2018.

After exploration of promising areas of Shu-Sarysu and Syrdaria Uranium Provinces is completed, new ISL production centers may be established.

Uranium production centre technical details
(as of January 2009)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8
Name of production centre	Taukentskiy Mining Chemical Plant LLP	Stepnoye Mining Group LLP	Mining Group-6 LLP	Betpak-Dala JV LLP	KATKO JV LLP	Inkai JV LLP	Mining Chemical Complex LLP Mining Group-	Zarechnoye JV JSC
Production centre classification	Existing(mining, committed)	Existing (mining)	Existing (mining)	Existing (mining, exploration)	Existing (mining, exploration)	Existing (mining, exploration)	Existing (mining)	Existing (mining, exploration)
Start-up date	1982	1978	1985	2004	1996	1996	1958	2001
Source of ore:								
• Deposit name	Kanzhugan, Moinkum (sites 1,3)	Mynkuduk-(eastern site), Uvanas	North&South Karamurun	Adkala, Inkai (site 4)	Moinkum (sites 1, 2, 3)	Inkai (sites 1, 2, 3)	Vostok, Zvezdnoye	Zarechnoye, South Zarechnoye
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Vein-Stockwork	Sandstone
• Reserves (tU)	36 211	24 286	28 413	38 230	52 353	159 600	10 464	18 694
• Grade (% U)	0.046	0.032	0.081	0.048	0.074	0.047	0.167	0.050
Mining operation:								
• Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	ISL	UG	ISL
• Size (t ore/day)							1 000	
• Average mining recovery (%)	87	90	91	90	85	80	90	94
Processing plant (acid/alkaline):								
• Acid/Alkaline	Acid	Acid	Acid	Acid	Acid	Acid	Acid	Acid
• Type (IX/SX)	IX, SX	IX	IX	IX	IX	IX	SX, AL	IX
• Size (t ore/day)								
For ISL (kilolitre/hour)	2 700	2 800	1 900	2 000	2 800	560	1 000	500
• Average process recovery (%)	98.9	98.7	98.7	98.7	98.7	98.5	92.5	98.5
Nominal production capacity (tU/year)	1 200	1 300	1 000	2000	3 000	1 000	500	500
Plans for expansion	Yes	No	No	Yes	Yes	Yes	No	Yes
Other remarks								

ranium production centre technical details (contd.)
(as of January 2009)

	Centre #9	Centre #10	Centre #11	Centre #12	Centre #13	Centre #14	Centre #15	Centre #16
Name of production centre	Karatau LLP	KenDala.kz JSC	Appak LLP	Kyzylkum LLP	Baiken-U LLP	Akbastau JV JSC	Semizbai-U LLP	NA
Production centre classification	Existing (mining)	Existing (mining, exploration)	Existing (mining, exploration)	Existing (exploration)	Existing (exploration)	Existing (exploration)	Existing (mining)	Planned (mining)
Start-up date	2006	2005	2005	2005	2006	2006	2006	2010
Source of ore:								
• Deposit name	Buddenovskoye (site 2)	Mynkuduk-(central site)	Mynkuduk-(western site)	Northern Kharassan (site 1)	Northern Kharassan (site 2)	Buddenovskoye (sites 1, 3, 4)	Semizbai Irkol	Zhalpak
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
• Reserves (tU)	16 929	46 919	24 845	34 352	24 824	25 100	46 251	14 525
• Grade (% U)	0.094	0.032	0.032	0.108	0.108	0.094	0.050	0.035
Mining operation:								
• Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL
• Size (t ore/day)								
• Average mining recovery (%)	85	90	90	90	90	85	87	90
Processing plant (acid/alkaline):								
• Acid/Alkaline	Acid	Acid	Acid	Acid	Acid	Acid	Acid	Acid
• Type (IX/SX)	IX	IX	IX	IX	IX	IX	IX	IX
• Size (t ore/day)								
For ISL (kilolitre/hour)	500	700	150	150	0	0	600	0
• Average process recovery (%)	98	98.7	98.9	98.5	98.5	NA	98.5	NA
Nominal production capacity (tU/year)	1 000	1 000	500	500	0	0	750	0
Plans for expansion	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Other remarks								

NA Not available.

Secondary Sources of Uranium

Production and/or Use of Mixed Oxide Fuels

Mixed Oxide (MOX) fuel is not produced or used in Kazakhstan.

Production and/or Use of Re-enriched Tails

Uranium obtained through re-enrichment of depleted uranium tails is not produced or used in Kazakhstan.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

In the framework of ecological policy in Kazakhstan a number of measures to improve environmental protection and encourage rational use of natural resources have been implemented in recent years.

Environmental protection activities of enterprises and organisations within the Holding corporate management are being fulfilled in accordance with legislation, other by-laws and regulatory documents. Statutory acts regulating negative impacts on the environment were developed; including requirements for documenting emission and pollutant discharges.

In the reporting period a significant reduction in emission and pollutant discharges were achieved at major enterprises due to the implementation of environmental activities. Production and consumption waste volumes are also being minimised. As a result of production and commercial operations of uranium facilities some 266 600 tonnes of wastes were utilised and neutralised in 2008; 2 400 tonnes more compared to 2007. Some 707 800 tonnes were transferred to third-party enterprises and disposed of in specialised storage and disposal facilities; 5.3% more than in 2007.

Wells for monitoring radionuclide migration in groundwater were set up on the territory of tailing ponds at the Ulba Metallurgical Plant and Stepnogorskyi Mining and Chemical Complex. No cases of radionuclide migration outside the tailing impoundments were reported.

In pursuit of the rational use of natural resources, activities to reduce water consumption were taken by means of reclamation through increased recovery and recycling during the restoration of disturbed soils.

A new organisation for reclaiming land after ISL mining was created as part of the Kazatomprom-Mining-Company LLP and a long term, “step-by-step” programme of liquidation of mined-out blocks of ISL sites was developed. The first stage (2007-2010) involves the restoration of mined-out blocks of the Uvanas deposit, exploited since 1978. Over the last two years, 98 blocks of the Uvanas deposit (a total area of 261 ha) were reclaimed. A total of 2 205 wells were removed, 6 ponds were reclaimed and 11 385 tonnes of contaminated soil was removed and disposed of.

At the end of 2009, the reclaimed area of 261 ha will be transferred to the state for use as pasture. In 2009, another 84 blocks of the Uvanas deposit, 10 ponds and 1 810 wells will be reclaimed.

In 2010, restoration works will commence at the Kanzhugan deposit, operating since 1982, and in 2012 similar work will commence at the Karamurun deposit, operating since 1985.

A great deal of work in preparation for establishing an environment management system and certification of production processes in compliance with ISO 14 001 requirements was implemented at a number of uranium facilities. Up to now 15 enterprises carried out an environmental audit and have been granted ISO 14 001 international certification.

In 2007 and 2008, Uranlikvidrudnik RSE continued reclamation work in areas of closed uranium mines, as well as liquidation and shutdown of pits. Governmental expenses amounted KZT 1 227.082 mln., including KZT 17.233 mln. for radiation control of previously rehabilitated facilities.

Social and/or Cultural Issues

All contracts for uranium exploration and mining provided by the Government require financial deductions for the development of local social and cultural improvements. All subsoil users are obliged to finance the establishment, development, maintenance and support of the regional social sphere, including health care facilities for employees and local citizens, education, sport, recreation and other activities in accordance with the Strategy of JSC NAC Kazatomprom and by an agreement with local authorities. Contributions from each operator amount to:

- USD 30 000 to 100 000 per year (during the exploration period).
- Up to 15% of annual operating expenses or USD 50 000 to 350 000 per year (during the mining period).

At the end of 2004, Demeu-Kazatomprom LLP was established. It is responsible for social and cultural issues related to uranium production in Kazakhstan.

Expenses related to environmental protection activity and social cultural issues in 2007-2008

		KZT mln.
1	Industrial expenses on environmental protection activities	1 364.8
2	Governmental expenses on rehabilitation and monitoring of developed deposits	1 227.1
3	Social and/or Cultural Issues	5 553.4

URANIUM REQUIREMENTS

Uranium Requirements

Internal demand for natural and enriched uranium is not expected to appear in Kazakhstan until 2015.

Construction of a NPP (VBER-300 reactor) is under consideration in Kazakhstan. The NPP could be constructed in the Mangistau region, where the fast-breeder reactor BN-350 had been operated since 1973. At present this reactor is decommissioned and its fuel is utilised.

Supply and Procurement Strategy

At present, the entire volume of uranium produced in Kazakhstan is exported to the world market.

URANIUM POLICIES, URANIUM STOCKS AND URANIUM PRICES

National Policies Relating to Uranium

The Decree of the Government of the Republic of Kazakhstan (23 January 2004), approved the Programme for Development of Uranium Industry in the Republic of Kazakhstan from 2004 to 2015.

The programme places priority on the development of the uranium industry as one of the high-tech industries in the country; export diversification and entry in the high-tech product markets in an effort to increase the country's export potential to world markets.

Based on the existing uranium resources, the major strategic task of the programme is to achieve an annual production capacity of 15 000 tU by 2015.

The programme's tasks are also aimed at strengthening Kazakhstan's position as the main manufacturer of fuel pellets for nuclear reactors in CIS countries, gaining access to the world nuclear fuel market; maintaining and expanding world market positions for uranium products along with conversion services; increasing nuclear fuel production capability and entering the world market for uranium-containing products of high technological availability produced from Kazakhstan's raw materials; along with implementing an action plan for environmental safety of nuclear-fuel cycle facilities.

NAC Kazatomprom was assigned as the national operator for the export and import of uranium and its compounds, nuclear fuel for nuclear power plants, special equipment and technologies, and associated materials.

Building on a conceptual vision of the global energy supply developed in 2005, Kazatomprom has been pursuing a strategy of building a transnational, vertically-integrated company participating in all stages of the nuclear fuel cycle (except for reprocessing of irradiated fuel and nuclear waste disposal).

In June 2008, Kazatomprom and Cameco Corporation established a new joint venture known as the Ulba Conversion LLP. Under this agreement, conversion production is to be established at the Ulba Metallurgical Plant in Ust-Kamenogorsk in the Eastern Kazakhstan region. Annual capacity at the future enterprise is planned at 12 000 tonnes UF_6/yr. Commissioning and production with an annual capacity of 750 tons UF_6 is planned to start in 2014.

On 12 October 2006, Kazakhstan and the Russian Federation agreed to a Joint Venture to establish, the "Center for uranium enrichment," with a fifty-fifty share between Kazatomprom and Techsnabexport. At present the development of a uranium enrichment plant in Angarsk (Russia, Irkutsk oblast) is at a stage of feasibility study in coordination with the first product output planned for 2011. It is intended that a 5 000 000 SWU design capacity will be achieved by 2013. Uranium will be enriched using an economically sound, energy-saving gas-centrifugal method.

In May 2007, the Russian Federation and Kazakhstan formed an international centre for uranium enrichment (ICUE). The main objective of the center is to provide non-nuclear states with the possibility of obtaining enriched uranium without developing national critical technologies in terms of the nuclear nonproliferation regime. The enriched uranium will be used for manufacturing nuclear fuel for nuclear power plants. The International Center for uranium enrichment is to be instituted in the city of Angarsk (Irkutsk oblast, Russia) on the basis of the Federal State Unitary Enterprise Angarsk Electrolysis Chemical

As a result of Kazatomprom's strategic programme fulfillment, the Ulba Metallurgical Plant is to be developed into a fuel pellet and nuclear fuel production facility for all types of reactors. Working toward this goal, Kazatomprom and the French company AREVA signed an agreement for joint development in the nuclear fuel cycle field in June 2008. In accordance with this Agreement, AREVA will provide technical assistance in the establishment of production operations (with a capacity of 1 200 tU/year) for manufacturing nuclear fuel assemblies at Kazatomprom's Ulba Metallurgical Plant. Within the framework of the Joint Venture (Kazatomprom – 51%, AREVA – 49%), manufacturing

will include a separate line with a 400 tU capacity for reactors of French design, with the fuel pellets for those assemblies being supplied by Kazatomprom. The plant is to be constructed in 2009-2012, with the first product output planned for 2013.

A feasibility study examining the construction of the first two-unit NPP with VBER-300 reactors in Aktau city, western Kazakhstan, will be completed in 2009. The first unit of Aktau NPP is planned to be constructed in 2016. Start-up of the second unit will be a year later in 2017.

For this purpose, within the framework of the Integrated Program of Kazakhstan-Russian cooperation in the field of nuclear power for peaceful use, the joint stock company "Kazakhstan-Russian company Nuclear power plants" was established on 30 October 2006 for the design, construction and promotion to world markets of the nuclear reactor with power generating units VBER-300. This JSC was established on a parity basis with the participation of Kazatomprom and Atomstroyexport.

URANIUM STOCKS

There are no uranium stocks of enriched uranium and nuclear fuel in Kazakhstan.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million KZT	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	957	1 587	5 051	7 278
Government exploration expenditures	0	0	0	0
Industry* development expenditures	80	2 538	4 351	8 345
Government development expenditures	0	0	0	0
Total expenditures	1 037	4 125	9 402	15 623
Industry* exploration drilling (m)	174 802	339 621	716 766	884 066
Industry* exploration holes drilled	382	666	1 368	1 700
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	48 827	175 162	137 096	197 105
Industry* development holes drilled	225	370	325	400
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	174 802	339 621	716 766	884 066
Subtotal exploration holes drilled	382	666	1 368	1 700
Subtotal development drilling (m)	48 827	175 162	137 096	197 105
Subtotal development holes drilled	225	370	325	400
Total drilling (m)	223 629	514 783	853 862	1 081 171
Total holes drilled	607	1 036	1 693	2 100

* Non-government.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	17 030	110 987	83
Open-pit mining	0	0	47 237	47 237	91
In situ leaching	16 360	262 859	313 581	313 581	89
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	16 360	262 859	377 848	471 805	87.8

* Resources reported *in situ* with recovery factors provided.

Reasonably Assured Conventional Resources by processing method*
(tonnes U)

Processing method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Conventional	16 360	262 859	377 848	471 805	87.8
In-place leaching**	NA	NA	NA	NA	
Heap leaching***	NA	NA	NA	NA	
Total	16 360	262 859	377 848	471 805	87.8

* Resources reported *in situ* with recovery factors provided.
** Also known as stope leaching or block leaching.
*** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type*
(tonnes U)

Deposit type	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**
Unconformity-related	0	0	0	0
Sandstone	16 360	262 859	326 931	326 931
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	21 733	97 681
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other**	0	0	29 184	47 193
Total	16 360	262 859	377 848	471 805

* Resources reported *in situ* with recovery factors provided.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	12 777	135 956	83
Open-pit mining	0	0	18 471	18 471	91
In situ leaching	33 519	271 365	323 824	323 824	89
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	33 519	271 365	355 072	478 251	87.4

* Resources reported *in situ* with recovery factors provided.

Inferred Conventional Resources by processing method*
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	33 519	271 365	355 072	478 251	87.4
In-place leaching**	NA	NA	NA	NA	
Heap leaching***	NA	NA	NA	NA	
Total	33 519	271 365	355 072	478 251	87.4

* Resources reported *in situ* with recovery factors provided.
** Also known as stope leaching or block leaching.
*** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type*
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	33 519	271 365	336 415	336 415
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0		18 657	139 552
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other**	0	0	0	2 284
Total	33 519	271 365	355 072	478 251

* Resources reported *in situ* with recovery factors provided.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
321 600	498 500	500 000

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
270 500	300 000	NA

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	21 618	0	0	0	21 618	0
Underground mining*	39 875	410	420	475	41 180	405
In situ leaching	44 981	4 871	6 213	8 037	64 102	11 533
Co-product/by-product	0	0	0	0	0	0
Total	106 474	5 281	6 633	8 512	126 900	11 938

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	106 474	5 281	6 633	8 512	126 900	11 938
In-place leaching*	0	0	0	0	0	0
Heap leaching**	85	96	69	54	304	26
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	106 474	5 281	6 633	8 512	126 900	11 938

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	44 981	4 871	6 213	8 037	64 102	11 533
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	39 875	410	420	475	41 180	405
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other	21 618	0	0	0	21 618	0
Total	106 474	5 281	6 633	8 512	126 900	11 938

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
5 135	60.3	0	0	451	5.3	2 926	34.4	8 512	100

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	6 941	7 845	7 940	9 448
Employment directly related to uranium production	4 460	4 706	6 598	7 643

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
13 000	13 000	18 000	18 000	19 000	19 000	28 000	28 000	15 000	15 000	24 000	24 000

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
12 000	12 000	14 000	14 000	10 000	10 000	12 000	12 000	4 000	4 000	5 000	6 000

Installed nuclear generating capacity to 2035
(MWe net)

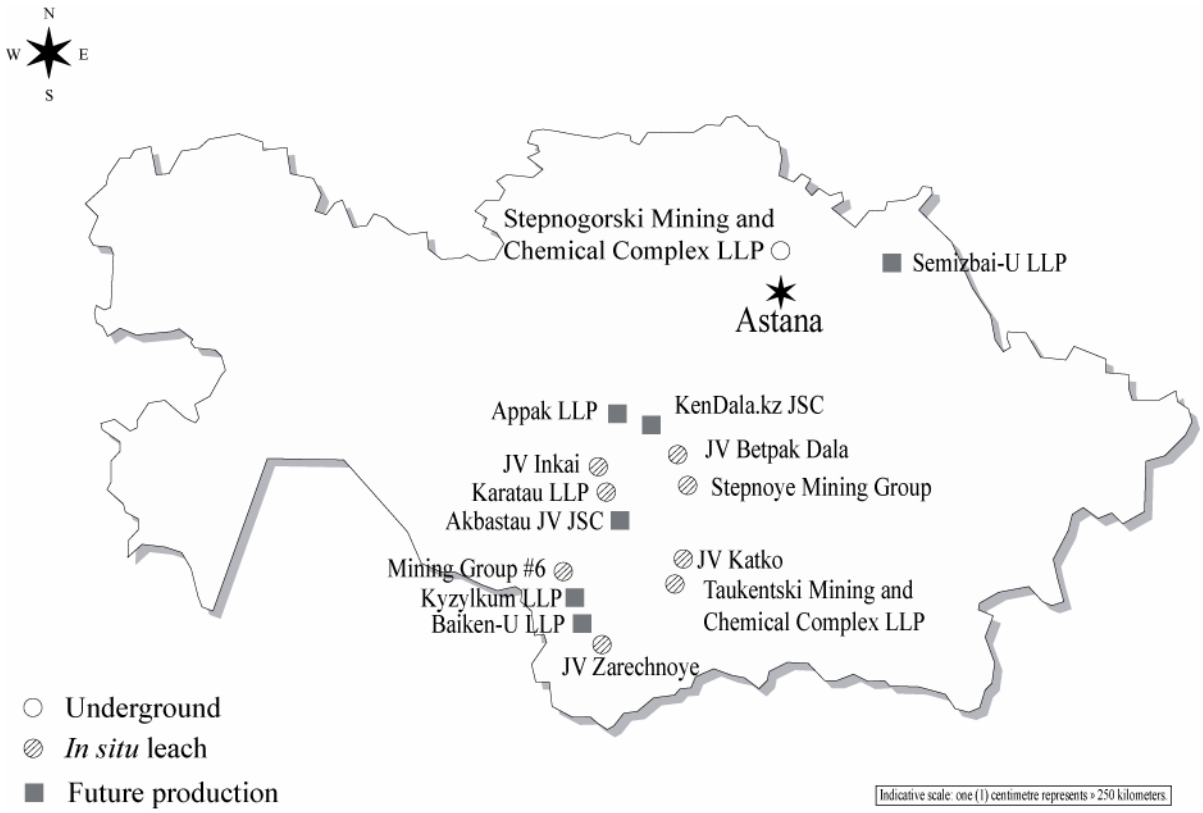
2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
					600

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
0	0	0	0	0	60

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
NA	NA	NA	NA	NA	NA	NA	NA



• Republic of Korea •

URANIUM EXPLORATION

Recent and ongoing uranium exploration and mine development activities

None reported.

URANIUM RESOURCES

Korea has no known uranium resources.

URANIUM PRODUCTION

Korea has no domestic uranium production capability.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

None reported.

URANIUM REQUIREMENTS

The nuclear capacity as of December 2009 in Korea was 17 716 MWe, representing 24% of Korea's total installed capacity. Nuclear power generation in the 20 units currently operating in Korea in 2009 reached 148 billion kWh and occupied 34.4% of the country's total electricity generation.

Currently, four Korean Standard Nuclear Power Plants (OPR 1 000) are under construction. Construction of Shin-Kori Units 1&2 will be completed in December 2010 (Unit 1) and December 2011 (Unit 2). Shin-Wolsong Units 1&2 will be connected to the grid on March 2012 (Unit 1) and January 2013 (Unit 2).

Shin-Kori units 3&4, the first APR1 400 (advanced power reactor 1400) units to be constructed, are under construction at Shin-Kori sites and will start commercial operation in September 2013 and September 2014, respectively.

In addition, Korea has a construction plan for 14 Units until 2030.

Six APR1 400 Units are planned to be constructed. Shin-Ulchin Units 1&2 will start commercial operation in December 2015 and December 2016, respectively. Shin-Kori Units 5&6 will start commercial operation in December 2018 and December 2019, respectively. Shin-Ulchin Units 3&4 will start commercial operation in June 2020 and June 2021, respectively.

Eight new units are also planned for construction. The capacity of these units will be 1 500 MWe each, but reactor models and construction sites have not yet been determined. The first two units will start commercial operation in June 2022 and June 2023, respectively; the next two in June 2025 and June 2026, respectively; the next two in June 2027 and June 2028, respectively; and the final two units in June 2029 and June 2030, respectively.

Along with the increase of nuclear capacity, the requirements of uranium concentrates and fuel cycle services are increasing continuously.

Supply and procurement strategy

In order to secure stable and economical uranium supply, KHNP maintains diversification policy and relies on long-term contracts in addition to mine investment abroad.

NATIONAL POLICIES RELATING TO URANIUM

KHNP has pursued a policy to secure a stable and economical uranium supply and KHNP maintains an optimal strategic inventory as part of a government policy.

URANIUM STOCKS

KHNP maintains strategic inventory for two years use.

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	142.9	150.9

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
17 716	17 716	18 716	18 716	25 916	25 916

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
31 516	31 516	NA	NA	42 716	42 716	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
3 400	3 400	4 200	4 200	4 400	4 400

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
6 200	6 200	6 700	6 700	7 500	7 500	NA	NA

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	0	0	0	0	0
Utility	2 000	6 000	0	0	8 000
Total	2 000	6 000	0	0	8 000

• Malawi* •

The Kayelekera uranium project

The Kayelekera uranium project, located in the Karonga district of the northern region of Malawi about 600 km by road from the capital city of Lilongwe, was successfully brought into production by Paladin Energy Ltd. in 2009. Transport of the first product to Walvis Bay, Namibia, via Zambia, took place on 17 August 2009. Uranium production, by open-pit mining, with an annual production of 1 270 tU, expected to be achieved in 2010, is expected to continue for some nine years.

Previous exploration and development work

In the early 1980s, Central Electricity Generating Board of Great Britain (CEGB) discovered mineralisation in the sandstones of Kayelekera. Extensive drilling from 1982 to 1988 defined an initial Inferred Resource of 9 800 tU at an average grade of 0.13% U. From 1989 to 1992, geotechnical, metallurgical, hydrological and environmental works were conducted, and a feasibility study to assess the viability of a conventional open pit mining operation. This work was completed in 1991 at a total cost of USD 9 million. The CEGB study indicated that the project was uneconomic using the mining model adopted and the low uranium prices of that time and the project was abandoned in 1992.

In 1998, Paladin Resources Ltd acquired an interest in the Kayelekera project through a joint venture with Balmain Resources Ltd which then held exploration rights over the project area. Engineering and financial evaluation work indicated a positive outcome for the project. In 2004, additional drilling was completed to improve confidence in resource estimates, and the pre-feasibility study was updated. Resource drilling and bulk sample drilling for metallurgical test-works were completed in 2005, followed by a bankable feasibility study.

The feasibility study and the environmental impact study were finalised in early 2007, and a mining licence was obtained in April 2007. Construction of the project started in 2007 at a budgeted

* Report prepared by Secretariat, and based on information from the *Environmental Impact Study* (Knight Piesold, 2007) and the Paladin Energy internet site (www.paladinenergy.com.au/index.aspx).

cost of USD 200 million. Major infrastructure upgrades to local roads were required. The construction project workforce number peaked at around 2 000, with more than 75% Malawian nationals. Open pit mining began in June 2008 and commissioning of the production facility in January 2009.

In 2008, Paladin Energy conducted an infill and extension drilling programme of the Kayelekera Project totalling 132 holes and 9 955 m.

Paladin Resources Ltd, an Australian listed public company, holds an 85% interest in the Kayelekera project, with the remaining 15% being held by the Republic of Malawi.

Geology

The Kayelekera uranium deposit is a sandstone-hosted uranium deposit, located close to the north tip of the North Rukuru Basin. This basin contains a thick (at least 1 500 m) sequence of Permian Karoo sandstones preserved in a semi-graben about 35 km to the west of and broadly parallel to the Lake Malawi section of the East African Rift system.

The Kayelekera mineralisation lies within the uppermost 150 m of the Muswanga Member, which is the upper part of the Karoo formation. The Muswanga Member consists of a total of eight separate arkose units with intervening silty mudstones in an approximate 1:1 ratio. Such a succession is indicative of cyclic sedimentation within a broad, shallow, intermittently subsiding basin.

The arkose units contain most of the uranium mineralisation. They are on average about 8 m thick, are generally coarse grained and poorly sorted, and contain a high percentage of fresh, pink feldspar clasts. The basal layer of arkose units is usually a quartz-feldspar pebble conglomerate.

Coffinite has been identified as the principal uranium bearing species and it occurs together with minor uraninite. Near surface weathering of primary ore has produced a zone of oxide ore characterised by yellow and green secondary uranium minerals (meta-autunite and boltwoodite). Approximately 40% of the total ore is reduced arkose, 30% oxydised arkose, 10% mixed arkose and 20% of the mudstone type.

Historical studies indicate that economically recoverable resources of uranium and coal only occur within the Kayelekera area. Coal is present in the project tenement area in two deposits: the Nkhachira deposit (850 000 tonnes, recoverable by open-pit and underground mining) and in the Kayelekera deposit itself. Coal in the Kayelekera deposit is contained within the uranium resources and is therefore unavailable for commercial extraction. Moreover, this coal is of very low quality.

Resources
(tonnes U)

Measured	Indicated	Inferred
3 512*	11 546*	18 010*

* Assuming a cut-off grade of 255 ppm U, JORC and NI 43-101 compliant as of November 2008.

Reserves
(tonnes U)

Proved	Probable
3 343*	7 922*

* Assuming a cut-off grade of 340 ppm U, JORC and NI 43-101 compliant as of November 2008.

The above resources are associated with arkose and mudstone.

The project

The Keyelekera uranium deposit is being mined by open pit. Operations are programmed for an approximate nine-year life, with an annual production of 1 270 tU. Full design operating capacity is expected to be achieved in December 2009. The final open pit dimensions are expected to be in the order of 300 m wide, by 600 m long and 130 m deep. The stripping ratio (waste to ore) is expected to be on average 2.4:1.

Uranium will be recovered using a solvent extraction process, with sulphuric acid as lixiviant and sulphur dioxide/air mixture as oxidant. Expected uranium mill recovery is 90%. Total uranium production is expected to amount around 11 500 tU. Processing of marginal ores at the end of mine life is expected to add an additional 3-4 years to the mine life.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	9 000	15 058	15 058	90
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	9 000	15 058	15 058	90

* *In situ* resources

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	9 000	15 058	15 058	90
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	9 000	15 058	15 058	90

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	9 000	15 058	15 058
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	9 000	15 058	15 058

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	1 825	1 825	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	1 825	1 825	

* *In situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	1 825	1 825	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	1 825	1 825	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	1 825
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	1 825

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

• Mongolia •

URANIUM EXPLORATION AND MINE DEVELOPMENT

Historical review

Mongolia has a long history of uranium exploration commencing with joint Russian and Mongolian endeavours to 1957. Initial success was obtained in the Saddle Hills area of northeastern Mongolia (Dornod and Gurvanbulag regions) where uranium is present in volcanogenic sediments. However, the country has been considered to have relatively high political risk associated with investment.

The 1997 Red Book provides additional information on the historical development of uranium mining in Mongolia, as well as a brief description of the uranium provinces in the country.

Recent and ongoing uranium exploration and mine development activities

Due to certain economic and social conditions uranium exploration and related activities were sharply reduced from 1996 to 2005. Since 2005, increasing prices for uranium have triggered intensive uranium exploration in Mongolia, involving mostly western investors. At present, more than 20 foreign invested companies hold official exploration licenses and are carrying out intensive exploration in the country.

Most active exploration is concentrated in young (Mesozoic-Keanozoic) basins in East-Central Mongolia, where a number of sandstone or sediment hosted, ISL amenable uranium deposits have been discovered by Mongolia-Russia-American joint venture “Gurvansaikhan”, recently managed by Denison Mines. Deposits such as Kharaat and Khairkhan were well explored and final reports were submitted to Professional Committee of Mineral Resources in the Ministry of Energy of Mineral Resources of Mongolia for official registration of calculated mineral reserves and resources – the first time submissions like this have been made among all kind of investors. Estimated and registered uranium reserves at Kharaat are 7 300 tU and at Khairkhan are 8 400 tU. These deposits are under final ISL testing and preparation for detailed exploration

Areva Mongol LLC, a French state-owned company, is conducting an active uranium exploration programme in the southeastern part of Mongolia, including drilling and sample testing. Much work has been done by Coge-Gobi LLC, a subsidiary joint Mongolia-French company, covering large area in south and southeaster Mongolia during the past 11 years, including signing an MOU with the Mongolian Government Authority for further cooperation covering aspects of mining technology and equipment. The company has carried out wide-spread reconnaissance and exploration and discovered the Dulaan uul prospect area in south eastern Mongolia where detailed drilling is ongoing.

Western Prospector Mongolia and Emeelt Mines (subsidiaries of Western Prospector Group) conducted an intensive exploration programme on the Gurvanbulag Central deposit and Mardaigol and Nemer deposits to expand the known open-ended uranium deposits and to determine the potential for additional uranium deposit discovery in the Saddle Hills uranium project area. First Development, an indirect wholly-owned subsidiary of CNNC International Limited (CNNC Intl.), a public company listed on the Hong Kong Stock Exchange, holds 69% of outstanding shares of theWestern Prospector Group.

Cameco Mongol LLC, registered in Mongolia as subsidiary of Cameco S.A. (registered in Luxembourg) started exploration activity in the second half of 2006, mainly targeting Mesozoic and younger sediment volcanogenic mineralisation in Eastern Mongolia.

East Asia Minerals Corporation is a well financed, Asian-based, Canadian mineral exploration company that holds twelve uranium properties, including the advanced Ingiin-Nars, Ulaan Nuur and Enger uranium projects. Two of the significant new discoveries are located within the highly prospective foreland basin (“Valley of Lakes”) located in SW Mongolia. The three most advanced projects are on the intercontinental rift basin of “East Gobi Basin” in south eastern Mongolia with other projects located within the “Choibalsan” basin in the north eastern and Shivee & Ugtam volcano tectonic structure in central and eastern regions of the country.

A wholly owned Mongolian subsidiary SRM LLC (Solomon Resources Mongolia) was established in January 2006 and since that time the company has focused on uranium exploration in Mongolia, investing USD 4 million in mineral exploration. Solomon held a total of eleven mineral license areas and completed very early stage ground geophysical and geological works on all of them. A total of 7 043 m of exploration drilling and about 10 000 line km of truck mounted gamma ray spectrometric survey were completed over the last three years. SRM temporarily stopped its exploration, but is willing to continue grass roots exploration for sandstone hosted uranium.

The main uranium prospect is the Dornod open cut mine in the far northeast of the country. Two separate deposits were mined by Priargunsky Mining & Chemical Enterprise from1988 to 1995 and the ore railed 500 km to Krasnokamensk in Siberia for treatment by Priargunsky. About 627 tU was produced.

Mongolia

Today the Canada-based Khan Resources Inc. (KRI) owns a 69% share in the Dornod project, mostly through its 58% subsidiary Central Asian Uranium Co. Ltd (CAUC). Russia's Priargunsky Mining & Chemical Enterprise (a subsidiary of Rosatom) and the Mongolian government each own 21% of CAUC, which holds the only uranium mining licence in Mongolia. A bankable feasibility study has confirmed the viability of the project, the capital cost estimate being USD 333 million and first production possibly in 2012. A definitive feasibility study released in March 2009 showed that the project was sound, on the basis of 24 780 tU indicated resources (NI 43-101 compliant), including 20 340 tU probable reserves. Annual production of 1 150 tU over 15 years is envisaged. In July 2009, the Mineral Resources and Petroleum Authority of Mongolia (MRPAM) suspended for three months the CAUC mining licence due to alleged violations of Mongolian laws.

Khan was granted a 3-year exploration licence by the MRPAM in early 2008 covering part of the Dornod orebody, and was applying to have this converted into a mining licence contiguous with that held by CAUC. Khan also holds 100% of an exploration license covering an adjoining "Additional Dornod property". In March 2009, Khan was reported as holding 58% of the No. 2 deposit and two thirds of No. 7 deposit (possibly via CAUC), and 100% of the remaining third of the No. 7 deposit, giving it 69% of the overall uranium resource. The company is aiming to negotiate an investment agreement with the government as soon as possible, and engineering is then likely to take three years to start up.

Gurvanbulag was the site of extensive underground development to 560 metres in the Soviet era. It has been held by the Canada-based Western Prospector Group Ltd since 2004 as the main focus of its Saddle Hills project. A recent NI 43-101 inferred resource figure based partly on Russian exploration to 1989 amounts to 9 000 tU. Western Prospector and its Mongolian subsidiary, Emeelt Mines, undertook a definitive feasibility study which showed that the project is barely economic, on the basis of 6 900 tU reserves averaging 0.137%U. With radiometric sorting the head grade would be 0.152%U and the mine could produce 700 tU/yr for 9 years. Mine development cost would be about US$ 280 million. It is located about 30 km west of Dornod and only 100 km from the Chinese border.

In mid 2008, KRI made a bid to take over the Western Prospector Group so as "to consolidate its position in the Saddle Hills district" but was outbid by Tinpo Holdings, who subsequently withdrew the offer due to political uncertainty. In March 2009, Western Prospector agreed to a USD 25 million takeover by China's CNNC International, a 74% subsidiary of CNNC Overseas Uranium Holding Ltd and through it, of SinoU. In June 2009, 69% of the shares had been taken over by CNNC. In July 2009, MRPAM suspended for three months all of the company's uranium exploration licences due to alleged violations of Mongolian laws.

Mardai is another deposit in this area, close to Dornod, and possibly held by Khan Resources. The Erdes Mining Enterprise, a Russian-Mongolian joint venture, opened of the Mardai open pit mine in 1988. The ore was railed to Krasnokamensk in Siberia for treatment at the Priargunsky mill until 1993. Total production appears to have been about 600 tU. The town was reported to house 10 000 Russian workers at the mine. There are three separate deposits with the government reporting 60 000 tU in total.

Canada's Denison Mines has a 70% interest in the Gurvan Saihan Joint Venture (GSJV), with the Government of Mongolia and a Russian partner, and also holds leases though its Mongolian affiliate International Uranium Mongolia XXK (IUM). GSJV has focused on defining resources amenable to ISL mining, and it holds interests in several Mongolian properties. In 2007, NI 43-101 resource figures were published for some of these. Indicated and inferred resources of 4 400 tU are quoted for Hairhan, and 2 400 tU Haraat.

In 2007, Century City entered into an agreement with China Nuclear Energy Industry Corp. (CNEIC), a subsidiary of CNNC, to explore and develop uranium resources on its leases in eastern Mongolia.

Red Hill Energy and Mega Uranium hold a number of exploration licences including the Emeelt, Khashaat and Bagamurat deposits 350 km southeast of Ulaan Baatar, and Jargalan, 500 km west of the city.

In April, 2008 Russia and Mongolia signed a high-level agreement to cooperate in identifying and developing Mongolia's uranium resources, and this aims to restore and consolidate Russia's influence in Mongolia's uranium sector. Russia is also examining the feasibility of building nuclear power plants in Mongolia.

In December 2008, the Japanese trading company Marubeni acquired rights to conduct feasibility studies on three uranium deposits, including Dornod and Gurvanbulag, developed by KRI and Western Prospector, and Mardai. The company plans to invest USD 430 million and has signed a letter of intent with Khan. It is perceived that the laws of the mining-dependent country have become increasingly protectionist in the recent years, and the President has announced that "the country aims to decide on state ownership rules for strategic mineral deposits by mid-2009." Khan Resources commented that "We are excited by Marubeni's interest in Khan's Dornod uranium project and are optimistic about the positive influence Japanese investors have on the Mongolian mining investment environment. Marubeni will work to improve the mining investment climate in Mongolia."

URANIUM RESOURCES

The uranium resources of Mongolia occur in the six deposits including Dornod, Gurvanbulag, Mardain-gol, Nemer, Haraat, Hairhan and Ulaan Nuur. The recoverable uranium resources in Mongolia attributable to category RAR + Inferred amounted to 49 300 tU. RAR amounts to 37 500 tU at a cost <USD 260/kgU. The majority of such resources may be mined using the conventional underground mining method. Inferred uranium resources amount to 11 800 tU recoverable at a cost of <USD 260/kgU. These resources may be mined using conventional mining methods and ISL. Prognosticated and Speculative resources are estimated to amount to 1.4 million tU.

The Dornod deposit is located in the Dornod volcano-tectonic structure which is filled with Mesozoic volcanic flows and sediments. The uranium mineralisation extends over an area of 20 km^2 and is concentrated in thirteen orebodies, ore shoots and stockworks. The uranium mineralisation consists of pitchblende, coffinite, and brannerite, as well as uranium bearing leucoxene. The average ore grade is about 0.11% U.

The Gurvanbulaag deposit is associated with the same Dornod volcano-tectonic structure. Here, the structure includes two rock types. A lower, 300-400 m thick series consisting of volcanic flows ranging in composition from rhyolite to andesitic basalts, interlayered with tuffaceous sediments. The upper, 300-800 m thick series includes acid effusive volcanics and their tuffaceous equivalents. The uranium mineralisation, including coffinite, pitchblende and uranophane, is reported to be controlled both by lithology of the host rocks (preferably tuffaceous ashes) and favorable structures. It extends over a depth ranging from 15-40 m to 720 m. The highest grade ore is concentrated in a zone affected by low-angle faulting, at the contact between the lower and upper series. Stratiform orebodies are spread over 3 km^2. These orebodies also appear to be controlled by tectonic features. A total of

17 orebodies of different sizes have been found. The highest grade ore covers about 1 500 m^2 with an average thickness of 3.5 m and an average grade of 0.17%U.

