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Laka plays with, amongst others things, its information services, an important role in the Dutch anti-nuclear movement.

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Small modular reactors for nuclear power: hope or mirage?

February 21, 2018 by M.V. Ramana

Print

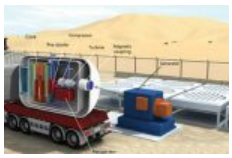

image of SMR proposed in Korea

Supporters of nuclear power hope that small nuclear reactors, unlike large plants, will be able to compete economically with other sources of electricity. But according to M.V. Ramana, a Professor at the University of British Columbia, this is likely to be a vain hope. In fact, according to Ramana, in the absence of a mass market, they may be even more expensive than large plants.

In October 2017, just after Puerto Rico was battered by Hurricane Maria, US Secretary of Energy Rick Perry asked the audience at a conference on clean energy in Washington, D.C.: "Wouldn't it make abundant good sense if we had small modular reactors that literally you could put in the back of a C-17, transport to an area like Puerto Rico, push it out the back end, crank it up and plug it in? ... It could serve hundreds of thousands".

As exemplified by Secretary Perry's remarks, small modular reactors (SMRs) have been suggested as a way to supply electricity for communities that inhabit islands or in other remote locations.

> *In the past decade, wind and solar energy have become significantly cheaper than nuclear power*

More generally, many nuclear advocates have suggested that SMRs can deal with all the problems confronting nuclear power, including unfavorable economics, risk of severe accidents, disposing of radioactive waste and the linkage with weapons proliferation. Of these, the key problem responsible for the present status of nuclear energy has been its inability to compete economically with other sources of electricity. As a result, the share of global electricity generated by nuclear power has dropped from 17.5% in 1996 to 10.5% in 2016 and is expected to continue falling.

Still expensive

The inability of nuclear power to compete economically results from two related problems. The first problem is that building a nuclear reactor requires high levels of capital, well beyond the financial capacity of a typical electricity utility, or a small country. This is less difficult for state- owned entities in large countries like China and India, but it does limit how much nuclear power even they can install.

The second problem is that, largely because of high construction costs, nuclear energy is expensive. Electricity from fossil fuels, such as coal and natural gas, has been cheaper historically – especially when costs of natural gas have been low, and no price is imposed on carbon. But, in the past decade, wind and solar energy, which do not emit carbon dioxide either, have become significantly cheaper than nuclear power. As a result, installed renewables have grown tremendously, in drastic contrast to nuclear energy.

How are SMRs supposed to change this picture? As the name suggests, SMRs produce smaller amounts of electricity compared to currently common nuclear power reactors. A smaller reactor is expected to cost less to build. This allows, in principle, smaller private utilities and countries with smaller GDPs to invest in nuclear power. While this may help deal with the first problem, it actually worsens the second problem because small reactors lose

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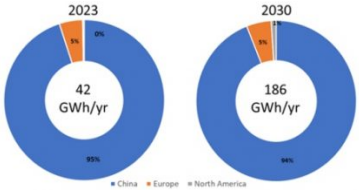

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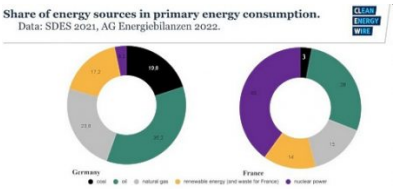

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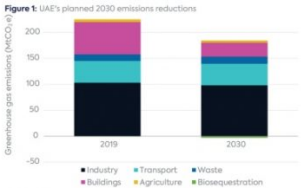

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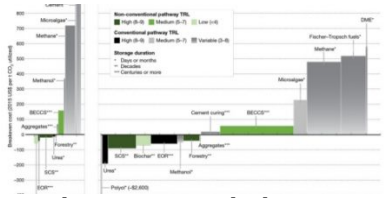


10 Carbon Capture methods compared: costs, scalability, permanence, cleanness
by Ella Adlen | posted on November 11, 2019

out on economies of scale. Larger reactors are cheaper on a per megawatt basis because their material and work requirements do not scale linearly with generation capacity.

> *"The problem I have with SMRs is not the technology, it's not the deployment – it's that there's no customers"*

SMR proponents argue that they can make up for the lost economies of scale by savings through mass manufacture in factories and resultant learning. But, to achieve such savings, these reactors have to be manufactured by the thousands, even under very optimistic assumptions about rates of learning. Rates of learning in nuclear power plant manufacturing have been extremely low; indeed, in both the United States and France, the two countries with the highest number of nuclear plants, costs rose with construction experience.

Ahead of the market

For high learning rates to be achieved, there must be a standardized reactor built in large quantities. Currently dozens of SMR designs are at various stages of development; it is very unlikely that one, or even a few designs, will be chosen by different countries and private entities, discarding the vast majority of designs that are currently being invested in. All of these unlikely occurrences must materialize if small reactors are to become competitive with large nuclear power plants, which are themselves not competitive.

There is a further hurdle to be overcome before these large numbers of SMRs can be built. For a company to invest in a factory to manufacture reactors, it would have to be confident that there is a market for them. This has not been the case and hence no company has invested large sums of its own money to commercialize SMRs.

