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Editorial

Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor:

- An update on *Don't Nuke the Climate!* campaign activities in Paris.
- Michael Mariotte responds to an attack on the *Don't Nuke the Climate!* campaign.
- M.V. Ramana argues that fast (breeder) reactors are no solution to climate change.
- Mark Diesendorf questions the need for base-load power stations.
- Eloi Glorieux updates the nuclear power debate in Belgium.
- Dave Sweeney reports on the Australian government's approval of uranium sales to India.

The Nuclear News section has reports on a Lazard study which concludes that the levelized costs of wind and solar power are not only beating nuclear but also coal and even natural gas; a ClimateWorks report which details the extraordinary cost savings and climate change abatement potential of energy efficiency; a notice about the Nuclear Phaseout Congress to be held in Zurich in March 2016; and a report on the November 20 attack on transmission towers that cut off the delivery of electricity from Ukraine to Crimea and also created an emergency situation at nuclear power plants.

Feel free to contact us if you have feedback on this issue of the Monitor, or if there are topics you would like to see covered in future issues.

Regards from the editorial team.

Email: monitor@wiseinternational.org

Monitored this issue:

When a campaign strikes a nerve

Author: *Michael Mariotte − President of the Nuclear Information & Resource Service*

NM815.4515 Every successful campaign for social change causes reaction. After all, if the campaign wasn't hitting at vested interests, then there would be no need for a campaign − its goals would simply be adopted by acclamation.

Indeed, campaigns that don't generate reaction are campaigns that don't succeed: that means they haven't attained enough attention or backing to matter to their targets.

Thus, it's always a source of initial gratification when, after launching a new campaign, reaction sets in. When you can see you've struck a nerve. When your opposition attacks you directly. And that high point is elevated further when the best attack your opposition can muster is one against the least important of your arguments.

So it is that the international *Don't Nuke the Climate* Campaign − which includes the two organisations that produce *Nuclear Monitor*, the World Information

Service on Energy and the Nuclear Information & Resource Service − last week began feeling that warm gratification, that recognition that we are beginning to have an impact.

A small group of Finnish people, who call themselves "ecomodernists" and are affiliated with a group called Energy for Humanity have taken it upon themselves to launch the first direct attack on the *Don't Nuke the Climate* campaign, in an essay titled 'A Most Unwise Campaign'.[1] The essay appears to be a follow-up to a self-published tract called *Climate Gamble: Is anti-nuclear activism endangering our future?* They're planning to distribute 5,000 copies of these at COP21 in Paris over the next two weeks in an effort to promote nuclear power and beat back our campaign.

Following the distorted and factually-challenged logic of James Hansen[2], the group begins by repeating the familiar argument that renewable energy cannot scale up fast enough to solve the climate crisis, that decarbonization of the world's power supply isn't happening quickly enough, and that, ergo, we need a massive amount of new nuclear power.

What does "massive" mean? The authors don't say, but the World Nuclear Association is less shy: it issued a statement[3] calling for 1,000 gigawatts (about 1,000 large reactors) of new nuclear power by mid-century. More on that argument in a minute.

The essay then shifts gears to focus on one issue: the carbon footprint of nuclear power, which it calls our "key argument." Actually, it isn't. Indeed, we readily admit that nuclear power is a low-carbon energy source when compared to fossil fuels. We assert that it is high carbon compared to renewables, but really, that's all relative. The essay devotes considerable effort to try (unsuccessfully) to debunk Professor Benjamin Sovacool's 2008 meta-analysis of studies comparing carbon footprints of various energy sources (the authors argue a study showing nuclear as relatively high-carbon should be excluded, although excluding such studies, without excluding studies showing nuclear with an essentially undetectable carbon footprint, defeats the purpose of a meta-analysis).

If nuclear's carbon footprint were really our key argument, the campaign would be far less compelling than it is − and far less threatening to nuclear industry interests.

You'd think that people in Finland, of all places, would get this. Because the most compelling argument against nuclear power as a climate solution (disregarding for the moment issues like nuclear meltdowns, radioactive waste, routine releases of toxic radiation, and nuclear proliferation, and focusing only on climate-related issues), proven over and over and especially in Finland, whose Olkiluoto-3 reactor under construction is the poster child for the failure of the nuclear renaissance, is the industry's inability to deliver a product that can generate electricity in a reasonable time at a reasonable price.