The Mardain-gol and Nemer deposits are also associated with the Dornod structure. They are geologically similar to the Dornod and Gurvanbulag deposits.The Haraat and Hairhan sandstone deposits occur in the upper portion of lower Cretaceous sediments of the Choir basin which overlies Proterozoic crystalline schists, gneisses and marbles intruded by Paleozoic granitoids. The ore occurs in alternating sandstone and clays, with interbedded lignitic layers. These rocks were originally geochemically reduced but are now oxidised to a depth of 25-30 m. The mineralisation occurs in this oxidised environment. Common minerals include autunite, torbernite and schroeckingerite. Associated elements include cerium, lanthanum, scandium, yttrium, ytterbium, rhenium, germanium, molybdenum and silver.

In addition to the resources associated with the Choir basin, other sedimentary basins in the Eastern Gobi district have a potential to host uranium deposits. One of them includes the Ulaan Nuur deposit.

URANIUM PRODUCTION

Historical review

Uranium production in Mongolia started with operation of the Dornod open pit mine in the Mardai-gol district in 1989, based on the known uranium resources in the Dornod and Gurvanbulag deposits. Both open pit and underground mines were developed. This operation has a design capacity of 2 000 0001 ore/year. Assuming an ore grade of 0.12%U, this equals a mining production capability of 2 400 tU/year. Mongolia has no processing facilities. The ores mined in the Mardai-gol district have been transported by rail 484 km to the Priargunsky Mining and Processing Combinate in Krasnokamensk, Russia, for processing. The mines have been operated by the Erdes Mining Enterprise, a joint venture between Mongolia and the Russian Federation. Marketing was done by Techsnabexport. Due to the political and economical changes both in Mongolia and the neighbouring areas of Russia, uranium production of Erdes was terminated in 1995. The historical uranium production between 1989 and 1995 was 535 tU.

Future production centres

In 2009, Khan Resources Inc. prepared a Definitive Feasibility Study (DFS) for its Dornod Project which comprises several uranium deposits and some infrastructure. The DFS shows a positive economic outcome, based on development of underground and open-pit mines, producing a total of approximately1 225 000 t of ore per year, at a rate of 3 500 t/d. Metallurgical recovery is 84.86%-89.28% The capital cost for mining and surface facilities is estimated at almost USD 333 million, with operating costs of USD 23.22/lb U_3O_8 (USD 60.32/kgU). The start of the development activities depends on receiving Government of Mongolia approval for the project.

URANIUM REQUIREMENTS

Mongolia has no reactor-related requirements since it has no reactors and no firm plans to develop nuclear generating capacity.

NATIONAL POLICIES RELATING TO URANIUM

The mining sector is Mongolia's single largest industry, accounting for 55% of industrial output and more than 40% of export earnings. In 2008 the government established a new Ministry of Mines and Energy. Mining was previously a division of the Ministry of Industry and Trade.

The Nuclear Energy Agency of the Government of Mongolia is responsible for development of policy for activities relating to the development of nuclear research and technology, radiation protection and safety, use of radiation sources and the coordination of uranium mining activity with other relevant organisations. The Nuclear Energy Agency is attached to the Prime Minister's office and is the national focal point for dealing with the IAEA. Its main functions include co-ordination of nuclear research activities in the country and implementation of nuclear regulatory activities.

Prior to 1996 radiation protection and safety was covered under Law on Health Protection (1977), Basic Regulation on Radiation Sanitation (1983), and Radiation Safety Standards (1983). The Law of "Radiation Protection and Safety" was enacted on 21 June 2001 and amended on 2 January 2003. The Law on "Nuclear-Weapon-Free Status" was enacted on 3 February 2000. Transport Regulation for Radioactive Sources was enacted in 1987.

On 16 July 2009, the Mongolian Parliament passed the Nuclear Energy Law to regulate the exploration, exploitation and development of uranium and other radioactive materials. The new law came into effect on 15 August 2009. A draft the code of practice on waste management and regulation is now under review.

The Nuclear Energy Law gives the Mongolian government the right to take ownership without payment of not less than 51% of the shares of a project or joint venture if the uranium mineralisation was discovered by state funded exploration, and not less than 34% if state funding was not used to find the mineralisation.

The law gives the State Administrative Authority the responsibility to implement and enforce state policy on the exploration and development of deposits of radioactive minerals and nuclear energy, including the power to grant, suspend or revoke any licences granted pursuant to the Nuclear Energy Law. The Nuclear Energy Law mandates that licences be obtained to conduct exploration for and production of radioactive minerals.

To obtain an exploration licence an applicant must conduct its activities in a transparent manner, have the financial resources to support exploration and reclamation, conduct responsible programs, and have demonstrated mining experience. Exploration licences will only be issued to applicants that meet the conditions set out in the Nuclear Energy Law, and agree to accept the state ownership of the required percentage of shares.

The Mongolian Parliament also passed enabling legislation regarding the re-registration of existing exploration and mining licences. Existing licence holders must apply to the State Administrative Authority by 15 November 2009 and comply with all of the conditions and requirements set out in the Nuclear Energy Law, including acceptance of the state's 34%-51% share participation in the licence holder.

Mongolia

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in US dollars	2006	2007	2008	2009 (expected)
Industry* exploration expenditures (foreign investment companies)	12 520 495.6	26 125 153.67	29 585 511.69	19 120 436.7
Industry* exploration expenditures (national investment companies)	6 940.2	13 114.13	63 736.39	58 020.9
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	12 527 435.81	26 138 267.8	29 649 248.0	19 178 457.61
Industry* exploration drilling (m) (foreign investment companies)	166 365	179 516	172 501.3	NA
Industry* exploration drilling (m) (national investment companies)	894.0	NA	167.9	NA
Industry* exploration holes drilled (foreign investment companies)	NA	NA	812	NA
Industry* exploration holes drilled (national investment companies)	NA	NA	2	NA
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	NA	NA	NA	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	167 259	170 637	172 669.2	NA
Subtotal exploration holes drilled	NA	NA	814	NA
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	167 259	170 637	172 669.2	NA
Total holes drilled	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	28 100	28 100	28 100	
Open-pit mining	0	7 300	7 300	7 300	
In situ leaching	0	2 100	2 100	2 100	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	37 500	37 500	37 500	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	35 400	35 400	35 400	90
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
In situ leaching	0	2 100	2 100	2 100	70
Unspecified	0	0	0	0	
Total	0	37 500	37 500	37 500	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	2 100	2 100	2 100
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	35 400	35 400	35 400
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	37 500	37 500	37 500

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	1 600	3 200	3 200	95
Open-pit mining	0	0	0	0	
In situ leaching	0	2 700	0	0	70
Co-product and by-product	0	0	0	0	
Unspecified	0	0	5 900	5 900	70
Total	0	4 300	11 800	11 800	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	1 600	3 200	3 200	95
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
In situ leaching	0	2 700	2 700	2 700	70
Unspecified	0	0	5 900	5 900	70
Total	0	4 300	11 800	11 800	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	2 700	8 600	8 600
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	1 600	3 200	3 200
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total		4 300	11 800	11 800

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	535	0	0	0	535	0
Underground mining*	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	535	0	0	0	535	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

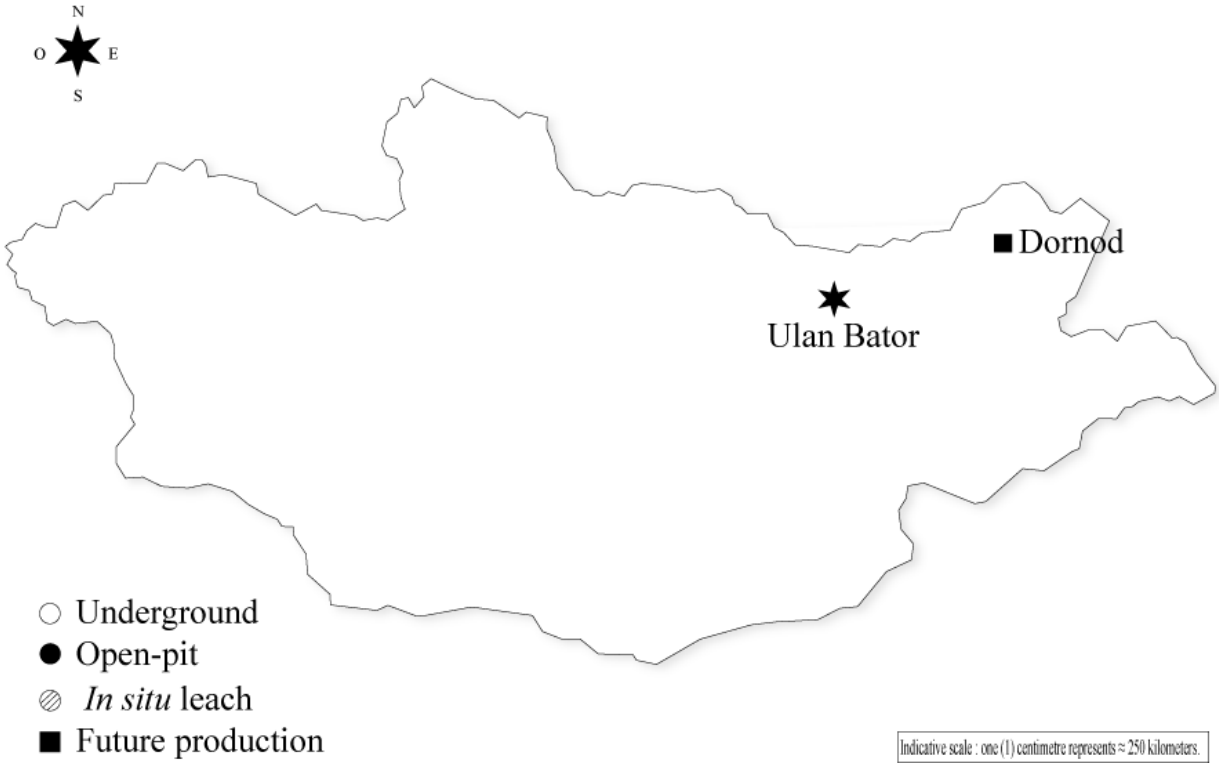
Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	535	**0**	0	0	535	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	535	0	0	0	535	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	535	0	0	0	535	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	535	0	0	0	535	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.



• Namibia* •

URANIUM EXPLORATION AND MINE DEVELOPMENT

Historical background

See the 2007 Red Book for additional details.

The new millennium upward trend in uranium prices has stimulated extensive exploration activity, mainly in the Namib Desert. Two major types of deposits have been targeted; the intrusive type, associated with Alaskite, as at Rössing, and the surficial, calcrete type, as at Langer Heinrich.

Substantial growth in uranium exploration has occurred in Erongo area of west-central Namibia, focusing mainly on previously-known deposits with considerable historical data. Over 60 exploration licences had been issued up until early 2007, when a moratorium on new licences was imposed by the Namibian government.

* Report prepared by the Secretariat, and based on information contained in company reports.

Geology

A comprehensive review of Namibia's uranium geology and exploration is found in:

Mineral Resources of Namibia, *Nuclear and Fossil Fuels – Uranium*, by H. Roesener and C.P. Schreuder, Section 7, pp. 1-62, www.mme.gov.na/gsn/pdf/uranium.pdf.

Recent and ongoing uranium exploration and mine development activities

Rössing

Recent exploration in the Rössing mine area has focussed on uranium occurrences within the mining license area that have been known since the late 1970s. Drilling on the SH and SK anomalies totalled 70 000 m between 2006 and 2008. A preliminary pit with an extraction ratio of 1:0 has been designed and plant process and capital cost analyses continue through study and design. The potential expansion of operations at the Rössing mine would entail an increase in size of the current mining pit (known as SJ) such that nine individual components of the existing operation would have to be relocated. The proposed development is currently envisaged to occur in two phases:

Phase 1 – Construction of a sulphuric acid manufacturing plant with associated sulphur storage at the mine and the transport of sulphur from the Port of Walvis Bay; construction of a radiometric ore sorting plant and mining of the SK4 ore body.

Phase 2 – Extending the current mining activities in the existing SJ open pit; new mining activity in the larger SK area; increasing waste rock and tailings disposal capacity; establishing an acid heap leaching facility and sulphur handling facility in the Port of Walvis Bay.

Langer Heinrich

The Langer Heinrich Uranium Project is located in the western portion of central Namibia, 80 km east of the major deepwater seaport at Walvis Bay and the coastal town of Swakopmund. An eight-year evaluation period followed the discovery of calcrete hosted uranium mineralisation in the early 1970s. In 1980, Gencor, now part of BHP Billiton, completed an USD 8.5 million full project evaluation study based upon conventional open-pit mining and alkaline extraction This included detailed resource definition and thorough mining, metallurgical and processing investigations for the proposed removal of about 300 000 tonnes of mineralised rock, as well as the construction of a purpose-built pilot plant. The Project was subsequently placed on care and maintenance due to depressed uranium prices.

In 1998, the Project was sold to the Australian listed public company Acclaim Uranium NL who completed a Pre-Feasibility Study, but uranium prices again curtailed further development. In 2002, Acclaim sold its holdings in the Langer Heinrich Uranium (Pty) Ltd to Paladin Resources.

In 2005, a reverse circulation drilling programme was carried out in order to increase confidence in resource modelling and to delineate extensions to known uranium mineralisation in the paleo-channel hosting the mineralisation. In 2006, additional reverse circulation drilling was conducted in the eastern portion of the Langer Heinrich ore body. A further resource definition campaign was started in 2007 with the aim of delimiting all mineralisation within the Langer Heinrich mining lease.

The Ministry of Mines and Energy granted an Exclusive Exploration License (EPL) to Langer Heinrich Uranium (Pty) Ltd in October 2006. The EPL covers 30 km^2 to the west of and adjoining the Langer Heinrich Mining License (ML140). Exploration in 2007 and 2008 included 3 000 m of reverse

circulation drilling, delineation of the additional 5 km palaeo-channel extension on the new tenement to complement the increased production requirements associated with the Stage III Langer Heinrich expansion. In August 2008, it was announced that as a result of its 2007/2008 resource drilling programme an updated ore reserve to support life of mine planning studies would be undertaken.

Proposed Developments

Trekkopje

The Trekkopje deposit (Klein Trekkopje and Trekkopje) occurs as surficial calcrete deposits in basal channel sediments. The geology of the Trekkopje deposits is similar to that of Langer Heinrich. The calcrete host rocks are calcium carbonate-cemented fluvial sediments that were deposited in ancient drainage valleys. The basal channels in the Trekkopje area follow the northeast-trending structural grain of the underlying basement rocks.

In December 1999, UraMin Inc, the parent company of UraMin Namibia, acquired control of the combined deposits. In 2006, UraMin initiated a programme of exploration drilling and in November that year developed a resource estimate for Trekkopje. Uramin Inc. was then taken over by Areva to become Areva Resources Southern Africa, with subsidiary Areva Resources Namibia now developing the mine.

Areva's heap leach project at Trekkopje is about 80 km northeast of Swakopmund and 35 km north of Rössing. In 2007, UraMin Inc announced an upgrade of uranium resources, including occurrences within two adjacent palaeo-channel deposits. In total, resources have been defined over an area of about 16 km by 1 km to 3 km. Some 80% of the ore is found at shallow depth, less than 15 metres below the surface.

The USD 900 million project is a shallow open-pit mine with a sodium carbonate/bicarbonate heap leach process – the first of this kind in the world. In 2009, geotechnical site investigation and the engineering design were completed for a new 30 million-tonne, on-off uranium heap leach pad covering 2.5 km^2. Water is to be supplied from a coastal desalination plant with about 55 000 m^3/day output requiring 16 MWe from the grid. In October 2009, the desalination facility that is to provide water to the plant commenced operations and tests will be carried out until mid-2010, with full production expected in 2011.

Husab

The Rössing South deposit is located about 6-7 kilometres south of the Rössing mine, within the central Damara Orogenic Belt (DOB) in a zone characterised by basement domes, regional folding, faulting, and late Damaran intrusive rocks. The Husab project, which includes the Ida Dome to the south, consists of a series of north-northeast trending regional-scale antiforms and synforms. A zone of uraniferous alaskites outcrop at the northern end of the deposit and trend southwest at shallow depth for some 8 km in what is considered an extension of the Rössing mine stratigraphy.

Perth-based Extract Resources Ltd (Kalahari Minerals 40%; Rio Tinto 15.6%), has been undertaking feasibility studies for mining the Rössing South orebody. Drilling was undertaken along the 15 km strike which lies under a cover of about 50 m of alluvial sand. A resource estimate of Zones 1 and 2 was developed from drilling results compiled between November 2007 and June 2009.

Pre-feasibility studies have been completed of an open pit mining project with output of 5 700 tU/yr. Capital costs are estimated at USD 700 million, with operating costs of USD 61/kgU (USD 23.46/lb U_3O_8). First production is slated for 2013.

Valencia

The Valencia Deposit, (100% owned by Valencia Uranium Pty Ltd, the operating subsidiary of Forsys Metals Corp) is located 35 km along strike from the producing Rössing Uranium Mine and 40 km north of the Langer Heinrich deposit. Historical work at Valencia was conducted by Goldfields Namibia between 1973 and 1977. Borehole drilling, chemical analysis, radiometric sorting tests on bulk ore samples in 1979 preceded two preliminary feasibility studies in 1981 and 1989. Due to low uranium prices at the time however, the project was considered uneconomic.

Since October 2005, Forsys has conducted a programme of confirmatory work including a ground radiometric survey, infill drilling and geotechnical data gathering in order to develop an updated resource estimate. Additional drilling programmes in 2008 delineated resources to the North, South and East of the Main Zone pit floor.

A scoping study report issued in June 2007 outlined an initial open pit design and site layout plan, identified waste and tailings disposal areas, access routes and proposed initial extractive solutions. Forsys then completed a pre-feasibility study in May 2009 that included pit optimisation, metallurgical environmental and economic analyses and a resource estimate upgrade.

In August 2008, Forsys announced that the Ministry of Mines and Energy had granted a 25 year Mining Licence No. 149 to Valencia Uranium (Pty) Ltd, allowing full scale development of the Valencia Uranium mining operation to proceed. Valencia plans to produce approximately 1 150 tU/yr over the life of mine, with production beginning as early as 2010.

Etango (formerly Goanikontes)

The Etango deposit, situated within the Welwitschia tenement (EPL 3345) in the Erongo Province, lies within the Central Zone of the northeast trending Pan African Damara Orogenic Belt that transects the African continent. The main uranium enriched zones are Anomaly A, Oshiveli and Onkelo Prospects; which were previously referred to as the Goanikontes area. These three prospects form a contiguous zone of uranium mineralisation spanning 5 km. The alaskite ore character is similar to that at the Rössing mine, but at a depth of up to 400 m. Other areas in the vicinity are also considered to have potential to host additional uranium resources (e.g. the western flank of the Palmenhorst Dome alone constitutes a prospective strike length of over 10 km).

In 2005, Bannerman Resources Limited acquired the Etango Project lease and subsequently obtained and digitised historical drill hole and mapping data, principally from the Namibian Geological Survey and the Geological Survey of South Africa. In July 2009, Bannerman produced an updated resource estimates for the combined deposits and proceeded with a definitive feasibility study. The goal is to begin mining in 2011.

Marenica

In April of 2006, Marenica Energy entered into a Joint Venture agreement, approved by the Ministry of Mines and Energy on 31 May 2006, whereby it could earn an 80% interest in the Marenica project. Marencia is situated in a palaeo-channel about 40 km north of Trekkopje. In July 2008, the company produced a 13 000 tU resource estimate in accordance with the JORC code.

Further results from down-hole probe work, announced in 2009, included historical drilling data from the main Marenica resource area as well as data from exploration holes at the regional Springbok prospect. In the third quarter 2009, the Exclusive Exploration Licence 3287 was renewed for two years

by the Namibian Ministry of Mines and Energy (MME). In November 2009, Marenica Uranium Project announced an interim resource estimate.

Omahola

Australia's Deep Yellow Ltd, through subsidiary Reptile Uranium Namibia, is assessing a primary uraniferous magnetite deposit at about 200 metres depth and extensive secondary calcrete deposits contained within the Red Sand-Tumas-Oryx-Tubas palaeochannel and associated systems. The Omahola Project comprises the INCA uranium and iron and Tubas Red Sand (TRS) deposits. Resource estimates for INCA and TRS are being developed during 2009 and 2010, with Feasibility Studies slated to follow. Deep Yellow also has a joint venture with a Namibian subsidiary of Toro Energy on contiguous land under exploration licenses.

INCA is situated about 10 km south of Etango and 35 km inland from the coast. Calcrete deposits stretch over about 40 km south and southeast of it. The company is working toward developing a mine combining ore from INCA with that from Tubas-Red Sand (TRS; 10 km south) to produce about 850 tU/yr. High grade uranium bearing mineralised sand from TRS could be trucked to either of the existing nearby uranium producers for treatment, since it contains low concentrations of carbonate and is amenable to either alkali or acid processing. The uranium mineralisation at INCA is primary and in part associated with sulphides (pyrite) and so could be processed through an acid based plant such as at Rössing mine.

Other Exploration Prospects

In December 2006, Nova Energy (Namibia), a subsidiary of Toro Energy Limited, was granted three Exclusive Prospecting Licences (EPLs) for nuclear fuel and base and rare metal exploration. The licences cover areas considered to be prospective for primary Rössing-type mineralisation and surficial Langer Heinrich-type mineralisation.

The Gawib West EPL3668 is located about 12km west of Langer Heinrich deposit and covers part of the upper Tumas drainage. The Langer Heinrich palaeo channel is interpreted to have once flowed directly west into the upper reaches of the Tumas drainage system. However, Initial drilling of the channel that drains downstream of Langer Heinrich was unsuccessful.

The Tumas North EPL3669 is located about 24 km southwest of Swakopmund and covers part of the northern arm of the Tumas drainage system. The tenement contains bedrock alaskites and superficial calcretes, both of which with potential to host uranium mineralisation. Initial reconnaissance and sampling has been carried out over the Tumas North (EPL3669) tenement and results are being analysed.

Chungochoab is a large EPL (3670) that covers a tract of land about 80km south-southeast of Swakopmund. Of the three anomalies revealed by airborne radiometric survey data, two that occur in an area underlain by calcrete have been surveyed. Results show significant radon signatures over potential palaeo-channel areas, which align with the more regional radiometric data. Drilling was planned to test these anomalies in 2009.

Xemplar Energy Corporation of Canada has uranium prospects (Warmbad, Cape Cross, Aus-Garub, Engo Valley) along Namibia’s Atlantic coast. Uranium occurrences have been investigated in the Warmbad area and in the coastal south of Namibia along the Orange River, bordering South Africa. An airborne radiometric survey flown in 2007 showed radiometric anomalies on 14 large, alaskite bodies which outcrop over an area of about 40 km by 28 km. These are considered to have

potential to host high tonnage, low-grade uranium occurrences. Some exploration and definition drilling has been conducted on these features.

Through its Namibian subsidiary, Namura Mineral Resources (Pty) Ltd., Xemplar also holds three EPLs in north-west Namibia, some 20 kilometres inland from the Atlantic coast (Cape Cross). The exploration target is a palae-ochannel containing uranium mineralisation underlain by calcrete and calcareous conglomerates.

Xemplar's early stage exploration properties are located in a relatively unexplored area with extensive calcite deposits that is judged to have the potential to host a large, low-grade deposit (Aus-Garub). Another prospect, in the northwest corner of Namibia (Engo Valley), has an estimated historical resource 2 300 tU.

URANIUM RESOURCES

The uranium resources of Namibia, including both identified and undiscovered, occur in a number of geological environments and consequently are hosted in several deposit types. The Identified Resources are mainly associated with intrusive and surficial deposits.

In addition to the Identified Resources in the Rössing, Rössing South, Etango and Valencia alaskite deposits located in the Precambrian Damara Orogenic Belt, and those associated with surficial calcretes at Langer Heinrich and Trekkopje, there is continuing exploration that may reveal large undiscovered uranium potential.

Although not quantitatively assessed, the uranium potential is considered greatest in the 5 000 km^2 granitic terrain of the Damara Belt, Tertiary to recent surficial sedimentary terrains in semi-arid areas, where further potential for calcrete deposits is thought to exist and sandstone basins that include the Permo-Triassic Karoo sediments.

Rössing

At the end of 2009 the total uranium inventory of the Rössing mine amounted to 67 033tU, comprising:

Resource Category	Tonnes (K)	Grade U (ppm)	U tonnes
Measured	6 710	198	1 320
Indicated	80 530	191	15 370
M & I	87 240	191	16 690
Inferred	16 740	192	3 210
Total	103 980	191	19 900

Reserve Category	Tonnes (K)	Grade U (ppm)	U tonnes
Proved	25 500	256	6 530
Probable	167 200	262	43 810
Total	192 700	261	50 340

Data rounding to nearest 10 tU.
Resources are stated as additional to the reserves.

Namibia

Langer Heinrich

Following completion of drilling programmes over the years 2005 through 2008, JORC-compliant ore resource estimates developed by Paladin Energy increased contained uranium by 64%. The mineral resource estimates presented below are based on the derivation of U_3O_8 grades using down-hole gamma logging results and applying standard practice radiometric determination methods for U_3O_8 determination (e U_3O_8).

Resources (212 ppm U cut off)	**Tonnes (K)**	**Grade U (ppm)**	**tU**
Measured	32 800	506	16 610
Indicated	23 600	477	11 260
M & I	56 400	494	27 860
Inferred	70 700	498	35 240
Total	127 100	496	63 100

Reserves (212 ppm U cut-off)	**Tonnes (K)**	**Grade U (ppm)**	**tU**
Total	25 400	997	25 330

Table values may not add due to rounding or conversion.

Trekkopje

The Trekkopje Project is an opencast mine containing a shallow, high-tonnage deposit of low-grade uranium, hosted by calcretised paleo-channels. The main mineralisation covers an area of about 16 kilometres by 4 kilometres and consists of two uranium deposits, Trekkopje and Klein Trekkopje, located approximately 7 kilometres apart. A substantial conversion of Inferred resources to Indicated resources occurred as a result of drilling in 2006 and 2007, upgrading the resources to:

Measured: 870 tU
Indicated: 42 340 tU
Inferred: 3 100 tU
(Over 9 000 tonnes of vanadium pentoxide by-product has been defined).

Husab

In 2009, Extract announced the following updated resource estimates for Zone 1, Zone 2 and Ida Dome.

Ore Deposit	**Resource Category**	**Tonnes (K)**	**Grade U (ppm)**	**tU**
Zone 1	Indicated	21 000	448	9 400
Zone 1	Inferred	126 000	370	46 500
Zone 2	Inferred	102 000	460	47 000
Ida Dome	Inferred	53 000	180	9 600
	Total	302 000	373	112 500

Table values rounded during calculation of tU.

Valencia

Summary of Valencia resources, as of January 2009

Resource Category	Cut off U ppm	Tonnes (K)	Grade U (ppm)	tU
Measured	51	24 500	126	3 100
Indicated	51	188 700	109	20 600
Measured & Indicated	51	213 200	111	23 700
Inferred	51	76 900	101	8 700
Total	51	290 100	112	32 400

Etango

In August 2009 Bannerman Resources Ltd announced updated resource estimates for the combined Anomaly A, summarised below:

Resource Category	Tonnes (K)	Grade U (ppm)	tU
Measured	3 800	203	800
Indicated	231 200	176	40 700
Inferred	120 700	167	20 200
Total	355 700	173	61 700

Marenica

As of late 2009, the calculated Interim Resource estimates amounted to:

Indicated 16Mt @ 144ppm: 2 300 tU
Inferred 106Mt @ 119ppm: 12 600 tU

Omahola

Tubas deposit has JORC-compliant inferred resources of 15 000 tU, and the Tumas deposit contains Indicated and Inferred resources amounting to some 3 000 tU.

URANIUM PRODUCTION

Historical review

See the 2007 Red Book.

Rössing

Based on increased uranium market price and a detailed feasibility study, the mine life was recently extended to 2016. Uranium production increased markedly in 2008 compared to previous years, and is expected to amount to about 3 400 tU in 2009.

A goal of raising production to 4 500 tU by 2012, is expected to be achieved as early as 2010. To boost production further a heap leach facility is being considering, which could augment production by 1 700 tU/yr from 2011.

Langer Heinrich

Full scale development of the mining operation proceeded after licensing and production at Langer Heinrich began in late 2006 following development of a bankable feasibility study that confirmed that a large body of uranium mineralisation could be mined by open pit with a minimum mine life of 11 years and a process plant life of 15 years. The study showed 1 000 tU/yr could be produced for the first 11 years at a head feed grade of 0.074% U and that a further 340 tU could be produced over an additional four years, using the accumulated low-grade (0.027% U) stockpile.

During the 2008/2009 financial year production amounted to 2.7Mlb of U_3O_8 (1 040 tU), compared to 1.71Mlb U_3O_8 (660 tU) in 2007/2008, an increase of over 60%. Stage II construction, which is designed to expand annual production to 3.7Mlb (1 425 tU), was completed in June 2009 and commissioning was underway in the following months. Plans for a further expansion (Stage III) which is to increase annual production to 5.2Mlb (2 000 tU) at an estimated capital cost of USD 71 million have also been approved. Stage III construction began in September 2009 and is expected to take 12 months.

Future production centres

The Trekkopje mine, located 20 km north of Rössing, is expected to start commercial production in 2011. Although the ore is low-grade (averaging 0.013% U), most is located at shallow depth and production costs should therefore be relatively low. A mining licence was granted in June 2008 and a trial mine and pilot heap leach plant were constructed in 2008 and operated in 2009. Production is targeted at 1 600 tU/year initially, with potential to scale up to 3 500 tU/year. Small quantities of vanadium by-product will also be produced. Heap leaching processing is expected to be used over the 12-year operating life of the facility.

Early in 2009 the trial mine and pilot plant employed about 140 people, not including contractors. It is estimated that about 320 more jobs will be filled by the end of June 2010 as the facility moves toward commercial production.

Valencia, located 35 km east of Rössing, is another project with near-term production potential. Although no mine development schedule has as yet been announced, first production is anticipated in 2011 amounting to as much as 1 000 tU/year.

Extract Resources is continuing to develop the Husab Project with the Rössing South Feasibility Study that due to be completed in mid-2010. A preliminary start-up date is listed as 2013, with potential annual production of 5 700 tU.

Employment in existing production centres

Rössing employment at the end of 2008 totalled 1 307 permanent employees, and an average of 1 000 contractors on site. The target for 2009 is a staff complement of 1 500 employees.

Langer Heinrich employed an average of 600 employees.

Other projects continue in the exploration phase of development.

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2	Centre #3
Name of production centre	Rössing	Langer Heinrich	Trekkopje
Production centre classification	Existing	Existing	Committed
Start-up date	1976	2006	2011
Source of ore:			
• Deposit name	SJ, SK & SH	Langer Heinrich	Trekkopje, Klein Trekkopje
• Deposit type	Intrusive	Calcrete	Calcrete
• Reserves (tU)	75 000	79 000	45 000
• Grade (% U)	0.03	0.05	0.011
Mining operation:			
• Type (OP/UG/ISL)	OP	OP	OP
• Size (t ore/day)	36 000	10 000	30 800
• Average mining recovery (%)	85	90	90
Processing plant (acid/alkaline):			
• Acid/Alkaline	Acid	Alkaline	Alkaline
• Type (IX/SX)	IX/SX	IX	HL/IX
• Size (t ore/day) For ISL (L/day or L/h)	30 000	8 000	25 000
• Average process recovery (%)	78	85	80
Nominal production capacity (tU/year)	3 817	1 425	1 600
Plans for expansion	Yes	2 000	Yes
Other remarks			

NA Not available.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

The Rössing Foundation was established in 1978 by Rössing Uranium Limited to implement and facilitate its corporate social responsibility activities within the communities of Namibia. In 2000, with the closure of the mine envisaged to be just a few years ahead, and with the town and its inhabitants still greatly dependent on the mine's economic benefits, Rössing Uranium decided to open a Rössing Foundation office in Arandis. In November 2003, it broadened its development functions, undertaking a number of activities across a broad spectrum of community development areas, including local authority support to the mine service community and Arandis in the areas of education, health, poverty alleviation, innovation, the environment, and enterprise development.

At the Ministry of Education's request, the Foundation supports the implementation of the Education and Training Sector Improvement Programme (ETSIP). In 2008, 25% of Grade 12 graduates from the Kolin Foundation Secondary School in Arandis qualified for access to tertiary

institutions. As part of its strategic focus, the Foundation established three Educational Centres in Arandis, Swakopmund and Ondangwa. During 2008, the centres provided 9 798 learners with educational subject related opportunities.

Arandis is economically dependent on the benefits flowing into its economy from mining activities. Planning for the long-term sustainability of the community must therefore take into account the inevitable future closure of the mine. The Arandis Sustainability Development Project (ASDP) was established to ensure the transformation from singular economic reliance on the mining sector to a diversified socio-economic base. The current Project Management Team is made up of the Arandis Town Council, Rössing, and Rössing Foundation representatives.

The Rössing Foundation supports small-scale miners' initiatives, the Community-based Natural Resource Management (CBNRM) Programme, small- and medium-scale enterprises (SMEs), as well as agriculture projects, in order to significantly contribute towards an increase in household income. The Rössing Foundation commenced piloting vegetable production by using a simplified hydroponic method that is tailored to suit the Arandis situation. The Foundation promotes agricultural development in the Topnaar community resident in the Kuiseb River area near Walvis Bay.

The Foundation continued its support of the eight conservancies in the Erongo and the north-central Regions. Five communities in the Erongo Region were supported in various ways, especially in capacity-building. Nine craft enterprise groups in the Ohangwena, Omusati, Oshana and Oshikoto Regions supported by the Foundation generated an income of NAD 266 350.

Rössing

A Social and Environmental Impact Assessment and Management Plan for three of the mine's expansion projects was submitted to Namibia's Ministry of Environment and Tourism. These projects include the building of a radiometric ore sorting plant, the mining of a small satellite ore body known as SK4 about 1 km to the east of the current open pit, and the building of a sulphur-burning sulphuric acid plant. After review, the Ministry issued an environmental clearance certificate. Rössing's land use inventory, which was compiled during 2007 from detailed geohydrological, archaeological, biodiversity and visual impact studies, was used during 2008 to plan future land use at the mine.

The efficient supply of fresh water continues to be a concern, especially considering the cumulative effect of the planned increased in uranium mining in the Erongo region. Most water loss at Rössing is from the tailings dam due to evaporation and incorporation in the tailings material, although ponded water is recycled. The consumption of fresh water by bulk users and the status of aquifers countrywide are continuously monitored by the Namibia Water Corporation Ltd (NamWater) and the Ministry of Agriculture, Water and Forestry's Department of Water Affairs (DWA). The results of these monitoring exercises are provided to bulk users and Basin Management Committees.

Regional bulk users are required to conserve groundwater resources by sharing information and promoting water demand management and/or sea water desalination. The impact of mining effluents on the water quality in neighbouring areas, especially the Khan and Swakop Rivers, continued to be a public concern. The DWA and Ministry of Mines and Energy's Directorate of Geological Survey are in the process of arranging an independent sampling exercise to establish the baseline water quality. The survey will cover monitoring boreholes close to and in the river courses.

The total closure cost projected for the mine in 2008 terms stands at just over NAD 896 million. This includes retrenchment and training costs, demolition and tailings rehabilitation, and long-term seepage control and monitoring costs. The provision for closure in the independent Rössing Environmental Rehabilitation Trust Fund stood at NAD 100 million at the end of 2008, and will be increased during the coming years to provide fully for the time of mine closure.

A Power Efficiency Department was established in 2008 to oversee electrical supply and energy efficiency. The Department's key responsibilities are to ensure and optimise electricity consumption by tracking and optimising system efficiencies

The implementation of Minimum Environmental and Occupational Health Standards and the initiation of a Strategic Environmental Assessment (SEA) of the Erongo Region were identified as fundamental steps. The SEA will be translated into a Strategic Environmental Plan that will provide scientifically backed insights to assist the Government in managing the uranium industry responsibly.

Land disturbance during 2008 amounted to a total of 45 ha compared with 10 ha in 2007. The total area impacted by the mine was 2 440 ha at the end of 2008. No further rehabilitation work was carried out during 2007/2008. Rössing's closure plan was updated during 2005 consistent with the 2005 life of mine plan. The next technical update of the plan is scheduled for 2010.

Langer Heinrich

Palladin has developed an Environmental Management System (EMS) and implemented it across the site operations. In April 2009, the mine received ISO14001 certification for its EMS following certification audits. As part of the EMS, Environmental Management Plans (EMPs) have been prepared for site operations and submitted for review to Government and other stakeholders. The EMPs are regularly updated and revised as part of the sites' continual improvement process.

The operational EMP for Langer Heinrich was submitted and reviewed by the respective Government departments and also by international financial lending institutions as part of project financing. A revised EMP for the mine, including the Stage II expansion, was submitted and approved by Government. An Environmental Impact Assessment (EIA) process for the proposed Stage III expansion began in early 2009. Stakeholder consultations were conducted and a Scoping Report prepared and submitted to Government in May 2009.

A Standard for water use and water quality was developed to ensure that efficient, safe and sustainable uses of water are practiced and that water resources and ecosystems around the site are protected. Detailed water balances, flow models and water management strategies were developed and implemented. Hydrological specialists were engaged to provide advice on the design, construction, operation and management of water and water infrastructure. The design and water management strategies have also been subject to external technical peer review and audit to provide a level of comfort that the water management, as proposed, meets international standards.

A mine closure standard has also been developed to ensure that the sites are left in a safe and stable manner and that environmental impacts are minimised. The closure planning process progressed during 2009 with the establishment of a Steering Committee which has developed a closure strategy and started preparing a detailed draft closure plan.

Namibia

In 2007, the Chamber of Mines of Namibia proactively decided to establish a Uranium Stewardship Committee (USC). USC contributes to emerging policy debates on the expansion of the industry, the safe, efficient and productive development of mines, a better understanding of the global context in which the industry operates and to stakeholder and public confidence in the industry. Rössing and Langer Heinrich actively supported establishment of the USC. The USC established an environment of "policy certainty", supporting efforts to develop a stable investment climate, helping develop dedicated regulatory and compliance arrangements, and evaluating the effectiveness of updated intervention strategies.

www.chamberofmines.org.na/main/safety-sustainable-development/namibia-uranium-stewardship-nus/uranium-stewardship-committee.html.

URANIUM REQUIREMENTS

Namibia has no reactor-related uranium requirements since it has no reactors and no plans to develop nuclear generating capacity.

NATIONAL POLICIES RELATING TO URANIUM

In Namibia, all mineral rights are vested in the State and are regulated by the Minerals (Prospecting and Mining) Act of 1992. This Act was promulgated soon after independence in order to repeal old legislation inherited from the colonial regime. The Act is currently under review and will accede to policies which are being formulated. Revision has reached an advanced stage and, once completed, will be submitted to the legal drafters for finalisation and prepared for submission to Parliament for consideration. It is anticipated that this exercise will be completed in 2010. An overview of the Minerals Policy in Namibia can be found at:

www.chamberofmines.org.na/fileadmin/downloads/Minerals_Policy_Final.pdf.