An example is the Westinghouse Electric Company, which worked on two SMR designs, and tried to get funding from the US Department of Energy (DOE). When it failed in that effort, Westinghouse stopped working on SMRs and decided to focus its efforts on marketing the AP1000 reactor and the decommissioning business. Explaining this decision, Danny Roderick, then president and CEO of Westinghouse, announced: "The problem I have with SMRs is not the technology, it's not the deployment – it's that there's no customers. ... The worst thing to do is get ahead of the market".

Delayed commercialization

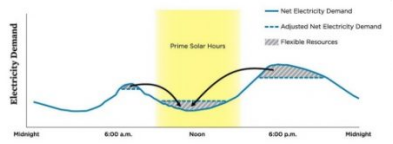
Given this state of affairs, it should not be surprising that no SMR has been commercialized. Timelines have been routinely set back. In 2001, for example, a DOE report on prevalent SMR designs concluded that "the most technically mature small modular reactor (SMR) designs and concepts have the potential to be economical and could be made available for deployment before the end of the decade provided that certain technical and licensing issues are addressed". Nothing of that sort happened; there is no SMR design available for deployment in the United States so far.

> *There are simply not enough remote communities, with adequate purchasing capacity, to be able to make it financially viable to manufacture SMRs by the thousands*

Similar delays have been experienced in other countries too. In Russia, the first SMR that is expected to be deployed is the KLT-40S, which is based on the design of reactors used in the small fleet of nuclear-powered icebreakers that Russia has operated for decades. This programme, too, has been delayed by more than a decade and the estimated costs have ballooned.

South Korea even licensed an SMR for construction in 2012 but no utility has been interested in constructing one, most likely because of the realization that the reactor is too expensive on a per-unit generating-capacity basis. Even the World Nuclear Association stated: "KAERI planned to build a 90 MWe demonstration plant to operate from 2017, *but this is not practical or economic in South Korea*" (my emphasis).

Likewise, China is building one twin-reactor high- temperature demonstration SMR and some SMR feasibility studies are underway, but plans for 18 additional SMRs have been "dropped" according to the World Nuclear Association, in part because the estimated cost of generating



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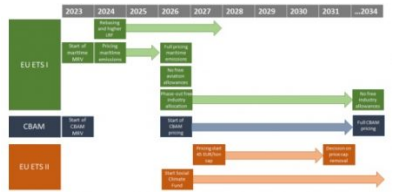

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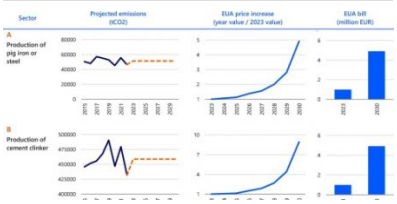

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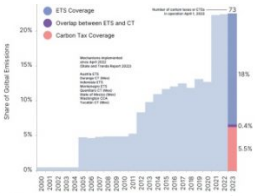

Carbon Pricing: almost 25% of emissions now covered globally, but coverage and prices must rise further
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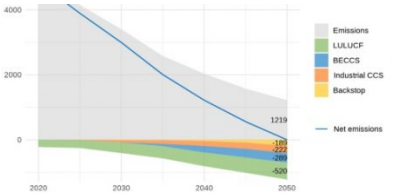

How much Carbon Capture does the

electricity is significantly higher than the generation cost at standard-sized light-water reactors.

No real market demand

On the demand side, many developing countries claim to be interested in SMRs but few seem to be willing to invest in the construction of one. Although many agreements and memoranda of understanding have been signed, there are still no plans for actual construction. Good examples are the cases of Jordan, Ghana and Indonesia, all of which have been touted as promising markets for SMRs, but none of which are buying one.

> *Neither nuclear reactor companies, nor any governments that back nuclear power, are willing to spend the hundreds of millions, if not a few billions, of dollars to set up SMRs just so that these small and remote communities will have nuclear electricity*

Another potential market that is often proffered as a reason for developing SMRs is small and remote communities. There again, the problem is one of numbers. There are simply not enough remote communities, with adequate purchasing capacity, to be able to make it financially viable to manufacture SMRs by the thousands so as to make them competitive with large reactors, let alone other sources of power. Neither nuclear reactor companies, nor any governments that back nuclear power, are willing to spend the hundreds of millions, if not a few billions, of dollars to set up SMRs just so that these small and remote communities will have nuclear electricity.

Meanwhile, other sources of electricity supply, in particular combinations of renewables and storage technologies such as batteries, are fast becoming cheaper. It is likely that they will become cheap enough to produce reliable and affordable electricity, even for these remote and small communities – never mind larger, grid- connected areas – well before SMRs are deployable, let alone economically competitive.

Editor's note:

Prof. M. V. Ramana is Simons Chair in Disarmament, Global and Human Security at the Liu Institute for Global Issues, as part of the School of Public Policy and Global Affairs at the University of British Columbia, Vancouver. This article was first published in National University of Singapore Energy Studies Institute Bulletin, Vol.10, Issue 6, Dec. 2017, and is republished here with permission.