Construction of Olkiluoto-3 began in 2005, with commercial operation scheduled for 2010, at a fixed cost of €3.2 billion. A decade later, the reactor is nowhere near complete and may not be finished this decade either. Its cost has just about tripled − right in line with the U.S. experience of the reactor boom-building years of the 1970s and 1980s. The thing is Olkiluoto is not an outlier, as efforts to build new reactors at Flamanville in France, and Vogtle and Summer in the U.S. demonstrate. Each of these projects is well behind schedule (and slipping further) and well over budget.

Meanwhile, costs for solar and wind power have been plummeting. When construction of Olkiluoto-3 began, solar power was not competitive with other generation sources. Now, even the nuclear / fossil fuel industry dominated International Energy Agency (IEA) admits that solar is not only cheaper than nuclear, it's cheaper than fossil fuels.[4] Wind power is so cheap they're literally giving it away in Texas. Energy efficiency remains even cheaper than any generation source.

No new nuclear reactors have come online anywhere in the West since construction of Olkiluto-3 began (Watts Bar-2 is close, but it's a stretch to call that "new," since construction on it began in the 1970s). Meanwhile, nearly half of all new generation last year was renewables, again according to the IEA.

Using outdated data, nuclear advocates like to say that renewables account for only a tiny percentage of worldwide electricity generation. While it certainly remains too low, the reality, according to the same IEA report, is that renewables are now the world's second largest power source, behind coal. And those who are paid to project growth and make money from accurate projections, like UBS, say the period of rapid growth has barely even started.[5]

So which technology can scale up faster to deal with what is, in fact, a climate crisis?

Nuclear proponents also argue that we should use all low-carbon generation sources, not just renewables. That we should include nuclear "in the mix."

The problem there is that nuclear has priced itself out of the conversation. With new reactor construction cost estimates pushing US$20 billion each (North Anna-3, Hinkley Point) at a time when equivalent amounts of renewables would cost a fraction of that, it makes no

Don't Nuke the Climate! campaign at COP21

The UN Climate Change Conference (COP21) has kicked off − but that's not the only thing happening in Paris. Following the terrorist attacks in Paris, the French government has prohibited mass mobilisation. It is terrible what has happened, but this is not the time to silence the voice of the people.

Here is a list of some of the activities that the *Don't Nuke the Climate!* campaign will be involved in.

December 5−6: Citizens Summit for Climate, Montreuil (http://coalitionclimat21.org/en):

- Weekend of debates, workshops, screenings and presentations of concrete alternatives in the face of climate change. The Summit also includes the World Village of Alternatives and Climate Forum. *Don't Nuke the Climate!* will be present with a workshop and a stand.
- Saturday Dec. 5: Stories of Frontline Communities.
- Saturday Dec. 5: How to fight against nuclear on a local level.
- Sunday Dec. 6: Nuclear won't save the climate: let's close Fessenheim!
- Sunday Dec. 6: Photo Booth, Don't Nuke the Climate, Take Action.

December 7−11: Zone for Climate Action:

- For four days, we will transform this artistic establishment into a site swarming with life, with creative proposals, and joyous resistance. *Don't Nuke the Climate!* will be present in the main hall every day with a photo booth.
- On Monday December 7 we'll show the documentary 'Welcome to Fukushima' (the trailer is online at www.youtube.com/watch?v=XvouOkTaB6c).

December 8: Don't Nuke the Climate conference:

- A conference about women and the effects of nuclear radiation. With Nadezdha Kutepova, Arjun Makhijani, a video message from Mary Olsen, and Sascha Gabizon as moderator.

This list will continue to grow as more activities are confirmed. If you have any questions, email thessa@wisenederland.nl and check out the website: www.wiseinternational.org/campaign/events-paris

sense whatsoever to build nuclear. It would simply take money away from the cheaper, faster sources, which happen to be renewables. If we're facing a crisis − and we are − why divert resources away from the most effective means of addressing it to the least effective? The end result is that you get less low-carbon power, not more. That's why nuclear power is counterproductive at addressing climate change: because we get less carbon reduction per dollar spent.

The nuclear folks also submit that countries like China and India are continuing to pursue nuclear power, and are doing so faster and cheaper than the west. That's true; they're also pursuing renewables and are doing so faster and cheaper than the West as well. Major construction of all kinds is cheaper and faster there. Of course, they're also less transparent, and there are far more government subsidies, making it difficult to determine the real costs. That non-transparent, government-paid construction model isn't going to fly in most nations. And, in China's case at least, its renewables program is far outpacing its nuclear program, which is unlikely to ever get much above its current 2−3% of the nation's generation capacity.