In 2007, the Government of Namibia instituted a moratorium on uranium exploration licenses for an indefinite term. At the time, the price of uranium had reached a level that had stimulated exploration for the mineral worldwide, in particular in Namibia. The government stated that the moratorium would give it time to reconsider its policies toward uranium following the upswing in demand, citing water and energy concerns.

Uranium is defined as a controlled mineral and section 102 of the Minerals Act deals with the export, processing, possession and enrichment of uranium. There is no particular policy or set of regulations that deals with the uranium production or the nuclear fuel cycle and Namibia is collaborating with Finland to develop appropriate governance. A project concept in this respect was progressed under the IAEA technical co-operation programme RAF3006.

The Namibian government in March 2009 launched the first State-owned mining company, Epangelo Mining. The company will receive NAD 1.5 million in start-up capital and it will be 100% State owned. This holding company will take equity and participate in new uranium exploration and development projects.

Uranium exploration and development expenditures and drilling effort – domestic*

Expenses in NAD	2006	2007	2008	2009 (expected)
Industry exploration expenditures	1 521 517	9 955 806	67 206 320	76 852 773
Government exploration expenditures	NA	NA	NA	NA
Industry development expenditures	0	0	0	0
Government development expenditures	NA	NA	NA	NA
Total expenditures	1 521 517	9 955 806	67 206 320	76 852 773
Industry exploration drilling (metres)	1 700	20 500	36 470	35 000
Number of industry exploration holes drilled	10	93	99	70
Government exploration drilling (metres)	NA	NA	NA	NA
Number of government exploration holes drilled	NA	NA	NA	NA
Industry development drilling (metres)	16 444	30 000	32 661	30 000
Number of development exploration holes drilled	191	350	363	333
Government development drilling (metres)	NA	NA	NA	NA
Number of development exploration holes drilled	NA	NA	NA	NA
Subtotal exploration drilling (metres)	1 700	20 500	36 470	35 000
Subtotal exploration holes	10	93	99	70
Subtotal development drilling (metres)	16 444	30 000	32 661	30 000
Subtotal development holes	191	350	363	333
Total drilling (metres)	18 144	50 500	69 131	65 000
Total number of holes	201	443	462	403

* Rössing only.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0		
Open-pit mining	0	2 480	158 150	158 150	78-85
In situ leaching	0	0	0	0	
Heap leaching	0	0	38 090	38 090	70
In-place leaching (stope/block)	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	2 480	196 240	196 240	

* *In situ* resources.

Reasonably Assured Conventional Resources by deposit type*
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	
Sandstone	0	0	0	
Hematite breccia complex	0	0	0	
Quartz-pebble conglomerate	0	0	0	
Vein	0	0	0	
Intrusive	0	2 480	116 660	116 660
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other**	0	0	79 580	79 580
Total	0	2 480	196 240	196 240

* *In situ* resources.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0		
Open-pit mining	0	0	150 220		78-85
In situ leaching	0	0	0		
Heap leaching	0	0	8 820		70
In-place leaching (stope/block leaching)	0	0	0		
Co-product and by-product	0	0	0		
Unspecified	0	0	0		
Total	0	0	159 040		

* *In situ* resources.

Inferred Conventional Resources by deposit type*
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	108 330	108 330
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Surficial-Calcrete	0	0	50 710	50 710
Other**	0	0	0	0
Total	0	0	159 040	159 040

* *In situ* resources.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	85 190	3 076	2 832	4 400	95 489	4 623
Underground mining*	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	85 190	3 076	2 832	4 400	95 489	4 623

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	85 190	3 076	2 832	4 400	95 489	4 623
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	85 190	3 076	2 832	4 400	95 489	4 623

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

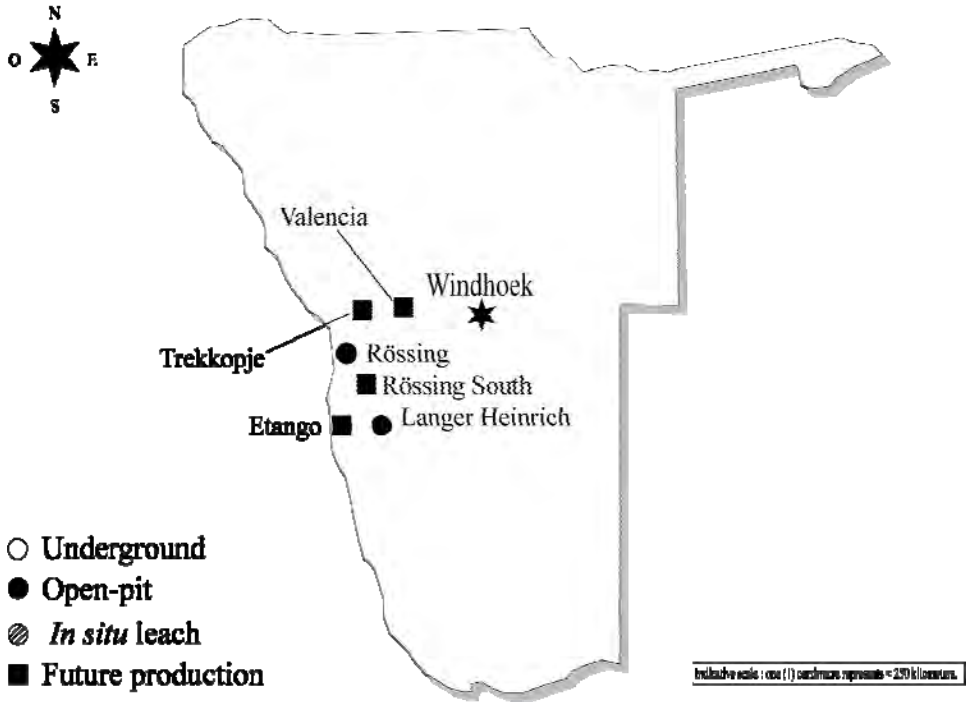
Uranium industry employment at existing production centres
(person-years)

		2006	2007	2008	2009 (expected)
Total Staff employment	Rössing	939	1 175	1 307	1 500
Employment directly related to uranium production	Rössing	426	573	708	953
Staff employment	Langer Heinrich			198	210
Contractors directly related to uranium production	Langer Heinrich			200	
Staff employment	Trekkopje				130
Contractors directly related to uranium production	Trekkopje				
Total Employment	All	>1 356	>1 748	>2 015	>2 793

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	5 000	6 500	0	0	6 000	15 000	0	0	8 000	19 000

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	6 000	14 000	0	0	5 000	10 000	0	0	5 000	7 500



• Niger* •

URANIUM EXPLORATION

Historical review

See the 2007 Red Book for a brief historical review.

* Report prepared by Secretariat, and based on information from the *Environmental Impact Study* (Knight Piesold, 2007), input from the Government of Niger and other sources.

Recent and ongoing uranium exploration and mine development activities

Somaïr

Mine development of the Tamgak deposit started in 2006 and continued in 2007.

Cominak

Further delineation of the southern part of the Ebba deposit continues. This deposit is located south of the previously mined Akouta and Akola deposits, in an area covered by a mining permit granted by the Government of Niger in 2006.

AREVA NC Niger

Intensive drilling campaigns were conducted in 2007 and 2008 on the different exploration permits, in particular Imouraren. Development of the Imouraren deposit was confirmed in January 2008. The deposit covers an area 8 km by 2.5 km and contains 146 000 tU (RAR and Inferred) at an average grade of 0.11% U.

China National Uranium Corporation

Exploration of the Azelik deposits started in 2006, and continued in 2007 and 2008. The Teguidda deposit is reported to have resources of 13 000 tU at an average grade of 0.2%.

GoviEx

GoviEx holds exploration properties of 2 300 km^2 near the Arlit mine, as well as 2 000 km^2 near Agadez. The company has been drilling to confirm historical uranium exploration data on the Madaouela (6 190 tU) and Arnou Melle deposits. In August 2008, Cameco bought an 11% share of GoviEX, with options to increase that share to 48%.

Niger Uranium

Niger Uranium holds eight prospecting licenses, covering a total area of almost 7 000 km^2. In August 2008, Niger Uranium announced an inferred resource of 1 700 tU at Gall, in shallow sandstone.

Trendfield

Trendfield formed the UREX joint venture with ***Artemis Resources*** (Australia) to explore the Tagaza deposits adjacent to Teguidda.

In April 2007, the government issued uranium exploration permits to AREVA, Rio Tinto and others for the Tchirozerine area, northwest of Agadez.

Niger

URANIUM RESOURCES

Identified Resources (RAR & Inferred)

Somaïr

Proven and Probable Reserves

Deposit	Ore (kt)	Grade (% U)	Uranium (t)
Ariège Sud	16	0.202	33
Artois	5 664	0.216	12 232
Stock Tabelle	106	0.152	161
Stock Tamou	227	0.202	460
Tabelle	323	0.273	882
Tamgak Plateau	2 848	0.287	8 183
Tamou	158	0.268	423
Tamou Ext Ouest	589	0.255	1 503
Total	9 931	0.240	23 877

Non-economic resources at present conditions
(Measured and Indicated)

	Ore (kt)	Grade (% U)	Uranium (t)
Total	15 560	0.093	14 406

Inferred Resources under development

Deposit	Ore (kt)	Grade (% U)	Uranium (t)
Tamgak Flexure		0.453	384
Tamgak Lix		0.342	5 356
Tamou Est		0.370	19 750
Total		0.364	25 454

Cominak

Deposit	Ore (kt)	Grade (% U)	Uranium (t)
Akola	76.9	0.453	384
Akouta	1 566.6	0.342	5 356
Ebba	5 344.2	0.370	19 750
Total	6 987.7	0.364	25 454

Imouaren

Recoverable resources as in feasibility study

	Ore (kt)	Grade (% U)	Uranium (t)
Measured	65 250	0.084	55 116
Indicated	217 104	0.075	162 804
Inferred	14 219	0.071	10 127
Total	296 573	0.077	228 047

Uranium recoverable by dynamic leaching (c/o > 0.06 % U: 163 953 t U @ 0.104 % U.

Uranium recoverable by heap leaching (0.03 < c/o < .06 % U):64 094 tU @ 0.046 % U.

Somina

Reserves (categories 331 and 332 of the UNFC classification) as in feasibility study

Deposit	Ore (kt)	Grade (% U)	Uranium (t)
T	2 351	0.136	3 201
IR	4 393	0.151	6 588
G	2 211	0.132	2 924
Total	8 955	0.142	12 713

Undiscovered Resources (Prognosticated & SR)

No change from Prognosticated Resources reported in the 2005 edition of the Red Book amounting to 24 608 tU at a cost of <USD 130/kgU.

URANIUM PRODUCTION

Historical review

In Niger, uranium is produced by two companies, Somaïr and Cominak, which have been operating mines in sandstone deposits since 1970 and 1978 respectively. A third company, the *Société Minière de Tassa N'Taghalgue* (SMTT) assigned its mining rights to Somaïr in 1996 and was subsequently dissolved.

Status of production capability

The total production capability of the two production centres in Niger is in the process of being increased from 3 800 tU in 2006 to 4 500 tU in 2009.

Ownership structure of the uranium industry

The ownership structure of Niger's two production companies is defined below:

Somaïr	Cominak
36.6% SOPAMIN (Niger) 37.5% AREVA NC (France) 25.9% CFMM (France)	31% SOPAMIN (Niger 34% AREVA NC (France) 25% OURD (Japan) 10% Enusa (Spain

Employment in the uranium industry

Employment in the two producing companies (Somaïr and Cominak), at the end of March 2008, was 1 932. An important programme of hiring new employees is currently under way in order to address the problems of retiring staff combined with the increasing of activity at the existing production centres.

The Imouraren project is expected to create about 1 400 permanent and many indirect jobs.

Future production centres

Somaïr

- Efforts are underway to increase production capability of the plant from 550 000 t ore to 660 000 t ore in 2009.

- Construction of a heap leaching unit, able to process 1 400 000 t ore per year is currently underway and commissioning is expected in 2009.

SOMINA *(Société des Mines d'Azelik)*

A new company (*Société des Mines d'Azelik*) was created on 3 June 2007, in order to mine the Azelik uranium deposits. First production is planned in 2011, with a production capability of 700 tU/year. The ownership structure of the company is:

	%
SOPAMIN (Government of Niger)	33.0
SINO-U (China)	37.2
ZX Joy Invest (China)	24.8
Trenfield Holdings SA (Niger private)	5.0

AREVA NC

On May 4, 2009, the Imouraren mine has been launched with an initial investment of more than 1.6 billion dollars. Once up to full production capacity, it should be producing 5 000 tU a year for 35 years. Production is scheduled to start in 2012.

The ownership structure of the company is (as of February 2010):

	%
SOPAMIN (Government of Niger)	33.35
AREVA (France)	56.65
Kepco (South Korea)	10.00

Uranium production centre technical details
(as of 1 January 2007)

	Centre #1	Centre #2	Centre #3	Centre #4
Name of production centre	Arlit (Somaïr)	Arlit (Somaïr)	Akouta (Cominak)	Imouraren
Production centre classification	Operating	Planned	Operating	Planned
Start-up date	1970	2009	1978	2012
Source of ore:				
• Deposit name	Tamou/Artois Tamgak	Low grade stockpiles	Akouta/Akola Ebba	Imouraren
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone
• Resources (tU)	29 200	5 000	36 935	22 8047
• Grade (% U)	0.28	0.07	0.40	0.077
Mining operation:				
• Type (OP/UG/ISL)	OP		UG	OP
• Size (t ore/day)	1 900	3 800	1 800	
• Average mining recovery (%)	100	100	100	
Processing plant (acid/alkaline):	Acid	Acid	Acid	
• Type (IX/SX)	SX	SX	SX	
• Size (t ore/day); for ISL (L/day or L/h)	1 900	3 800	1 900	
• Average process recovery (%)	95	65	95	
Nominal production capacity (tU/year)	1 500	700	2 300	5 000
Plans for expansion	Yes			
Other remarks				

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Three environmental impact assessment studies were completed in 2005-2006 in order to obtain administrative authorisation to mine the Ebba (Cominak), Artois and Tamgak (Somaïr) uranium deposits.

Both companies, Somaïr and Cominak are certified ISO 14001 for sustainable management and environmental protection.

At Imouraren, AREVA will spend Euro 6 million per year on health, education, training, as well as providing to locale people access to water and energy.

URANIUM REQUIREMENTS

Niger has no existing facilities and no plans to develop nuclear generating capacity and consequently has no reactor-related uranium requirements.

NATIONAL POLICIES RELATING TO URANIUM

One of the main objectives of Niger's national uranium policy is to achieve a greater degree of international competitiveness in its uranium industry.

URANIUM STOCKS

None reported.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million CFA Francs	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	6 355	43 103	27 688	68 210
Government exploration expenditures	NA	NA	NA	NA
Industry* development expenditures	NA	34 970	59 693	74 890
Government development expenditures	NA	NA	NA	NA
Total expenditures	NA	78 073	87 381	143 100
Industry* exploration drilling (m)	NA	NA	NA	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	NA	NA	NA	NA
Government exploration holes drilled	NA	NA	NA	NA
Industry* development drilling (m)	NA	NA	NA	NA
Industry* development holes drilled	NA	NA	NA	NA
Government development drilling (m)	NA	NA	NA	NA
Number of development exploration holes drilled	NA	NA	NA	NA
Subtotal exploration drilling (m)	NA	NA	NA	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	134 567	NA	NA	NA
Total holes drilled	1 038	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	22 000	38 000	39 000	90
Open-pit mining	12 000	15 500	199 000	200 605	95
In situ leaching	0	0	0	0	
Heap leaching	5 000	5 000	5 000	5 000	65
In-place leaching (stope/block leaching)	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	17 000	42 500	242 000	244 605	

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	
Sandstone	17 000	42 500	242 000	244 605
Hematite breccia complex	0	0	0	
Quartz-pebble conglomerate	0	0	0	
Vein	0	0	0	
Intrusive	0	0	0	
Volcanic and caldera-related	0	0	0	
Metasomatite	0	0	0	
Other*	0	0	0	
Total	17 000	42 500	242 000	244 605

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	18 000	18 000	18 000	
Open-pit mining	0	12 900	12 900	12 900	
In situ leaching	0	0	0	0	
Heap leaching	0	0	0	0	
In-place leaching (stope/block leaching)	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	30 900	30 900	30 900	

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone		30 900	30 900	30 900
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	30 900	30 900	30 900

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
14 500	24 600	

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	37 185	1 602	1 790	1 743	42 320	1 808
Underground mining*	57 674	1 841	1 403	1 289	32 207	1 400
In situ leaching	0	0	0	0	0	0
Heap leaching	5 785	0	0	0	5 785	0
In-place leaching**	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	100 644	3 443	3 193	3 032	110 312	3 208

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.
** Also known as stope leaching or block leaching.
*** Includes mine water treatment and environmental restoration.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
1 037	34.2	0	0	1 358	44.8	637	21.0	3 032	100

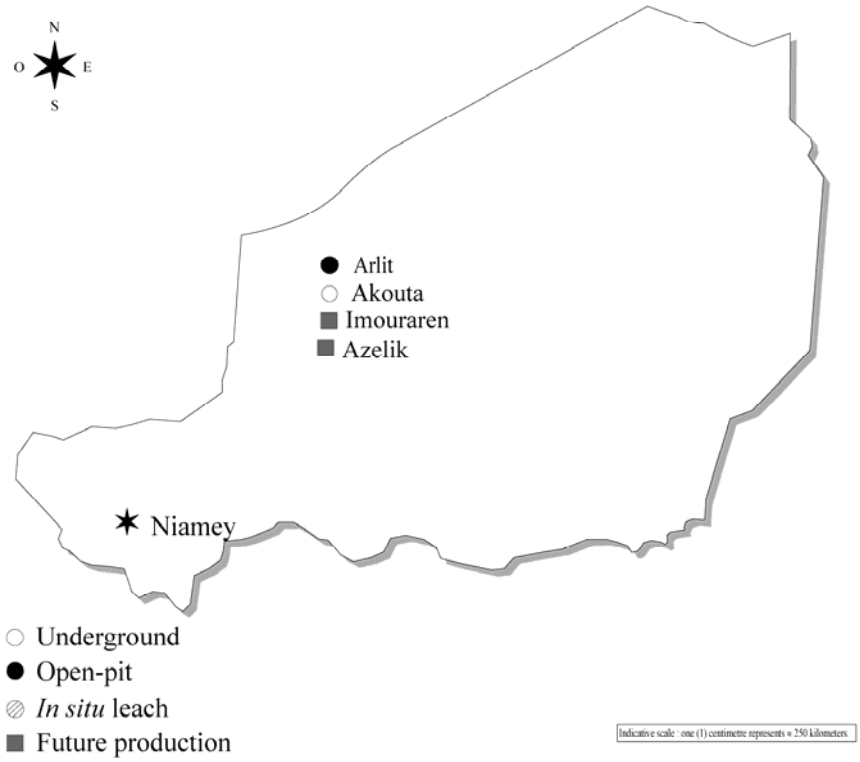
Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres	1 741	NA	1 932	NA
Employment directly related to uranium production	1 388	NA	NA	NA

Short-term production capability
(tonnes U/year)

2010				**2015**				**2020**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
4 500	4 500	4 500	4 500	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000

2025				**2030**				**2035**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA



• Peru •

URANIUM EXPLORATION

Historical review

See the 2007 Red Book for a short historical review.

In addition to the Macusani uraniferous district located in southeastern Peru, where radiometric prospecting revealed over 40 uraniferous areas, the most important being Chapi, Chilcuno-VI, Pinocho, Cerro Concharrumio and Cerro Calvario, the rest of the country is considered to have potential to host uranium resources. The Instituto Peruano de Energia Nuclear (IPEN), through its promotional activities, is working to highlight new areas of interest.

Recent and ongoing uranium exploration and mine development

Several companies have settled in the area of Macusani in order to explore and develop uranium resources through bore holes in different prospects of the district mentioned above.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The identified uranium resources of Peru are primarily located in the Macusani area, Department of Puno. See the relevant table for details.

Undiscovered Conventional Resources (Prognosticated & SR)

Undiscovered Conventional Resources are estimated to total 26 350 tU. Of this total, 6 610 tU in the Chapi deposit area are classified as Prognosticated Resources and 19 740 tU are classified as Speculative Resources, based on the distribution of the Tertiary volcanic host rock in the Macusani uraniferous district (1 000 km^2).

Undiscovered Non-conventional Resources

The uranium contained in phosphate rocks (with an average content of 60 ppm U) and in polymetallic deposits (Cu-Pb-Zn-Ag-W-Ni) is estimated to amount to 21 600 tU:

Bayovar phosphates	16 000 tU
Other locations (39)	5 600 tU
Total	21 600 tU

Peru has never produced uranium and reported no plans to do so. Additionally, Peru has no uranium requirements nor reported any plans to develop a nuclear generation capacity.

NATIONAL POLICIES RELATING TO URANIUM

Mining activities that are the responsibility of the State, under the Law for the Promotion of Investment in the Mining Sector, have been subject to a privatisation process as part of a programme for the stability and security of long-term investments, including uranium. In the past few years, interest in uranium exploration has revived enabling various foreign private companies to resume exploration in the zone in which the Peruvian Nuclear Energy Institute (IPEN) carried out its prospecting and exploration work; using the technical information provided by IPEN.

The state, in promoting investment in uranium mining in the country, is reviewing new areas to explore for uranium and increase uranium potential. The technical office of the National Authority (OTAN) is responsible for regulatory and policy matters.

Peru reported no information on uranium stocks or prices.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	1 790	1 790	1 790	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	1 790	1 790	1 790	

* *In situ* resources.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Conventional	0	0	0	0	
In-place leaching*	0	0	0	0	
Heap leaching**	0	1 790	1 790	1 790	
Total	0	1 790	1 790	1 790	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	1 790	1 790	1 790
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	1 790	1 790	1 790

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	1 860	1 860	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	1 860	1 860	

* *In situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	0	
In-place leaching*	0	0	0	0	
Heap leaching**	0	1 860	1 860	1 860	
Total	0	1 860	1 860	1 860	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	1 860	1 860	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	1 860	1 860	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
6 610	6 610	6 610

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
19 740	19 740	NA

• Poland •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

Poland

Recent and ongoing uranium exploration and mine development activities

There are no current (up-to-date) documented uranium deposits in Poland and no concessions for uranium granted. Although there are some perspective indications of uranium resources, there are currently no prospects for the discovery of uranium that could be economically exploited.

URANIUM RESOURCES

In situ uranium resources amounting to 7 270 tU have been identified in the following regions of Poland. Since recovery costs have not been developed, these figures are not included in the global resource base.

Region	***In situ*** (tU)	**Uranium content** (% U)
Rajsk deposit (Podlasie Depression)	5 320	0.025
Perybaltic Syneclise		
Okrzeszyn (Sudetes)	940	0.05-0.11
Grzmiaca (Sudetes)	790	0.05
Wambierzyce (Sudetes)	220	0.0236

Prognosticated Resources are estimated to amount to over 100 000 tU in the following regions. No costs of recovery have been developed for these resources.

Region	**Prognosticated** (tU)*
Rajsk deposit (Podlasie Depression)	88 850
Perybaltic Syneclise	10 000
Wambierzyce (Sudetes)	2 000

* Only assigned for a depth of up to 1 000 m.

Unconventional Resources and other materials

None reported.

URANIUM PRODUCTION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

In addition to the information provided in the 2007 edition, it is noted that the Ladek and Snieznik Klodzki metamorphic deposits contained some uranium mineralisation and the “Kopaliny-Kletno” deposit wase discovered. There were approximately 20 tU extracted from this deposit.

According to estimations, in years 1948-1967 there were approximately 650 tU exploited in Sudetes.

Status of production capability

Currently in Poland no concessions have been granted for uranium.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

All activities associated with uranium mining and processing in Poland were performed in years 1948-1976. The companies associated with this activity no longer exist. However, there is still a need to remediate the environment in the area around the sites where the mines operated. The Geological and Mining Law stipulates that the State Treasury is accountable for liabilities from all past uranium production activities in Poland. Therefore, the government is responsible for funding remediation, either from the national or the district Environmental Protection Fund.

Only a limited number of issues related to mining and milling are considered to be causing serious impacts. The most important is the tailings pound in Kowary. The 1.3 ha tailing pond is a hydrological construction closed on three sides by a dam that has been modified a number of times over the past years.. The remediation programme of the tailings pond was prepared in 1997 by the Wroclaw University of Technology and successfully carried out under PHARE multi-country uranium remediation programme until 2003. The specific objectives of the remediation programme are related to the construction of the drainage systems, the design and construction of the tailings pond cover and the final site reclamation.

NATIONAL POLICIES RELATING TO URANIUM

Demand for nuclear fuel (type and amount) in Poland in the future (to 2030) depends on category and size of the reactors to be built.

According to the last accepted document concerning energy policy in Poland, the first nuclear power station should be in operation from about 2020.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	NA	0	0	0	NA	0
Underground mining*	650	0	0	0	650	0
In situ leaching	NA	0	0	0	NA	0
Co-product/by-product	NA	0	0	0	NA	0
Total	NA	0	0	0	NA	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Poland

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	NA	0	0	0	NA	0
Sandstone	NA	0	0	0	NA	0
Hematite breccia complex	NA	0	0	0	NA	0
Quartz-pebble conglomerate	NA	0	0	0	NA	0
Vein	650	0	0	0	650	0
Intrusive	NA	0	0	0	NA	0
Volcanic and caldera-related	NA	0	0	0	NA	0
Metasomatite	NA	0	0	0	NA	0
Other*	NA	0	0	0	NA	0
Total	NA	0	0	0	NA	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
0	0	0	0	0	0

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1 500*	1 500*	3 000*	3 000*	4 500*	4 500*	NA	NA

* According to the project of “Poland’s Energy Policy until 2030”.

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
0	0	0	0	0	0

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
NA	NA	NA	NA	NA	NA	NA	NA

• Portugal •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium exploration.

Recent and ongoing uranium exploration and mine development activities

None reported.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

No change since last report.

Undiscovered Conventional Resources (Prognosticated & SR)

No change since last report.

URANIUM PRODUCTION

Historical review

See the 2007 edition of the Red Book for a historical review of uranium production.

Status of production capability

No processing facilities have operated since 2001. Demolition/reclamation of the Urgeiriça mill as well as other mine sites, are in an advanced phase. A EUR 5 million reclamation project of the tailings dam started in 2005 after an environmental impact assessment. Neutralisation of acid mine water from Urgeiriça, Bica, Cunha Baixa and Quinta do Bispo is ongoing.

Ownership structure of the uranium industry

The Portuguese uranium mining and processing company ENU was extinguished on 31 December 2004. Presently no company holds the necessary exploration or mining rights over uranium resources to make them eligible to obtain mineral rights to produce uranium.

Portugal

Employment in the uranium industry

None.

Future production centres

Although no future production centres are planned, the Nisa mine may start in the future if the appropriate government authorities grant mineral rights to one of the several companies interested in obtaining these rights.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

Site rehabilitation

During 2007 and 2008, the only activities associated to Uranium in Portugal were related to the rehabilitation of exhausted mine sites and monitoring.

In Portugal, Empresa de Desenvolvimento Mineiro (EDM), the state owned company responsible for dealing with mining legacy in general, has carried out remediation work on 22 closed uranium mining sites, costing a total of more than € 14 million (USD 20 million).

On this aspect, the most important work performed has been the rehabilitation of the mine site and the tailings pond (13 ha) of Urgeiriça mine, but the following uranium mines were also fully rehabilitated:

1. Vale da Abrutiga.
2. Cunha Baixa e Quinta do Bispo.
3. Espinho.

Most of the work has been designed to achieve safety, health or environmental outcomes, but social and economic factors are also considered in the case of Urgeiriça and nearby mine sites. These include community recreational use of mine water lakes in the Valinhos area, and initial studies on mining heritage conservation and tourism, making use of land and buildings of the Company at Urgeiriça (RadiaNatura project).

Expenditures (€)

Mine Site	Expenditure x 1 000		
	2007	2008	Total
Vale de Abrutiga	428	1 900	2 328
Espinho	189	214	403
Cunha Baixa/Quinta do Bispo	141	329	470
Urgeiriça	4 900	3 650	8 550
Other 17 mines	279	582	861
Monitoring	750	600	1 350
Total	5 937	6 675	13 962

URANIUM REQUIREMENTS

Portugal has no uranium requirements.

NATIONAL POLICIES RELATING TO URANIUM

The Portuguese policy for energy, developed under the lines of the strategy paper "Estratégia Nacional para a Energia" (A National Strategy for Energy), was presented the 29 September 2005. This strategy underlines the importance of renewable energy sources (mainly wind and hydropower) and energy efficiency as means of reducing the dependence of external energy sources and its impact on the balance of trade. Nuclear energy is not considered under the term of this policy that extends until October 2009.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	500	500	0
Open-pit mining	0	4 500	5 500	5 500	75
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	4 500	6 000	6 000	75

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Conventional	0	4 500	6 000	6 000	75
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	4 500	6 000	6 000	75

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Portugal

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	4 500	6 000	6 000
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	4 500	6 000	6 000

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred conventional resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	0
Open-pit mining	0	1 000	1 000	1 000	75
In situ leaching	0	0	0	0	0
Co-product and by-product	0	0	0	0	0
Unspecified	0	0	0	0	0
Total	0	1 000	1 000	1 000	75

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	1 000	1 000	1 000	NA
In-place leaching*	0	0	0	0	0
Heap leaching**	0	0	0	0	0
Total	0	1 000	1 000	1 000	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	1 000	1 000	1 000
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	1 000	1 000	1 000

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
1 000	1 500	1 500

Speculative Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	0	0

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	1 810	0	0	0	1 810	0
Underground mining*	1 326	0	0	0	1 326	0
In situ leaching	584	0	0	0	584	0
Co-product/by-product	0	0	0	0	0	0
Total	3 720	0	0	0	3 720	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Portugal

Historical uraum production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	3 136	0	0	0	3 136	0
In-place leaching*	250	0	0	0	250	0
Heap leaching**	321	0	0	0	321	0
U recovered from phosphates		0	0	0		0
Other methods***	13	0	0	0	13	0
Total	3 720	0	0	0	3 720	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	3 720	0	0	0	3 720	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	3 720	0	0	0	3 720	0

* Includes Surficial, Collapse breccia pipe, Phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	168	0	0	0	168
Producer	0	0	0	0	0
Utility	0	0	0	0	0
Total	168	0	0	0	168

• Russian Federation •

URANIUM EXPLORATION

Historical review

Since the beginning of uranium exploration in 1944, more than 100 uranium deposits have been discovered within 14 districts in the Russian Federation. The most significant deposits are located within five uranium bearing districts: the Streltsovsk district, which includes 19 volcanic caldera-related deposits where the mining of some deposits is ongoing, the Trans-Ural and Vitim districts, where sandstone basal-channel type deposits are developed for uranium production by in situ leaching (ISL) mining and the Elkon district containing large deposits of metasomatite type that are planned to be mined.

Recent and ongoing uranium exploration activities

There are two types of uranium exploration activities in the Russian Federation: prospecting aimed at new deposit discovery and exploration of previously discovered deposits, with a view to updating resource estimates.

Uranium exploration in the Russian Federation is financed from the state budget by the Federal Agency for Subsoil Use (Rosnedra). In 2007, the budget was increased 1.4 times as compared to 2006, and in 2008 it increased by further 20% and reached RUR 1 267 million. The executing organisations were the territorial subsidiaries of the Urangeo, as well as Sosnovgeo, Koltsovgeology and Chitageologorazvedka.

In 2007-2008, most uranium exploration was performed in the Republic of Kalmykia, the Republic of Buryatia, Trans-Baikal Territory and the Chukotka Peninsula. Prospecting in Buryatia (the Vitim uranium district) identified a group of uranium bearing paleovalleys and the Dulesminskoe uranium occurrence. Prospecting performed in the Trans-Baikal Territory (area to the north of Lake Baikal) identified promising areas for subsequent exploration. In Kalmykia, two-well trial in-situ leaching (ISL) works at the Balkovskoe deposit yielded positive results.

As a result of uranium exploration in 2007, Russian prognosticated uranium resources increased by 24 500 tU and speculative resources by 63 000 tU; and in 2008 by 5 700 tU and 92 700 tU, respectively.

In 2009, Rosnedra allocated RUR 872.9 million to uranium exploration. Most of these funds are used to finance prospecting in the regions located near the operating uranium mines, as well as in the promising regions of Eastern Siberia and Kalmykia.

In 2007-2008, subsidiaries of uranium holding company “Atomredmetzoloto” (ARMZ) performed exploration and resource estimation of uranium deposits which are being prepared for development.

Russian Federation

In 2007, ARMZ spent RUR 41.4 million to finance uranium exploration and in 2008 financing increased 3 times and reached RUR 126.7 million. During the course of this work, the following activities were performed:

- exploration of the Khokhlovskoe deposit in the Trans-Ural district;
- exploration of the flanks and deep levels of deposits under operation in the Streltsovsk district;
- exploration of the Khiagda deposit in the Vitim district;
- exploration of the Lunnoe deposit in the Elkon district.

In 2009, ARMZ allocated RUR 917.4 million for:

- further exploration of the Khokhlovkskoe deposit,
- exploration of the Kolichikan and Istochnoe deposits in the Vitim uranium district,
- exploration of the Elkon and Neprokhodimoe deposits in the Elkon uranium district,
- exploration of the Beryozovoe deposit in the Trans-Baikal Territory,
- exploration of the basement rocks of Streltsovsk caldera for high-grade ores, similar to Antei deposit.

Most of exploration is performed through ARMZ drilling subsidiary Rusburmash.

In 2008, ARMZ, through its joint venture with Kazatomprom Akbastau (Kazakhstan), explored areas 1 and 3 of the Budennovskoe deposit and produced a resource update. In 2009, Akbastau plans to complete exploration in area 1, as well as to continue exploration in areas 3 and 4 of the Budennovskoe deposit.

Recent mine development activities

Mine development activities included: pilot operations at the mines under construction and project development works at the planned mines.

Pilot operations

At Khiagda (Republic of Buryatia), pilot uranium ISL mining operations were completed and the Khiagda deposit is now on the way to the commercial operation stage. In 2007 and 2008, Khiagda produced 26 tU and 61 tU, respectively.

In 2008, the capacity of the pilot processing plant was expanded to 300 tU/yr. Khiagda will start commercial mining in 2012, with the output expected to reach 1 000 tU/yr by 2014 and 1 800 tU/yr by 2018.

In October 2007, Dalur started pilot operations at the Khokhlovskoe deposit. The results obtained confirmed ISL as a viable and profitable mining method at this site.

Project developments

A pre-feasibility study was performed for deposits in the Elkon uranium district and deposits in the Trans-Baikal Territory.

In November 2007, ARMZ established the Elkon Mining Company (Republic of Sakha-Yakutia) to develop deposits in the Elkon district, which ranks second in the world in terms of uranium resources. In 2008, the company conducted research aimed at developing state of the art and highly efficient ore mining and processing technologies, as well as completing an environmental study and site survey for construction of the mining and processing facilities.

In 2009, the Elkon Mining Company started exploration, and will complete a pre-feasibility study to start development of project documentation. The Elkon Mining Company will attract financing from the Investment Fund of the Russian Federation for the construction of infrastructure facilities (roads, power transmission lines, railroads, etc.).

In December 2007, ARMZ established the Gornoe Mining Company (Trans-Baikal Territory) to develop the Gornoe and Berezovoe deposits. In 2008-2009, the company completed a scoping study, pre-project documentation, an environmental impact assessment and continued exploration of the Berezovoe deposit.

In December 2007, ARMZ established the Olovskaya Company (Trans-Baikal Territory) to develop the Olovskoe deposit. In 2008, the company completed a scoping study and an environmental impact assessment. The company plans to start a feasibility study in 2009.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

In 2006-2008, a comprehensive technical and economic re-evaluation of uranium deposit resources was undertaken. As a result, some uranium deposits were re-classified from noneconomic (so-called “non-balance-sheet”) resources to the category of resources which could be reasonably developed.

As of 1 January 2009, the recoverable uranium resources in the Russian Federation attributable to RAR + Inferred amounted to 566 300 tU, an increase of 20 700 tU since 2007. *In situ* resources (without considering mining and processing losses) amounted to 687 100 tU.

The overall increase in resources was primarily due to the addition of:

- several small metasomatite type deposits located in the Elkon uranium district (Republic of Sakha-Yakutia);
- uranium in fishbone detritus deposits located in the Kalmykia Republic;
- small volcanic type uranium deposits located in the Khabarovsk Region.

RAR amounted to 181 400 tU, 55% of which are recoverable at a cost of <USD80/kgU. The majority of such resources may be mined by the conventional underground mining method. Almost all the resources in this category are attributed to operational and under construction enterprises.

Inferred resources amounted to 384 900 tU, of which about 15% are recoverable at a cost of <USD80/kgU. These resources may be mined by conventional underground mining and the ISL method.

As a result of re-evaluation, Elkon deposit resources were re-classified to the higher cost category of <USD130/kgU.

Undiscovered Conventional Resources (Prognosticated & SR)

As of 1 January 2009, Prognosticated uranium resources amounted to 182 000 tU and Speculative resources amounted to 633 000 tU.

The majority of the Prognosticated resources are located in the Trans-Baikal Territory (Streltsovsk and East Trans-Baikal uranium districts), the Republic of Buryatia (Vitim district), the Republic of Sakha-Yakutia (Elkon district) and the Republic of Kalmykia. There are also some Prognosticated resources located in the Kurgan Region (Trans-Ural uranium district) and the Leningrad Region.

URANIUM PRODUCTION

Historical review

See the 2007 Red Book for a brief historical review.

To date, more than 130 000 tU has been produced from the Streltsovsk deposits at the Priargunsky mining complex, making it the world's largest uranium producing centre. Cumulative production through 2008 in the Russian Federation totaled 139 735 tU, making it the fifth largest uranium producer in the world.

Status of production capability

Uranium production in the Russian Federation is carried out by daughter mining companies of ARMZ Uranium Holding Co. (Atomredmetzoloto). In 2008, uranium production in the Russian Federation amounted to 3 521 tU, of which 3 050 tU were produced using conventional underground mining methods (including 2 831 tU produced at the plant from primary ore and 219 tU from ore processed by heap leaching), and 471 tU using the ISL method.

The Priargunsky Mining and Chemical Works (Trans-Baikal Territory) remains the key uranium production centre in the Russian Federation. The resource base is represented by the volcanic type uranium deposits of the Streltsovsk district, with current *in-situ* resources totaling about 130 000 tU (as of 1 January 2009).

In 2008, 3 050 tU were produced at Priargunsky. Uranium ore is extracted in three underground mines. The bulk of the ore is processed at the local hydrometallurgical plant using conventional sulfuric acid leaching technology and ion-exchange resin sorption. Heap leaching was used to produce 219 tU.

In 2008, construction completed and operations started at a new sulfuric acid plant in Priargunsky. The company is upgrading mining equipment and commenced operation of a second unit of the radiometric sorting plant. To maintain the production rates, Priargunsky is preparing a feasibility study to develop new underground mines, numbers 6 and 8.