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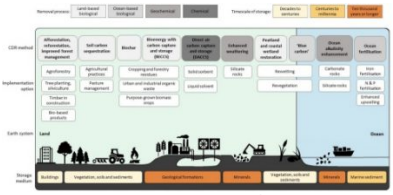

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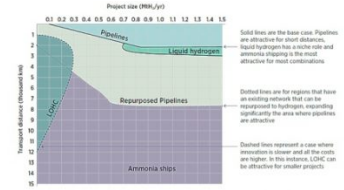

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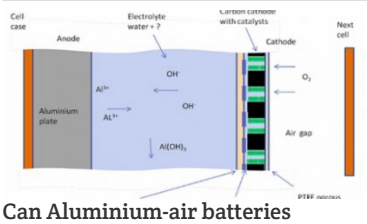

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Does Nuclear slow down the scale-up of Wind and Solar? France and Germany can't agree

Nuclear power capacity is growing globally. Where, how and why

EU states agree deal on electricity market to protect consumers from price volatility, boost cheap renewable power

Filed Under: Energy, Markets, Nuclear, Renewables Tagged With: energy efficiency, energy security, energy transition, financing, grid, nuclear energy, renewables

Comments

Nigel West says
February 21, 2018 at 11:24

"Meanwhile, other sources of electricity supply, in particular combinations of renewables and storage technologies such as batteries, are fast becoming cheaper."

Batteries are not feasible or economic for providing reliable on demand electricity at grid scale in most areas of the world. It's irrelevant that intermittent renewables and batteries might be cheaper.

It can take almost 10 years to build a large GW size reactor, whereas modular reactors can be built far quicker in a few years. That has a huge impact on economics. Large GW size reactors provide economies of scale, but that advantage is negated compared to small modular reactors which can be built in a few years so earning revenue and providing investors with returns far quicker.

Tilleul says
February 21, 2018 at 18:21

Batteries have been consistent in providing reliable on demand electricity in every areas of the world and even outside since they are also used to power the ISS. In the 30s you had 15% of rural homes in the US powered by wind-battery systems before the rural electrification act made it mandatory to expand the grid there.

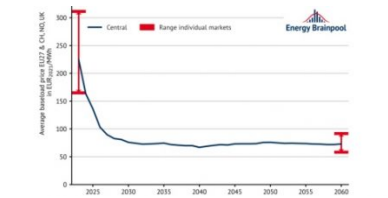
Grid electricity is not feasible everywhere on the planet, battery based electricity can be deployed everywhere.

And more important : battery factories exists and are currently expanded, SMR factories don't exist, even SMR don't exist actually.

If you start from scratch, you need decades to get from concept to prototype and prototype to industrialized product and industrialized product to a factory building the industrialised product… It took nearly 20 years for Tesla to go to mass production of electric car.

Jim says
February 23, 2018 at 10:35

Yes Nigel that would explain why there are zero operating SMRs, and just a few under construction . As things stand, no country, company or utility has any intention of betting billions on building an SMR supply chain. The prevailing scepticism is evident in a February 2017 Lloyd's Register report based on "insights and opinions of leaders across the sector" and the views of almost 600 professionals and experts from utilities, distributors, operators and equipment manufacturers. Respondents predicted that SMRs have a "low likelihood of eventual take-up, and will have a minimal impact when they do arrive".



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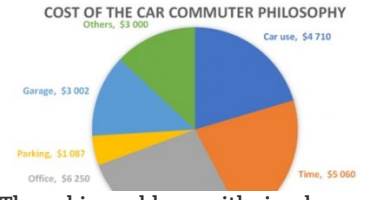

The 10 big problems with simply replacing fossil cars with electric
by Schalk Cloete | posted on December 6, 2021

John Massey says
February 21, 2018 at 16:46

I certainly don't expect to see SMRs any day (year!) soon, but equally I think it's a bit premature to dismiss them completely.
As Nigel West mentions, faster speed of deployment will be helpful, making them more market responsive than single, giant projects. On an individual project basis they will require less colossal sums to be raised, opening up the market to investors with shallower pockets (increasing financing competition, reducing its cost). And they seem to me to simply be a better fit to future power systems which will be more distributed than centralised, where flexibility will be key.
Of course once upon a time solar and wind faced the exact same problem: needing to create scale in order to reduce costs, but how to create that scale when you're too expensive to compete.
The solution not mentioned in the article was to create a big market through policy: market mandates, feed-in-tariffs, tax credits and so on. Long-term result: we now have cheap solar and wind.
A problem for SMRs is that in the short-term there is a direct comparison with its "big" nuclear brother (both in cost and, I expect, public perception).
But should it be viewed as a quite different technology: one better suited to long-term future power systems and with more obvious learning curve prospects, through mass production, repetition, automation and hence incremental improvement?
Ultimately I'd say it's how policymakers answer that last question that matters more than the current economics.

Robert Hargraves says
February 22, 2018 at 12:54

SMRs are not for remote, isolated communities. They are modular, designed to avoid the EPC (engineering/procurement/construction) fiasco for the huge AP1000s in the US.

Batteries can't replace nuclear. Musk reported the 129 MWh battery in Australia cost $50 million. With an optimistic 1000 full charge/discharge cycle lifetime, that's 38 cents/kWh, even if the electricity to charge it were free.