Now add back in all those other arguments that we temporarily dropped before − the ones about nuclear accidents, already nearly one major accident per decade, a number that would soar with 1,000 new reactors; and radioactive waste, which still has (and may never have) no scientifically-defensible solution; releases of toxic radiation even in routine operation that are killing people[6], the environmental devastation from uranium mining, and the rest. And, seriously, there are people out there who still argue that nuclear power is an answer to an environmental problem?

That there are those people is, of course, why we have to mount the *Don't Nuke the Climate Campaign* in the first place. That we've touched a nerve means we know we're beginning to win. That we can expect more pushback simply demonstrates that the time is right. A nuclear-free, carbon-free energy future is within our grasp. We're hoping for real movement at COP21 in Paris these next couple of weeks; and even if not there, inevitably across the world as the decade enters its second half and the reality that this really is the answer takes hold.

For more on the campaign, visit WISE's international website (www.wiseinternational.org/campaign) and NIRS' U.S. website (www.nirs.org/cop21/dontnuketheclimate.htm).

You can support the Don't Nuke the Climate Campaign at http://dontnuketheclimate.nirs.org/

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Do we need base-load power stations?

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Web: *www.ies.unsw.edu.au/our-people/associate-professor-mark-diesendorf*

NM815.4516 One of the principal claims used to justify a substantial role for nuclear energy in combating global climate change is that renewable energy cannot supply *base-load* electric power. Underlying this claim is the assumption that the only way of supplying base-load electricity demand is by means of base-load power stations, such as nuclear and coal, that operate at full power 24/7. This notion is being widely promulgated.

For example, former Australian Industry Minister Ian Macfarlane claimed at a uranium industry conference that: "Base load, zero emission, the only way it can be produced is by hydro and nuclear".[1] UK Energy and Climate Secretary, Amber Rudd, attempted to justify the decision to build the proposed Hinkley Point C nuclear power station on the grounds that "We have to secure baseload electricity".[2]

The concept of base-load demand is illustrated in Figure 1, which shows the daily variation of electricity demand in summer in a conventional large-scale electricity grid without much solar energy. Base-load demand is the region across the bottom of the graph. Traditionally base-load demand has been supplied by so-called base-load power stations. Because they are inflexible in operation, in the sense that they are unsuitable for following the variations in demand and supply on timescales of minutes and hours, they are supplemented with flexible peak-load and slightly flexible intermediate-load power stations. Peak-load power stations are hydro-electric systems with dams and open-cycle gas turbines (GTs), essentially jet engines. They can respond to variations in demand and supply on timescales of minutes.

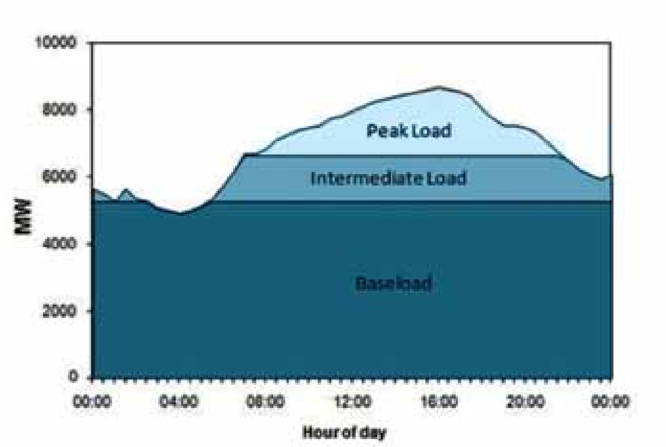

Figure 1: Daily electricity demand and supply in a conventional large-scale system with little renewable energy.

The assumptions that base-load power stations are necessary to supply base-load demand and to provide a reliable supply of grid electricity have been disproven by both practical experience in electricity grids with high contributions from renewable energy and by hourly computer simulations.

As an example of practical experience, in 2014 the state of South Australia had 39% of annual electricity consumption from renewable energy (33% wind + 6% solar) and, as a result, the state's base-load coal-fired power stations are being shut down as redundant.[3] For several periods the whole state system has operated reliably on a combination of renewables and gas with only small imports from the neighbouring state of Victoria.[4]

The north German states of Mecklenburg-Vorpommern[5] and Schleswig-Holstein[6] are already operating on 100% net renewable energy, mostly wind. The 'net' indicates trading with each other and their neighbours. They do not rely on base-load power stations.