Since 2004, Dalur (Kurgan Region) has been developing the Dalmatovskoe deposit using the sulfuric acid ISL mining method and since 2007, pilot ISL operation at the Khokhlovskoe deposit. In 2008, Dalur produced 410 tU and commissioning a local sorption unit in the Zapadnaya sector of the Dalmatovskoe deposit was achieved. In 2009, production of 460 tU is planned at Dalur.

In 2008, pilot ISL production at the Khiagdinskoye deposit in the Khiagda mine (Republic of Buryatia) was completed and processing unit capacity was expanded to 300 tU/yr. The State Reserves Commission of the Russian Federation confirmed commercial resources of the Khiagda deposit and a feasibility study is under development. In 2009, a bridge was built and commissioned over the Vitim River for materials and equipment transport to Khiagda. In 2008, output amounted to 61 tU and the forecast for 2009 is 151 tU.

Employment in the uranium industry

In 2008, the Russian uranium industry employed 12 870 people, of which 11 619 worked for Priargunsky. Of the Priargunsky employees, 5 120 were directly involved in uranium production and processing, while the rest worked in auxiliary and service companies (coal production, power plant, etc.).

Future production centres

In late 2007, the uranium mining companies Elkon, Olovskaya and Gornoe were established to develop standby deposits in South Yakutia and the Trans-Baikal Territory.

The company Elkon is performing a pre-feasibility study towards construction of a uranium production centre with the annual capacity of up to 5 000 tU. Elkon *in-situ* resources total 319 000 tU.

The proposed production centre will include underground mining, radiometric sorting, milling, processing and uranium concentrate production.

In 2008, the company performed a combination of pre-design works, including a site survey for construction facilities and baseline environmental studies. In 2009, the company plans to complete a pre-feasibility study.

The Gornoe company was established to develop the Gornoe and Berezovoe deposits in the Krasnochikoy District of the Trans-Baikal Territory. The deposits will be developed using conventional mining methods combined with block and heap leaching for ore processing. The annual production capacity is expected to amount to 600 tU.

Russian Federation

The Olovskaya company was established to develop the Olovskoe deposit in the Chernyshevsky District of the Trans-Baikal Territory. The company proposes to construct an open pit and underground mine, as well as a heap leaching site for processing the recovered ore in addition to a hydrometallurgical processing plant. The capacity of the future enterprise will be 600 tU/yr. Olovskaya is currently performing pre-feasibility and environmental studies.

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2	Centre #3
Name of production centre	Priargunsky Mining and Chemical Works (Priargunsky)	Dalur	Khiagda
Production centre classification	Existing	Existing	Construction
Start-up date	1968	2004	2011
Source of ore:			
• Deposit name	Antei, Streltsovskoe, Oktyabrskoe, etc.	Dalmatovskoe Khokhlovskoe	Khiagda, Vershinnoe, etc
• Deposit type	Volcanic, in caldera	Sandstone basal channel	Sandstone basal channel
• Resources (tU)	129 530	10 970	26 805
• Grade (% U)	0.18	0.04	0.05
Mining operation:			
• Type (OP/UG/ISL)	UG, HL*	ISL	ISL
• Size (t ore/day)	6 700	NA	NA
• Average mining recovery (%)	95	75	75
Processing plant (acid/alkaline):			
• Acid/Alkaline	Acid	Acid	Acid
• Type (IX/SX)	IX	IX	IX
• Size (t ore/day) For ISL (litre/day or litre/hour)	4 700	NA	NA
• Average process recovery (%)	95	98	98
Nominal production capacity (tU/year)	3 000	800	1 000
Plans for expansion	3 500 t/y	No	1 800 t/y
Other remarks			

NA Not available.
* HL – heap leaching, IPL – in place leaching.

Uranium production centre technical details (contd.)
(as of 1 January 2009)

	Centre #4	Centre #5	Centre #6
Name of production centre	Elkon Mining and Metallurgical Complex (Elkon)	Gornoe Uranium Mining Company (Gornoe)	Olovskaya Mining and Chemical Company (Olovskaya)
Production centre classification	Planned	Planned	Planned
Start-up date	2015	2014	2014
Source of ore:			
• Deposit name	Yuzhnoe, Severnoe	Gornoe, Beryozovoe	Olovskoe
• Deposit type	Metasomatic	Vein	Vein
• Resourcess (tU)	319 594	7 918	11 726
• Grade (% U)	0.15	0.2	0.082
Mining operation:			
• Type (OP/UG/ISL)	UG	UG, HL, IPL*	OP, UG, HL*
• Size (t ore/day)	8 000	1 900	3 000
• Average mining recovery (%)	85	70	70
Processing plant (acid/alkaline):			
• Acid/Alkaline	Acid	Acid	Acid
• Type (IX/SX)	IX	IX	IX
• Size (t ore/day) For ISL (litre/day or litre/hour)	NA	NA	NA
• Average process recovery (%)	95	80	80
Nominal production capacity (tU/year)	5 000	600	600
Plans for expansion	Exploration of the Elkon district deposits	No	No
Other remarks			

NA Not available.
* HL – heap leaching, IPL – In place leaching.

Uranium requirements

As of 1 January 2009, 10 nuclear power stations in the Russian Federation were in operation with a total of 31 power units and a total installed capacity of 23.2 GWe. This fleet includes 15 water-cooled VVER reactors (9 VVER-1000, 6 VVER-440), 15 uranium-graphite channel type reactors (11 RBMK-1000 and 4 EGP6) and one fast breeder reactor (BN-600). In 2008, nuclear power generation reached 162.3 TWh (gross), an increase of 2.5% over 2007. The nuclear share of the total electricity generation in the Russian Federation was 16%.The current annual uranium requirement of the Russian nuclear reactors amounts to 4 100 tU.

Russian Federation

The plan for the next few years is to construct one nuclear power unit per year with a subsequent increase to two units per year. In connection with the revised plans for nuclear unit commissioning and construction rates in the short-term, there are two scenarios of nuclear capacity development and, thus, of the Russian reactor natural uranium requirements. The nuclear power development scenarios were prepared taking into account the capacity of the power units to be decommissioned.

Under the low scenario of nuclear power industry development in 2009-2035, the forecast is to commission an average one power unit with the installed capacity of 1 100 MWe per year. Under the high development scenario, after 2015 the number of power units under construction will increase, and two power units with a capacity of 1 100 MWe are expected to be commissioned each year.

Increasing capacity in the nuclear power industry will require increased supplies of nuclear fuel and, thus, uranium requirements will grow. The aggregate current annual requirement of the Russian nuclear industry, including export of nuclear fuel and low-enriched uranium, is estimated at 23 000 tU, including reactor requirements which in 2008 amounted to 4 100 tU. The requirements are supplied with the uranium produced in the Russian Federation and Kazakhstan, uranium stockpiles, secondary sources and imported uranium-containing material.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million RUR	**2006**	**2007**	**2008**	**2009** (expected)
Industry* exploration expenditures	12.8	41.4	120.7	917.4
Government exploration expenditures	773.6	1 078.1	1 267	872.9
Industry* development expenditures	118	520.6	3 831.5	5 330.8
Government development expenditures	0	0	0	0
Total expenditures	904.4	1 659.4	5 219.2	7 121.1
Industry* exploration drilling (m)	15 500	7 520	95 000	173 000
Industry* exploration holes drilled	NA	NA	NA	NA
Government exploration drilling (m)	86 641	112 409	134 260	95 920
Government exploration holes drilled	490	593	746	518
Industry* development drilling (m)	0	0	72 600	NA
Industry* development holes drilled	0	0	216	NA
Government development drilling (m)	NA	NA	NA	NA
Government development holes drilled	NA	NA	NA	NA
Subtotal exploration drilling (m)	102 141	119 929	229 260	268 920
Subtotal exploration holes drilled	490	593	746	518
Subtotal development drilling (m)	NA	NA	72 600	NA
Subtotal development holes drilled	NA	NA	216	NA
Total drilling (m)	102 141	119 929	301 860	268 920
Total holes drilled	490	593	962	518

* Non-government.

Uranium exploration and development expenditures – non-domestic

Expenses in million RUR	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	0	764.7	1 816.7
Government exploration expenditures	0	0	0	0
Industry* development expenditures			406.7	1 160.7
Government development expenditures	0	0	0	0
Total expenditures			1 171.5	2 977.4

* Non-government.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	89 900	152 900	152 900	85-90
Open-pit mining	0	0	0	0	
In situ leaching	0	10 500	10 500	10 500	75
Co-product and by-product	0	0	0	0	
Unspecified	0	0	18 000	18 000	75
Total	0	100 400	181 400	181 400	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	82 800	137 900	137 900	
In-place leaching*	0	0	6 300	6 300	
Heap leaching**	0	7 100	8 700	8 700	
In situ leaching	0	10 500	10 500	10 500	
Unspecified	0	0	18 000	18 000	
Total	0	100 400	181 400	181 400	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	10 500	10 500	10 500
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	1 700	1 700
Intrusive	0	0	0	0
Volcanic and caldera-related	0	89 900	102 600	102 600
Metasomatite	0	0	57 800	57 800
Other*	0	0	8 800	8 800
Total	0	100 400	181 400	181 400

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	26 900	247 500	285 600	90-85
Open-pit mining	0	0	0	0	
In situ leaching	0	30 800	30 800	32 100	75
Co-product and by-product	0	0	0	0	
Unspecified	0	0	20 600	67 200	75
Total	0	57 700	298 900	384 900	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	24 800	241 300	275 500	
In-place leaching*	0	0	3 200	7 100	
Heap leaching**	0	2 100	3 000	3 000	
In situ leaching	0	30 800	30 800	32 100	
Unspecified	0	0	20 600	67 200	
Total	0	57 700	298 900	384 900	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	30 800	30 800	54 200
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	3 100	6 200
Intrusive	0	0	0	0
Volcanic and caldera-related	0	26 900	31 300	58 700
Metasomatite	0	0	230 900	254 600
Other*	0	0	2 800	11 200
Total	0	57 700	298 900	384 900

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	182 000	182 000

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	0	633 000

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	38 655	0	0	0	38 655	0
Underground mining*	86 987	2 901	3 037	3 050	95 975	3 000
In situ leaching	3 969	289	376	471	5 105	611
Co-product/by-product	0	0	0	0	0	0
Total	129 611	3 190	3 413	3 521	139 735	3 611

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005[1]	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	123 902	2 711	2 818	2 831	132 262	2 793
In-place leaching*	237	4	0	0	241	0
Heap leaching**	1 503	186	219	219	2 127	207
In situ leaching	3 969	289	376	471	5 105	611
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	129 611	3 190	3 413	3 521	139 735	3 611

1. Pre-2006 totals may include uranium recovered by heap and in-place leaching.
* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	3 969	289	376	471	5 105	611
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	125 642	2 901	3 037	3 050	134 630	3 000
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	129 611	3 190	3 413	3 521	139 735	3 611

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
3 521	100							3 521	100

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	12 575	12 950	12 870	12 870
Employment directly related to uranium production	4 804	5 100	5 120	5 120

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
3 520	3 520	3 520	3 520	5 240	5 240	5 240	5 900	7 600	7 600	7 600	11 990

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
7 600	7 600	7 600	13 800	6 800	6 800	6 800	13 900	6 800	6 800	6 800	13 400

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	158.3	163.3

Installed nuclear generating capacity to 2035
(MWe net)

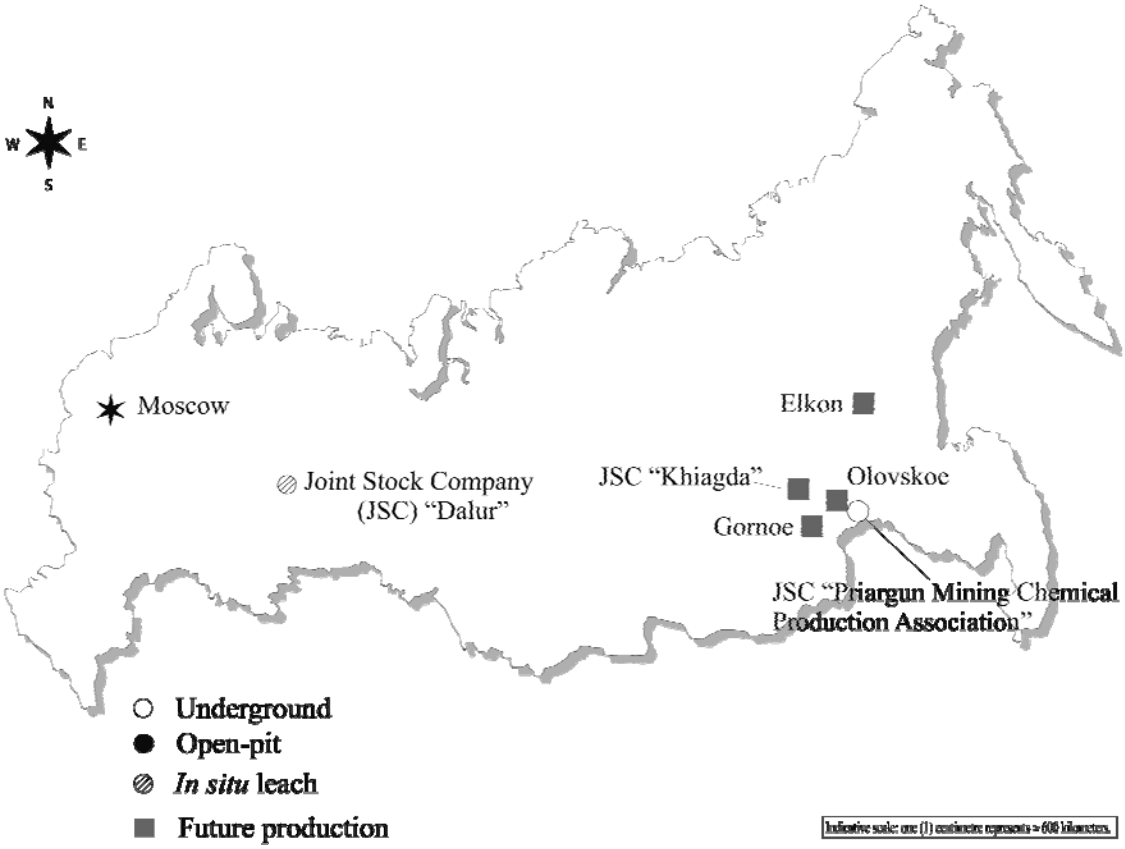
2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
23 200	24 200	24 200	25 000	30 000	33 000

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
37 000	44 000	40 000	50 000	42 000	60 000	44 000	70 000

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
4 100	5 400	5 400	5 400	7 200	7 700

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
8 200	9 700	8 800	11 000	9 200	13 000	9 700	15 000



• Slovak Republic •

URANIUM EXPLORATION AND RESOURCES

Historical review

Uranium exploration began in the Slovak Republic in 1947. This work led to the identification of six areas of uranium mineralisation, but it was concluded at that time that the Slovak Republic had only small uranium resources of limited economic interest. Exploration in the eastern part of the Ore Mountains between 1985 and 1990 also led to the development of resource estimates for Kosice I (Jahodna – Kurishkova). No further uranium exploration took place until 2005.

Recent and ongoing uranium exploration and mine development activities

In 2005, the private Canadian company Tournigan Energy Ltd. acquired an exploration license covering 32 km^2 around the uranium mineralisation discovered near Kosice I (Jahodna – Kuriskova) in Eastern Slovakia. In March 2006, an independent NI 43-101 technical report (April 2009) was issued that contained a mineral resource estimate of 12 500 tU, grading at 0.25% U (cut-off 0.05%U). Ludovika Energy Ltd. (Tournigan's wholly owned Slovakian subsidiary) is continuing exploration at this and other less advanced properties (Novoveska Huta and Spisska Teplica) in Eastern Slovakia.

At present there are 14 active exploration licenses in the Republic of Slovakia. In addition to activities described above, Beckov Minerals (a subsidiary of Ultra Uranium Corp.) is exploring two areas of western Slovakia and Crown Energy Ltd. (a wholly owned subsidiary of GB Energy Ltd.) is engaged in exploration of three areas in eastern Slovakia.

URANIUM PRODUCTION

Historical review

Between 1954 and 1957 a small amount of uranium (1.4 tU) was mined in the Novoveska Huta – Hnilcik region. Mining activities between 1961 and 1990 produced 210 tU from eight localities, with the majority of the production coming from the Novoveska Huta, Muran, Kravany, Svabovce and Vikartovce deposits. Production was stopped due to poor economics.

Status of production capability

The Slovak Republic currently has no uranium mining industry or production capability.

Secondary sources of uranium

The Slovak Republic does not produce or use mixed-oxide fuels, re-enriched tails and reprocessed uranium.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

None reported.

URANIUM REQUIREMENTS

The Slovak Republic has two nuclear power stations located at Bohunice and Mochovce. The NPP Bohunice had four units of the VVER-440 type in operation, with installed capacity of 2 x 406 MWe net and 2 x 407 MWe net. Following the Slovak Government's commitments to joining the European Union, the oldest of these reactors (Unit 1) at Bohunice was shutdown on 31 December 2006, followed by the shutdown of a second old Bohunice reactor (Unit 2) on

31 December 2008. The two upgraded VVER-440 type reactors at Mochovce (Units 1 and 2) remain in operation, as do two VVER reactors at Bohunice, more recent designs than those shut down (Bohunice V2, Units 3 and 4).

All four of the reactors that remain in operation are undergoing a programme of power up rating from 2008 through 2010.

In 1986, construction of Mochove units 3 and 4 was started in 1986, but halted in 1992. In early 2009, Slovenské elektrárne signed contracts with six main suppliers for the completion of these two units to existing best practice design standards. Construction commenced in late 2009.

NATIONAL POLICIES RELATING TO URANIUM

Resolution No. 29/2006 of the Government of the Slovak Republic includes a priority to utilise domestic primary energy sources for electricity and heat production in an economically effective fashion.

Resolution No. 732/2008 of the Government of the Slovak Republic on energy security has the objective of developing a competitive energy sector that would safeguard secure, reliable and efficient supplies of all forms of energy at reasonable prices, at the same time respecting consumers, the environment, safety of supplies and technical safety, while promoting sustainable development.

Given the high share of nuclear power in the energy mix of the Slovak Republic, this resolution must necessarily deal with the availability of fuel element supplies, which are offered in Europe only by the Russian Federation and France. In the future, producers of these fuel elements are expected to require from customers a counter-value in the form of uranium as a specific form of payment.

Legislative and economic support for the efficient and rational use of domestic uranium resources is considered a viable means of reducing energy supply dependence, especially given sharply rising prices over the past years in the world market. Rising prices of uranium and thus nuclear fuel can be of benefit to states able to supply their own uranium and require only its processing into nuclear fuel.

At present, the Slovak Republic utility purchases complete fuel assemblies for all operating units from Russian manufacturers. Therefore, there are no special contracts for uranium, conversion and enrichment services.

URANIUM STOCKS AND PRICES

The Slovak Republic does not maintain an inventory of uranium. The Slovak government keeps small stock of enriched uranium in form of complete fuel assemblies. Based on above-mentioned information, the Slovak Republic utility does not hold any special uranium contracts; therefore it cannot publish prices for uranium.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	5 636	90
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	0	5 636	

* *In situ* resources (based on N*I*43-101 report of Tournigan Energy Ltd. (April 2009).

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	5 636	90
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	0	5 636	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	5 636
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	5 636

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	6 885	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	0	6 885	

* *In situ* resources (based on NI43-101 report of Tournigan Energy Ltd. (April 2009).

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	6 885	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	0	6 885	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	6 885
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	6 885

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	14.1	15.4

Installed nuclear generating capacity to 2035*
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
2 100	1 710	1 640	1 780	2 460	2 740

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
2 460	3 850	2 480	4 060	3 400	4 060	3 400	4 060

* From *Nuclear Energy Data 2009*, OECD, Paris, 2009.

Annual reactor-related uranium requirements to 2035 (excluding MOX)*
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
380	380	380	380	375	580

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
376	563	375	563	188	375	188	375

* From *Nuclear Energy Data 2009*, OECD, Paris, 2009.

• Slovenia •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review of exploration and production.

Recent and ongoing uranium exploration and mine development activities

None reported.

Slovenia

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Resource assessment of the Zirovski deposit was carried out in 1994. RAR are estimated to amount to 2 200 tU with an average grade of 0.14% U in the <USD 80/kgU category. Inferred resources total 5 000 tU in the <USD 80/kgU category and 10 000 tU in the <USD 130/kgU category at an average grade of 0.13% U. The Zirovski deposit occurs in the grey sandstone of the Permian Groeden formation, where the ore bodies occur as linear arrays of elongated lenses within folded sandstone.

Undiscovered Conventional Resources (Prognosticated & SR)

See relevant table.

URANIUM PRODUCTION

Status of production capability

In 1992, a decision for final closure and subsequent decommissioning of the Zirovski Vrh mine and mill was made and there has been no production from the Zirovski facility since. In 1994, the plan for decommissioning the facility was accepted by Slovenian government authorities.

Ownership structure of the uranium industry

No changes in ownership have occurred since 1988. The Zirovski Vrh production centre is owned by the Republic of Slovenia.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

See the 2007 edition of the Red Book.

URANIUM REQUIREMENTS

There has been no significant change in the Slovenian nuclear energy programme in the last two years (2007 and 2008). One nuclear power station (Nuklearna Elektrarna Krško) is in operation. The fuel cycle is 18 months in duration and planned to continue at this cycle basis. Cycle 24 started in April 2009 and is planned to end in October 2010.

Supply and procurement strategy

Total uranium requirements per cycle remain the same as in the 2007 report. There are no operating or strategic uranium reserves in Slovenia and supply is based on requirement contracts. There is a committed supply contract until 2013.

NATIONAL POLICIES RELATING TO URANIUM

Slovenia is not a uranium producing country, uranium stocks are imported for the commercial operation of the power plant (Nuklearna Elektrarna Krško).

URANIUM STOCKS

There is no uranium stock policy in Slovenia. All required uranium stocks are purchased on a "just in time" basis.

URANIUM PRICES

This information is considered confidential.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	2 200	2 200	2 200	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Heap leaching	0	0	0	0	
In-place leaching (stope/block leaching)	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	2 200	2 200	2 200	

* *In situ* resources.

Reasonably Assured Conventional Resources by deposit type*
(tonnes U)

Deposit Type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	2 200	2 200	2 200
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other**	0	0	0	0
Total	0	2 200	2 200	2 200

* *In situ* resources.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Slovenia

Inferred Conventional Resources by production method*
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	5 000	10 000	10 000	
Open-pit mining	0	0	0	0	
In situ leaching	0	0	0	0	
Heap leaching	0	0	0	0	
In-place leaching (stope/block leaching)	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	5 000	10 000	10 000	

* *In situ* resources.

Inferred Conventional Resources by deposit type*
(tonnes U)

Deposit Type	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**
Unconformity-related	0	0	0	0
Sandstone	0	5 000	10 000	10 000
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other**	0	0	0	0
Total	0	5 000	10 000	10 000

* *In situ* resources.
** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	1 060	1 060

Speculative Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
NA	NA	NA

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	0	0	0	0	0	0
Underground mining*	382	0	0	0	382	0
In situ leaching	0	0	0	0	0	0
Heap leaching	0	0	0	0	0	0
In-place leaching**	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	0	0	0	0	0	0
Total	382	0	0	0	382	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.
** Also known as stope leaching or block leaching.
*** Includes mine water treatment and environmental restoration.

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	5.345	5.972+

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
696	696	690	704	690	704

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
690	704	0	0	0	0	0	0

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
NA	230	210	245	NA	NA

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
210	245	0	0	0	0	0	0

Note: Requirements are based on an 18 month cycle, no requirements for years of 2012, 2015, 2018 and 2021. The NEK operating licence is currently due to expire in 2023 although NEK has applied for a 20 year extension, it has yet to be confirmed.

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	0	0	0	0	0
Utility	0	0	0	0	0
Total	0	0	0	0	0

• South Africa •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

Sharply rising prices have reawakened interest in uranium exploration and production in South Africa during 2007 and 2008. The metal's market fundamentals, being now at their most positive in over two decades, make the prospect of uranium beneficiation in the country more feasible.

Opportunities are also increasing for the recovery of uranium from unconventional resources such as phosphates in the west coast of South Africa and fossil fuels in the Springbok Flats as the uranium price has risen in recent times.

Recent and ongoing uranium exploration

In South Africa, the launching of a "uranium beneficiation" programme by the government, encouraging demand/supply fundamentals and a much more positive attitude towards nuclear power are underpinning rapid uranium price increases, which in turn are fuelling investment in greenfield and brownfield projects.

There are at least eight companies actively exploring for, developing, or already mining deposits and some of this activity started in the last two years:

First Uranium Corporation of Canada is comprised of two operating entities; Ezulwini Mining Company Proprietary Limited (Ezulwini) and Mine Waste Solutions Proprietary Limited (MWS). Subsequent to the granting of the Ezulwini prospecting right in January 2008, diamond drilling

commenced on the revised exploration programme. The original plan called for 18 holes from surfaceon a 400 m by 400 m spacing. This programme was amended to 10 surface drill holes on a 300 m by 300 m spacing, each to depth of 2 000 m. Of the planned 10 surface drill holes, 4 were completed with a capital cost of approximately ZAR 30 million. The capital expenditure for the balance of the 10 exploration drill holes still in the approval process, is estimated at approximately ZAR 64 million. Underground drilling has been deferred to a later date.

Extensive exploration activities currently underway in the Karoo Uranium Province are expected to lead to an increase of Identified Conventional Resources.

UraMin Inc. has identified several areas of interest in the Springbok Flats coal field on 22 prospecting rights, focussing on the Leffi and Mocha Blocks. The resources for the entire Springbok Flats coal field is estimated at 77 072 tU at grades of 0.06-0.1% U. The most significant constraint to exploitation is determining a uranium extraction process that does not detrimentally affect the environment (i.e. groundwater and atmosphere).

UraMin Inc. is also conducting a drilling programme on the largest sandstone – hosted uranium deposits in Ryst Kuil Channel, southeast of Beaufort West, as well as in Sutherland, Karoo Northern Cape, within 34 prospect areas. Mineralisation amounting to a total of approximately 27 million pounds U_3O_8 (10 385 tU) has been identified on the properties in Sutherland and proximate areas.

Little or no activity is taking place in the other uranium resource fields: surficial fluvial, lacustrine and pedogenic in the North West Cape, Concordia granite in Namaqualand in the Vicinity of Springbok, Natal Group in Kwazulu – Natal north of Shepstone and the Mozaan Group in the northern part of Kwazulu – Natal, even though they all have the potential to contain economically – viable deposits.

URANIUM RESOURCES

Identified Conventional Resources (Reasonably Assured and Inferred Resources)

The Witwatersrand Basin contains the majority (about 73%) of South Africa's *in situ* Identified Conventional Resources recoverable at less than USD 80/kgU. It has been the site of extensive prospecting activities and is currently the only source of uranium production in South Africa. Less than 10% of the total South African Identified Conventional Resources recoverable at less than USD 40/kgU and 13% of the Identified Conventional Resources recoverable at less than USD 80/kgU are associated with South Africa's only uranium recovery facility.

The majority of these uranium resources are associated with gold resources within the Witwatersrand Supergroup. However, since only one mine, Vaal River Operations, has a uranium recovery plant in operation, large amounts of uranium are presently being discarded into tailing dams. Recovery of uranium from this source will depend to a large extent on the degree of dilution by non-uraniferous tailings and the possible use of such tailings as backfill in mined-out areas.

The ZAR to USD exchange rate, mining operation, extraction technology and processes as well as uranium and gold prices affect significantly South Africa's uranium resource figures. Recovered uranium generally accounts for less than 10% of the total revenue from the ore mined.

South Africa

The Springbok Flats coal field contains the largest Identified Conventional Resources, but it is constrained by lack of a metallurgical process that can extract the uranium from the coal host –

rock.Harmony Gold has been investigating the potential of recovering uranium from 11 tailings dumps southwest of Johannesburg in the Gauteng Free State Provinces. The Cooke dump near Dooornkop is believed to contain 9 464 tU, as well as gold.

Gold Fields is also investigating the uranium potential of tailings dumps and a gold – uranium quartz – pebble conglomerate at the Beatrix mine in the Central Rand Group near Welkom. This conglomerate contains 30 million tonnes of ore with about 24 600 tU and 75 tonnes Au identified resources.

Western Uranium Limited has undertaken a feasibility study on the Henkries mine near Pofadder, a surficial pedogenic deposit consisting of calcrete containing carnotite with an identified resource of 1 126 tU, although grades are below 90 ppm U_3O_8 (0.0076%U).

In March 2008, First Uranium published a revised technical report on the Mine Waste Solutions **(**MWS) tailings reclamation project, which included updated resource figures.

Undiscovered Conventional Resources (Prognosticated and Speculative Resources)

No change reported from figures published in the 2007 Red Book.

Unconventional Resources and other materials

A phosphate field has been identified off the west coast of South Africa with contained uranium. Uranium grades do not exceed 430 ppm U (0.043% U) and extraction of uranium from genetically similar off shore phosphate workings has proved to be unfeasible.

URANIUM PRODUCTION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

South Africa's uranium production amounted to 1 400 tU_3O_8 (1 185 tU) in 2007, representing a 3.7% decrease compared to 2006. In 2008, the total production was 1 700 tU_3O_8 (1 440 tU). South Africa's uranium production is set to increase to over 5 000 tU_3O_8 (4 240 tU) over the next 10 years dominated by projects in the Witwatersrand Basin and in the Karoo Uranium province.

South Africa is planning to build four to six new nuclear reactors by 2030 and in order to secure nuclear fuel supplies for South Africa's growing electricity needs gold miners are now looking into the possibility of reviving their old mine dumps to extract uranium and spur investment in expansions, new capacity, new projects and grass roots exploration.

More mining companies are taking advantage of the uranium boom, with new players; such as First Uranium Corporation (Simmer and Jack Mines Ltd.) , SRX Uranium One, UraMin Inc., Western

Uranium Ltd., Harmony Gold, and Witwatersrand Consolidated Gold Resources (Wits Gold) investing in exploration programmes, production and marketing.

Of significant importance is the fact that in many South Africa production centres uranium is mined in conjunction with gold. Gold alone is processed in the metallurgical plants and all costs

are attributable to gold. Although the uranium passes through the processing plant, there is no uranium recovery and the residue is deposited into the surface tailings ponds.

Status of production capability and mine development activities

AngloGold Ashanti, the largest producer of gold and by-product uranium, has increased its production since 2007 and acquired additional uranium assets. Uranium production for 2007 was 1.38-million lbs U_3O_8 (530 tU) and production in 2008 was 1.5-million lbs U_3O_8 (575 tU). AngloGold Ashanti is planning to increase annual uranium production in 2009 and 2010, as it expands its uranium processing plant to 400 kt/mo in 2010.

First Uranium Corporation (Simmer & Jack) is focused on the development of its South African uranium and gold mines through the re-opening and underground workings in the Ezulwini Mine and the expansion of the Mine Waste Solutions tailings recovery operation.

At the Ezulwini uranium and gold mine it plans to reach an annual production of 130 kt of ore by 2009 and 180 kt by 2012 from Upper and Middle Elsburg reefs. The uranium plant at the Ezulwini Mine is scheduled for ADU (ammonium diuranate, or yellowcake) recovery in early 2009. The first two modules of the USD 63 million uranium plant (and the second module of the gold plant) at Mine Waste Solutions (MWS) are scheduled for ADU recovery in early 2009. In May 2009, uranium production commenced with the commissioning of the new uranium module. The average annual production over the 16 year life of the project is expected be 349 tU and 3 636 kg of gold.

Buffelsfontein Gold Mines Limited (BGM) has built a processing plant at Ezulwini mine in the Central Rand Group south west of Johannesburg. Production started in October 2007, building to an annual production rate of 336 tU from 2008 to 2024.

In June 2007, SRX Uranium One opened the Dominion Reefs mine, west of Klerksdorp, with uranium as the primary commodity, after extensive exploration and feasibility studies. Exploration and mine development are currently underway and this mine will have a maximum depth of 500 m and a mine life of 30 years. The processing plant has a design capacity of 1 460 tU per annum, which is planned to be increased to 1 730 tU by 2011. The first ADU (ammonium diuranate) was produced in May 2007. Dominion produced 491 000 lbs U_3O_8 (189 tU) and 501 000 lbs U_3O_8 (193 tU) respectively in 2007 and 2008.

UraMin Inc. has a feasibility study underway at its 74%-owned Ryst Kuil uranium project in South Africa. UraMin intends to bring these near-surface open-pit amenable projects into production, utilising mining and processing methods currently in practice worldwide in similar deposits. The Ryst Kuil Channel mine, southeast of Beaufort West, is about to open following extensive investigations within the Karoo Uranium province (molybdenum is expected to be recovered as a by-product).

South Africa’s entire production of uranium oxide is treated and exported by the Nuclear Fuels Corporation (NUFCOR). NUFCOR has two processing plants capable of producing approximately

4 000 t U_3O_8 (3 390 tU). The committed processing plant of SRX Uranium One, with a design capacity of 1 460 tU per annum, is expected to be operating at full capacity by 2010.

Concerning South Africa uranium extraction processes, earlier developments included the use of combined SX-IX systems (Eluex or Bufflex) and the introduction of continuous counter current ion exchange (CCIX). Column SX has found a ready application to uranium in view of the rapid extraction kinetics. With the renewed interest in uranium processing, efforts are being redirected towards further development of resin-in-pulp (RIP) as a means of driving down capital and operating costs.

Mine waste solutions (MWS) and Ezulwini are different types of operations. While the design of the processing plants for each project essentially follow the same principles, they have been customised to accommodate their specific production requirements in terms of the material being treated, volumes and grade content. Both uranium plants are based on an atmospheric leach process using sulphuric acid between 60-80 degrees. The uranium solution undergoes an Ion Exchange/Solvent Exchange (IX/SX) process to upgrade the solution content. Ammonium is then added to convert the solution into solid ADU.

MWS is a tailings recovery operation wherein the material from the tailings pond is hydraulically mined and the slurry is pumped from the reclamation station to the gold and uranium plants for recovery. The existing gold recovery plant has a capacity of 633 000 t/mo, but it does not have the facility to recover uranium. The waste material from this plant is deposited into the tailings pond for later processing and recovery. Currently under construction, and planned for commissioning in 2010, is a new gold and 2 uranium modules that has its own reclamation station, with a design capacity of 650 000 t/mo. The combined flow from both reclamation stations, totalling 1 283 000 t/mo arrives at the plants where a 10% feed will be processed through the uranium circuits, hence the processing capacity of 128 300 t/mo. A second phase, comprising a further gold and uranium module is planned for construction with commissioning expected in 2010. This will increase the uranium plant processing capacity from 128 300 t/mo to 193 300 t/mo.

Ezulwini Mining Company commissioned its uranium plant and commenced uranium production in May 2009. The planned plant capacity is 200 000 t/mo. First Uranium has a commercial contract in place with NUFCOR for the provision of calcining services. Under this agreement, NUFCOR has refurbished a redundant calcining stream for dedicated use by First Uranium and Mintails.

Ownership structure of the uranium industry

AngloGold Ashanti's primary stock exchange listing is on the JSE (Johannesburg stock exchange). It is also listed on the exchanges in New York, London, Australia and Ghana as well as on Euronext Paris and Euronext Brussels. In South Africa, AngloGold Ashanti operates seven wholly-owned underground mines which are located in two geographical regions on the Witwatersrand Basin. The most important are Vaal operating gold mines which produce uranium as a by-product.

First Uranium Corporation (Simmer & Jack). Ezulwini and Mine Waste Solutions (MWS) are wholly owned subsidiaries of First Uranium Corporation.

Uranium One Inc. is a Canadian-based uranium producing company with a primary listing on the Toronto Stock Exchange and a secondary listing on the JSE.

UraMin Inc. was sold in July 2007 to Areva for USD 2.5 billion. Areva is a French government majority-owned fully integrated uranium and nuclear company.

Western Uranium Limited is a subsidiary of Brinkley Mining Plc whose principal activities are mining and exploring for uranium in Australia.

Harmony Gold's primary listing is on the JSE. Harmony's ordinary shares are also listed on stock exchanges in London, Paris and Berlin, and are quoted in the form of American Depositary Receipts on the New York and Nasdaq exchanges and as International Depositary Receipts on the Brussels exchange.

Gold Fields is listed on JSE Limited (primary listing), the New York Stock Exchange and the Dubai International Financial Exchange, the New Euronext in Brussels and the Swiss Exchange.

Witwatersrand Consolidated Gold Resources (Wits Gold Limited) is listed on the main boards of the JSE and the Toronton Stock Exchange. The company is an active gold explorer with substantial mineral resources in the Witwatersrand Basin in South Africa

NUFCOR is a wholly owned subsidiary of AngloGold Ashanti Limited.

The South African Government is not associated with any uranium production and /or enrichment activities.

Employment in the uranium industry

A total of 4 980 workers are employed in South Africa's uranium mining industry. The company breakdown is as follows: AngloGold Ashanti, 100; NUFCOR, 55; First Uranium Corporation, 3 000 (with a planned capacity of 5 500 once both projects are fully operational); Uranium One Inc., 250; UraMin Inc., 125; Western Uranium Limited, 200; Harmony Gold, 750 and Witwatersrand Consolidated Gold Resources, 500.

Future production centres

By the end year 2009, with First Uranium's projects; Ezulwini, Ryst Kuil Channel and Buffeslsfontein going into production, production is expected to double to 2 800 tU_3O_8 (2 375 tU).

Five years from now (2014), with the South African state utility (Eskom) PBMR project underway, assuming all the mining projects that are scheduled to start producing in the coming years are producing as projected, if the demand/supply fundamentals continue to be positive in the forecast period and if the regulatory changes do not affect production in South Africa, production could pass the 5 000 tU_3O_8 (4 240 tU).

Uranium Production Centre technical details
(as of January 2009)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7
Name of production centre	AngloGold Ashanti. Vaal River Operations	First Uranium Ezulwini mining	First Uranium Buffelsfontein	SXR Uranium One	Uramin Inc	Uramin Inc.	Uramin Inc.
Production centre classification	Existing	Existing	Existing	Existing	Committed	Committed	Committed
Start-up date	1977	2009	2005	2007	NA	NA	NA
Source of ore:							
• Deposit name	Vaal Reef	Ezulwini mining	Wits; BGM	Dominion Reef	Ryst Kuil Channel	Springbok Flats	Sutherland
• Deposit type	Quartz-pebble conglomerate	Quartz-pebble conglomerate	Quartz-pebble conglomerate	Quartz-pebble conglomerate	Sandstone	Sandstone	Sandstone
• Reserves (tU)	70 146 tU	RAR:29 500TU_3O_8 IR: 83 000 TU_3O_8	RAR: 27 721 Mt IR: 14 326 Mt	RAR:295 000TU_3O_8 IR: 83 000 TU_3O_8	6 790 tU	77 072 tU	
• Grade (% U)	Not available	RAR: 0.081 % IR : 0.038%	RAR: 0.287kg/t IR: 14 326	0.10% IR : 0.038%	0.10%	0.10%	
Mining operation:							
• Type (OP/UG/ISL)	UG	UG	UG	UG	OP	OP	OP
• Size (t ore/day)		100 000 tpm (3 333 tpd)	2700 tpd				
• Average mining recovery (%)	Variable	78%					
Processing plant (acid/alkaline):							
• Acid/Alkaline	Acid	Acid	Acid	Acid			
• Type (IX/SX)	SX	IX/SX	SX	SX	SX	SX	SX
• Size (t ore/day)		3 333					
For ISL							
• Average process recovery (%)							
Nominal production capacity (tU/year)	3 400	NA	NA	1 460	1 136	NA	NA
Plans for expansion	Yes	No	Yes	Yes	Yes	Yes	Yes
Other remarks	None	None	None	None	None	None	None

NA Not available.