New fission technologies will be even cheaper than coal. ThorCon is developing such a hybrid thorium/uranium liquid fuel fission power plant, to be deployed in Indonesia, first. Using shipyard construction, capital costs will be $1.2/watt, producing electricity at a base cost of 3 cents/kWh. [last sentence omitted – no commercial messages allowed]

Roger Lambert says
February 27, 2018 at 20:57

"With an optimistic 1000 full charge/discharge cycle lifetime, that's 38 cents/kWh, even if the electricity to charge it were free."

Really?

Colorado's XCel Energy recently received bids for wind + storage and solar + storage that are nowhere near your figures:

Wind + storage = **2.1 cents per KwH**. Not 38 cents/kWh

solar + storage = **3.6 cents/kWh**. Not 38.

These bids are lower than the operating costs of already existing coal plants. You are off by more than an order of magnitude.

Robert Hargraves says
February 27, 2018 at 21:58

Roger, Here's your likely source, but I don't believe it.
https://www.denverpost.com/2018/01/16/xcel-energy-low-bids-for-colorado-electricity/

Sometime utility companies are not all that savvy. Here's their source for the article.
https://www.documentcloud.org/documents/4340162-Xcel-Solicitation-Report.html
There is a lot of redacted information, plus numbers that are nonsensical, such as battery storage at $11.30 per kilowatt-month ?!

John Massey says
February 28, 2018 at 11:07

From "the horses mouth" (page 10):
https://www.documentcloud.org/documents/4340162-Xcel-Solicitation-Report.html
I'm guessing those costs are including both some tax credits (I'm not US-based, or a US policy expert, but I think they qualify?) plus some forward pricing (i.e. assuming future storage, solar or wind costs lower than today's).
Still, impressively low and an impressively small premium for adding storage.
By the way, $ per kW-mo just means a capacity-based payment, rather than one based on energy delivered. Pretty common when the application is grid service, peak capacity guarantee or similar.

Bas Gresnigt says
March 4, 2018 at 17:46

"Batteries can't replace nuclear. "
They already compensate short (up to ~24hrs) fluctuations. That period will increase gradually.

For long fluctuations, such as months long lulls in the wind, the Germans are piloting unmanned Power-to-Gas plants. Combined with storage in deep earth caverns, those provide a much cheaper solution than nuclear.

NL already stores a winter supply of conditioned natural gas so the conditioning plant can be sized on av. consumption and not on the winter peaks.
No problem to do the same with H2 gas generated when wind & solar produce to much power. Especially since power is extremely cheap at those periods.
That solution is probably even cheaper than hydro with pumped storage.

Hans says
March 5, 2018 at 21:30

Much of the seasonal variation can be flattened out by international transmission. A 2017 Swiss study published in Nature Climate Change finds that for Europe that the North of Norway and the Balkan and Greece have anti-correlated wind patterns to Western Europe, so that with enough transmission the seasonal variation can be flattened:

https://www.nature.com/articles/nclimate3338

Bas Gresnigt says
March 6, 2018 at 09:57

Hans, Thanks.
~5 years ago I found out that there is a small negative correlation between wind in Spain-Portugal and at North Sea countries.

At that time an Agora study also concluded that grid extension would be the cheapest solution to compensate for the intermittency of wind & solar.

However I'm no longer sure about that because:
– wind & solar are decreasing fast towards 10years.

– the political risks with countries such as Greece, Spain, etc.

So it now seems to me that a mix, limited grid extensions together with PtG, is the cheapest and most reliable solution.

Bas Gresnigt says
March 6, 2018 at 10:08

Sorry. Something went wrong at the smaller than sign.
Please read the last two paragraphs as:

However I'm no longer sure about that because:
– wind & solar are decreasing fast to less than 2cnt/KWh. PtG is on a similar cost decreasing path.
– long transmission lines are hardly decreasing in costs. Even increasing due to NIMBY and rights-of-way. They are also not flexible needing more than 10years to build.
– the political risks with countries such as Greece, Spain, etc.

So it now seems to me that a mix, limited grid extensions together with PtG, is the cheapest and most reliable solution.

Jeff Walther says
February 22, 2018 at 21:19

So-called renewables (the 20-year life windmills aren't renewable, the 30-year life solar panels aren't renewable) are only cheaper than nuclear power because of subsidies and "renewable energy portfolio standards" (forcing utilities to use renewables). End the subsidies and no more windmills would be build; no more solar panels would be installed.

On a per energy generated basis, subsidies for wind and solar are 30 – 50 times higher than subsidies for nuclear, and that doesn't even count the effect of the portfolio standards and the requirement that energy from wind and solar be accepted by grid operators first, no matter how detrimental to other more reliable generators.

End the subsidies for wind and solar and then let's take another look at these economics. Or subsidize nuclear and give it the same grid generator preference as wind and solar and again, then let's take another look.

Karel Beckman says
February 23, 2018 at 08:42

Can you back up your claims with facts? Don't you think nuclear energy has profited from subsidies? I don't know what it's like in the U.S. but e.g. in France the entire sector was built by the State. It's still supported by the State with untold billions. Newly to be built Hinkley Point C gets a huge subsidy. The biggest builder of nuclear projects today is Rosatom, owned by the Russian State. And don't ratepayers pay for expensive nuclear project in the U.S.?