"That's cheating", nuclear proponents may reply, "they are relying on power imported by transmission lines from base-load power stations elsewhere." Well, actually the imports from base-load power stations are small. For countries that are completely isolated (e.g. Australia) or almost isolated (e.g. the USA) from their neighbours, hourly computer simulations of the operation of the electricity supply-demand system, based on commercially available renewable energy sources scaled up to 80-100% annual contributions, confirm the practical experience.

In the USA a major computer simulation by a large team of scientists and engineers found that 80-90% renewable energy is technically feasible and reliable. (They didn't examine 100% renewable electricity.) The 2012 report, *Renewable Electricity Futures Study. Vol.1. Technical report TP-6A20-A52409-1* was published by the US National Renewable Energy Laboratory (NREL) and can be downloaded.[7] The simulation balances supply and demand each hour. The report finds that (p.iii): "renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the United States."

Similar results have been obtained from hourly simulation modeling of the Australian National Electricity Market with 100% renewable energy, published by Ben Elliston, Iain MacGill and me in 2013 and 2014, based on commercially available technologies and real data on electricity demand, wind and solar energy. (Peer-reviewed publications listed online.[8]) There are no base-load power stations in the Australian model and only a relatively small amount of storage. Recent simulations (to be published) span 8 years of hourly data.

These, together with studies from Europe, find that base-load power stations are unnecessary to meet standard reliability criteria for the whole supply-demand system, such as loss-of-load probability or annual energy shortfall. Furthermore, they find that reliability can be maintained even when variable renewable energy sources, wind and solar PV, provide major contributions to annual electricity generation, up to 70% in Australia. How is this possible?

Firstly, the fluctuations in variable wind and solar PV are balanced by flexible renewable energy sources that are dispatchable, i.e. can supply power on demand. These are hydro with dams, biofueled open-cycle gas turbines and concentrated solar thermal power (CST) with thermal storage, as illustrated in Figure 2. It is not essential for every power station in the system to be dispatchable. Being able to draw upon a diversity of renewable energy sources, with different statistical properties, provides reliability.

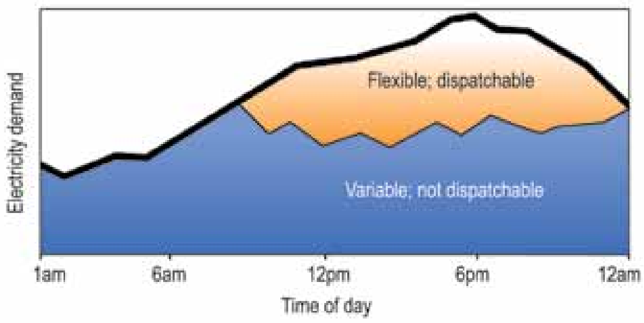

Figure 2: Electricity demand and supply in a large-scale system with a large contribution of variable renewable energy

Secondly, spreading out wind and solar PV farms geographically reduces the fluctuations in their total output and so reduces the already small contribution from biofuelled gas turbines.

Thirdly, new transmission lines may be needed to assist achieving wide geographic distribution of renewable energy sources and to multiply the diversity of types of renewable energy source feeding into the grid. For example, an important proposed link is between the high wind regions in north Germany and the low wind, limited solar regions in south Germany. Texas, with its huge wind resource, needs greater connectivity with its neighbouring US states.

Fourthly, introducing smart demand management, to shave the peaks in electricity demand and to manage periods of low electricity supply, can further increase reliability. This can be assisted with smart meters and switches controlled by both electricity suppliers and consumers, and programmed by consumers to switch off certain circuits (e.g. air conditioning, water heating, aluminium smelting) for short periods when demand on the grid is high and/or supply is low.

As summarized by the NREL study (p.iii): "RE (Renewable Energy) Futures finds that increased electricity system flexibility, needed to enable electricity supply-demand balance with high levels of renewable generation, can come from a portfolio of supply- and demand-side options, including flexible conventional generation, grid storage, new transmission, more responsive loads, and changes in power system operations."[7]

A recent study by Mark Jacobson and colleagues went well beyond above studies. It showed that *all* energy use in the USA, including transport and heat, could be supplied by renewable *electricity*. The computer simulation used synthetic data on electricity demand, wind and sunshine taken every 30 seconds over a period of 6 years.

In the words of former Australian Greens' Senator Christine Milne: "We are now in the midst of a fight between the past and the future". The dissemination of the base-load myth and other myths denigrating renewable energy falsely[9], and the refutation of these myths, are part of that struggle.