Uranium Production Centre technical details (contd.)
(as of January 2009)

	Centre #8	Centre #9	Centre #10	Centre #11	Centre #12	Centre #13
Name of production centre	Western Uranium	Western Uranium	Harmony Gold	Harmony Gold	Wits Gold Uranium	First Uranium Mine Waste Solutions(MWS)
Production centre classification	Commited	Commited	Commited	Commited	Commited	Commited
Start-up date	NA	NA	NA	NA	NA	NA
Source of ore:						
• Deposit name	Waterval Rietkuil	Henkries	Cooke Dump	Beatrix mine	Klerksdorp & Southern Free	Surface
• Deposit type	Quartz-pebble conglomerate	Surficial	Slimes dams & dumps	Quartz-pebble conglomerate	Quartz-pebble conglomerate	Tailings/dams
• Reserves (tU)	50 590tU	1 420tU	9 464tU	24 600tU	266.5 Mt 0.233 kg/t U_3O_8	
• Grade (% U)	0.09%		at 0.09 g/t			
Mining operation:						
• Type (OP/UG/ISL)	UG	OP	NA	UG	UG	
• Size (t ore/day)						4 276
• Average mining recovery (%)						NA
Processing plant (acid/alkaline):						
• Acid/Alkaline						Acid
• Type (IX/SX)	SX	SX	SX	SX	SX	IX/SX
• Size (t ore/day)						128 000 tpd
For ISL						
• Average process recovery (%)						75% atmospheric leach
Nominal production capacity (tU/year)	NA	NA	NA	NA	NA	NA
Plans for expansion	Yes	Yes	Yes	Yes	Yes	Yes
Other remarks	None	None	None	None	None	None

NA Not available.

South Africa

Secondary sources of uranium

Production and/or use of mixed oxide fuels

South African has never produced or use mixed oxide Fuels.

Production and/or use of re-enriched tails

South Africa currently does not have a uranium enrichment industry. South Africa only uranium enrichment plant at Pelindaba was decommissioned and dismantled in the period 1997-1998.

Production and/or use of reprocessed uranium

No reprocessed uranium has been produced or utilised in South Africa.

In 2007, the South Africa government declared uranium "a strategic mineral" and launched a "uranium beneficiation" programme in order to secure nuclear fuel supplies for South Africa's growing electricity needs.

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

Within South Africa mine related land exists that has been contaminated by radioactivity, particularly where existing and previous uranium plants are or were located. The National Nuclear Regulator is responsible for the implementation of nuclear legislation conforming to international norms related to these activities. South Africa has strict environmental legislation which ensures that such areas are suitably rehabilitated after closure.

Environmental issues relating to gold/uranium mining within Witwatersrand Basin are dust pollution, surface and ground water contamination and residual radioactivity. Scrap materials from decommissioned plants may only be sold after they have been decontaminated to internationally acceptable standards.

The by-product status of uranium production in South Africa makes it impossible to establish what portion of the total expenditure on environmental related activities specifically pertains to uranium. The South African mining industry, however, allocates considerable resources for environmental rehabilitation from the exploration stage through to mining and finally mill closure.

As part of the permitting process each operating company has to have an approved Environmental Management Plan (EMP) and Social and Labour Plan (SLP) in order to secure mining rights. Ezulwini has an approved New Order Mining Right and MWS is currently in the final stages of its application. Ezulwini's approved SLP supports the Korekile Home for Cerebral Palsy Children, Kamohelong Home Based Care, Zamani Project and the Thabong Village.

Mine Waste Solution (MWS) has been actively involved in the community for years under their Old Order Mining Right. Current programmes involve the subsidisation of the Margaret Village Creche and providing support to the Pinnacle Primary and Secondary Schools. As a precursor to the submission of the respective EMP's, Environmental Impact Assessments were conducted for both operations. Possible areas of impact were identified and effective management systems have been put in place for the management thereof.

At Ezulwini, with respect to extraneous water reporting to underground areas, systems have been put in place to separate dolomitic water from process water underground to ensure that no process water is pumped to surface. In phase 1 of the project the dolomitic water is discharged to the environment, and in phase 2 the intention is to have this treated to potable water standard within the plant site and made available to the region.

A positive outflow of the operation at MWS is the reprocessing of tailings from several sources and the deposition of virtually benign material at a single site. All existing footprints will subsequently be rehabilitated. Further, with the removal of tailings material from current sites, the pollution effect to dolomitic acquifers below the current dumps will be eliminated.

URANIUM REQUIREMENTS

South Africa's only one nuclear power station is Koeberg with two reactors; Koeberg I commissioned in 1984 and Koeberg II in 1985, with a combined installed capacity of 1 840 MWe. Together, the reactors require about 292 tU per annum.

In 2007, the South African state utility (Eskom) planned to boost its total electricity generation output from 1.8 GWet to 80 GWe by 2025, including 20 GWe of new nuclear generating capacity of which a portion would be provided by Pebble Bed Modular Reactor (PBMR) units. However, in December 2008 it was announced that due to a lack of finance these plans would be delayed for several years.

With its growing energy needs, uranium could definitely contribute to the country's nuclear energy supply and promote sustainable development. Although nuclear power cannot replace other forms of energy, it can form a larger part of the energy picture and the integrated energy plan in South Africa. Increased use of nuclear power is expected to contribute to the government commitment to diversify energy sources as well as strengthen security of supply.

Supply and procurement strategy

South Africa currently does not have a uranium enrichment industry and sources its uranium from the international market. The Nuclear Fuel Corporation (NUFCOR) processes and exports all uranium oxide produced in South Africa, although no local domestic mine sales were reported in 2007 and 2008.

According to PBMR (Pty) Ltd., enriched uranium for PBMRs under development will be imported from Russia through Durban harbour then transported to Pelindaba in the North West province. There the uranium will be manufactured into fuel spheres for the reactors and then be transported via road to Koeberg in the Western Cape, where the planned PBMR demonstration model construction site is planned.

The PBMR has been dogged by controversy since it entered the public domain. But PBMR (Pty) Ltd., says the PBMR is a new generation of safer and technologically sophisticated nuclear reactor, in which meltdown scenarios, as in the case of Chernobyl in 1986, are virtually impossible. PBMR (Pty) Ltd. also dismisses concerns around transportation or accidents, saying uranium transportation by sea and road has had an impeccable track record in the last half century. The highest

standards are in place to ensure safe transportation and, with each passing year, the PBMR is becoming a more viable solution for South Africa.

NATIONAL POLICIES RELATING TO URANIUM

The National Nuclear Regulator Act No. 47 and the Nuclear Energy Act No. 46 of 1999 provide expression to South Africa's national policies relating to the prospecting and mining of uranium, the State's role, foreign participation, as well as the export of uranium and the disposal of spent nuclear fuel.

The South Africa Nuclear Energy Corporation Limited (NECSA), a State owned company, regulates the acquisition and possession of nuclear fuel, the import and export of such fuel and prescribes measures regarding the discarding of radioactive waste and the storage of irradiated nuclear material.

The aim of South Africa government's nuclear energy policy and strategy is to secure South Africa's supply of uranium for 40 to 60 years. This strategy would outline a vision for nuclear base-load electricity generation capacity (similar to Koeberg) and small to medium–sized nuclear power plants (such as the PBMR) in South Africa.

The policies of the South African government encourage local beneficiation of mineral resources. The beneficiation (value added) with respect to uranium comes with responsibilities and sensitivities in safety and environmental management, and has to be pursued within the country's national and international obligations.

Because nuclear reactors generate highly hazardous waste that remains radioactive for tens of thousands of years and has to be stored, nuclear critics say it is too high a risk. Nuclear proponents have not come up with coherent plans or answers that address health and safety concerns. The risky transportation of the hazardous material, the potential for accidents and high construction and start-up costs are all factors that weigh against nuclear energy.

South Africa's nuclear proponents say that despite all these risks the country needs to push ahead with nuclear development. They believe the solution lies in the PBMR.

URANIUM STOCKS

The South African state utility (Eskom) has increased its strategic stock levels to mitigate the current supply/demand imbalance. However the information is classified and cannot be released.

URANIUM PRICES

Uranium prices are confidential.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in thousand ZAR	2006	2007	2008[1]	2009[1] (expected)
Industry* exploration expenditures	158 750	7 000	30 000	64 000
Government exploration expenditures	NIL	NIL	NIL	NIL
Industry* development expenditures	2 772	99 000	NIL	NIL
Government development expenditures	NIL	NIL	NIL	NIL
Total expenditures	161 522	106 000	30 000	64 000
Industry* exploration drilling (m)	91 621	21 269	8 000	12 000
Industry* exploration holes drilled	164	855	NA	NA
Government exploration drilling (m)	NIL	NIL	NIL	NA
Government exploration holes drilled	NIL	NIL	NIL	NA
Industry* development drilling (m)	NA	95 346	NA	NA
Industry* development holes drilled	56	243	4	6
Government development drilling (m)	NIL	NIL	NIL	NIL
Government development holes drilled	NIL	NIL	NIL	NIL
Subtotal exploration drilling (m)	91 621	21 269	8 000	12 000
Subtotal exploration holes drilled	164	855	NA	NA
Subtotal development drilling (m)	NA	95 364	NA	NA
Subtotal development holes drilled	56	243	NA	NA
Total drilling (m)	91 621	116 615	NA	NA
Total holes drilled	220	1 098	NA	NA

* Non-government.
1. 2008 and 2009 figures are only for Ezulwini Mining Company.

Uranium exploration and development expenditures – non-domestic

Expenses in thousand ZAR	2006	2007	2008	2009 (expected)
Industry exploration expenditures	NIL	NIL	NIL	NIL
Government exploration expenditures	NIL	NIL	NIL	NIL
Industry development expenditures	NIL	NIL	NIL	NIL
Government development expenditures	NIL	NIL	NIL	NIL
Total expenditures	NIL	NIL	NIL	NIL

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	93 977	136 117	193 665	193 665	N/A
Open-pit mining	1 643	22 543	24 938	24 938	N/A
In situ leaching	0	0	0	0	N/A
Co-product and by-product	0	0	0	0	N/A
Unspecified	19 248	47 272	65 775	65 775	N/A
Total	114 868	205 932	284 378	284 378	N/A

* *In situ* resources. RAR data provided incomplete and totals for the two tables do not match.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	1 643	22 543	24 938	24 938
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	88 135	126 380	163 632	163 632
Vein	0	0	0	0
Intrusive	1 351	1 351	1 351	1 351
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	91 129	150 274	189 921	189 921

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included. Also includes unspecified.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	114 877	124 260	130 322	130 322	N/A
Open-pit mining	2 974	7 376	7 894	7 894	N/A
In situ leaching	0	0	0	0	N/A
Co-product and by-product	0	0	0	0	N/A
Unspecified	1 906	5 676	12 495	12 495	N/A
Total	119 757	137 312	150 711	150 711	N/A

* *In situ* resources. Inferred Resources data provided incomplete and totals for the two tables do not match.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	2 974	7 376	7 894	7 894
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	113 702	123 085	129 147	129 147
Vein	0	0	0	0
Intrusive	1 175	1 175	1 175	1 175
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	117 851	131 636	138 216	138 216

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost Ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
34 901	110 310	110 310

Speculative Conventional Resources
(tonnes U)

Cost Ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
0	0	1 112 900

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*						
Underground mining*						
In situ leaching						
Co-product/by-product	154 673	534	1 400	1 750	158 357	2 800
Total**	154 673	534	1 400	1 750	158 357	2 800

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.
** Production for 2007 and 2008 are 540 tU resp. 570 tU (secretariat estimate).

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	200	200	350
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	154 673	534	1 400	1 500	158 107	2 450
Vein	0	0	0	0	0	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	154 673	534	1 400	1 700	158 307	2 800

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
0	0	1 700	100	0	0	N/A	N/A	1 700	N/A

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	150	1 150	3 000	5 500
Employment directly related to uranium production	65	85	450	1 000

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
4 860	4 860	NA	NA	4 860	6 320	NA	NA	4 860	6 320	NA	NA

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
4 860	6 320	NA	NA	4 860	6 320	NA	NA	4 860	6 320	NA	NA

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	12.6	12.8

Installed nuclear generating capacity to 2035
(MWe net)

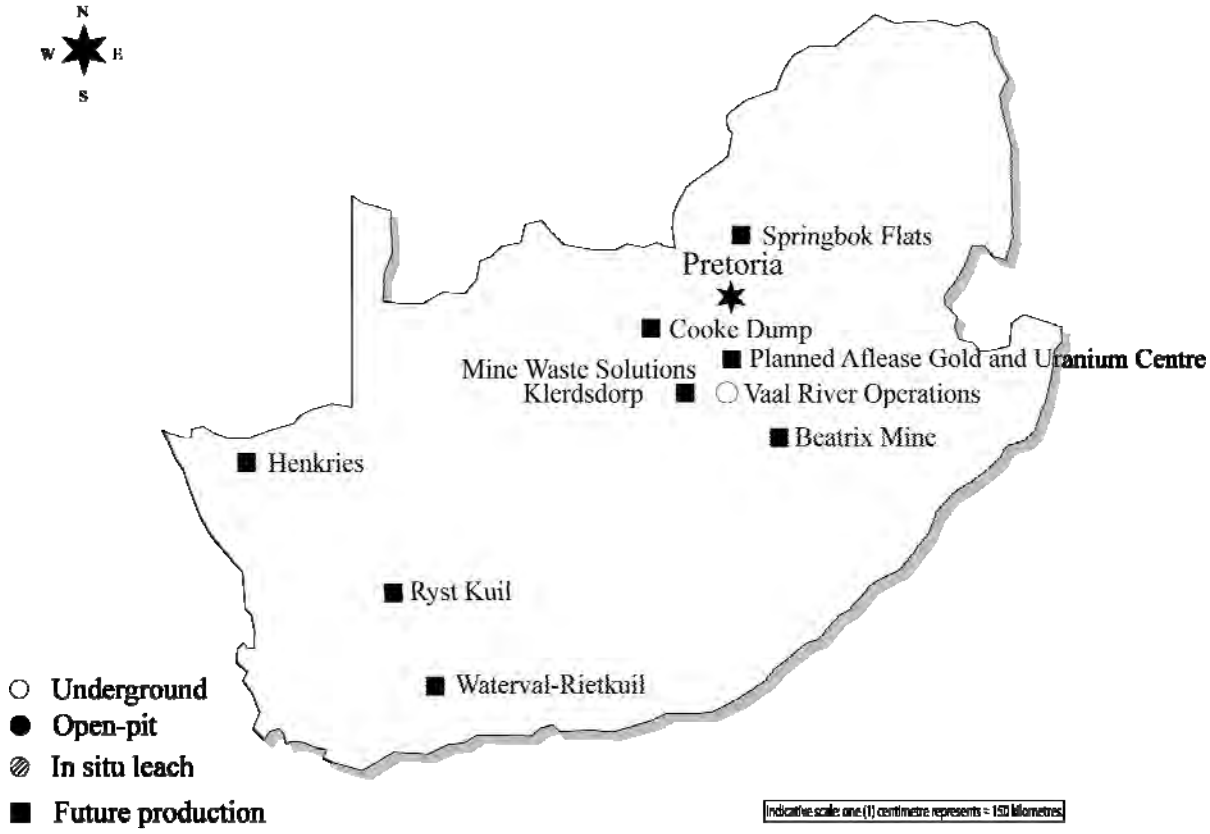
2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 800	1 800	1 800	1 840	2 005	8 420

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
10 500	15 340	30 000	50 000	30 000	50 000	30 000	50 000

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
282	292	292	292	294	1 312

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1 569	2 144	2 099	3 235	3 175	3 235	3 225	3 500



• Spain •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

Recent and ongoing uranium exploration and mine development activities

Berkeley Resources through its Spanish filial Minera de Rio Alagón S.L (MRA) has a total of 11 granted exploration licences totalling 45 214 hectares. The licences are located in two different provinces, ten in Salamanca and two in the province of Cáceres.

The company has been actively exploring for uranium for several years, with focus on a number of historically known uranium projects located within their tenements.

From their work Berkeley has generated a JORC complaint resource base of 27 million pounds of U_3O_8 (10 385 tU) distributed in four deposits by means of reassessment of historic data, combined with their own reverse circulation (RC) and diamond drilling programmes which commenced in December 2006.

In April 2009 the Council of Ministers has approved a collaboration agreement signed between Berkeley and ENUSA to complete a feasibility study over the following 18 months on the State Reserves within the Salamanca province. Through this agreement Berkeley can purchase up to 90% of the assets which include, exploration and exploitation of the *in situ* reserves and processing through the existing Quercus plant.

Canada-based Mawson Resources is also active in exploration in Spain.

URANIUM RESOURCES

Identified Resources (RAR & Inferred)

Both of the RAR and Inferred resources remain unchanged from the 2007 Red Book, and are reported as recoverable by open-pit mining.

Undiscovered Resources (Prognosticated & SR)

No resources for these categories were reported.

URANIUM PRODUCTION

Historical review

See the 2005 edition of the Red Book for a short historical review.

Status of production capability

Mining activities were terminated in December 2000. The processing plant finished uranium concentrate production in November 2002. A plan for its decommissioning was presented to the Regulatory Authorities in 2005. Due to the agreement between ENUSA and Berkeley this decommissioning plan is in standby waiting for the results of a feasibility study that is now in process for the possible future use of the Quercus plant.

Ownership structure of the uranium industry

The only production facility in Spain belongs to the company ENUSA Industrias Avanzadas, S.A., owned (60%) by Sociedad de Participaciones Industriales (SEPI) and Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), with 40%.

Employment in the uranium industry

Employment at the Fe Mine was 43 at the end of the year 2008.

Future production centres

No new production centres are being considered.

Secondary sources of uranium

Spain reported mixed oxide fuel and re-enriched tails production and use as zero.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

The present conditions of uranium production facilities in Spain are as follows:

- Fábrica de Uranio de Andujar (Jaén Province): Mill and tailings pile are closed and remediated, with a ten-year surveillance and control programme (groundwater quality, erosion control, infiltration and radon control). This programme is ongoing and has been extended.
- Mine and Plant "LOBO-G" (Badajoz Province): Open pit and mill tailings dump are closed and remediated, with a surveillance and control programme (groundwater quality, erosion control, infiltration and radon control) until 2004. A long term stewardship and monitoring programme began after the declaration of closure in 2004.
- Old Mines (Andalucía and Extremadura Regions): Underground and open pit mines are restored as of 2000.
- Two old mines in Salamanca (Valdemascaño and Casilla de Flores) have been restored during 2007, following which a three year surveillance programme has been initiated.
- Elefante Plant (Salamanca Province): Decommissioning Plan of the heap leaching plant was approved by Regulatory Authorities in January 2001. The plant was dismantled, ore stockpiles (used for heap leaching) were re-graded and covered with a protective layer in 2004 and a multi-year surveillance and control programme was initiated.
- In 2004, the remediation plan of the open pit mine in Saelices el Chico (Salamanca Province) was approved by the Regulatory Authorities. This remediation plan was finished in 2008. The proposed surveillance and control programme has been sent to the Regulatory Authorities for its approval.
- Quercus Plant (Salamanca Province): Mining activities ended in December 2000 and processing in November 2002. A plan for its decommissioning was submitted to the Regulatory Authorities in 2005. Due to the agreement between ENUSA and Berkeley, this decommissioning plan is in standby awaiting results of a feasibility study that is now in process for the possible future use of the Quercus plant. During this time a surveillance and maintenance programme has been applied over the plant and associated facilities.

URANIUM REQUIREMENTS

The net capacity of Spain's nuclear plants is about 7.46 GWe with eight operating reactors. No new reactors are expected to be built in the near future.

On July 2009 the Ministry of Industry granted a four-year licence extension to the Garoña nuclear power plant (466 MWe), despite the safety regulator recommending a ten year licence extension (until 2019). The new license will allow the plant to operate until July 2013, following which it must be closed-down after 42 years of successful operation.

Supply and procurement strategy

All uranium procurement activities are carried out by ENUSA Industrias Avanzadas S.A. on behalf of the Spanish utilities that own the eight operating nuclear power plants in Spain.

NATIONAL POLICIES RELATING TO URANIUM

Spain's uranium import policy provides for diversification of supply. Spanish legislation leaves uranium exploration and production open to national and foreign companies.

URANIUM STOCKS

Present Spanish regulation provides that a strategic uranium inventory contained in enriched uranium should be held jointly by the utilities that own nuclear power plants. The current stock contains at least 611 tU (721 t U_3O_8). Additional inventories could be maintained depending on uranium market conditions. No information on uranium prices was reported.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in USD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	426 771	3 886 638	4 551 634	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	426 771	3 886 638	4 551 634	NA
Industry* exploration drilling (m)	97	16 272	19 021	4 000
Industry* exploration holes drilled	1	228	312	40
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	97	16 272	19 021	4 000
Subtotal exploration holes drilled	1	228	312	40
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	97	16 272	19 021	4 000
Total holes drilled	1	228	312	40

* Non-government.

Spain

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	2 500	4 900	4 900	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	2 500	4 900	4 900	

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	2 500	4 900	4 900	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	2 500	4 900	4 900	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	2 500	4 900	4 900
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	2 500	4 900	4 900

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	6 400	6 400	
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	6 400	6 400	

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	6 400	6 400	
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	6 400	6 400	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	0
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	6 400	6 400
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	6 400	6 400

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	5 028	0	0	0	5 028	0
Underground mining*	0	0	0	0	0	0
In situ leaching	0	0	0	0	0	0
Co-product/by-product	0	0	0	0	0	0
Total	5 028	0	0	0	5 028	0

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.

Spain

Historical uranium production by processing method
(tonnes U in concentrate)

Processing method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Conventional	4 961	0	0	0	4 961	0
In-place leaching*	0	0	0	0	0	0
Heap leaching**	0	0	0	0	0	0
U recovered from phosphates	0	0	0	0	0	0
Other methods***	67	0	0	0	67	0
Total	5 028	0	0	0	5 028	0

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.
*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrate)

Deposit type	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Unconformity-related	0	0	0	0	0	0
Sandstone	0	0	0	0	0	0
Hematite breccia complex	0	0	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0	0	0
Vein	5 028	0	0	0	5 028	0
Intrusive	0	0	0	0	0	0
Volcanic and caldera-related	0	0	0	0	0	0
Metasomatite	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	5 028	0	0	0	5 028	0

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	58	58	43	43
Employment directly related to uranium production	0	0	0	0

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	53.4	57.2

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
7 456	NA	7 600	7 600	7 600	7 600

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
7 600	7 600	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 513	678	1700	1800	1300	1300

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1300	1300	1300	1300	1300	1300	1300	1300

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	0	0	0	0	0
Utility	NA	611	0	NA	NA
Total	NA	611	0	NA	NA

• Sweden* •

URANIUM EXPLORATION

Historical review

Uranium exploration was carried out during the period 1950-1985. However, at the end of 1985, exploration activities were stopped due to availability of uranium at low prices on the world market.

* Report prepared by Secretariat, based on previous Red Books and company reports.

Sweden

There are four main uranium provinces in Sweden:

The first is in the Upper Cambrian and Lower Ordovician sediments in southern Sweden and along the border of the Caledonian mountain range in central Sweden. The uranium occurrences are stratiform, in black (alumn) shales. Billigen (Vastergotland), where the Ranstad deposits is located, covers an area of more than 500 km^2.

The second uranium province Arjeplog-Arvidsjaur-Sorsele, is immediately south of the Arctic Circle. It comprises of one deposit, Pleutajokk, and a group of more than 20 occurrences. The individual occurrences are discordant, of a vein or impregnation-type, associated with sode-metasomatism.

A third province is located north of Ostersund in central Sweden. Several discordant mineralised zones have been discovered in, or adjacent to, a window of Precambrian basement within the metamorphic Caledonites.

A fourth province is located near Asele in northern Sweden.

Recent and ongoing exploration and mine development activities

Since 2007, a number of exploration companies have been conducting uranium exploration activities in Sweden. In some cases, these permits were challenged in the early stages by some members of local communities.

Mawson Resources Inc of Canada has reported on work at a number of generally small deposits, including a NI 43-101 complaint indicated resources 3.3 million lbs U_3O_8 (1 270 tU) at 0.08% U_3O_8 (0.068% U) in the Hotagen district, a CIM compliant inferred resources 8.8 million lbs U_3O_8 (3 385 tU) at 0.03% U_3O_8 (0.025% U) for the Duobblon uranium project and a report on the Tåsjö project outlining a uranium occurrence of about 110 million lbs U_3O_8 (42 300 tU) at 0.05% U_3O_8 (0.042% U) contained in mineralised phosphatic shale with rare earths, all in northern Sweden. Uranium International Corp has also been conducting early stage exploration on a number of small deposits in central and northern Sweden and in late 2009 Aura Energy applied for significant landholdings to investigate more thoroughly the Alum Shale Formation. Through 2007 and 2008, Continental Precious Metals completed NI 43-101 technical reports outlining a significant uranium resource estimate on an adjoining lease on the Alum Shale, amounting to 20 000 000 tU indicated and 2.4 billion tU inferred. In mid-2009 it was reported that Continental Resources was investigating the potential use of bioleaching technology to release metals trapped within organic matter in the black shale.

Further work is required to improve confidence in these early stage exploration estimates, but results to date indicate that uranium resources in Sweden may be significant. No information is available from the Swedish government of on the exploration expenditures of these companies.

URANIUM RESOURCES

Identified Resources (RAR & Inferred)

Small resources in granite rocks (vein deposits) are the only uranium resources reported to date by Sweden.

Undiscovered Resources (Prognosticated & SR)

Neither Prognosticated nor Speculative Resources are reported in Sweden.

Unconventional Resources

There are potentially large resources of uranium in alum shale; however, these deposits are very low grade and the cost of recovery is above USD 130/kgU.

URANIUM PRODUCTION

Historical review

In the 1960s, a total of 200 tU were produced from the alum shale deposit in Ranstad and represents all of Sweden's historical production. This mine is now being restored to protect the environment.

Status of production capability

There is no uranium production in Sweden and there are no plans for production.

Secondary sources of uranium

Sweden does not report the use of mixed-oxide fuel or reprocessed uranium. Swedish utilities used re-enriched tails amounting to 230 t and 571 t nat U equivalent in 2007 and 2008, respectively.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

The Ranstad mine was rehabilitated in the 1990s at a total cost of SEK 150 million. An environmental monitoring programme is now being carried out.

URANIUM REQUIREMENTS

By the end of 2005, two of Sweden's 12 nuclear power reactors, Barsebäck 1 (1999) and Barsebäck 2 (2005), had been retired from service as a result of a political decision. The remaining 10 reactors require annually about 1 500 tU.

Swedish utilities have been expanding nuclear capacity through power uprates at the existing reactors in an effort to replace the 1 200 MWe lost when Barsebäck 1 & 2 were closed. By the end of 2008, some 1 050 MWe had been added to the ten surviving reactors.

In Sweden there is a tax applied on the production of electricity at a nuclear plant, regulated by the *Act on Excise Duties on Thermal Capacity on Nuclear Power Reactors*. Originally imposed in the late 1990s, the tax rate was increased in 2006 and again in 2008, amounting to a total of about total SEK 4 billion (€435 million).

In early 2009, the Swedish government announced plans to overturn a 30 year ban on the construction of new nuclear power plants in order to increase security of energy supply and to reduce greenhouse gas emissions. The government intends to introduce the legislation required to make this change in 2010.

Supply and procurement strategy

The utilities are free to negotiate their own purchases.

NATIONAL POLICIES RELATING TO URANIUM

Two separate permits under the *Minerals Act* and the *Environmental Code* are required to mine uranium deposits in Sweden. In addition, the *Nuclear Activities Act* contains provisions regulating the right to acquire, possess or deal in any other way with nuclear materials or minerals containing such materials.

Permit applications under the Environmental Code are considered by the Government, and permits may only be granted if approval has been recommended by the local authority in whose area the deposit occurs.

URANIUM STOCKS

The Swedish parliament decided in 1998 to replace the previous obligation that utilities had to keep a stockpile of enriched uranium corresponding to the production of 35 TWh with a reporting mechanism. Sweden reported no information on uranium stocks.

URANIUM PRICES

As Sweden is now part of the deregulated Nordic electricity market, costs of nuclear fuel are no longer reported.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0			
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	4 000	4 000	
Total	0	0	4 000	4 000	

Inferred Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0			
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	6 000	6 000	
Total	0	0	6 000	6 000	

Net nuclear electricity generation

	2007	**2008**
Nuclear electricity generated (TWh net)	64.3	61.3

Installed nuclear generating capacity to 2035*
(MWe net)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
9.0	NA	7.6	7.6	7.6	7.6

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
7.6	7.6	N/A	N/A	N/A	N/A	N/A	N/A

* *Nuclear Energy Data*, OECD, Paris, 2009.

Annual reactor-related uranium requirements to 2035 (excluding MOX)*
(tonnes U)

2008	**2009**	**2010**		**2015**	
		Low	*High*	*Low*	*High*
1 574		N/A	1 790	N/A	1 800

2020		**2025**		**2030**		**2035**	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
N/A	1 800	N/A	1 800	N/A	1 800	N/A	1 800

* *Nuclear Energy Data*, OECD, Paris, 2009.

• Tanzania* •

URANIUM EXPLORATION

Historical review

Uranium was first discovered in Chiwiligo pegmatite in the Uluguru Mountains in 1953. The first general evaluation of uranium potential of Tanzania was done by conducting a country-wide airborne geophysical survey for the government between 1976 and 1979. Results revealed a large number of radiometric anomalies in a variety of geological settings.

A uranium exploration programme was subsequently carried out by Uranerzbergbau GmbH between 1978 and 1983, but it was stopped because of declining uranium prices. Targets of this survey were anomalies in the Karoo, in younger surficial sediments, in phosphatic sediments of Pleistocene age as well as carbonatite of the Gallapo. Numerous occurrences of surface uranium mineralisation were identified and the potential for several uranium deposit types in the country was recognised.

A large part of the southern Tanzanian geology is comprised of Karoo rocks, terrigenous sediments of a few thousands of meters thickness that accumulated in basins during the Late Paleozoic-Early Mesozoic. The basal series is comprised of glacial deposits, which in turn are overlain by fluvial-deltaic coal-bearing sediments succeeded by arkoses and continental red beds. Transitional carbonaceous shales with coals gradually develop into thick lacustrine series which are topped by Late Permian bone-bearing beds. The Triassic is characterised by a very thick fluvio-deltaic succession of siliciclastics resting with regional unconformity on the Permian. This Early Triassic sequence exhibits well-developed repetitive depositional cycles. Heightened uranium values are observed in the Triassic arenaceous series with diagenetic alteration and subsequent cementation.

Recent and ongoing uranium exploration and mine development activities

Exploration efforts have been focussed on the highly uranium prospective Karoo-age sediments of southern Tanzania (the Mkuju River, Mbamba Bay and Southern Tanzania Projects) and paleochannel associated calcrete and sandstone hosted uranium targets within the Bahi catchment of central Tanzania (the Bahi North and Handa Projects).

The government has issued about 70 licences to companies interested in uranium exploration. Results of initial surveys have indicated the presence of rich uranium deposits. From 2007, two overseas companies – British-based Uranium Resources and Australia's Western Metals – undertook joint exploratory drilling that revealed evidence of significant uranium deposits, especially in Lindi and Ruvuma Regions.

Uranium mining company Mantra Resources Ltd (Mantra) of South Africa and Uranex have been allowed by the Tanzanian government to begin preparations for mining after demonstrating that

* Prepared by secretariat, based on open source information, Mantra Ltd company report and Uranex NL.

they met all environmental conditions mandated by the National Environment Management Council. Mantra expects to complete a pre-feasibility study for its Mkuju River project in the near future, prior to commencement of a full feasibility study. Infill and exploration drilling is also currently being undertaken.

The drilling programmes were scheduled to be concluded by the end of 2009 and to be followed by a revised resource estimate expected to be completed in 2010. The initial resource estimate is based on drilling that covers only a small part of the total area of the prospect, and potential exists to substantially increase the resource base with ongoing work.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The newly discovered uranium resources, based on JORC and NI 43-101 compliant information of MANTRA Resources Limited and Uranex NL, amount to a total of about 28 400 tU (RAR and IR), categorised as high cost (<USD 260/kgU). These resources are considered to be amenable to open-pit mining.

Undiscovered Conventional Resources (Prognosticated & SR)

Undiscovered resources are not reported, however there is a high potential for uranium deposits in several areas, as noted above.

URANIUM PRODU26CTION

No uranium has been produced in Tanzania.

Future production centres

The Ministry for Energy and Minerals has stated that two companies are expected to begin uranium mining in 2012. Using the current resource estimate as a base case scenario, the projects could support a minimum annual production of 1 000 tU for at least a 10-year mine life.

ENVIRONMENTAL ACTIVITIES AND SOCI0-CULTURAL ISSUES

The government of Tanzania has recently made efforts to allay public concerns over the prospect of uranium mining. The environmental, health, economic and social impacts are to be carefully considered and the government indicated that it is aware of the high safety standards required for uranium mining in order to protect people and the environment.

URANIUM REQUIREMENTS

Uranium requirements

None.

NATIONAL POLICIES RELATING TO URANIUM

A new Mining Advisory Committee was established to advise the government on all mining related issues. The committee is to advise on matters outlined in the *Mining Act* of 1998 as well as all matters pertaining to Mining Development Agreements (MDAs). The new committee has been appointed while the process was begun to put in place the Mining Policy and eventually a new *Mining Act* and associated regulations.

URANIUM STOCKS

None.

Reasonably Assured Conventional Resources by production method
(tonnes U)

Production method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	8 900	81
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	0	8 900	81

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	**<USD 40/kgU**	**<USD 80/kgU**	**<USD 130/kgU**	**<USD 260/kgU**	**Recovery factor** (%)
Conventional	0	0	0	8 900	81
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	0	8 900	81

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	8 900
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	0	0	8 900

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	0	0	
Open-pit mining	0	0	0	19 500	81
In situ leaching	0	0	0	0	
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	0	0	0	19 500	81

Inferred Conventional Resources by processing method
(tonnes U)

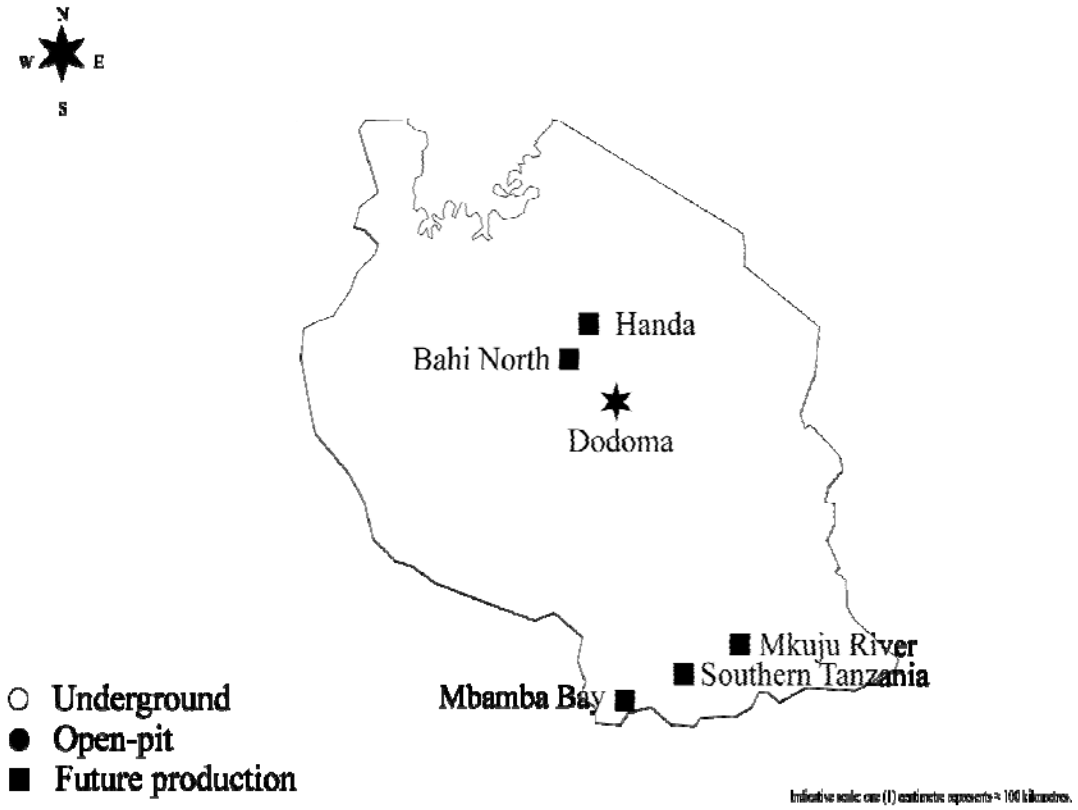
Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	0	0	19 500	81
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	0	0	0	19 500	81

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	0	0	17 400
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	2 100
Total	0	0	0	19 500

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.



• Turkey •

URANIUM EXPLORATION

Historical review

See the 2007 edition of the Red Book for a brief historical review.

Recent and ongoing uranium exploration and mine development activities

In 2007 and 2008, granite and acidic intrusive rocks and sedimentary rocks were explored for radioactive raw material, over a 10 000 km^2 area in the Kırşehir-Nevşehir-Aksaray-Ankara region.

In 2009, granite and acidic intrusive rocks and sedimentary rocks will be explored for radioactive raw material over a 5 000 km^2 area in the Kütahya-Uşak-Manisa region.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

Salihli – Köprübaşı: 2 852 tU in 10 ore bodies and at grades of 0.03-0.04% U in fluvial Neogene sediments.

Fakılı: 490 tU at 0.42% U in Neogene lacustrine sediments.

Koçarlı (Küçükçavdar): 208 tU at 0.04% U in Neogene sediments.

Demirtepe: 1 729 tU at 0.07% U in gneiss fracture zones.

Yozgat – Sorgun: 3 850 tU at 0.08% Uin Eocene deltaic lagoon sediments.

Undiscovered Conventional Resources (Prognosticated & SR)

None reported.

Unconventional Resources and other materials

None reported.

URANIUM PRODUCTION

Turkey has no uranium production.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

None reported.