Hans says
February 23, 2018 at 11:22

I completely agree: Stop all subsidies, and loan garantuees for all technologies; put a realistic price on CO2 emissions and conventional pollution; let nuclear power stations pay for their own insurance and waste disposal; break up utility monopolies, allow for a free market for power production and retail, and put the grid in public hands. I am very confident that under these

circumstances renewables will win from nuclear “with two fingers in its’ nose” as we say in Holland.

Jim Hopf says
February 26, 2018 at 00:49

Nuclear would thrive under such a scenario. Analyses, as well as the 50 year operational record, show that nuclear’s external costs are negligible; orders of magnitude lower than fossil and similar to renewables.

Waste management is *already* fully paid for by the nuclear industry! It is other industries (mainly fossil) that get to just dump their wastes directly into the environment for free. Liability limits are common for heavy industry, but if nuclear did have to pay for unlimited insurance, estimates are that it would add only ~0.1 cents/kW-hr.

The free pollution subsidy that fossil generation gets, and the direct subsidies that renewables get (production tax credits, feed in tariffs and literal mandates for its use in many states/countries) are both more than an order of magnitude larger than any subsidies that nuclear gets, including liability limits.

Also note how a price on air pollution and CO2 would increase the cost of all that fossil generation that intermittent renewables rely on for backup (which is to say most of the time – the powerful fossil industry knows this). That in turn would increase the overall cost of a renewables heavy system (vs. nuclear). They could turn to large-scale electricity storage, but that would also be extremely expensive.

Holland? Home of Royal Dutch Shell, and which gets ~80% of its electricity from gas and oil (unsurprisingly)? You sure you want CO2 and pollution taxes?

Anyway, we don’t need to figure out who is right. Both of us would be willing to agree to the policies you describe above. Tax CO2 and other air pollutants harmful to public health, get rid of ALL subsidies and mandates, and let the market decide how to respond.

You seem to think that renewable energy will win, i.e., provide all or most power, even with the associated costs (e.g., storage) that will be necessary at such high level of intermittent renewable penetration. I’m willing to take that bet (although the real reason is that I think that would be the best policy, regardless of what source(s) win). I think the lowest cost system will be a mixture of renewables plus a significant amount of nuclear, along with perhaps a small amount of gas. But who knows, I may be wrong.

The beauty of policies that simply put the correct price on CO2, air pollution and other external costs is that you don’t have to figure out which energy sources will win out or what technological advances will come in the future. We don’t need to know any of that in order to figure out that this would be the best policy, and to implement it now. Under such policies, the market would automatically adjust to any changes in market conditions (e.g., changes in the costs of different energy sources of CO2 emissions reduction options) and select the lowest cost approach.

May the best energy source(s) win!

John Massey says
February 23, 2018 at 12:45

Well, that’s a nice rant, but in the real world…

UK CfD price for 3.3GW of offshore wind (awarded in 2017):
0.9GW for delivery in 2021/22: £74.75 per MWh
2.4GW for delivery in 2022.23: £57.50 per MWh

Onshore wind is currently not eligible to enter these auctions, but would be much cheaper if it could (e.g. look at nearby Germany).
Solar: we've just seen the UK's first solar farm completed without price subsidy (and we don't even have much sun). It doesn't take much research to look around the world at what's happening to prices in sunny places.

UK CfD price for 3.2GW of nuclear:
£92.50 per MWh in 2012 prices (so already over £100 per MWh in actual price to be paid and not due to be online until around 2025 – if on time).
Since you also mentioned grid, upgrading the grid to support that project has been priced at £800m.

This isn't to make some anti-nuclear rant, but the reality is that big new nuclear is expensive – and has been getting worse, not better. New builds are too often over-budget and behind schedule.
That's why I think SMRs are interesting – perhaps modular mass production is what's needed to change that?
And yes, to get there might mean they'll need some policy help to get them started.

Roger Lambert says
February 27, 2018 at 18:40

Wind installs have a much longer lifespan than 20 years. Solar panels appear to have a useful lifespan about 4 times longer than your quoted figure.
[...]

Renzo Tavoni says
February 23, 2018 at 18:36

I have been a nuclear supporter and I dont' dismiss that opinion and I think that tecnology will be in the future (far ?) an important part of the mix of technologies for electricity production.
The real problems of nuclear are: lack of standardisation both of reactors and of licencing process, lack of correct public information.
These caused the delays during construction that were responsible of non economic result.
Coming to SMR : they simply dont exist and it is impossible to judge them; perhaps the performances announced could be reached but before the thousands we need a prototipe and a commercial one.
And I hope that instead of developing many of them ,the best one will be the leader of a standardised model.

Dr G Vaidyanathan says
February 24, 2018 at 06:36

When you compare energy sources, you must look at the internal costs and also the external costs that are not accounted.i.e. the impact on the environment and health.ExternE project of EU has done work in this direction and has reported that external costs are minimum for solar, wind and nuclear energy. In other words these are least harmful. You cannot talk of costs of SMRs until a good number are built. Evaluation of health effects in Japan after Hiroshima, Nagasaki and presently Fukushima, in Russia after Chernobyl and in USA after TMI2 accidents have shown no increase in the increase of cancers or other radiation related diseases. The world needs low carbon energy and Nuclear provides the answer. Unfortunately the author of the paper is highly biased against nuclear and one could not have a better article which also looks into the positive side of nuclear power.

Ike Bottema says
February 25, 2018 at 17:13

> *one could not have a better article which also looks into the positive side of nuclear power*

I don't follow you there but otherwise spot on! Nuclear is not the dangerous beast it's made out to be; a factor that itself drives up costs in OECD countries. And yes fossil fuel externalities should be accounted for in power production pricing. The bottom line is that nuclear is essential in order to attain clean energy prosperity.

Jim Hopf says
February 25, 2018 at 21:02

"many nuclear advocates have suggested that SMRs can deal with all the problems confronting nuclear power, including unfavorable economics, risk of severe accidents, disposing of radioactive waste and the linkage with weapons proliferation"

While SMRs are inherently dramatically superior with respect to accident risk and potential release, they will not help with the "problems" of waste and proliferation (not LWR SMRs, anyway) and few people are really claiming that they would. But those waste and proliferation "problems" are phony and don't require any "solution". Nuclear already has negligible proliferation impact and the long term risks/impacts from its waste stream are already far *smaller* than those of other energy sources.

But, as the article says, the only real problem is economics. The author doubts that scale of production will grow enough to yield reduced costs. It may be true that large-scale assembly line production, by itself, will not yield sufficient cost reduction. But he's missing the main avenue by which the SMR approach *could* result in economic competitiveness. That is, taking deserved credit for SMRs' inherent, dramatically reduced level of hazard, and regulating them accordingly.

SMRs remove the main mechanism by which meltdowns can occur (inability to get rid of decay in after a loss of offsite power). Developers have stated that all (active?) components could fail and a meltdown would still not result. And even if a meltdown were to somehow (non-mechanistically?) occur, the potential release is so small that radiation levels above the range of natural background would not occur anywhere outside the plant site boundary. The bottom line is that SMRs are simply incapable of harming anyone, and they should be regulated accordingly.

Excessive and ever-increasing regulations and standard-of-perfection fab QA requirements (unique to nuclear) are the primary reason for nuclear's current high costs, as evidenced by the fact that nuclear used to be built at ~1/3 the cost, many decades ago. (It's not like nuclear can't be inexpensive, it WAS.) SMRs offer the justification for doing away with all those excessive requirements. That would be the primary means by which their costs would fall. That along with experience in fabricating large numbers of carbon copies, by a dedicated, centralized construction facility (assembly line) staff.

> **Robert Hargraves says**
> February 25, 2018 at 22:03
>
> I doubt SMRs lose out much on the economy-of-scale argument. Much of the construction can be done in a factory, instead of on site. There's less money at risk at one time, so there's less financial risk. And nothing is more expensive than a half-finished LWR.

Jim Hopf says
February 25, 2018 at 21:07

Another point the author makes is that there is a lack of interest of market for SMRs, and that therefore sufficient scale of production will not be reached. Upon

examination, however, this is a case of nuclear's main problem being a lack of political support, vs. any objective or technical lack of merit.

As we all know, solar and wind were heavily subsidized for decades and then there were outright mandates for large amounts of renewables use (regardless of cost) on top of that. After decades of such massive support, and guarantees of large markets, the cost of renewables has finally come down (although those quoted low costs still ignore costs associated with grid requirements and intermittentcy).

Well gosh, imagine if SMRs had that level of govt./political support. It would pretty much eliminate the author's concern about insufficient demand or markets for SMRs, now wouldn't it. Demand/market would be guaranteed by govt. fiat!

And again, there is the lack of govt support in the form of utterly excessive regulations and requirements (which seem almost designed to deliberately hold nuclear back and make it expensive). How economic would wind be if it had to provide absolute proof that it will never kill a *single* bird?

SMRs may not be as successful as renewables because they are not politically supported the way renewables are, period. Lack of political/public support, and policies that treat nuclear fairly, has always been nuclear's actual main problem. High costs are a *symptom* of that problem. The industry should spend less time developing new and "better" reactor technology (which attempts to meet the standards of perfection that are imposed on nuclear only), and spend more time an money on finding better ways to wield political influence and communicate with the public.

Roger Lambert says
February 27, 2018 at 18:43

"As we all know, solar and wind were heavily subsidized for decades…"

Renewables heavily-subsidized? Hardly:

https://c1cleantechnicacom-wpengine.netdna-ssl.com/files/2016/02/david-subsidies.jpg

James says
February 27, 2018 at 22:55

Wonderful, subsidies expressed in absolute dollars instead of dollars (or cents) per kW-hr, and a date (2010) that is before the bulk of the renewables subsidies which have occurred after that.

Here's the real story concerning per kW-hr subsidies. (The chart shows falling per kW-hr subsidies after 2010, but the absolute subsidy, especially cumulatively, increased dramatically, and the kW-hrs generated actually became significant).

https://www.forbes.com/sites/jamesconca/2017/05/30/why-do-federal-subsidies-make-renewable-energy-so-costly/#4edd00d4128c

Roger Lambert says
February 28, 2018 at 18:36

You realize, of course, that solar and wind are nascent technologies? And that 'normalizing' subsidy data based on energy produced only lately is the height of cherry-picking?