Turkey

URANIUM REQUIREMENTS

Turkey has no operating nuclear power plants but it launched a tender for construction and operation of nuclear power plants on 24 September for constructing units up to an installed capacity of 3 000-5 000 MWe at the Akkuyu Site. Only one consortium submitted a bid for the tender. After assessment, the competition was cancelled on 20 November 2009. The government is now considering options to build new generating facilities in order to meet rising electricity demand.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in USD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	56 000	50 000	73 500	189 000
Industry* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	56 000	50 000	73 500	189 000
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Government exploration drilling (m)	0	0	0	1 000
Government exploration holes drilled	0	0	0	3
Industry* development drilling (m)	0	0	0	0
Industry* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	0	0	0	0
Subtotal exploration holes drilled	0	0	0	0
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	3
Total drilling (m)	0	0	0	1 000
Total holes drilled	0	0	0	3

* Non-government.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor
Underground mining					
Open-pit mining		9 129	9 129	9 129	
In situ leaching					
Co-product and by-product					
Unspecified					
Total		9 129	9 129	9 129	

* *In situ* resources.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor
Conventional	0	0	0	0	
In-place leaching (stope/block leaching*)	0	0	0	0	
Heap leaching**	0	9 129	9 129	9 129	
Total	0	9 129	9 129	9 129	

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	7 400	7 400	7 400
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	1 729	1 729	1 729
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	0	0	0	0
Other*	0	0	0	0
Total	0	9 129	9 129	9 129

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
0	0	0	0	1 500	4 500

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
4 500	4 500	NA	NA	NA	NA	NA	NA

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	1.9	0	0	0	1.9
Producer	0	0	0	0	0
Utility	0	0	0	0	0
Total	1.9	0	0	0	1.9

• Ukraine •

URANIUM EXPLORATION

Historical review

Prospecting for uranium in Ukraine began in 1944, leading to the discovery of the Pervomayskoye and Zheltorechenskoye deposits, which were subsequently mined out in 1967 and 1989, respectively. The first sandstone type deposit Devladovskoye was discovered in 1955. In the mid-60s the exploration was concentrated in the Kirovograd region for metasomatite type deposits. leading to the discovery of the Michurinskoye, Vatutinskoye and Severinskoye deposits. At present, low-grade (0.1-0.2%) metasomatite type deposits are principally mined, although ISL mining of sandstone deposits is also ongoing.

Recent and ongoing uranium exploration and mine development activities

Using international and national practice, specialists at *Kirovgeology* have developed a predictive map for uranium in Ukraine at a scale 1:500 000, where ore areas and potential ore regions and nodes have been identified as prospective regions for the discovery of unconformity-related, vein type, hematite breccias and volcanic type deposits. The ore grades of these deposits are expected to surpass those of the metasomatite type deposits.

In 2007-2008 prospecting studies for the discovery of deposits of different geological economic types were conducted. “Unconformity” type deposits were discovered within the western slope of the Ukrainian Shield in zones of the Riphean unconformity. Work is ongoing in the Drukhovskaya area (450 km^2) in the central part of Suchano Perzhanskoy zone where 19 holes were drilled to study epigenic processes. Within zones of Vendian unconformity, work was conducted in the South Podolian area (840 km^2) of the southwestern slope of the Ukrainian Shield.

Work to review Prognosticated resources in vein-type deposits in the Rozanovskaya (450 km^2), Gayvoronskaya (860 km^2) and Khmelnitskoy (450 km^2) areas were conducted. In the Rozanovskaya area, 18 holes were drilled. In the Gayvoronskaya area, 28 holes were drilled and radioactive anomalies were discovered. In the Khmelnitskoy area, 19 holes were drilled and radioactive anomalies were also discovered. Because of limited uranium exploration activity in 2007-2008, no economically sufficient results were obtained.

Estimation of Dibrovskoye rare earth-thorium-uranium mineralisation within the Pryazov block of the Ukrainian Shield is being conducted, initially to assess Prognosticated resources of uranium and thorium. In total, 3 800 m were drilled. The work on estimating thorium presence in the Ukrainian Shield continued in 2007-2008 based on compiling a registration map of thorium occurrences at a scale 1:500 000.

Exploration work for metasomatite type deposits, beginning with areas in the vicinity of operating mines, is being conducted to evaluate their potential.

Government and private companies in Ukraine do not conduct any exploration activities for uranium in other countries. Neither foreign governments nor private companies conduct any exploration for uranium in Ukraine.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

As of 1 January 2009, RAR and IR resources at mining cost <80 USD/kgU totalled 61 573 tU compared to 230 580 tU as of 1 January 2007. RAR and IR resources recovered at mining cost <40 USD/kgU amounted to 6 427 tU and 43 140 in 2009 and 2007, respectively. These significant changes are principally the result of a re-evaluation of mining costs in the Ukraine, combined with uranium production at the Michurinskoye and Vatutinskoye deposits.

The main economic resources of uranium are concentrated in Ukraine within deposits of two types:

- Metasomatite type deposits located within the Kirovograd block of the Ukrainian Shield. The deposits are monometallic. Uranium content of the ore is 0.1-0.2% U. These deposits are suitable for underground mining.

- Sandstone type deposits located within the Dnieper-Bug metallogenic area (17.3 thousand km^2). In addition to uranium, molybdenum, selenium and rare earths of the lanthanide group occur in these ores. Uranium content of the ore is 0.01-0.06% U. These deposits are suitable for mining by ISL.

Undiscovered Conventional Resources (Prognosticated & SR)

No changes from the 2007 Red Book.

URANIUM PRODUCTION

In 1949, the construction of the Industrial Complex “Pridneprovskiy Chemical Plant” (PHZ) for milling uranium ores (near Dneprodzerzhinsk, Dnepropetrovsk Region) began after mining was initiated in 1947. PHZ processed ores from the Michurinskoye deposit (near Kirovograd, Kirovograd District), phosphate ores of the Melovoye deposit (near Shevchenko, now Aktau, Kazakhstan) and raw concentrate from GDR, Hungary and Bulgaria. In 1951, the State enterprise “Eastern Ore Dressing Complex” (SE “VostGOK”) was established on the base the Pervomayskoye and the Zheltorechenskoye deposits (near Zheltye Vody, Dnepropetrovsk Region). Now SE “VostGOK” is responsible for uranium recovery in Ukraine.

Construction of the second processing (hydrometallurgical) plant (GMZ) in Ukraine (subdivision of SE “VostGOK”) began in 1956 and uranium concentrate from this plant was first produced in 1959. To the end of the 60s the Pervomayskoye and the Zheltorechenskoye deposits were mined-out and the source of raw materials moved to the Kirovograd area.

In situ leaching (ISL) has been practiced in Ukraine since 1961. From 1966 to 1983 three deposits (Devladovskoye, Bratskoye and Safonovskoye) were mined by sulphuric acid ISL at a depth of about 100 m. These sandstone deposits are located within the sedimentary cover of the Ukrainian Shield. However, ISL mining was stopped mainly due to environmental reasons. At present, monitoring of conditions of the mined-out deposits is ongoing. Development of two deposits for ISL mining with alternate leaching reagents is being planned.

Status of production facilities, production capability, recent and ongoing activities and other issues

The hydrometallurgical processing plant VostGOK is situated in the Zheltye Vody region. The annual capacity of the plant is 1.5 Mt ore with work conducted by 30-35 persons per shift. Ore is transported to the plant by specially equipped trains from two mines, Ingulskiy and Smolinskiy, situated 100 km and 150 km west, respectively. After crushing and radiometric sorting, the ore is leached in autoclaves using sulphuric acid at a temperature of 150-200°C and 20 atmospheres pressure for four hours. Acid expenditure is 80 kg/t ore. For uranium extraction, an ion-exchange resin is applied. After washing with a mixture of sulphuric and nitric acids, the uranium-bearing solution is subjected to further concentration and purification through extraction with solvents and ammonium gas for precipitation. The dewatered precipitate is calcined at 800°C until a dark colour product is obtained.

In metasomatite type deposits the uranium content of the ore is about 0.1%. Mineralisation (uraninite, brannerite, coffinite, nasturane) is disseminated throughout the volume of ore in steeply falling ore bodies. Quarrying is conducted by underground mining, processing by crushing the ore with recovery in sulfuric acid in autoclaves. Poor uranium ore grades combined with the most expensive technologies of mining and processing makes uranium production non profitable under existing market conditions.

In order to decrease production costs, innovative production technologies have recently been introduced in the mines, such as deep radiometric sorting (separation), in place leaching and heap leaching, and reprocessing (reclamation) of dumps at operating mines.

The Novokonstantinovskoye deposit, situated in the Kirovograd region near the village Alekseevka, is currently being developed as an underground mine. Production of close to 1 500 tU/yr is envisaged, with potential expansion to 2 500 tU/yr.

Construction of a uranium mining centre is being planned for the Safonovskoye deposit, with a planned capacity of 250 tU/yr. A feasibility study is now being reviewed by the government.

Ownership of uranium industry

All the enterprises of uranium industry connected with mining, ore-dressing of uranium and further obtaining nuclear fuel in Ukraine belong to the state and are subordinate to the Department of atomic-industrial complex of the Ministry of Fuel and Energy of Ukraine.

In April 2008 the Government of Ukraine founded a new entity called "Nuclear Fuel" through the merger of existing organisations in the sphere of the directorate of Ministry of Fuel and Energy.

Uranium production centre technical details
(as of 1 January 2009)

	Centre #1	Centre #2
Name of production centre	Hydrometallurgical plant (HMP) c. Zheltye Vody	Hydrometallurgical plant
Production centre classification	Operating	Committed
Start-up date	1958	2015
Source of ore:		
Deposit name	Michurinskoye Central Vatutinskoye	Novokonstantinovskoye
Deposit type	Metasomatite	Metasomatite
Resources (tU)	77 070	93 630
Grade (% U)	0.1%	0.14%
Mining operation:		
Type (OP/UG/ISL)	UG	UG
Size (t ore/day)	4 500	7 500
Average mining recovery (%)	81	82
Processing plant (acid/alkaline):	Acid	Acid
Type (IX/SX)	IX	IX
Size (t ore/day) for ISL (L/day or L/h)	NA	NA
Average process recovery (%)	92	92
Nominal production capacity (tU/year)	1 500	2 500
Plans for expansion	NA	NA
Other remarks		

NA Not available.

Secondary sources of uranium

Mixed oxide fuel (MOX) has never been produced and has never been used in power plant reactors in Ukraine.

Re-enrichment of uranium tails has never been conducted. There are no storage facilities for such uranium in Ukraine.

Reprocessing (regeneration) of uranium from spent nuclear fuel is not conducted in Ukraine and reactor fuel produced from reprocessed (regenerated) uranium (Rep U) has never been used.

ENVIRONMENTAL ACTIVITIES AND SOCIAL CULTURAL ISSUES

The main environmental impacts of uranium production (mines Inguletskaya and Smolinskaya) result from ore sheds, tailings dumps from radiometric ore-dressing, waste rock dumps, ventilation systems, and transport pathways (railways, technological motor roads).

The main environmental impacts from uranium production (hydrometallurgical plants, heap-leaching sites) are:

- harmful chemical and ore dust emissions (for the sites of hydrometallurgical plants and heap leaching);
- wind transportation of aerosols and groundwater contamination from tailings impoundments.

To assure environmental impacts are minimised, permanent monitoring is being conducted.

At the mined out Devladovskoye and Bratskoye ISL deposits, observations of ground water conditions have been conducted since 1988. Results show that the halo of residual leaching reagents does not cross the contours of mined out ore bodies, but is diluted and reduced in volume.

Treatment at the hydrometallurgical plant (Zheltye Vody) results in the removal and storage of processing wastes (tailings), clearing of the liquid part and using recycled water in the technological process. Two tailings impoundments, one situated at 9 km from the hydrometallurgical plant consisting of two sections (135 and 163 hectares), and the second at 0.5 km from the plant (55 hectares), receive tailings. The second tailings impoundment is filled to capacity and reclamation is ongoing.

There are however problems connected with decommissioning of uranium mining and uranium processing enterprises. The Prydnieprovsky chemical Plant in c. Dnieprodzerzhynsk produced uranium concentrate from 1949 to 1991. On the territory of the Plant and outside its limits, nine tailings impoundments were used during uranium production (total area of 268 hectares containing 42 Mt of wastes) with total activity of 75 000 Ku. The area of radioactive pollution of the territory of production site of the Plant with exposed dose of gamma radiation over 100 MkR/hour is 250 000 m^2. Some buildings and other facilities are polluted by radioactivity. The Cabinet of Ministers of Ukraine issued the “State Programme for putting unsafe objects of the Pridnieprovskiy Chemical plant in an environmentally safe condition and providing protection of the population from the harmful impacts of

ionising radiation". This programme has been funded since 2005 at the expense of State Budget to a sum of UAH 22.3 million (about USD 4.5 million).

This State Programme was approved in 1995 to improve radiation protection at all enterprises of the atomic industry and all contaminated areas resulting from mining and processing of uranium.

The cost of works foreseen by the programme is assessed as USD 360 million. The programme will include decontamination of polluted soils, environmental monitoring, installation of monitoring systems where necessary, improvement of technology of management with water flows, radioactive rocks in dumps, polluted equipment and land areas.

URANIUM REQUIREMENTS

Natural uranium production in Ukraine is at the level of 30% of the country's nuclear energy requirements.

Since the beginning of electricity production in nuclear power plants (NPP) in Ukraine, requirements of NPPs in nuclear fuel have been provided at the expense of 100% import of fuel elements from the Russian Federation (provider TVEL).

To supply four operating NPPs with a total of 15 units (13-VVER-100 and 2-VVER-440), 15 loading sets of fuel elements are provided from Russia annually. The total cost of delivery is about USD 300 million.

In 2005, operational testing of six fuel units sets produced by Westinghouse for reactors VVER-1000 at the South-Ukrainian NPP began. At present, the cost of nuclear fuel from Westinghouse is 40% higher than the cost of Russian fuel. Therefore Westinghouse is not expected to become the provider of nuclear fuel for Ukraine in the near future.

It is expected that, by 2010-2012, 100% of requirements of NPPs will be supplied by natural uranium production within Ukraine.

Natural uranium requirements in 2005-2006 were met by mining and purchases from TVEL (Russia), URANGESELLSCHAFT (Germany) and RWE NUKEM GmbH (Germany).

Installed nuclear generating capacity by 2035

At present 15 units are operating at four nuclear power stations: Zaporozhskaya (6 VVER-1000 units); South-Ukrainian (three VVER-1000 units); Rovenskaya, (four units, 2 VVER 440 and 2 VVER-1000) and; Khmelnitskaya (2 VVER-1000 units).

According to the programme of development of nuclear energy in the Ukraine, it is foreseen to preserve by 2030 a share of electric energy production by nuclear of not less than 45-50% of the total production. This means that nuclear energy production will increase about two times from 75.2 to 150 billion KWe/h annually.

In order to realise this programme, life extension of the operating NPP units will need to be carried out, 12 new NPPs (including ten new units with a capacity of 1 500 MWe each) will need to be built and 12 NPPs will need to be decommissioned due to aging, following life extension.

NATIONAL POLICIES RELATING TO URANIUM

On 17 April 2009 the Cabinet of Ministers of Ukraine passed Resolution N 650-p “Some questions of liquidation and organisation of state mergers in the nuclear industry.” This Resolution founded “Nuclear Fuel,” by the state merger of all enterprises and scientific-research is institutes connected to the nuclear fuel cycle. The Resolution is aimed at improving investment conditions.

The Ukrainian Government Policy aims to increase uranium production and attract foreign investment for the development of uranium mining projects within the territory of Ukraine. According to the Government’s strategy of nuclear energy production development to 2030, it is foreseen to retain the share of electric energy production by NPP at the level of 45-50% of total electricity production. As a result, NPP production will have to be doubled by 2030 (from 87 to 150 GWe).

It is also foreseen by this policy that the country will increase its domestic uranium mining capacity in order to meet NPP requirements.

URANIUM STOCKS

There are no uranium stocks for future supply of NPP reactors in Ukraine, and no stocks of enriched uranium and nuclear fuel. Since there are no facilities for uranium dressing and processing of nuclear fuel in Ukraine, there are no stocks of enriched and processed materials.

URANIUM PRICES

The data on costs of natural uranium production in Ukraine are not available.

To produce reactor fuel for Ukrainian NPPs, the prices of natural U, conversion and ore-dressing, taking into account recent increases, are guaranteed by the Russian Federation Government. Guaranteed profitable price conditions for providing nuclear fuel by the concern “TVEL” at the conditions of international tender until 2010 have also been provided.

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million UAH	2006	2007	2007	2009 (expected)
Industry exploration expenditures	0	0	0	0
Government exploration expenditures	30.3	31.8	34.2	36.8
Industry development expenditures	0	0	0	0
Government development expenditures	0.6	1.0	1.2	1.0
Total expenditures	30.9	32.8	35.4	37.8
Industry exploration drilling (metres)	0	0	0	0
Number of industry exploration holes drilled	0	0	0	0
Government exploration drilling (metres)	37 720	35 213	23 316	22 650
Number of government exploration holes drilled	241	226	151	145
Industry development drilling (metres)	0	0	0	0
Number of development exploration holes drilled	0	0	0	0
Government development drilling (metres)	4 494	7 380	8 314	8 500
Number of development exploration holes drilled	74	134	151	154
Subtotal exploration drilling (metres)	0	0	0	0
Subtotal exploration holes	0	0	0	0
Subtotal development drilling (metres)	4 494	7 380	8 314	8 500
Subtotal development holes	74	134	151	154
Total drilling (metres)	42 214	42 593	31 630	31 150
Total number of holes	315	360	302	299

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor
Underground mining	2 805	37 741	79 862	154 701	88.7%
Open-pit mining	0	0	0	0	
In situ leaching	0	6 900	6 900	6 900	75%
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	2 805	44 641	86 762	161 601	88.1%

* *In situ* resources.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor
Conventional	2 805	44 641	86 762	161 601	88.1%
In-place leaching*	0	0	0	0	
Heap leaching**					
Total	2 805	44 641	86 762	161 601	88.1%

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	
Sandstone	0	6 900	6 900	6 900
Hematite breccia complex	0	0	0	
Quartz-pebble conglomerate	0	0	0	
Vein	0	0	0	
Intrusive	0	0	0	
Volcanic and caldera-related	0	0	0	
Metasomatite	2 805	37 741	79 682	154 701
Other*	0	0	0	
Total	2 805	44 641	86 762	161 601

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Inferred Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	3 622	15 732	31 679	90 494	88.7%
Open-pit mining	0	0	0	0	
In situ leaching	0	1 200	1 200	1 200	75%
Co-product and by-product	0	0	0	0	
Unspecified	0	0	0	0	
Total	3 622	16 932	32 879	91 694	88.5%

* *In situ* resources.

Inferred Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	3 622	16 932	32 879	91 694	88.5%
In-place leaching*	0	0	0	0	
Heap leaching**	0	0	0	0	
Total	3 622	16 932	32 879	91 694	88.5%

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred Conventional Resources by deposit type
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	1 200	1 200	1 200
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	0	0
Volcanic and caldera-related	0	0	0	0
Metasomatite	3 622	15 732	31 679	90 494
Other*	0	0	0	0
Total	3 622	16 932	32 879	91 694

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
8 400	22 500	22 500

Speculative Conventional Resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
0	255 000	255 000

Historical uranium production
(tonnes U in concentrate)

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	10 000	0	0	0	10 000	0
Underground mining*	98 032	760	750	760	100 302	725
In situ leaching	3 925	0	0	0	3 925	0
Heap leaching	20	0	0	0	20	0
In-place leaching**	3	0	0	0	3	25
Co-product/by-product	20	0	0	0	20	0
U recovered from phosphates	10 000	0	0	0	10 000	0
Other methods***	53 454	50	50	70	53 454	80
Total	121 957	810	800	830	124 397	830

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.
** Also known as stope leaching or block leaching.
*** Includes mine water treatment and environmental restoration.

Ukraine

Ownership of uranium production in 2008

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
830	100	0	0	0	0	0	0	830	100

Uranium industry employment at existing production centres
(person-years)

	2006	2007	2008	2009 (expected)
Total employment related to existing production centres	4 310	NA	NA	NA
Employment directly related to uranium production	1 720	1 690	1 580	1 460

Short-term production capability
(tonnes U/year)

2010				2015				2020			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
9 00	1 700	NA	NA	810	3 230	NA	NA	NA	NA	810	5 500

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	250	5 800	NA	NA	170	6 400	NA	NA	NA	NA

Net nuclear electricity generation

	2007	2008
Nuclear electricity generated (TWh net)	87.22	NA

Installed nuclear generating capacity to 2035
(MWe net)

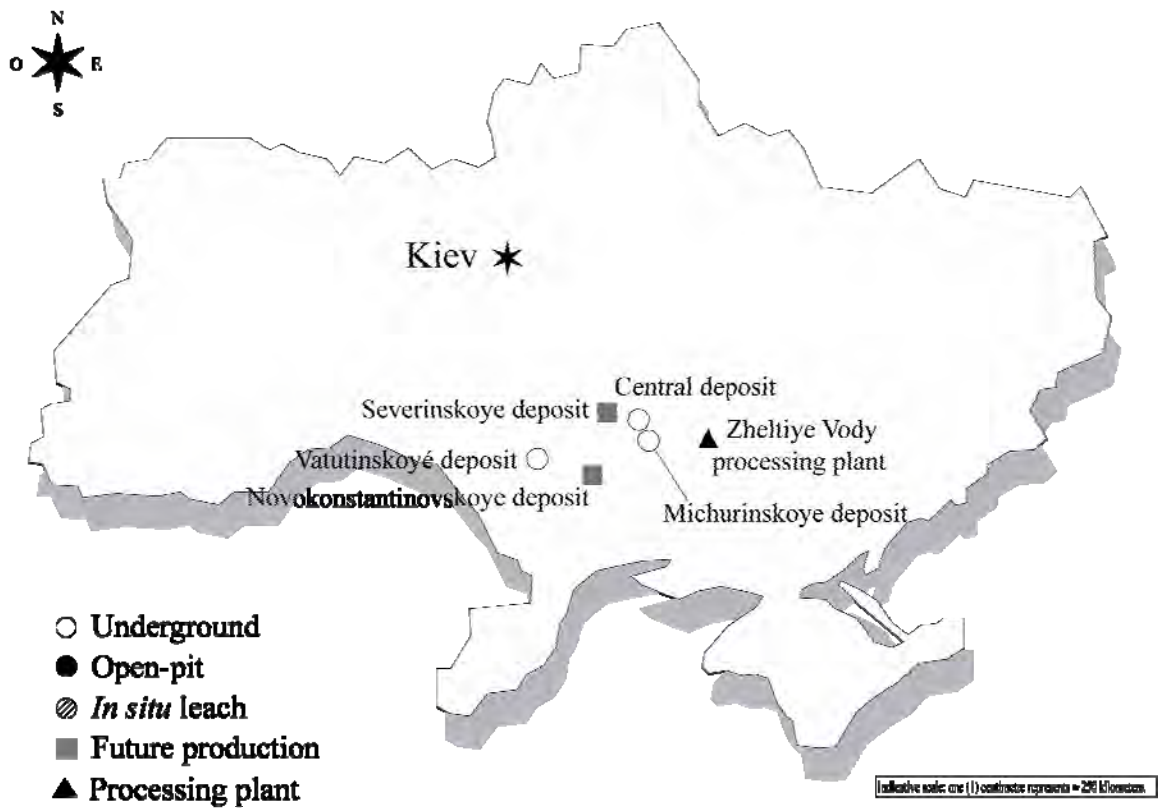
2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
13 800	13 800	13 800	13 800	15 800	17 900

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
16 600	20 200	18 800	26 200	20 000	26 200	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
2 480	2 480	2 480	2 480	2 480	3 230

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 020	3 660	3 390	4 800	3 600	4 800	NA	NA



• United Kingdom •

URANIUM EXPLORATION

Historical review

Some uranium mining occurred in Cornwall, as a sideline to other mineral mining, especially tin, in the late 1800s. Systematic exploration occurred in the periods 1945-1951, 1957-1960 and 1968-1982, but no significant uranium reserves were located.

Recent and ongoing uranium exploration and mine development activities

Exploration in overseas countries is carried out by private companies operating through autonomous subsidiary or affiliate organisations established in the country concerned *(*e.g., members of the Rio Tinto group of companies).

There were no industry expenditures reported for domestic exploration from 1988 to the end of 2006, nor were there any government expenditures reported for exploration either domestic or abroad. Since 1983, all domestic exploration activities have been halted.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The Reasonably Assured Resources (RAR) and Inferred Resources are essentially zero. There has been no geological appraisal of the UK uranium resources since 1980.

Undiscovered Conventional Resources (Prognosticated & SR)

There are small quantities of *in situ* Undiscovered Resources as well as Speculative Resources. Two districts are believed to contain uranium resources: Metalliferous mining region of southwest England (Cornwall and Devon) and North Scotland, including Orkneys.

URANIUM PRODUCTION

Status of production capability

The United Kingdom is not a uranium producer.

Secondary sources of uranium

Production and/or use of mixed-oxide fuels

None of the reactors in the United Kingdom currently use MOX fuel. In October 2001 the UK Government announced the approval for MOX manufacture in the UK. In December 2001 BNFL started the first stage of plutonium commissioning of the Sellafield MOX (SMP) the plant

manufactures MOX fuel from plutonium oxide separated from the reprocessing of spent fuel and tails of depleted uranium oxide. Detailed programmes for SMP are considered to be commercially confidential.

Production and/or use of re-enriched tails

Urenco has a long-term contractual agreement to upgrade tails material, but considers this to be commercially confidential.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

There is no uranium mining in the United Kingdom.

URANIUM REQUIREMENTS

The UK Government published a White Paper in 2008 "Meeting the Energy Challenge" which after a public consultation concluded that nuclear power should remain part of the energy mix in a low carbon economy.

It will be for the private sector to undertake, fund, construct and operate new nuclear plants and cover the cost of decommissioning and their full share of long-term waste management costs.

The remaining Magnox power stations are currently due to close in 2010. The Advanced Gas cooled Reactors (AGRs) operated by British Energy, which is now part of EDF, at Hartlepool and Heysham 1 are due to close in 2014, followed by Hinkley Point B and Hunterston B in 2016, Dungeness B in 2018 and Heysham 2 and Torness in 2023. The Pressurised Water Reactor at Sizewell B is expected to remain operational until 2035.

In the near to medium future the uranium requirements of the United Kingdom are difficult to predict due to the proposed new build programme.

Supply and procurement strategy

In 2007 the Nuclear Decommissioning Authority (NDA) published the "Uranium and Plutonium: Macro-Economic Study" which provides an economic analysis of potential future disposition options for the UK's stock of nuclear materials. The study analyses a range of options but does not set out a preferred option or make any recommendations on options to the NDA or Government. The recommendation of options will follow an integrated, transparent, decision making process conducted by NDA, Government, Regulatory bodies and other stakeholders.

NATIONAL POLICIES RELATING TO URANIUM

See the 2007 Red Book.

URANIUM STOCKS

The UK uranium stockpile practices are the responsibility of the individual bodies concerned. Actual stock levels are commercially confidential.

URANIUM PRICES

Uranium prices are commercially confidential in the United Kingdom.

Mixed-oxide fuel production and use
(tonnes of natural U equivalent)

Mixed-oxide (MOX) fuels	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	NA	22	11	NA	NA	NA
Use	NA	NA	NA	NA	NA	NA
Number of commercial reactors using MOX	NA	NA	NA	NA	NA	NA

Re-enriched tails production and use
(tonnes of natural U equivalent)

Re-enriched tails	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	NA	NA	NA	NA	NA	NA
Use	NA	NA	NA	NA	NA	NA

Reprocessed uranium use
(tonnes of natural U equivalent)

Reprocessed uranium	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	51 270	860	260	1 689	54 079	NA
Use	~ 15 000	NA	NA	NA	~ 15 000	NA

Net nuclear electricity generation*

	2007	**2008**
Nuclear electricity generated (TWh net)	57.3	NA

Installed nuclear generating capacity to 2035*
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
11 000	10 900	10 600	10 600	4 800	4 800

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
3 700	4 800	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2035 (excluding MOX)*
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
1 071	NA	1 860	2 150	980	1 140

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
450	520	350	405	350	405	NA	NA

* *Nuclear Energy Data*, OECD, Paris, 2009.

• United States of America •

URANIUM EXPLORATION

Historical review

See the 2007 Red Book for a brief historical review of exploration in the United States (U.S.).

Recent and ongoing uranium exploration and mine development activities

In the U.S., expenditures for uranium surface drilling during 2008 were USD 81.9 million, up USD 14.4 million from expenditures in 2007 of USD 67.5 million. This continued upward trend in investment – a 673% increase since 2004 – indicates a significant turnaround for the industry from the steady decline in drilling expenditures experienced between 1997 and 2003.

The number of exploration and development holes drilled was 9 355 in 2008 and 9 347 in 2007. The number of holes drilled in these years represent a significant increase from the number of holes drilled in 2006 (4 903) and 2005 (3 143). There were also significant increases in the total drilling

length. In 2008, 1 552 656 m were drilled which is a slight decrease from the 1 568 501 m drilled in 2007. However, the 2007 total was a 90% increase from the 826 923 m drilled in 2006. The total lengths drilled in 2008 and 2007 were the largest for any two years since before 1990.

U.S. uranium drilling activities, 2003-2008

Year	Exploration drilling		Development drilling		Exploration and development drilling	
	Number of holes	Meters (thousand)	Number of holes	Meters (thousand)	Number of holes	Meters (thousand)
2003	NA	NA	NA	NA	W	W
2004	W	W	W	W	2 185	381
2005	W	W	W	W	3 143	508
2006	1 473	250	3 430	577	4 903	827
2007	4 351	671	4 996	898	9 347	1 569
2008	5 198	775	4 157	778	9 355	1 553

NA = Not available.

W = Data withheld to avoid disclosure of individual company data.

Note: Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration: Form EIA-851A, "Domestic Uranium Production Report" (2003-2008).

In 2008, private industry expenditures for uranium exploration and mine development activities in the United States totalled USD 246.4 million, a slight increase from the USD 245.7 million spent in 2007.

In 2008, expenditures on U.S. uranium production, including facility expenses, amounted to USD 221 million, significantly higher – by 145% – than those in 2007. Expenditures for land were USD 65 million, a 16% decrease compared to 2007.

The total expenditures for land, exploration, drilling, production and reclamation were USD 468 million in 2008, 39% more than in 2007.

In 2007 and 2008, there were no exploration expenditures for uranium in the United States or abroad by the U.S. Government. Data on industry exploration expenses abroad are not available.

Much of the recent increase in development and production expenditures is due to the general rise in uranium (and vanadium) prices since 2004. As a result, there is renewed interest in leasing activity for historical uranium reserve properties in several western States. This interest led to the purchase of uranium mineral rights on these tracts and the formation of new joint ventures to explore and develop prospective new deposits. Encompassed in this activity are thousands of acres located principally in the following western States: Arizona, California, Colorado, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, and Wyoming.

U.S. Uranium Expenditures, 2003-2008
(Million Dollars)

Year	Drilling	Production	Land and other				Total expenditures
			Total land and other	Land	Exploration	Reclamation	
2003	W	W	31.3	NA	NA	NA	W
2004	10.6	27.8	48.4	NA	NA	NA	86.9
2005	18.1	58.2	59.7	NA	NA	NA	136.0
2006	40.1	65.9	115.2	41.0	23.3	50.9	221.2
2007	67.5	90.4	178.2	77.7	50.3	50.2	336.2
2008	81.9	221.2	164.4	65.2	50.2	49.1	467.6

Drilling: All expenditures directly associated with exploration and development drilling.

Production: All expenditures for mining, milling, processing of uranium, and facility expense.

Land and other: All expenditures for: land; geological research; geochemical, and geophysical surveys; costs incurred by field personnel in the course of exploration, reclamation and restoration work; and overhead and administrative charges directly associated with supervising and supporting field activities.

NA = Not available.

W = Data withheld to avoid disclosure of individual company data.

Notes: Expenditures are in nominal U.S. dollars. Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration: Form EIA-851A, "Domestic Uranium Production Report" (2003-2008).

Titles to most of the uranium properties and claim blocks with reserves and resources identified by drilling during the 1970s and early 1980s have been acquired through three options: re-staking, acquisition from previous owners, and mergers. Areas surrounding many properties are being considered for further evaluation. Most of the companies involved are following up acquisitions with in-house evaluations of old drill holes and geochemical data acquired with the property, new drilling to verify reserves, and external expert technical reports to meet financial reporting standards for mining properties. In addition, the uranium industry is assessing the potential of areas bordering many mined-out properties.

The U.S. Department of Energy (DOE) has 31 active lease tracts and one inactive lease tract in the Uravan Mineral Belt of western Colorado with six different leaseholders. Leaseholders can conduct ongoing uranium production on these tracts. As leases become inactive and are returned to the DOE, they are not leased again under the current programme. The DOE is responsible for ensuring that any abandoned uranium production sites on these tracts comply with environmental laws and regulations. After reclamation, the land associated with the DOE lease tracts is eligible for return to the public domain under the administrative jurisdiction of the Bureau of Land Management, U.S. Department of the Interior.

Work on these leases continues but with just enough effort to meet lease requirements. One company has filed an exploration plan for its lease. These leases have been held by DOE and its predecessor agencies since 1948 when these properties were set aside to provide uranium for weapons. Past production from these leases totalled 3 000 tU (7.8 million lbs U_3O_8) and about 4-5 times that of

vanadium. DOE estimates that 770 tU (2.0 million lbs U_3O_8) could be generated annually from the 38 tracts in future years. Production from these properties will rely on either open-pit or underground mining with conventional milling.

The western Colorado Plateau ores can be exploited only by conventional mining and milling methods as the ores are often above the water table or are not readily soluble using current U.S. *in-situ* leach (ISL) technology which is designed to limit ground-water contamination. Breccia-pipe uranium mineralisation in north western Arizona has attracted much attention as these deposits are among the highest grade in the U.S. (averaging 0.60% U_3O_8, or 0.51% U, during past production). Drilling projects are ongoing at several pipes north of the Grand Canyon in north western Arizona. Ore from the breccia-pipe deposits in Arizona and U-V (uranium-vanadium) sandstone deposits in eastern Utah and western Colorado will most likely be shipped to the White Mesa and Shootaring Canyon mills in south eastern Utah. Uranium mining in these areas will however be limited by milling capacity and by the transportation costs. The White Mesa Mill presently processes “alternate feed material” (uranium-contaminated soils and other materials). The Shootaring Canyon Mill now has a reclamation license. Converting this license to an operating license is a lengthy process that might take several years.

The San Juan Basin of north western New Mexico contains nearly 40% of U.S. uranium reserves with some ores amenable to ISL recovery, but future development is being influenced by Native American concerns. In 2005, the Navajo Nation banned uranium exploration, mining, and processing in “Indian Country.” The term “Indian Country” as used by the Navajo includes tribal lands and non-tribal lands where mining activities may have an impact on nearby tribal lands or may impact predominately Native American communities on non-tribal lands. Community ground water supplies are of particular concern. A Federal appeals court decision recognised the term “Indian country” as legitimate and granted the U.S. Environmental Protection Agency (USEPA) regulatory control over injection of lixiviant into ground water for recovery of uranium at the proposed Church Rock ISL mine (formerly the “Section 8” mine). The State of New Mexico had already issued a permit for this activity, but the permit was challenged and blocked. The company must reapply to USEPA.

URANIUM RESOURCES

Identified Conventional Resources (RAR & Inferred)

The U.S. has updated its RAR estimates for the first time since 2003. The estimate of RAR for the <USD 80/kgU category as of 1 January 2009 was 39 064 tU, down from the 2003 estimate of 102 000 tU. The estimated RAR in the <USD 130/kgU category at the end of 2009 was 207 435 tU, a decrease from the 2003 estimate of 342 000 tU. For the <USD 260 kg/U category, estimated RAR amounts to 472 056 tU. Differences from the 2003 estimates for the <USD 80/kg U are based on a revised examination of major U.S. properties, taking into account increases in mining costs, published re-assessments of current resources, newly assessed properties, and mine depletion. In general, higher mining costs over the past several years have resulted in resources being shifted from lower-cost to higher-cost categories.

The U.S. does not report resources for the Inferred category separately.

Undiscovered Conventional Resources (Prognosticated & SR)

For the United States, the estimates of resources for the Prognosticated (formerly Estimated Additional Resources, or EAR) and Speculative categories are unchanged from the prior-reported estimates as of 1994.

Unconventional Resources and Other Materials

Not available.

URANIUM PRODUCTION

Historical review

See the 2007 Red Book for a summary of the early history of uranium production in the U.S.

Uranium mine production from all sources in 2008 was 1 492 tU. Although 2008 production was 15% less than 2007 production (1 746 tU) and 17% less than 2006 production (1 805 tU), it is a significant increase (58%) from the 2004 production 943 tU.

In 2008, uranium concentrate production (yellowcake) was obtained from facilities in the States of Colorado, Nebraska, Texas, Utah, and Wyoming. Yellowcake was produced from one U.S. mill (White Mesa), and six *in situ* leach production centres (Crow Butte, Alta Mesa Project, Rosita, Smith Ranch-Highland Uranium Project, Kingsville Dome, and Vasquez).

Although the production level dropped from 2007 to 2008, the amount of uranium shipped from these facilities has steadily increased over the past several years. In 2008, 1 589 tU were shipped from these facilities. This shipment level is 2% more than the 1 558 tU shipped in 2007. For perspective, in 2004, 877 tU were shipped. Thus, 2008 shipments represent an increase of more than 81% over 4 years.

Status of production capability

Exploration, assessment, and development of uranium properties and milling operations in the U.S. intensified in 2007 as the spot price reached USD 356/kg U_3O_8 (USD 137/lb U_3O_8) in June 2007. Many in ISL license applications, exploration permit requests, toll milling agreements, and preliminary plans for new conventional mill construction were filed during the year with Federal and State regulatory agencies.

At the end of 2008, there were 17 ISL production facilities, with a combined production capability of 6 524 tU, either in operation (six totalling 3 964 tU), on standby (four), licensed (three), pending a license award (one), or under development (three).

At the end of 2008, there were five conventional uranium production centres in the U.S. either in operation or under consideration for operation. One mill was producing and four were being considered for restoration.

Several uranium companies are in pre-licensing negotiations with State and Federal regulatory agencies for both conventional and ISL uranium mining in Wyoming, Colorado, Utah, New Mexico, and Texas. Existing and new ISL properties are most likely to be the largest contributors to expanded U.S. production in the near term. New ISL mining operations have relatively short lead times due to simpler regulatory requirements, lower capital costs, and shorter construction schedules than new conventional mills.

Ownership structure of the uranium industry

Seven facilities produced uranium in 2008. Ownership of these facilities included public and privately held firms with both foreign and domestic participation.