Do you realize who produced those numbers you are quoting about the supposedly enormous RE subsidies? The Institute for Energy Research, that's who. And who are they> They are a Koch founded and funded organization, run by Robert L. Bradley, Jr., who:

"IER's founder and CEO is Robert L. Bradley Jr., former Director of Policy Analysis at Enron. Bradley worked for over 16 years at Enron, also working as the speechwriter for Kenneth L. Lay, and wrote "Renewable Energy: Not Cheap, Not 'Green'" (Cato Institute, 1997) where he voices his opposition of green energy." DeSmog blog has a profile. It makes interesting reading:

https://www.desmogblog.com/institute-energy-research

Jim Hopf claimed that "solar and wind were heavily subsidized for decades ". I am pointing out that compared to fossil fuels, that his statement is deceptive. You are complaining about the date of the graph I provided. Fine, I will provide another. They both illustrate that renewables are NOT subsidized heavily compared to fossil fuels.

However…. even IF they were, it would be justified.

Subsidizing RE is how governments actually use a few thin dimes to fight this wee problem we have called Global Warming. And, since CO2 stays in the atmosphere for ten thousand years or so, and the cost of adaptation, according to one study, will be $1240 trillion dollars only up to year 2100, these thin dimes we spend will be the best ROI in the history of the known Universe. Because every single dollar spent on a RE subsidy pays for infrastructure that reduces CO2 emissions. And every single dollar spent on fossil fuel does the opposite.

Here is an updated chart of U.S. energy subsidies (in this case, only permanent tax breaks):

https://www.vox.com/energy-and-environment/2017/10/6/16428458/us-energy-subsidies

Jim Hopf says
February 28, 2018 at 22:54

I agree that fossil is the most subsidized of all, especially if you count their free pollution subsidy. The fact that they get to emit mass quantities of CO2 and other pollutants that harm public health, for free, constitutes a massive subsidy, or market intervention on fossil generation's behalf. NOT having a price on those emissions constitutes a huge market distortion.

I'm more focused on the comparison between nuclear and renewables, with respect to subsidy. After all, wasn't the topic of this article nuclear power (SMRs)??

With the exception of a single plant being built now, nuclear has not gotten any of the per kW-hr subsidies (tax credits, feed in tariffs, etc..) that renewables have gotten. It also has never been part of the outright mandates for RE use that most states have.

All nuclear has ever gotten is a few hundred million in annual R&D funding, and most of that R&D so far has done little to actually help nuclear, the way the direct subsidies RE gets would. For example, a puny ~1 cent/kW-hr subsidy would be enough to prevent virtually all nuclear plant closures. And whereas R&D is all nuclear gets, renewables have even received more R&D money for the last 25 years, in addition to all the (much larger) direct subsidies that it gets.

Solar and wind are far beyond the point of being nascent. We're now hearing renewables advocates crowing about solar and wind being cheaper than fossil (now), and how they are ready to take over the world, and are capable of providing all (or at least most) of our power. And yet, when the subject of continued large RE subsidies come up, they are all the sudden still nascent?? It's comical how RE advocates try to have it both ways.

As renewables have (now) grown to be significant producers, the cost of those large per kW-hr subsidies are adding up. In absolute terms, RE has received as much or more subsidy just since 2008 (start of Obama admin), as nuclear has over its entire 50+ year history.

Yes, we should spend resources to address global warming. But subsidizing RE is but one way to do that. Is having large subsidies and outright mandates for RE only, while acting to undermine

also-non-emitting nuclear (or at least give it no support) really the best approach?

In many markets, large subsidies and mandates for intermittent RE is actually having the effect of causing nuclear plants (that generate large amounts of CO2-free energy, 24/7) to close, which has sometimes resulted in *increased* emissions. Thus, it's not even clear, in many cases, that RE subsidies reduce CO2!

Yes, we should spend resources to address GW. To say it better, we need to correct the market flaw where fossil generators get to pollute the environment for free, that is, charge what it actually costs for each form of power generation.

The best way to do that is have technology-neutral, market-based policies. Ideally, we would place a price on emissions of CO2 and other harmful pollutants, and get rid of all source-specific subsidies and mandate policies. Barring that, we should give all clean sources equal subsidy.

In either case, nuclear would be treated the same as renewables, under policy. Then we would let the market decide on the relative merits of renewables, nuclear, SMRs, etc... Frankly, I'm not sure how much new nuclear would be built, or what will happen with SMRs. But we definitely would not be seeing nuclear plant closures.

Roger Lambert says
March 1, 2018 at 18:48

"All nuclear has ever gotten is a few hundred million in annual R&D funding"

According to this study by Management Information Services for the Nuclear Energy Institute, nuclear has enjoyed $73 billion of subsidies, more than wind + solar. (That is about 500 times more than your figure.)

Note, however, these figures are from 2010:

http://www.misi-net.com/publications/NEI-1011.pdf

I must say I find it rather ironic that you decry subsidies for wind and solar because they are no longer nascent, but simultaneously want them for nuclear.

Nuclear, compared to wind and solar, is dangerous. It is expensive. It takes decades to construct. Like wind and solar, it has occasional to frequent significant intermittency and downtimes, but they are unpredictable. It is a "baseload" technology at a time when we no longer need baseload.

In my view, we have a rare opportunity to make our energy system not only pollution-free, but to make it far less expensive as we tackle global warming. Wind and solar (and hopefully, someday tidal) energy have infrastructure that can be done at any scale from small to large. Which means communities, municipalities, states, regions can become owners of their renewable infrastructure, and just like homeowners with PV on their rooftops, enjoy essentially free electricity for many decades after the capital cost is recouped.

Nuclear does not fit into that model, because it costs ten billion bucks – or more – per pop. We just do not need it.

And there is no one left to build it anymore anyway.

William E Higgins Jr says

March 1, 2018 at 22:28
Looking at that article, it includes 60 years of nuclear development as a subsidy. Included in that most likely is all the design costs for every ship reactor for the navy, and at least the first civilian reactor. It also probably included set up of the nrc, until that agency became funded by the power plants. Add in the development costs for potential long term storage and interim storage, as well as development for a transfer or storage cask for spent fuel. The government was supposed to create long term storage, but it was blocked

Jim Hopf says
March 1, 2018 at 23:29

I said a few hundred million ANNUALLY (in R&D, most of which has not helped the industry).

Also, the very reference you give shows that renewables (mainly solar and wind) have gotten slightly more total subsidy than nuclear, even if you go back to 1950. As most of nuclear's subsidies were way back then, it means that for the past 25-30 years, solar and wind subsidies have been vastly larger. And that's in absolute dollars. As solar and wind still generate ~1/3 as much as nuclear today (with the cumulate kW-hrs generated so far being smaller by a far greater margin. This explains data showing that solar and wind's per kW-hr subsidies are vastly larger.

I didn't say I want to have nuclear subsidies but not renewables subsidies. I said they should receive *equal* subsidies. Or, better yet, have no subsidies (or mandates) and have taxes on CO2 and other pollution instead.

As for your claims about renewables being cheaper than nuclear (even at high penetration levels, w/ massive storage??), I suggested letting the market decide that (after imposition of CO2 pricing, and eliminating all policies that would favor either nuclear or renewables over the other).

Dangerous? How can that be given that non-Soviet nuclear has never caused any deaths or had any measurable public health impact, over its entire 50-year history, including Fukushima. And with statistics showing nuclear to actually be safer than solar or wind.

https://www.nextbigfuture.com/2011/03/deaths-per-twh-by-energy-source.html

Comparing nuclear's ~1% unplanned downtime (they plan maintenance and refueling outages for periods of low demand) to solar and wind's ~65-80% down time (capacity factor) is absurd. Just ask any utility manager responsible for keeping the lights on. Or ask France... An all nuclear grid would require far less energy storage capacity than an all renewable grid would.

$10 billion a pop? That's what SMRs are there to address. Again, the subject of the very article.

Bas Gresnigt says
March 6, 2018 at 10:44

You forget the biggest subsidy nuclear get:
The liability insurance premium granted by nuclear laws as those restrict liability to only a few percent of the damage nuclear power plants can (and do as history shows) create.

Furthermore the death due to nuclear radiation at Fukushima.
E.g. This study found an increase of 16% in perinatal deaths under a non-evacutated population of ~13million, mainly due to Cs-137 fall-out. Considering its half life of 30years it implies ~10,000 deaths (more if one doesn't consider the dilution due to rain, etc)....
https://www.ncbi.nlm.nih.gov/pubmed/27661055

William Higgins says
February 25, 2018 at 22:59

What about creation of an emergency resources ship, with Roll on – roll off capabilities. If no dock would be available to unload, a well deck for two LCAC transports would be provided.
The ship could have a helicopter deck, to provide facility for emergency supply transport or patient transport. It could have medical facilities similar to a hospital ship. The ships load could include construction equipment to open or establish transport routes. Supplies could be carried by electric transport vehicles. Additional vehicles could be designed to be charged on board, then bring the power supply either to areas in need or to the other electric vehicles. With potable drinking water, the hip could be designed to create water resources, which can then be transported for distribution.
The power source for all this could be several small modular reactors (2 to 4). SHaft power could be electric drive, rather than a steam plant.

priffe says
March 16, 2018 at 13:59

In Sweden, it was proudly announced on Monday that an entire community of 211 people had gone off grid, Simris, in a project run by EON.
https://www.eon.se/om-e-on/innovation/lokala-energisystem/direkt-fran-simris.html
EON says locally produced electricity is the future, "energy islands". The project is heavily subsidized and using front edge technology wind, solar and regulation. Back up generator is powered by burning waste or biogas (which however is not produced locally),
The project has garnered a lot of attention, also from abroad (Italy, Denmark etc).
Then EON had to retract – the community is actually off grid only once every five weeks.
One week out of five.
Then they had to retract again – on the test weeks, off grid only 8-16 on weekdays. 🙄

It is this kind of fake news fantasy that makes people wary of the promises made by people with no insight into economical realities or practical considerations. People who spent all their time in front of screens looking at the 'models' and never on the ground.

Sweden has for 50 years had 90% of its electricity from cheap and low emission nuclear and hydro.
45% of the generation from 12 reactors built in one decade at a low cost, with

obviously good safety. Waste problem solved in the 70s, what problem remains is bureacracy. And activism.

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February 21, 2018 at 17:22

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