Uranium production centre technical details
(as of January 2009)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8
Name of production centre	Canon City	Crow Butte	Kingsville Dome	Smith Ranch Highland	Sweetwater	White Mesa Mill	Vasquez	Hobson Mill
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Start-up date	1979	1991	1988	1988	1981	1980	2004	1979
Source of ore:								
• Deposit name	Various	Crow Butte & North Trend	Kingsville Dome	Smith Ranch Highland	Various	Various	Vasquez	supplied with concentrate from the La Palangana
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	
• Reserves (tU)	W	W	W	W	W	W	W	W
• Grade (% U)	W	W	W	W	W	W	W	W
Mining operation:								ISL
• Type (OP/UG/ISL)	UG	ISL	ISL	ISL	OP	UG	ISL	NA
• Size (t ore/day)	NA	NA	NA	NA	NA	NA	NA	NA
• Average mining recovery (%)	NA	NA	NA	NA	NA	NA	NA	
Processing plant (acid/alkaline):								
• Acid/Alkaline	Acid&Alkaline				Acid	Acid	Alkaline	Alkaline
• Type (IX/SX)	SX	IX	IX	IX	SX	SX	IX	IX
• Size (t ore/day) For ISL (mega or kilolitre/day or litre/hour, specify)		NA	NA	NA	2 721 TPD	NA	NA	NA
• Average process recovery (%)	NA	NA	NA	NA	NA	NA	NA	NA
Nominal production capacity (tU/year)	210	385	385	2 116	350	1 200	308	385
Plans for expansion	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Other remarks	Standby	Operating	Producing	Operating	Standby	Operating	Restoration	Licensed

NA Not available.

Uranium production centre technical details (contd.)
(as of January 2009)

	Centre #9	Centre #10	Centre #11	Centre #12	Centre #13	Centre #14	Centre #15	Centre #16
Name of production centre	Rosita	Alta Mesa	Church Rock	Crown Point	Irigaray Ranch	Christensen Ranch	Shootaring Canyon Uranium Mill	Lost Creek
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Development
Start-up date	1990	2005	1967	NA	NA	NA	1982	2010
Source of ore:								
• Deposit name	Rosita (Rogers)	Alta Mesa	Church Rock	Crown Point	Irigaray	Christensen	Various	Lost Creek
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
• Reserves (tU)	W	W	W	W	NA	NA	NA	NA
• Grade (% U)	W	W	W	W	NA	NA	NA	NA
Mining operation:	W							
• Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	ISL	UG	ISL
• Size (t ore/day)	NA	NA	NA	NA	NA	NA	NA	NA
• Average mining recovery (%)	NA	NA	NA	NA	NA	NA	NA	NA
Processing plant (acid/alkaline):	NA							
• Acid/Alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Acid&Alkaline	Alkaline
• Type (IX/SX)	IX	IX	IX	IX	IX	IX	SX	IX
• Size (t ore/day)	NA	NA	NA	NA	NA	NA	680 TPD	NA
For ISL (mega or kilolitre/day or litre/hour, specify)	NA						NA	
• Average process recovery (%)		NA	NA	NA	NA	NA	NA	NA
Nominal production capacity (tU/year)	NA	385	385	385	NA	250	NA	770
Plans for expansion	385	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Development
Other remarks	Unknown	Producing	Licensed	Operating	Standby	Standby	Operational	Developing

NA Not available.

Uranium production centre technical details (contd.)
(as of January 2009)

	Centre #17	Centre #18	Centre #19	Centre #20	Centre 21	Centre #22	Centre #23
Name of production centre	Nichols Ranch ISL Project	Goliad Uranium Project	Jab and Antelope	Moore Ranch	La Palangana	Piñon Ridge Mill	Nichols Project
Production centre classification	Development	Development	Development	Development	Development	Development	Development
Start-up date	NA	NA	NA	2010	NA	2010	NA
Source of ore:							
• Deposit name	Nichols Ranch and Hank	Various	Various	Various	Various	Piñon Ridge Mill	Various
• Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
• Reserves (tU)	NA	NA	NA	NA	NA	NA	NA
• Grade (% U)	NA	NA	NA	NA	NA	NA	NA
Mining operation:							
• Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	UG	ISL
• Size (t ore/day)	NA	NA	NA	NA	NA	NA	NA
• Average mining recovery (%)	NA	NA	NA	NA	NA	NA	NA
Processing plant (acid/alkaline):							
• Acid/Alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Acid&Alkaline	Alkaline
• Type (IX/SX)	IX	IX	IX	IX	IX	SX	IX
• Size (t ore/day) For ISL (mega or kilolitre/day or litre/hour, specify)	NA	NA	NA	NA	NA	907 TPD	NA
• Average process recovery (%)	NA	NA	NA	NA	NA	NA	NA
Nominal production capacity (tU/year)	NA	NA	770	770	385	NA	NA
Plans for expansion	Development	Development	Development	Development	Development	Development	Development
Other remarks	Developing	Partially permitted and licensed	Developing	Developing	Licensed	Developing	Developing

NA Not available.

Employment in the uranium industry

Employment in the raw materials sector (exploration, mining, milling, and processing) of the United States uranium industry has generally declined each year during the period 1998-2003, but has been increasing since 2004.

In 2008, total employment in the U.S. uranium production industry was 1 563 person-years, an increase of 27% from the 2007 total. Mining employment increased 48%, which was the highest level among the uranium employment sectors. In 2008, uranium exploration, milling and processing employment rose 22%, while reclamation employment had little change from 2007. Eight States (Arizona, Colorado, Nebraska, New Mexico, Texas, Utah, Washington, and Wyoming) accounted for 97% of total employment in the U.S. uranium production industry.

Future production centres

There are a number of production centres that are either in process of permitting and licensing or under development. One is a conventional uranium mill (Pinion Ridge) and nine are ISL plants (Church Rock, Crown Point, Lost Creek Project, La Palangana, Nichols Ranch ISR Project, Goliad ISR Uranium Project, Nichols Project, Jab and Antelope, and Moore Ranch).

Secondary sources of uranium

Secondary supplies of uranium continue to enter the U.S. market from utility inventories and down blending of U.S. and Russian highly enriched uranium. The Uranium Producers of America (a 13-company industry consortium) is encouraging DOE to hold its uranium inventory as a strategic reserve for shortages that could develop in the future and to control its impact on the current market.

Production and/or use of mixed oxide fuels

Mixed oxide fuel production was zero. The use of mixed oxide fuels was 0.1 t natU equivalent in 2005.

Production and/or use of re-enriched tails

The DOE and the Bonneville Power Administration initiated a pilot project to re-enrich 8 500 tonnes of the DOE's enrichment tails inventory in 2005. The pilot project is anticipated to produce a maximum of 1 900 t natU equivalent over a two-year period for use by the Columbia Generating Station between 2009 and 2017.

Production and/or use of reprocessed uranium

Reprocessed uranium production and use is zero.

ENVIRONMENTAL ACTIVITIES AND SOCIO-CULTURAL ISSUES

The USEPA and various New Mexico state agencies have started studies of the environmental impact of historic uranium mining in the Grants Mineral belt of north western New Mexico, the largest producing district in the United States. Although mill sites in the area have been the subject of extensive past assessment, monitoring, and cleanup efforts, mine sites have had much less attention. The USEPA will initially study those sites where companies still exist that can be shown to have corporate financial responsibility for assessment and cleanup under U.S. law. Other sites with no corporate principal responsible party will be studied later. These legacy impacts include ground and surface water, stream sediment, and soil contamination. Impacted ground waters include shallow surficial aquifers and deeper, drinking-water aquifers used by local residents.

Work by the U.S. Geological Survey (USGS) confirms that groundwater reclamation at ISL uranium mines in Texas has not successfully returned water quality to pre-mining baseline using pump and treat technologies. In each case where a company has been released from ongoing obligations, standards have been relaxed in order to do so. In Wyoming and Nebraska, restoration to “class of use” is required. “Class of use” requirements provide a range of concentrations that are typically less restrictive than meeting baseline levels. Operators have been successful in these states in meeting these requirements.

State, county, and local governments, tribes, and environmental groups have stepped up their monitoring and regulatory activities or active opposition to ongoing, proposed new mining, or expansion of existing uranium mines. The Goliad County (Texas) government and many others continue to oppose development of the Goliad ISL mine as the company moves closer to initiating production. Proposed expansion of the Crow Butte ISL operation in northwest Nebraska is being opposed by agricultural and tribal interests. In late 2008, the Hualapai Tribe banned mining on its lands just south of the Grand Canyon in north western Arizona. In the 1980s, the USGS had conducted uranium exploration research on these tribal lands. In the San Juan basin of New Mexico, several tribes oppose uranium mining under Mt. Taylor, a designated Traditional Cultural Property, and in March 2008 won a temporary stay of exploration for one year. Major uranium deposits occur in underlying host sandstones.

Most states with uranium exploration activity are considering regulatory revisions or new regulations to govern uranium mining. In Colorado, concerns over the development of the Centennial ISL project near Greeley resulted in a bill passed by the state legislature and signed into law May 2008 [11]. This bill “requires all *in situ* leach mining to restore all affected ground water to its premining quality for all water quality parameters that are specifically identified in the baseline site characterisation or in the water quality control commission’s regulations. Requires applicants for *in situ* leach mining permits to notify the owners of record of lands within 3 miles of the affected land and to describe in their application at least 5 similar mining operations that did not result in ground water contamination and the applicants’ compliance history.”

In 2006, the U.S. Nuclear Regulatory Commission (NRC) deferred active regulation on ground-water restoration at ISL sites in Nebraska and Wyoming, pending development of agreements with the two States. The main issue of contention is whether the NRC’s primary goal of ground-water restoration to pre-operational (baseline) water quality conditions is achievable or whether secondary standards, allowable under other Federal laws, should apply. The differences in concentration between

the two standards are significant; for example, the primary restoration standard at the Crow Butte property in northwestern Nebraska is 0.092 mg/l uranium compared to a secondary restoration standard of 5 mg/l. Ground-water restoration constitutes about 40% of the decommissioning costs for U.S. ISL mines, based on 1994 data for 14 reclaimed properties.

In January 2006, the USEPA released a review document entitled, "Technologically enhanced naturally occurring radioactive materials from uranium mining, Volume 1- mining and reclamation background". This volume documents the uranium mining component of a larger effort to evaluate hazards associated with technologically enhanced, naturally occurring radioactive materials (TENORM) in several industries such as oil and gas production, phosphate mining, water treatment, and rare earth mining. Volume 2 of this report will evaluate the radiation hazards associated with uranium mine wastes. The main focus of both volumes is uranium mine wastes from underground or open-pit mining, but wastes from ISL mining operations are also included. Of particular concern are the radioactive wastes generated by the above-ground parts of the ISL operations, specifically the radioactivity of waters in the evaporation ponds. The NRC has primary authority over these wastes as "byproduct materials" under U.S. regulations, but the USEPA controls the injection of ISL lixiviant fluids under its Underground Injection Control program. In August 2006, the USEPA released a "uranium location" database for the U.S. compiled from 19 other databases which includes names and location data for about 14 800 properties where uranium presence has been identified. Over 4 000 of these locations are mines with past uranium production.

Mine reclamation

See the 2007 edition of the Red Book for a summary of mine reclamation activities to 2006.

The Nuclear Regulatory Commission continues to evaluate how best to determine ground water restoration costs at depleted ISL mines and the associated bond requirements.

URANIUM REQUIREMENTS

Preliminary uranium requirements for the United States in 2008 are 16 424 tU. In the high case, requirements are projected to increase to 23 464 tU in 2030. In the low case, requirements are projected to peak in 2015 at 19 871 tU and then to begin to decline to about 13 124 tonnes U in 2030.

Supply and procurement strategy

The U.S. allows supply and procurement of uranium production to be driven by market forces with resultant sales and purchases conducted solely in the private sector by firms involved in the uranium mining and nuclear power industries.

NATIONAL POLICIES RELATING TO URANIUM

An Agreement between the Government of the United States and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons (HEU Purchase Agreement) was signed on 16 October 1992 by the United States and the Russian Federation providing for the blending down of 500 tons of HEU to low-enriched uranium

(LEU) over 20 years. USEC, Inc., the U.S. Government's sole executive agent for implementing the HEU Purchase Agreement, receives deliveries of LEU from the Russian Federation for sale to commercial nuclear power plants. USEC purchases and sells only the enrichment component of this LEU under existing commercial contracts with purchasers of enrichment services. An agreement for the maintenance of a domestic uranium enrichment industry that was signed on 17 June 2002 by the Department of Energy and USEC, Inc. contained conditions for USEC, Inc. to continue as the U.S. Government's sole executive agent for the HEU Purchase Agreement. In June 2006 Russia indicated that the HEU agreement will not be renewed when the initial agreement expires in 2013.

Under a separate agreement under the HEU program, the natural uranium feed component is sold under a commercial arrangement between three western corporations (Cameco, COGEMA, and Nukem) and Techsnabexport of the Russian Federation. Outside of the natural uranium feed component of HEU-derived LEU, imports of uranium from the Russian Federation have been limited by the *Agreement Suspending the Antidumping Duty Investigation on Uranium from the Russian Federation* (Suspension Agreement) signed between the Department of Commerce (DOC) and the Ministry of Atomic Energy of the Russian Federation in 1992. As a result of the Suspension Agreement, DOC suspended antidumping investigations and the Russian Federation agreed to sell uranium to the United States under a quota system whereby Russian imports would have to be matched by an equivalent quantity of newly produced U.S. uranium. A 1994 amendment to the suspension agreement contained language specifying an expected termination date of 31 March 2004. However, the Russian Federation did not request the DOC to undertake a termination review, a requirement for termination. The DOC took the position that the Suspension Agreement had not expired. A second sunset review agreement was subsequently signed on 1 July 2005, maintaining the Suspension Agreement terms during the review.

On 13 February 2002, the DOC issued determinations in antidumping and countervailing duty investigations involving LEU from France, Germany, the Netherlands, and the United Kingdom. The DOC placed an antidumping duty order on LEU imports from France while all four countries were issued countervailing duty orders. The decision resulted in countervailing duties being assessed against France, but not against Germany, the Netherlands, and the United Kingdom. The DOC determinations were challenged at the U.S. Court of International Trade (CIT).

In January 2009, the U.S. Supreme Court reversed a lower court decision and upheld a petition of the United States Enrichment Corporation that the purchase of enrichment services, quantified by separative work units (SWU), should be offered protection under the Tariff Act of 1930. Essentially, the decision supports enforcement of anti-dumping practices of low enriched uranium on the U.S. market.

URANIUM STOCKS

As of 2008, the total inventories (including government, producer, and utility stocks) were 97 892 tU. Of this total, government stocks were 57 031 tU which includes 17 596 tU as concentrates, 12 485 tU of enriched uranium, and 25 950 tU of depleted uranium.

Total commercial inventories (producer and utility stocks) in 2008 amounted to 41 861 tU, a 3.2% decline from the 43 227 tU of inventories held in 2007. In 2006, the total was 40 998 tU. In 2008, over 70% of the commercial inventories, or 31 506 tU, were stocks held by owners and

operators of commercial reactors. This was a slight increase from the 31 243 tU owned by this group at the end of 2007.

In 2008, enriched uranium inventories decreased 8.4% to 8 919 tU from 9 732 tU in 2007. However, natural uranium inventories increased 5% in 2008 to 22 588 tU from 21 512 tU in 2007. These changes are relatively small compared to the near 94% increase in natural uranium inventory that occurred between 2004 and 2006.

Utility stocks held at year-end 2006, a total of 30 081 tU, were 20.8% more than the 24 897 tU held at year-end 2005. The 2006 estimated utility inventories of natural uranium had increased to 21 358 tU from 17 439 tU in 2005, while enriched uranium stocks increased to 8 722 tU in 2006 from 7 458 tU in 2005. These totals include utility-owned stocks reported as inventories at enrichment supplier facilities.

URANIUM PRICES

Owners and operators of U.S. civilian nuclear power reactors purchase uranium under spot contracts and long-term contracts. A spot contract is defined as a one-time delivery of the entire contract to occur within one year of contract execution. A long term contract is defined as one or more deliveries to occur after a year following contract execution.

In 2008, purchases under spot contracts amounted to 3 354 tU which is a 33% increase from the 2 525 tU purchased under spot contracts in 2007.

The weighted-average spot price decreased from USD 229/kgU (USD88.08/lb U_3O_8) in 2007 to USD 174/kgU (USD 66.92/lb U_3O_8) in 2008.

The uranium purchased under long-term contracts in 2008 amounted to 16 457 tU which is only a 2% decrease from the 16 816 tU purchased in 2007. In contrast, the weighted-average price under long term contracts in 2008 was USD108.12/kgU (USD41.58/lb U_3O_8) which is a significant increase — 70% — from the USD 63.57/kgU (USD24.45/lb U_3O_8) price in 2007.

Average U.S. uranium prices, 2000-2008
(USD per kilogram U equivalent)

Year	Spot Contracts	Long-term Contracts
2008	174.06	108.12
2007	229.44	63.57
2006	102.64	42.59
2005	52.10	35.62
2004	38.40	31.82
2003	26.26	28.44
2002	24.15	27.51
2001	20.59	28.49
2000	22.20	30.42

Note: Prices shown are quantity-weighted averages (nominal U.S. dollars) for all primary transactions (domestic- and foreign-origin uranium) for which prices were reported. The transactions can include U.S.-origin as well as foreign-origin uranium.
Source: *Uranium Marketing Annual Report*, 2008, Table 7.

United States of America

Uranium exploration and development expenditures and drilling effort – domestic

Expenses in million USD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures [1]	23.3	50.3	50.2	NA
Government exploration expenditures	0	0	0	NA
Industry* development expenditures [2]	132.0	195.4	196.2	NA
Government development expenditures	0	0	0	NA
Total expenditures	155.3	245.7	246.4	NA
Industry* exploration drilling (m) [3]	250 241	670 560	775 109	NA
Industry* exploration holes drilled [4]	1 473	4 351	5 198	NA
Government exploration drilling (m)	0	0	0	NA
Government exploration holes drilled	0	0	0	NA
Industry* development drilling (m) [5]	576 682	897 941	777 547	NA
Industry* development holes drilled [6]	3 430	4 996	4 157	NA
Government development drilling (m)	0	0	0	NA
Government development holes drilled	0	0	0	NA
Subtotal exploration drilling (m)	250 241	670 560	775 109	NA
Subtotal exploration holes drilled	1 473	4 351	5 198	NA
Subtotal development drilling (m)	576 682	897 941	777 547	NA
Subtotal development holes drilled	3 430	4 996	4 157	NA
Total drilling (m)	826 923	1 568 501	1 552 656	NA
Total holes drilled	4 903	9 347	9 355	NA

* Non-government.
[1] DUPR Table 8, Exploration.
[2] DUPR Table 8, Drilling + Land + Reclamation.
[3] DUPR Table 1, Exploration, Feet (converted into meters using EIA Uranium Industry Annual Appendix D Uranium Conversion Guide).
[4] DUPR Table 1 – Exploration, Number of Holes.
[5] DUPR Table 1 – Development Drilling.
[6] DUPR Table 1 – Development Drilling.

Uranium exploration and development expenditures – non-domestic

Expenses in Million USD	2006	2007	2008	2009 (expected)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	NA	NA

* Non-government.

Reasonably Assured Conventional Resources by production method*
(tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	82 863	233 960	NA
Open-pit mining	0	2 472	35 847	125 025	NA
In situ leaching	0	36 592	88 530	110 991	NA
Co-product and by-product	0	0	0	0	NA
Unspecified	0	0	195	2 080	NA
Total	0	39 064	207 435	472 056	

* EIA Uranium Reserves Data.

Reasonably Assured Conventional Resources by processing method
(tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional	0	39 064	207 435	472 056	NA
In-place leaching*	0	NA	NA	NA	NA
Heap leaching**	0	NA	NA	NA	NA
Total	0	39 064	207 435	472 056	NA

* Also known as stope leaching or block leaching.
** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably Assured Conventional Resources by deposit type*
(tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unconformity-related	0	0	0	0
Sandstone	0	39 064	191 953	401 149
Hematite breccia complex	0	0	0	0
Quartz-pebble conglomerate	0	0	0	0
Vein	0	0	0	0
Intrusive	0	0	W	W
Volcanic and caldera-related	0	0	W	W
Metasomatite	0	0	0	0
Other**	0	0	W	W
Total	0	39 064	207 435	472 056

* EIA Uranium Reserves Data.

** Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

Prognosticated Conventional Resources
(tonnes U)[1]

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
839 000	1 273 000	1 237 000

Speculative Conventional Resources
(tonnes U)[1]

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Unassigned
858 000	858 000	482 000

Historical uranium production by production method
(tonnes U in concentrate)[1]

Production method	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Open-pit mining*	NA	0	0	0	0	0
Underground mining*	NA	W	W	W	W	NA
In situ leaching	NA	W	W	W	W	NA
Co-product/by-product	NA	NA	NA	NA	NA	NA
Total	358 596	1 805	1 747	1 492	363 640	NA

* Pre-2006 totals may include uranium recovered by heap and in-place leaching.
[1] 2008 DUPR Table 2.

Ownership of uranium production in 2008[1]

Domestic				Foreign				Totals	
Government		Private		Government		Private			
[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]	[tU]	[%]
		NA	NA			NA	NA	1 492	100

[1] 2008 DUPR, Table 2.

Uranium industry employment at existing production centres
(person-years)

	2006	**2007**	**2008**	**2009** (expected)
Total employment related to existing production centres [1]	600	1 076	1 409	NA
Employment directly related to uranium production [2]	412	701	952	NA

[1] 2008 DUPR Table 6, all sectors except Reclamation.
[2] 2008 DUPR Table 6, all sectors except Exploration and Reclamation.

Short-term production capability
(tonnes U/year)

2010				**2015**				**2020**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2025				**2030**				**2035**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: If the only available projections are based on USD 130/kgU, please report them but clearly indicate this cost category on the form. Also, please do not leave blanks. For example, if there is no production capability at a particular cost, reply “0”. If data on production capability are not available, reply “NA”.

Mixed-oxide fuel production and use
(tonnes of natural U equivalent)

Mixed-oxide (MOX) fuels	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	0	0	0	NA	NA	NA
Use	NA	0	NA	NA	NA	NA
Number of commercial reactors using MOX	0	0	0	0	0	0

Re-enriched tails production and use
(tonnes of natural U equivalent)[1]

Re-enriched tails	**Total through end of 2005**	**2006**	**2007**	**2008**	**Total through end of 2008**	**2009** (expected)
Production	1 015.3	924.5	NA	NA	NA	NA
Use	0	0	NA	NA	NA	NA

[1] *Uranium 2007: Resources, Production and Demand*, OECD, Paris, 2008.

United States of America

Reprocessed uranium use
(tonnes of natural U equivalent)

Reprocessed uranium	Total through end of 2005	2006	2007	2008	Total through end of 2008	2009 (expected)
Production	0	0	0	NA	NA	NA
Use	0	0	0	NA	NA	NA

Net nuclear electricity generation[1, 2]

	2007	2008
Nuclear electricity generated (TWh net)	806.4[1]	806.2

[1] 2007 Electric Power Annual.
[2] April 2008 Electric Power Monthly.

Installed nuclear generating capacity to 2035
(MWe net)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
100 700	101 000	101 200	101 200	104 100	104 100

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
105 100	113 800	100 700	120 100	74 300	132 200	NA	NA

[1] *Nuclear Energy Data*, OECD, Paris, 2009.

Annual reactor-related uranium requirements to 2035 (excluding MOX)
(tonnes U)

2008	2009	2010		2015	
		Low	*High*	*Low*	*High*
16 424	16 157	17 528	17 528	19 871	19 871

2020		2025		2030		2035	
Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
18 559	19 951	18 051	21 077	13 124	23 464	NA	NA

Source: Submission from the *Nuclear Energy Data*, OECD, Paris, 2009, which used the 2007 Uranium Marketing Annual Report (UMAR).
2009 value: 2007 UMAR Table 12.

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government[1]	17 596	12 485	25 950	NA	56 031
Producer[2]	NA	NA	NA	NA	10 354
Utility[2]	22 588	8 919	NA	NA	31 507
Total	NA	NA	NA	NA	97 892

Sources:
[1] U.S. Department of Energy, *Excess Uranium Inventory Management Plan*, December 2008.
[2] *Uranium Market Annual Report 2008*, Tables 22 and 23.

Appendix 1

MEMBERS OF THE JOINT NEA-IAEA URANIUM GROUP

Algeria	Mr. S. CHEGROUCHE Ms. H. GUETTAF	Centre de recherche nucléaire de Draria (CRND), Draria
	Ms. N.F. BOURENAN	Ministère de l'Énergie et des Mines Alger
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Australia	Mr. I. LAMBERT **(Vice-Chair)** Mr. A. McKAY Ms. L. CARSON	Geoscience Australia, Canberra
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	Mr. P. PETROV Ms. S. ILKOVA	Ministry of Economy and Energy, Sofia
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China	Mr. Z. DECUN	Technical Science and Foreign Affairs Dept., China Nuclear Uranium Corporation (CNUC), Bejing
	Mr. W. Cong	Bureau of Geology, China National Nuclear Cooperation (CNNC), Beijing
Czech Republic	Mr. P. VOSTAREK	DIAMO s.p. Stráz pod Ralskem
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	Ms. S. GABRIEL	Commissariat à l'énergie atomique Direction de l'énergie nucléaire, Gif-sur-Yvette
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Germany	Mr. U. SCHWARZ-SCHAMPERA	Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover
Hungary	Mr. G. Németh	Paks Nuclear Power Plant, Paks
India	Mr. A. CHAKI Mr. A. AWATI	Atomic Minerals Directorate for Exploration and Research (AMD), Dept. of Atomic Energy, Hyderabad
Indonesia	Mr. J. BARATHA	National Nuclear Energy Agency, Jakarta
Iran, Islamic Republic of	Mr. F. YEGANI Mr. A. REZA	Atomic Energy Organisation of Iran, Tehran
Italy	Mr. F. VETTRAINO	ENEA – Nuclear Fission Division, Bologna
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	Mr. H. MIYADA	Japan Oil, Gas and Metals National Corporation, Kawasaki
	Mr. K. HISATANI	Japan Oil, Gas and Metals National Corporation, Kawasaki
	Mr. K. SAWANAKA	Japan Oil, Gas and Metals National Corporation, Kawasaki
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Kazakhstan	Mr. S. KABAYEV Ms. O. GORBATENKO	National Atomic Company "KAZATOMPROM", Almaty
Morocco	Mr. M. BENMANSOUR	Centre National de l'Énergie, des Sciences et des Techniques Nucléaires (CNESTEN), Kénitra
Namibia	Ms. H. ITAMBA Mr. E.I. SHIVOLO	Ministry of Mines and Energy, Windhoek
Nigeria	Mr. F. OSAISAI	Nigeria Atomic Energy Commission, Abuja
Pakistan	Mr. Kahlid BIN SATTAR	Pakistan Atomic Energy Commission, Atomic Energy Minerals Centre, Lahore

Romania	Mr. N. DUMITRESCU	Commission for Nuclear Activities Control, Bucharest
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	Mr. A.V. TARKHANOV Mr. O. KNJAZEV	All-Russian Institute of Chemical Technology, Ministry of Atomic Energy, Moscow
South Africa	Mr. L. AINSLEE	South Africa Nuclear Energy Corp. Corp. (NECSA), Pretoria
Spain	Mr. F. T. GARCIA	Enusa Industrias Avanzadas, S.A.
Switzerland	Mr. G. KLAIBER	Nordostschweizerische (NOK) Kraftwerke AG, Baden
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	Mr. L.GROMOK Mr. I. KOSHYK	Department for Nuclear Energy and Atomic Industry of Fuel and Energy
United Kingdom	Mr. K. WELHAM	Rio Tinto plc, London
United States	Mr. S. SITZER **(Vice-Chair)**	Energy Information Administration US Department of Energy, Washington
	Mr. J. OTTON Ms. S. HALL	US Geological Survey, Denver
Uzbekistan	Mr. H. HALMURZAEV	State Geological Enterprise "Kyzyltepageologia", Tashkent
Zambia	Mr. C. MUKOFU Mr. G. NDALAM	Ministry of Mines and Minerals Development, Mines Safety Department, Kitwe
European Commission	Mr. Z. PATAKI	Euratom Supply Agency, Luxembourg
IAEA	Mr. J. SLEZÁK **(Scientific Secretary)**	Division of Nuclear Fuel Cycle and Waste Technology, Vienna
OECD/NEA	Mr. R. VANCE **(Scientific Secretary)**	Nuclear Development Division, Paris

Appendix 2

LIST OF REPORTING ORGANISATIONS AND CONTACT PERSONS

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Australia	Geoscience Australia, GPO Box 378, Canberra, ACT 2601 Contact person: Mr. Aden D McKay
Belgium	Ministère des Affaires économiques, Administration de l'énergie, Division des applications nucléaires, 16 Boulevard du Roi Albert II, B-1000 Bruxelles Contact person: Ms. Françoise Renneboog (SYNATOM)
Botswana	Botswana Department of Radiation Protection, Private Bag BO1, Bontleng, Garborone, Botswana Contact person: Mr. Stephen Williams
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Iran, Islamic Rep. of	Atomic Energy Organisation of Iran, Nuclear Fuel Production Deputy, North Karegar Ave., P.O. Box 14155-1339, Tehran Contact person: Mr. Farrokhshad Yegani
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Niger	Ministère des Mines et de l'Énergie, B.P. 11700, Niamey Contact person: Mr. Massalabi Oumarou
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Appendix 3

GLOSSARY OF DEFINITIONS AND TERMINOLOGY

UNITS

Metric units are used in all tabulations and statements. Resources and production quantities are expressed in terms of tonnes (t) contained uranium (U) rather than uranium oxide (U_3O_8).

1 short ton U_3O_8	= 0.769 tU
1 percent U_3O_8	= 0.848 percent U
1 USD/lb U_3O_8	= USD 2.6/kg U
1 tonne	= 1 metric ton

RESOURCE TERMINOLOGY

Resource estimates are divided into separate categories reflecting different levels of confidence in the quantities reported. The resources are further separated into categories based on the cost of production.

a) Definitions of resource categories

Uranium resources are broadly classified as either conventional or unconventional. Conventional resources are those that have an established history of production where uranium is a primary product, co-product or an important by-product (e.g., from the mining of copper and gold). Very low-grade resources or those from which uranium is only recoverable as a minor by-product are considered unconventional resources.

Conventional resources are further divided, according to different confidence levels of occurrence, into four categories. The correlation between these resource categories and those used in selected national resource classification systems is shown in Figure A.

Reasonably Assured Resources (RAR) refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities which could be recovered within the given production cost ranges with currently proven mining and processing technology, can be specified. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics. Reasonably Assured Resources have a high assurance of existence. Unless otherwise noted, RAR are expressed in terms of quantities of uranium recoverable from mineable ore (see Recoverable Resources).

Inferred Resources (IR) refers to uranium, in addition to RAR, that is inferred to occur based on direct geological evidence, in extensions of well-explored deposits, or in deposits in which geological continuity has been established but where specific data, including measurements of the deposits, and knowledge of the deposit's characteristics, are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best known parts of the deposit or in similar deposits. Less reliance can be placed on the estimates in this category than on those for RAR. Unless otherwise noted, Inferred Resources are expressed in terms of quantities of uranium recoverable from mineable ore (see Recoverable Resources).

Figure A. **Approximate Correlation of Terms used in Major Resources Classification Systems**

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES		
NEA/IAEA	REASONABLY ASSURED		INFERRED	PROGNOSTICATED	SPECULATIVE	
Australia	DEMONSTRATED		INFERRED	UNDISCOVERED		
	MEASURED	INDICATED				
Canada (NRCan)	MEASURED	INDICATED	INFERRED	PROGNOSTICATED	SPECULATIVE	
United States (DOE)	REASONABLY ASSURED		ESTIMATED ADDITIONAL		SPECULATIVE	
Russian Federation, Kazakhstan, Ukraine, Uzbekistan	A + B	C 1	C 2	P1	P2	P3
UNFC[1]	G1 + G2		G3	G4	G4	

The terms illustrated are not strictly comparable as the criteria used in the various systems are not identical. "Grey zones" in correlation are therefore unavoidable, particularly as the resources become less assured. Nonetheless, the chart presents a reasonable approximation of the comparability of terms.

1. United Nations Framework Classification correlation with NEA/IAEA and national classification systems is still under consideration.

Prognosticated Resources (PR) refers to uranium, in addition to Inferred Resources, that is expected to occur in deposits for which the evidence is mainly indirect and which are believed to exist in well-defined geological trends or areas of mineralisation with known deposits. Estimates of tonnage, grade and cost of discovery, delineation and recovery are based primarily on knowledge of deposit characteristics in known deposits within the respective trends or areas and on such sampling, geological, geophysical or geochemical evidence as may be available. Less reliance can be placed on the estimates in this category than on those for Inferred Resources. Prognosticated Resources are normally expressed in terms of uranium contained in mineable ore, i.e., *in situ* quantities.

Speculative Resources (SR) refers to uranium, in addition to Prognosticated Resources, that is thought to exist, mostly on the basis of indirect evidence and geological extrapolations, in deposits discoverable with existing exploration techniques. The location of deposits envisaged in this category could generally be specified only as being somewhere within a given region or geological trend. As the term implies, the existence and size of such resources are speculative. SR are normally expressed in terms of uranium contained in mineable ore, i.e., *in situ* quantities.

b) Cost categories

The cost categories, in United States dollars (USD), used in this report are defined as: <USD 40/kgU, <USD 80/kgU, <USD 130/kgU, and <USD 20/kgU. All resource categories are defined in terms of costs of uranium recovered at the ore processing plant.

NOTE: It is not intended that the cost categories should follow fluctuations in market conditions.

Conversion of costs from other currencies into USD is done using an average exchange rate for the month of June in that year except for the projected costs for the year of the report, which uses the exchange rate of 1 January 2009 (Appendix 8).

When estimating the cost of production for assigning resources within these cost categories, account has been taken of the following costs:

- The direct costs of mining, transporting and processing the uranium ore.
- The costs of associated environmental and waste management during and after mining.
- The costs of maintaining non-operating production units where applicable.
- In the case of ongoing projects, those capital costs that remain non-amortised.
- The capital cost of providing new production units where applicable, including the cost of financing.
- Indirect costs such as office overheads, taxes and royalties where applicable.
- Future exploration and development costs wherever required for further ore delineation to the stage where it is ready to be mined.
- Sunk costs are not normally taken into consideration.

c) Relationship between resource categories

Figure B illustrates the inter-relationship between the different resource categories. The horizontal axis expresses the level of assurance about the actual existence of a given tonnage based on varying degrees of geologic knowledge while the vertical axis expresses the economic feasibility of exploitation by the division into cost categories.

Figure B. **NEA/IAEA Classification Scheme for Uranium Resources**

		IDENTIFIED RESOURCES		UNDISCOVERED RESOURCES	
Recoverable at costs	<USD 40/kgU	REASONABLY ASSURED RESOURCES	INFERRED RESOURCES	PROGNOSTICATED RESOURCES	SPECULATIVE RESOURCES
	USD 40-80/kgU	REASONABLY ASSURED RESOURCES	INFERRED RESOURCES	PROGNOSTICATED RESOURCES	
	USD 80-130/kgU	REASONABLY ASSURED RESOURCES	INFERRED RESOURCES	PROGNOSTICATED RESOURCES	
	USD 130-260/kgU	REASONABLY ASSURED RESOURCES	INFERRED RESOURCES	PROGNOSTICATED RESOURCES	

Decreasing economic attractiveness

Decreasing confidence in estimates

d) Recoverable resources

RAR and IR estimates are expressed in terms of recoverable tonnes of uranium, i.e. quantities of uranium recoverable from mineable ore, as opposed to quantities contained in mineable ore, or quantities *in situ*, i.e., not taking into account mining and milling losses. Therefore both expected mining and ore processing losses have been deducted in most cases. If a country reports its resources as *in situ* and the country does not provide a recovery factor, the Secretariat assigns a recovery factor to those resources based on geology and projected mining and processing methods to determine recoverable resources. The recovery factors that have been applied are:

Mining and milling method	**Overall recovery factor** (%)
Open-pit mining with conventional milling	80
Underground mining with conventional milling	75
ISL (acid)	75
ISL (alkaline)	70
Heap leaching	70
Block and stope leaching	75
Co-product or by-product	65
Unspecified method	75

SECONDARY SOURCES OF URANIUM TERMINOLOGY

a) Mixed oxide fuel (MOX): MOX is the abbreviation for a fuel for nuclear power plants that consists of a mixture of uranium oxide and plutonium oxide. Current practice is to use a mixture of depleted uranium oxide and plutonium oxide.

b) Depleted uranium: Uranium where the ^{235}U assay is below the naturally occurring 0.7110%. (Natural uranium is a mixture of three isotopes, uranium 238 – accounting for 99.2836%, uranium 235 – 0.7110%, and uranium 234 – 0.0054%). Depleted uranium is a by-product of the enrichment process, where enriched uranium is produced from initial natural uranium feed material.

PRODUCTION TERMINOLOGY[2]

a) Production centres: A production centre, as referred to in this report, is a production unit consisting of one or more ore processing plants, one or more associated mines and uranium resources that are tributary to these facilities. For the purpose of describing production centres, they have been divided into four classes, as follows:

i) **Existing** production centres are those that currently exist in operational condition and include those plants which are closed down but which could be readily brought back into operation.

ii) **Committed** production centres are those that are either under construction or are firmly committed for construction.

2. IAEA (1984), *Manual on the Projection of Uranium Production Capability*, General Guidelines, Technical Report Series No. 238, Vienna, Austria.

iii) **Planned** production centres are those for which feasibility studies are either completed or under way, but for which construction commitments have not yet been made. This class also includes those plants that are closed which would require substantial expenditures to bring them back into operation.

iv) **Prospective** production centres are those that could be supported by tributary RAR and Inferred, i.e., "Identified Resources", but for which construction plans have not yet been made.

b) Production capacity and capability

Production capacity: Denotes the nominal level of output, based on the design of the plant and facilities over an extended period, under normal commercial operating practices.

Production capability: Refers to an estimate of the level of production that could be practically and realistically achieved under favourable circumstances from the plant and facilities at any of the types of production centres described above, given the nature of the resources tributary to them. Projections of production capability are supported only by RAR and/or IR. The projection is presented based on those resources recoverable at costs <USD 130/kgU.

Production: Denotes the amount of uranium output, in tonnes U contained in concentrate, from an ore processing plant or production centre (with milling losses deducted).

c) Mining and milling

***In situ* leaching (ISL)**: The extraction of uranium from sandstone using chemical solutions and the recovery of uranium at the surface. ISL extraction is conducted by injecting a suitable uranium-dissolving leach solution (acid or alkaline) into the ore zone below the water table thereby oxidising, complexing, and mobilising the uranium; then recovering the pregnant solutions through production wells, and finally pumping the uranium bearing solution to the surface for further processing. This process is sometime referred to as ***In situ* recovery (ISR)**.

Heap leaching (HL): Heaps of ore are formed over a collecting system underlain by an impervious membrane. Dilute sulphuric acid solutions are distributed over the top surface of the ore. As the solutions seep down through the heap, they dissolve a significant (50-75%) amount of the uranium in the ore. The uranium is recovered from the heap leach product liquor by ion exchange or solvent extraction.

In place leaching (IPL): involves leaching of broken ore without removing it from an underground mine. This is also sometimes referred to as stope leaching or block leaching.

Co-product: Uranium is a co-product when it is one of two commodities that must be produced to make a mine economic. Both commodities influence output, for example, uranium and copper are co-produced at Olympic Dam in Australia. Co-product uranium is produced using either the open-pit or underground mining methods.

By-product: Uranium is considered a by-product when it is a secondary or additional product. By-product uranium can be produced in association with a main product or with co-products, e.g., uranium recovered from the Palabora copper mining operations in South Africa. By-product uranium is produced using either the open-pit or underground mining methods.

Uranium from phosphate rocks: Uranium has been recovered as a by-product of phosphoric acid production. Uranium is separated from phosphoric acid by a solvent extraction process. The most frequently used reagent is a synergetic mixture of Tri-m-Octyl Phosphine Oxide (TOPO) and Di 2-Ethylhexyl Phosphoric Acid (DEPA).

Ion exchange (IX): Reversible exchange of ions contained in a host material for different ions in solution without destruction of the host material or disturbance of electrical neutrality. The process is accomplished by diffusion and occurs typically in crystals possessing – one or two – dimensional channels where ions are weakly bonded. It also occurs in resins consisting of three-dimensional hydrocarbon networks to which are attached many ionisable groups. Ion exchange is used for recovering uranium from leaching solutions.

Solvent extraction (SX): A method of separation in which a generally aqueous solution is mixed with an immiscible solvent to transfer one or more components into the solvent. This method is used to recover uranium from leaching solutions.

DEMAND TERMINOLOGY

a) Reactor-related requirements: Refers to natural uranium acquisitions *not* necessarily consumption during a calendar year.

ENVIRONMENTAL TERMINOLOGY[3]

a) Close-out: In the context of uranium mill tailings impoundment, the operational, regulatory and administrative actions required to place a tailings impoundment into long-term conditions such that little or no future surveillance and maintenance are required.

b) Decommissioning: Actions taken at the end of the operating life of a uranium mill or other uranium facility in retiring it from service with adequate regard for the health and safety of workers and members of the public and protection of the environment. The time period to achieve decommissioning may range from a few to several hundred years.

c) Decontamination: The removal or reduction of radioactive or toxic chemical contamination using physical, chemical, or biological processes.

d) Dismantling: The disassembly and removal of any structure, system or component during decommissioning. Dismantling may be performed immediately after permanent retirement of a mine or mill facility or may be deferred.

e) Environmental restoration: Cleanup and restoration, according to predefined criteria, of sites contaminated with radioactive and/or hazardous substances during past uranium production activities.

f) Environmental impact statement: A set of documents recording the results of an evaluation of the physical, ecological, cultural and socio-economic effects of a planned installation, facility, or technology.

3. Definitions based on those published in OECD (2002), *Environmental Remediation of Uranium Production Facilities*, Paris.

g) Groundwater restoration: The process of returning affected groundwater to acceptable quality and quantity levels for future use.

h) Reclamation: The process of restoring a site to predefined conditions, which allows new uses.

i) Restricted release (or use): A designation, by the regulatory body of a country, that restricts the release or use of equipment, buildings, materials or the site because of its potential radiological or other hazards.

j) Tailings: The remaining portion of a metal-bearing ore consisting of finely ground rock and process liquids after some or all of the metal, such as uranium, has been extracted.

k) Tailings impoundment: A structure in which the tailings are deposited to prevent their release into the environment.

l) Unrestricted release (or use): A designation, by the regulatory body of a country, that enables the release or use of equipment, buildings, materials or the site without any restriction.

GEOLOGICAL TERMINOLOGY

a) Uranium occurrence: A naturally occurring, anomalous concentration of uranium.

b) Uranium deposit: A mass of naturally occurring mineral from which uranium could be exploited at present or in the future.

c) Geologic types of uranium deposits[4]

Uranium resources can be assigned on the basis of their geological setting to the following categories of uranium ore deposit types (arranged according to their approximate economic significance):

1. Unconformity-related deposits.
2. Sandstone deposits.
3. Hematite breccia complex deposits.
4. Quartz-pebble conglomerate deposits.
5. Vein deposits.
6. Intrusive deposits.
7. Volcanic and caldera-related deposits.
8. Metasomatite deposits.
9. Surficial deposits.
10. Collapse breccia pipe deposits.
11. Phosphorite deposits.
12. Other types of deposits.
13. Rock types with elevated uranium content.

1. Unconformity-related deposits: Unconformity-related deposits are associated with and occur immediately below and above an unconformable contact that separates a crystalline basement intensively altered from overlying clastic sediments of either Proterozoic or Phanerozoic age.

The unconformity-related deposits include the following sub-types:

4. This classification of the geological types of uranium deposits was developed by the IAEA in 1988-89 and updated for use in the Red Book.

- *Unconformity contact*

  i. Fracture bound deposits occur in metasediments immediately below the unconformity. Mineralisation is monometallic and of medium grade. Examples include Rabbit Lake and Dominique Peter in the Athabasca Basin, Canada.

  ii. Clay-bound deposits occur associated with clay at the base of the sedimentary cover directly above the unconformity. Mineralisation is commonly polymetallic and of high to very high grade. An example is Cigar Lake in the Athabasca Basin, Canada.

- *Sub-unconformity-post-metamorphic deposits*
  Deposits are strata-structure bound in metasediments below the unconformity on which clastic sediments rest. These deposits can have large resources, at low to medium grade. Examples are Jabiluka and Ranger in Australia.

2. **Sandstone deposits:** Sandstone uranium deposits occur in medium to coarse-grained sandstones deposited in a continental fluvial or marginal marine sedimentary environment. Uranium is precipitated under reducing conditions caused by a variety of reducing agents within the sandstone, for example, carbonaceous material, sulphides (pyrite), hydrocarbons and ferro-magnesium minerals (chlorite), etc. Sandstone uranium deposits can be divided into four main sub-types:

- *Roll-front deposits*: The mineralised zones are convex down the hydrologic gradient. They display diffuse boundaries with reduced sandstone on the down-gradient side and sharp contacts with oxidised sandstone on the up-gradient side. The mineralised zones are elongate and sinuous approximately parallel to the strike, and perpendicular to the direction of deposition and groundwater flow. Resources can range from a few hundred tonnes to several thousands of tonnes of uranium, at grades averaging 0.05-0.25%. Examples are Moynkum, Inkay and Mynkuduk (Kazakhstan); Crow Butte and Smith Ranch (United States) and Bukinay, Sugraly and Uchkuduk (Uzbekistan).

- *Tabular deposits* consist of uranium matrix impregnations that form irregularly shaped lenticular masses within reduced sediments. The mineralised zones are largely oriented parallel to the depositional trend. Individual deposits can contain several hundreds of tonnes up to 150 000 tonnes of uranium, at average grades ranging from 0.05-0.5%, occasionally up to 1%. Examples of deposits include Westmoreland (Australia), Nuhetting (China), Hamr-Stráz (Czech Republic), Akouta, Arlit, Imouraren (Niger) and Colorado Plateau (United States).

- *Basal channel deposits*: Paleodrainage systems consist of several hundred metres wide channels filled with thick permeable alluvial-fluvial sediments. Here, the uranium is predominantly associated with detrital plant debris in ore bodies that display, in a plan-view, an elongated lens or ribbon-like configuration and, in a section-view, a lenticular or, more rarely, a roll shape. Individual deposits can range from several hundreds to 20 000 tonnes uranium, at grades ranging from 0.01-3%. Examples are the deposits of Dalmatovskoye (Transural Region), Malinovskoye (West Siberia), Khiagdinskoye (Vitim district) in Russia and Beverley in Australia.

- *Tectonic/lithologic deposits* occur in sandstone related to a permeable zone. Uranium is precipitated in open zones related to tectonic extension. Individual deposits contain a few hundred tonnes up to 5 000 tonnes of uranium at average grades ranging from 0.1-0.5%. Examples include the deposits of Mas Laveyre (France) and Mikouloungou (Gabon).

3. **Hematite breccia complex deposits:** Deposits of this group occur in hematite-rich breccias and contain uranium in association with copper, gold, silver and rare earths. The main representative of this type of deposit is the Olympic Dam deposit in South Australia. Significant deposits and prospects of this type occur in the same region, including Prominent Hill, Wirrda Well, Acropolis and Oak Dam as well as some younger breccia-hosted deposits in the Mount Painter area.

4. **Quartz-pebble conglomerate deposits:** Detrital uranium oxide ores are found in quartz-pebble conglomerates deposited as basal units in fluvial to lacustrine braided stream systems older than 2.3-2.4 Ga. The conglomerate matrix is pyritiferous, and gold, as well as other oxide and sulphide detrital minerals are often present in minor amounts. Examples include deposits found in the Witwatersrand Basin where uranium is mined as a by-product of gold. Uranium deposits of this type were mined in the Blind River/Elliot Lake area of Canada.

5. **Vein deposits:** In vein deposits, the major part of the mineralisation fills fractures with highly variable thickness, but generally important extension along strike. The veins consist mainly of gangue material (e.g. carbonates, quartz) and ore material, mainly pitchblende. Typical examples range from the thick and massive pitchblende veins of Pribram (Czech Republic), Schlema-Alberoda (Germany) and Shinkolobwe (Democratic Republic of Congo), to the stockworks and episyenite columns of Bernardan (France) and Gunnar (Canada), to the narrow cracks in granite or metamorphic rocks, also filled with pitchblende of Mina Fe (Spain) and Singhbhum (India).

6. **Intrusive deposits:** Deposits included in this type are those associated with intrusive or anatectic rocks of different chemical composition (alaskite, granite, monzonite, peralkaline syenite, carbonatite and pegmatite). Examples include the Rossing and Trekkopje deposits (Namibia), the uranium occurrences in the porphyry copper deposits such as Bingham Canyon and Twin Butte (United States), the Ilimaussaq deposit (Greenland), Palabora (South Africa), as well as the deposits in the Bancroft area (Canada).

7. **Volcanic and caldera-related deposits**: Uranium deposits of this type are located within and nearby volcanic caldera filled by mafic to felsic volcanic complexes and intercalated clastic sediments. Mineralisation is largely controlled by structures (minor stratabound), occurs at several stratigraphic levels of the volcanic and sedimentary units and extends into the basement where it is found in fractured granite and in metamorphites. Uranium minerals are commonly associated with molybdenum, other sulphides, violet fluorine and quartz. Most significant commercial deposits are located within Streltsovsk caldera in the Russian Federation. Examples are known in China, Mongolia (Dornot deposit), Canada (Michelin deposit) and Mexico (Nopal deposit).

8. **Metasomatite deposits**: Deposits of this type are confined to the areas of tectono-magmatic activity of the Precambrian shields and are related to near-fault alkali metasomatites, developed upon different basement rocks: granites, migmatites, gneisses and ferruginous quartzites with production of albitites, aegirinites, alkali-amphibolic and carbonaceous-ferruginous rocks. Ore lenses and stocks are a few metres to tens of metres thick and a few hundred metres long. Vertical extent of ore mineralisation can be up to 1.5 km. Ores are uraninite-brannerite by composition and belong to ordinary grade. The reserves are usually medium scale or large. Examples include Michurinskoye, Vatutinskoye, Severinskoye, Zheltorechenskoye and Pervomayskoye deposits (Ukraine), Lagoa Real, Itataia and Espinharas (Brazil), the Valhalla deposit (Australia) and deposits of the Arjeplog region in the north of Sweden.

9. **Surficial deposits:** Surficial uranium deposits are broadly defined as young (Tertiary to Recent) near–surface uranium concentrations in sediments and soils. The largest of the surficial uranium deposits are

in calcrete (calcium and magnesium carbonates), and they have been found in Australia (Yeelirrie deposit), Namibia (Langer Heinrich deposit) and Somalia. These calcrete-hosted deposits are associated with deeply weathered uranium-rich granites. They also can occur in valley-fill sediments along Tertiary drainage channels and in playa lake sediments (e.g., Lake Maitland, Australia). Surficial deposits also can occur in peat bogs and soils.

10. **Collapse breccia pipe deposits:** Deposits in this group occur in circular, vertical pipes filled with down-dropped fragments. The uranium is concentrated as primary uranium ore, generally uraninite, in the permeable breccia matrix, and in the arcuate, ring-fracture zone surrounding the pipe. Type examples are the deposits in the Arizona Strip north of the Grand Canyon and those immediately south of the Grand Canyon in the United States.

11. **Phosphorite deposits**: Phosphorite deposits consist of marine phosphorite of continental-shelf origin containing syn-sedimentary stratiform, disseminated uranium in fine-grained apatite. Phosphorite deposits constitute large uranium resources, but at a very low grade. Uranium can be recovered as a by-product of phosphate production. Examples include New Wales Florida (pebble phosphate) and Uncle Sam (United States), Gantour (Morocco) and Al-Abiad (Jordan). Other type of phosphorite deposits consists of organic phosphate, including argillaceous marine sediments enriched in fish remains that are uraniferous (Melovoe deposit, Kazakhstan).

12. **Other deposits**

    Metamorphic deposits: In metamorphic uranium deposits, the uranium concentration directly results from metamorphic processes. The temperature and pressure conditions, and age of the uranium deposition have to be similar to those of the metamorphism of the enclosing rocks. Examples include the Forstau deposit (Austria) and Mary Kathleen (Australia).

    Limestone deposits: This includes uranium mineralisation in the Jurassic Todilto Limestone in the Grants district (United States). Uraninite occurs in intra-formational folds and fractures as introduced mineralisation.

    Uranium coal deposits: Elevated uranium contents occur in lignite/coal, and in clay and sandstone immediately adjacent to lignite. Examples are uranium in the Serres Basin (Greece), in North and South Dakota (United States), Koldjat and Nizhne Iliyskoe (Kazakhstan) and Freital (Germany). Uranium grades are very low and average less than 50 ppm U.

13. **Rock types with elevated uranium contents:** Elevated uranium contents have been observed in different rock types such as pegmatite, granites and black shale. In the past no economic deposits have been mined commercially in these types of rocks. Their grades are very low, and it is unlikely that they will be economic in the foreseeable future.

    Rare metal pegmatites: These pegmatites contain Sn, Ta, Nb and Li mineralisation. They have variable U, Th and rare earth elements contents. Examples include Greenbushes and Wodgina pegmatites (Western Australia). The Greenbushes pegmatites commonly have 6-20 ppm U and 3-25 ppm Th.

    Granites: A small proportion of un-mineralised granitic rocks have elevated uranium contents. These "high heat producing" granites are potassium feldspar-rich. Roughly 1% of the total number of granitic rocks analysed in Australia have uranium-contents above 50 ppm.

    Black Shale: Black shale-related uranium mineralisation consists of marine organic-rich shale or coal-rich pyritic shale, containing syn-sedimentary disseminated uranium adsorbed onto organic material. Examples include the uraniferous alum shale in Sweden and Estonia, the Chatanooga shale (United States), the Chanziping deposit (China), and the Gera-Ronneburg deposit (Germany).

Appendix 4

ACRONYM LIST

AGR	Advanced gas-cooled reactor
AL	Acid leaching
ALKAL	Alkaline atmospheric leaching
BWR	Boiling water reactor
CANDU	***Can***adian ***d***euterium ***u***ranium
CEC	Commission of the European Communities
CWG	Crush-wet grind
DOE	Department of Energy (United States)
EIA	U.S. Energy Information Administration
EU	European Union
EUP	Enriched uranium product
FLOT	Flotation
Ga	Giga-years
GDR	German Democratic Republic
GIF	Generation IV International Forum
GNSS	Global Nuclear Services and Supply
GWe	Gigawatt electric
HEU	Highly Enriched Uranium
HL	Heap leaching
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
INPRO	International project on innovative nuclear reactors and fuel cycles
IPL	In place leaching
ISL	*In situ* leaching
IX	Ion exchange
kg	Kilograms
km	Kilometre
LEU	Low enriched uranium
LWR	Light water reactor
MAGNOX	Magnesium oxide
MOX	Mixed oxide fuel

MWe	Megawatt electric
NEA	Nuclear Energy Agency
OECD	Organisation for Economic Co-operation and Development
OP	Open-pit
ppm	Part per million
Pu	Plutonium
PHWR	Pressurised heavy-water reactor
PWR	Pressurised water reactor
RAR	Reasonably assured resources
RBMK	Water-cooled, graphite-moderated reactor (Russian acronym)
SWU	Separative work unit
SX	Solvent extraction
t	Tonnes (metric tons)
Th	Thorium
tHM	Tonnes heavy metal
TOE	Tonnes oil equivalent
tU	Tonnes uranium
TVA	Tennessee Valley Administration
TWh	Terrawatt-hour
U	Uranium
UG	Underground mining
USSR	Union of Soviet Socialist Republics
VVER	Water-cooled, water-moderated reactor (Russian acronym)

Appendix 5

ENERGY CONVERSION FACTORS

The need to establish a set of factors to convert quantities of uranium into common units of energy appeared during recent years with the increasing frequency of requests for such factors applying to the various reactor types.

ENERGY VALUES FOR URANIUM USED IN VARIOUS RECTOR TYPES[1]

Country	Canada	France	Germany		Japan		Russian Federation		Sweden		United Kingdom		United States	
Reactor type	CANDU	N4 PWR	BWR	PWR	BWR	PWR	VVER-1000	RBMK -1000	BWR	PWR	MAGNOX	AGR	BWR	PWR
Burn-up [Mw/day/tU]														
a) Natural uranium or natural uranium equivalent	7 770	5 848	5 665	5 230	5 532	4 694	4 855	4 707	6 250	5 780	5 900	NA	4 996	4 888
b) Enriched uranium	–	42 500	40 000	42 000	33 000	43 400	42 000	22 000	40 000	42 000	–	24 000	33 000	40 000
Uranium enrichment [%^{235}U]	–	3.60	3.2	3.60	3.00	4.10	4.23	2.40	3.20	3.60	–	2.90	3.02	3.66
Tails assay [%^{235}U]	–	0.25	0.30	0.30	0.25	0.30	0.25	0.25	0.25	0.25	–	0.30	0.30	0.30
Efficiency of converting thermal energy into electricity	30%	34.60%	33.50%	34.20%	33%	34%	33.30%	31.20%	34.00%	34.50%	26%	40%	32%	32%
Thermal energy equivalent of 1 t natural uranium [in 10^{15} joules][2]	0.671	0.505	0.490	0.452	0.478	0.406	0.419	0.406	0.540	0.500	0.512	0.360	0.432	0.422
Electrical energy equivalent of 1 t natural uranium [in 10^{15} joules][2]	0.201	0.175	0.164	0.155	0.158	0.140	0.139	0.127	0.184	0.173	0.133	0.144	0.138	0.135

1. Does not include Pu and U recycled. Does not take into account the requirement of an initial core load, which would reduce the equivalence by about 6%, if based on a plant life of about 30 years with a 70% capacity factor.
2. Does not take into account the energy consumed for ^{235}U enrichment in LWR and AGR fuel. The factor to be applied to the energy equivalent under the condition of 3% ^{235}U enrichment and 0.2% tails assay should be multiplied by 0.957.

NA Not available.

Conversion Factors and Energy Equivalence for Fossil Fuel for Comparison

1 cal		=	4.1868 J
1 J		=	0.239 cal
1 tonne of oil equivalent (TOE)(net, LHV)		=	42 GJ* = 1 TOE
1 tonne of coal equivalent (TCE)(standard, LHV)		=	29.3 GJ* = 1 TCE
1 000 m^3 of natural gas (standard, LHV)		=	36 GJ
1 tonne of crude oil		=	approx. 7.3 barrels
1 tonne of liquid natural gas (LNG)		=	45 GJ
1 000 kWh (primary energy)		=	9.36 MJ
1 TOE		=	10 034 Mcal
1 TCE		=	7 000 Mcal
1 000 m^3 natural gas		=	8 600 Mcal
1 tonne LNG		=	11 000 Mcal
1 000 kWh (primary energy)		=	2 236 Mcal**
1 TCE		=	0.698 TOE
1 000 m^3 natural gas		=	0.857 TOE
1 tonne LNG		=	1.096 TOE
1 000 kWh (primary energy)		=	0.223 TOE
1 tonne of fuelwood		=	0.3215 TOE
1 tonne of uranium:	light water reactors	=	10 000-16 000 TOE
	open cycle	=	14 000-23 000 TCE

* World Energy Council standard conversion factors (from WEC, 1998 Survey of Energy Resources, 18th Edition).

** With 1 000kWh (final consumption) = 860 Mcal as WEC conversion factor.

Appendix 6

LISTING OF ALL RED BOOK EDITIONS (1965-2010) AND NATIONAL REPORTS

Listing of Red Book editions (1965-2010)

1.	OECD/ENEA	World Uranium and Thorium Resources, Paris, 1965
2.	OECD/ENEA	Uranium Resources, Revised Estimates, Paris, 1967
3.	OECD/ENEA-IAEA	Uranium Production and Short-Term Demand, Paris, 1969
4.	OECD/ENEA-IAEA	Uranium Resources, Production and Demand, Paris, 1970
5.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1973
6.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1976
7.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1977
8.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1979
9.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1982
10.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1983
11.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1986
12.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1988
13.	OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1990
14.	OECD/NEA-IAEA	Uranium 1991: Resources, Production and Demand, Paris, 1992
15.	OECD/NEA-IAEA	Uranium 1993: Resources, Production and Demand, Paris, 1994
16.	OECD/NEA-IAEA	Uranium 1995: Resources, Production and Demand, Paris, 1996
17.	OECD/NEA-IAEA	Uranium 1997: Resources, Production and Demand, Paris, 1998
18.	OECD/NEA-IAEA	Uranium 1999: Resources, Production and Demand, Paris, 2000
19.	OECD/NEA-IAEA	Uranium 2001: Resources, Production and Demand, Paris, 2002
20.	OECD/NEA-IAEA	Uranium 2003: Resources, Production and Demand, Paris, 2004
21.	OECD/NEA-IAEA	Uranium 2005: Resources, Production and Demand, Paris, 2006
22.	OECD/NEA-IAEA	Uranium 2007: Resources, Production and Demand, Paris, 2008
23.	OECD/NEA-IAEA	Uranium 2009: Resources, Production and Demand, Paris, 2010

INDEX OF NATIONAL REPORTS IN RED BOOKS

(The following index lists all national reports by the year in which these reports were published in the Red Books. A listing of all Red Book editions is shown at the end of this Index)

	1965	**1967**	**1969**	**1970**	**1973**	**1976**	**1977**	**1979**	**1982**	**1983**	**1986**
Algeria						1976	1977	1979	1982		
Argentina		1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Armenia											
Australia		1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Austria							1977				
Bangladesh											1986
Belgium									1982	1983	1986
Benin											
Bolivia							1977	1979	1982	1983	1986
Botswana								1979		1983	1986
Brazil				1970	1973	1976	1977	1979	1982	1983	1986
Bulgaria											
Cameroon							1977		1982	1983	
Canada	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Central African Republic				1970	1973		1977	1979			1986
Chile							1977	1979	1982	1983	1986
China											
Colombia							1977	1979	1982	1983	1986
Costa Rica									1982	1983	1986
Côte d'Ivoire									1982		
Cuba											
Czech Rep.											
Czech and Slovak Rep.											
Denmark (Greenland)	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Dominican Republic									1982		
Ecuador							1977		1982	1983	1986
Egypt							1977	1979			1986
El Salvador										1983	1986
Estonia											
Ethiopia								1979		1983	1986
Finland					1973	1976	1977	1979	1982	1983	1986
France	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Gabon		1967		1970	1973				1982	1983	1986
Germany				1970		1976	1977	1979	1982	1983	1986
Ghana							1977			1983	
Greece							1977	1979	1982	1983	1986
Guatemala											1986

INDEX OF NATIONAL REPORTS IN RED BOOKS (contd.)

1988	**1990**	**1992**	**1994**	**1996**	**1998**	**2000**	**2002**	**2004**	**2006**	**2008**	**2010**	
							2002	2004	2006	2008		Algeria
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Argentina
						2000	2002	2004	2006		2010	Armenia
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Australia
												Austria
1988												Bangladesh
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008		Belgium
	1990											Benin
												Bolivia
1988											2010	Botswana
		1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Brazil
	1990	1992	1994	1996	1998					2008	2010	Bulgaria
												Cameroon
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Canada
												Central African Republic
1988		1992	1994	1996	1998	2000	2002	2004	2006	2008		Chile
	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	China
1988	1990			1996	1998					2008		Colombia
1988	1990											Costa Rica
												Côte d'Ivoire
1988		1992		1996	1998							Cuba
			1994	1996	1998	2000	2002	2004	2006	2008	2010	Czech Rep.
	1990											Czech and Slovak Rep.
	1990	1992		1996	1998			2004			2010	Denmark (Greenland)
												Dominican Republic
1988												Ecuador
1988	1990	1992	1994	1996	1998	2000		2004	2006	2008	2010	Egypt
												El Salvador
					1998			2004				Estonia
												Ethiopia
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Finland
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	France
				1996	1998	2000	2002	2004	2006			Gabon
1988	1990	1992	1994	1996	1998	2000	2002		2006	2008	2010	Germany
												Ghana
1988	1990	1992	1994	1996	1998							Greece
1988												Guatemala

INDEX OF NATIONAL REPORTS IN RED BOOKS (contd.)

	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Guyana								1979	1982	1983	1986
Hungary											
India	1965	1967		1970	1973	1976	1977	1979	1982	1983	1986
Indonesia							1977				1986
Iran, Islamic Republic of							1977				
Ireland								1979	1982	1983	1986
Italy		1967		1970	1973	1976	1977	1979	1982	1983	1986
Jamaica									1982	1983	
Japan	1965	1967		1970	1973	1976	1977	1979	1982	1983	1986
Jordan							1977				1986
Kazakhstan											
Korea, Rep. of						1976	1977	1979	1982	1983	1986
Kyrgyzstan											
Lesotho											
Liberia							1977			1983	
Libyan Arab Jamahirya										1983	
Lithuania											
Madagascar						1976	1977	1979	1982	1983	1986
Malawi											
Malaysia										1983	1986
Mali											1986
Mauritania											
Mexico				1970	1973	1976	1977	1979	1982		1986
Mongolia											
Morocco	1965	1967				1976	1977	1979	1982	1983	1986
Namibia								1979	1982	1983	1986
Netherlands									1982	1983	1986
New Zealand		1967					1977	1979			
Niger		1967		1970	1973		1977				1986
Nigeria								1979			
Norway								1979	1982	1983	
Pakistan		1967									
Panama										1983	
Paraguay										1983	1986
Peru							1977	1979		1983	1986
Philippines							1977		1982	1983	1986
Poland											
Portugal	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Romania											
Russian Fed.											
Rwanda											1986
Senegal									1982		
Slovak Rep.											
Slovenia											
Somalia							1977	1979			

INDEX OF NATIONAL REPORTS IN RED BOOKS (contd.)

1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	
												Guyana
		1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Hungary
	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	India
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006		2010	Indonesia
					1998	2000	2002	2004	2006	2008	2010	Iran, Islamic Republic of
		1992			1998							Ireland
1988		1992	1994	1996	1998	2000						Italy
												Jamaica
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Japan
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Jordan
			1994	1996	1998	2000	2002	2004	2006	2008	2010	Kazakhstan
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Korea, Rep. of
				1996			2002					Kyrgyzstan
1988												Lesotho
												Liberia
												Libyan Arab Jamahirya
			1994	1996	1988	2000	2002	2004	2006	2008		Lithuania
1988												Madagascar
						2000				2008	2010	Malawi
1988	1990	1992	1994	1996	1998	2000	2002					Malaysia
1988												Mali
	1990											Mauritania
	1990	1992	1994	1996	1998	2000						Mexico
			1994	1996	1998							Mongolia
1988	1990				1998						2010	Morocco
1988	1990			1996	1998	2000	2002	2004	2006	2008	2010	Namibia
	1990	1992	1994	1996	1998	2000	2002					Netherlands
												New Zealand
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Niger
												Nigeria
		1992		1996	1998							Norway
					1998	2000	2002					Pakistan
1988												Panama
												Paraguay
1988	1990	1992	1994	1996	1998	2000		2004	2006	2008	2010	Peru
	1990		1994	1996	1998	2000	2002	2004	2006			Philippines
						2000	2002			2008	2010	Poland
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Portugal
		1992	1994	1996	1998	2000	2002					Romania
			1994		1998	2000	2002	2004	2006	2008	2010	Russian Fed.
												Rwanda
												Senegal
			1994	1996	1998	2000	2002	2004	2006	2008	2010	Slovak Rep.
			1994	1996	1998		2002	2004	2006	2008	2010	Slovenia
												Somalia

INDEX OF NATIONAL REPORTS IN RED BOOKS (contd.)

	1965	**1967**	**1969**	**1970**	**1973**	**1976**	**1977**	**1979**	**1982**	**1983**	**1986**
South Africa	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Spain	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Sri Lanka							1977		1982	1983	1986
Sudan							1977				
Surinam									1982	1983	
Sweden	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Switzerland						1976	1977	1979	1982	1983	1986
Syrian Arab Rep.									1982	1983	1986
Tajikistan											
Tanzania											
Thailand							1977	1979	1982	1983	1986
Togo								1979			
Turkey					1973	1976	1977	1979	1982	1983	1986
Turkmenistan											
Ukraine											
United Kingdom						1976	1977	1979	1982	1983	1986
United States	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986
Uruguay							1977		1982	1983	1986
USSR											
Uzbekistan											
Venezuela											1986
Vietnam											
Yugoslavia					1973	1976	1977		1982		
Zaire		1967			1973		1977				
Zambia											1986
Zimbabwe									1982		

INDEX OF NATIONAL REPORTS IN RED BOOKS (contd.)

1988	**1990**	**1992**	**1994**	**1996**	**1998**	**2000**	**2002**	**2004**	**2006**	**2008**	**2010**	
		1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	South Africa
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Spain
1988												Sri Lanka
												Sudan
												Surinam
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Sweden
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008		Switzerland
1988	1990		1994									Syrian Arab Rep.
							2002					Tajikistan
	1990										2010	Tanzania
1988	1990	1992	1994	1996	1998	2000	2002		2006			Thailand
												Togo
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	Turkey
								2004				Turkmenistan
			1994	1996	1998	2000	2002	2004	2006	2008	2010	Ukraine
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	United Kingdom
1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	United States
1988	1990											Uruguay
		1992										USSR
			1994	1996	1998	2000	2002	2004	2006			Uzbekistan
1988												Venezuela
		1992	1994	1996	1998	2000	2002	2004	2006	2008		Vietnam
	1990	1992										Yugoslavia
1988												Zaire
1988	1990	1992	1994	1996	1998							Zambia
1988		1992	1994	1996	1998							Zimbabwe

Appendix 7

CURRENCY EXCHANGE RATES*
(in national currency units per USD)

COUNTRY (currency abbreviation)	**June 2006**	**June 2007**	**June 2008**	**January 2009**
Algeria (DZD)	70.32	69.28	63.26	69.32
Argentina (ARS)	3.08	3.08	3.12	3.43
Armenia (AMD)	440	348	308.83	307.5
Australia (AUD)	1.31	1.21	1.042	1.437
Austria (EURO)	0.778	0.744	0.643	0.699
Belgium (EURO)	0.778	0.744	0.643	0.699
Botswana (BWP)	5.53	6.05	6.32	7.52
Brazil (BRL)	2.19	1.93	1.648	2.37
Bulgaria (BGN)	1.51	1.46	1.258	1.367
Canada (CAD)	1.1	1.07	0.983	1.219
Chile (CLP)	524	520	470	622
China (CNY)	8	7.64	6.95	7.82
Colombia (COP)	2 438	1 990	1 772	2 213
Cuba (CUP)	1	1	1	1
Czech Republic (CZK)	22	21.08	16.1	18.55
Denmark (DKK)	5.82	5.54		5.211
Egypt (EGP)	5.76	5.68	5.34	5.51
Finland (EURO)	0.778	0.744	0.643	0.699
France (EURO)	0.778	0.744	0.643	0.699
Gabon (XAF) [CFA Franc BEAC]	510.335	488.032	421.78	458.514
Germany (EURO)	0.778	0.744	0.643	0.699
Greece (EURO)	0.778	0.744	0.643	0.699
Hungary (HUF)	204	186	155	186
India (INR)	45.19	40.5	42.82	47
Indonesia (IDR)	9 200	8 680	9 310	11 066
Iran, Islamic Republic of (IRR)	9 155	9 280	9 155	9 780
Italy (EURO)	0.778	0.744	0.643	0.699
Japan (JPY)	112	121	105	90.3
Jordan (JOD)	0.708		0.708	0.708
Kazakhstan (KZT)	122	120.2	120.3	120.1
Korea, Republic of (KRW)	933	920	1039	1339

COUNTRY (currency abbreviation)	**June 2006**	**June 2007**	**June 2008**	**January 2009**
Kyrgyzstan (KGS)	40.47	37.94		39.15
Lithuania (LTL)	2.686	2.569	2.218	2. 415
Malawi (MWK)	140.18	140.2		140.6
Malaysia (MYR)	3.62	3.36	3.2	3.46
Mauritania (MRO)	276	262	238.18	260.85
Mexico (MXN)	11.29	10.78	10.3	13.36
Mongolia (MNT)	1 175	1 162	1 163	1 270
Morocco (MAD)	8.67	8.24	7.265	8.03
Namibia (NAD)	6.54	7.08	7.65	9.43
Netherlands (EURO)	0.778	0.744	0.643	0.699
Niger (XOF) [CFA Franc BCEAO]	510.335	488.032	421.78	458.514
Norway (NOK)	6.11	6.05	5.06	6.949
Peru (PEN)	3.27	3.16	2.8	3.11
Philippines (PHP)	52.92	46.16	43.69	47.51
Poland (PLN)	3.01	2.76	2.14	2.85
Portugal (EURO)	0.778	0.744	0.643	0.699
Romania (RON)	2.75	2.44	2.31	2.81
Russian Federation (RUB)	27	25.84	23.56	27.52
Serbia & Montenegro (RSD)	68.65	60.44	51.1	62
Slovak Republic (SKK/Euro)	29.44	25.04	19.65	0.699
Slovenia (SIT/Euro)	186	0.744	0.643	0.699
South Africa (ZAR)	6.54	7.08	7.65	9.43
Spain (EURO)	0.778	0.744	0.643	0.699
Sweden (SEK)	7.21	6.92	6	7.69
Switzerland (CHF)	1.21	1.22	1.045	1.046
Syrian Arab Republic (SYP)	52.2	50.4	45.6	46.3
Tajikistan (TJS)	3.25			3.42
Thailand (THB)	38.12	34.48	32.26	34.92
Turkey (TRY)	1.53	1.32	1.24	1.51
Ukraine (UAH)	5.01	5.0	4.69	8.0
United Kingdom (GBP)	0.533	0.506	0.505	0.684
United States (USD)	1.000	1.000	1.000	1.000
Uruguay (UYU)	23.9	23.78		24.33
Uzbekistan (UZS)	1 221.39	1 259	1 307	1 388
Viet Nam (VND)	15 935	16 063	16 190	16 929
Zambia (ZMK)	3460	4000	3 432	4 750
Zimbabwe (ZWD, ZWR 9 Oct. 08)	3 370	3 650	680 000 000	150 000

* *Source*: The Department of Finance of the United Nations Development Programme, New York.

Appendix 8

GROUPING OF COUNTRIES AND AREAS WITH URANIUM-RELATED ACTIVITIES

The countries and geographical areas referenced in this report are listed below. Countries followed by "*" are members of OECD.

1. North America

Canada*	Mexico*	United States of America*

2. Central and South America

Argentina	Bolivia	Brazil
Chile*	Colombia	Costa Rica
Cuba	Ecuador	El Salvador
Guatemala	Jamaica	Paraguay
Peru	Uruguay	Venezuela

3. Western Europe

Austria*	Belgium*	Denmark*
Finland*	France*	Germany*
Ireland*	Italy*	Netherlands*
Norway*	Portugal*	Spain*
Sweden*	Switzerland*	United Kingdom*

4. Central, Eastern and South-eastern Europe

Armenia	Bulgaria	Croatia
Czech Republic*	Estonia	Greece*
Hungary*	Lithuania	Poland*
Romania	Russian Federation	Slovak Republic*
Slovenia	Turkey*	Ukraine

5. Africa

Algeria	Botswana	Central African Republic
Congo, Democratic Republic	Egypt	Gabon
Ghana	Lesotho	Libya
Madagascar	Malawi	Mali
Morocco	Namibia	Niger
Nigeria	Somalia	South Africa
Zambia	Zimbabwe	

6. Middle East, Central and Southern Asia

Bangladesh	India	Iran, Islamic Republic of
Israel	Jordan	Kazakhstan
Kyrgyzstan	Pakistan	Sri Lanka

Syria	Tajikistan	Turkmenistan
Uzbekistan		

7. South-eastern Asia

Indonesia	Malaysia	Philippines
Thailand	Vietnam	

8. Pacific

Australia*	New Zealand*

9. East Asia[1]

China	Japan*	Mongolia
Korea, Republic of*		
Korea, Democratic People's Republic of		

The countries associated with other groupings of nations used in this report are listed below.

Commonwealth of Independent States (CIS) or Newly Independent States (NIS)

Armenia	Kazakhstan	Tajikistan
Azerbaijan	Kyrgyzstan	Turkmenistan
Belarus	Moldavia	Ukraine
Georgia	Russian Federation	Uzbekistan

European Union

Austria	Estonia	Ireland	Netherlands	Spain
Belgium	Finland	Italy	Poland	Sweden
Bulgaria	France	Latvia	Portugal	United Kingdom
Cyprus	Germany	Lithuania	Romania	
Czech Republic	Greece	Luxemburg	Slovak Republic	
Denmark	Hungary	Malta	Slovenia	

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1. Includes Chinese Taipei.

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Uranium 2009: Resources, Production and Demand

With several countries currently building nuclear power plants and planning the construction of more to meet long-term increases in electricity demand, uranium resources, production and demand remain topics of notable interest. In response to the projected growth in demand for uranium and declining inventories, the uranium industry – the first critical link in the fuel supply chain for nuclear reactors – is boosting production and developing plans for further increases in the near future. Strong market conditions will, however, be necessary to trigger the investments required to meet projected demand.

The "Red Book", jointly prepared by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, is a recognised world reference on uranium. It is based on information compiled in 40 countries, including those that are major producers and consumers of uranium. This 23rd edition provides a comprehensive review of world uranium supply and demand as of 1 January 2009, as well as data on global uranium exploration, resources, production and reactor-related requirements. It provides substantive new information from major uranium production centres around the world, as well as from countries developing production centres for the first time. Projections of nuclear generating capacity and reactor-related uranium requirements through 2035 are also featured, along with an analysis of long-term uranium supply and demand issues.

IAEA
International Atomic Energy Agency

NEA
Nuclear Energy Agency

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