Further reading

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Belgium: Reactor restarts and lifespan extensions but 2025 phase-out law remains

Author: *Eloi Glorieux − Senior Energy Campaigner, Greenpeace Belgium.*

NM815.4517 FANC, the Belgian nuclear regulator, recently took two far-reaching decisions. On September 30, FANC accepted the Long Term Operation Action Plan for the two oldest reactors at the Doel nuclear power plant, paving the way for a 10 year lifetime extension.

And on November 17, FANC approved the Safety Case report of Electrabel/Engie. According to FANC, the nuclear operator sufficiently demonstrated that the Doel 3 and Tihange 2 reactors can restart safely. Both reactors have been shut down since March 2014. In the summer of 2012 thousands of cracks were discovered in the reactor vessels.

Lifetime extension Doel 1 and 2

The decision to extend the lifespan of Doel 1 and 2 − the two 40 year old pressurized water reactors (PWR) − was taken in July after long debates in the parliament. The main justification used by Energy Minister Marghem was security of supply. Shortly after the vote in the parliament, this argument was refuted by the federal energy regulator, CREG, and the national grid operator, Elia. Both declared that the security of supply would not be endangered when both reactors were to be decommissioned in 2015.

At the end of September FANC approved Electrabel's LTO Action Plan, which was the last obstacle for plex (lifespan extension). Very remarkable is that several important safety requirements first imposed by FANC as a condition for lifetime extension have been watered down or even disappeared completely from the final action plan. In its original LTO Strategy Note of 2009, the Scientific Council of FANC urged that old reactors were upgraded to the safety level of the newest generation of PWR's, i.e. the EPR. The final LTO Action Plan for Doel 1&2, approved by FANC, urges not more than the safety level of the "most recent Belgian reactors", i.e. the safety level of PWRs from 1985.

The Belgian Stress Tests Action Plan, incorporated in the LTO-revision, also urged the replacement of the reactor pressure vessel heads of Doel 1&2. The approved LTO Action Plan now only asks that the necessity to replace the heads would be examined.

Also the installation of filtered ventilation systems on the reactor buildings of both units was identified as a necessary improvement action for plex. FANC now accepts that these important safety actions are implemented only within five years.

It became clear that when necessary actions to upgrade the safety of the old reactors were considered to be too expensive for the operator or would endanger the lifetime extension as such, they were weakened or postponed in time.

Doel 1 and 2 and Tihange 1 challenged in court

The decisions to extend the lifetime of Doel 1&2, but also of Tihange 1 (decision taken already in December 2013) were taken without a preceding environmental impact assessment and cross-border public consultation process, as required by the Espoo and Aarhus Conventions and the European Directives.

Greenpeace Belgium therefore filed a legal complaint before the civil court. In July, the court declared itself incompetent to adjudicate because of the principle of separation of powers. Greenpeace appealed and the sentence is now expected in the coming months.

Another complaint was filed before the State Council against the approval by FANC of the LTO Action Plans of Doel 1&2. Greenpeace and Ecopower are also preparing a complaint before the European Commission for an infraction against the EU competition and state aid rules. In order to make the plex of the old units profitable for Electrabel/Engie, the government granted some unjustified benefits to the operator.

Cracked reactors will restart in December

In the summer of 2012, thousands of unexplained hydrogen flakes were detected at the reactor pressure vessels of Doel 3 and Tihange 2, both 1,000 MW PWR's from 1982 and 1983. In May 2013, although the origin of the problem remained unclear and uncertainty existed about the evolution of the cracks, FANC approved the restart of both reactors and imposed some additional tests. In March 2014, the results of these test necessitated once again the shut-down of the reactors.

After the presentation of a report in which the operator demonstrated the integrity of the reactor vessels under continued operation, FANC approved in November 2015 the restart of both reactors. Once again FANC revealed itself as a defender of the health of the nuclear industry, rather than as a watchdog for the safety and health of the public. Three years after the cracks were discovered, there is still not certainty about the cause of the problem or the evolution of it.

Doel and Tihange are situated very close to the cities of Antwerp and Liège. 1.5 million people are living within 30 km from the Doel nuclear plant. Under such circumstances, the restart of both reactors remains more than questionable.

Nuclear phase-out jeopardized but not undone

The decisions to plex the oldest reactors for another 10 years and to restart the two cracked reactors will surely hamper the nuclear phase-out in Belgium. However, the final phase-out date remains 2025. According to the new law, the phase-out calendar is now as follows:

2022 : Doel 3
2023 : Tihange 2
2025 : Doel 1, Doel 2, Doel 4, Tihange 1 and Tihange 4

Betting on the wrong horse: Fast reactors and climate change

Author: *M.V. Ramana − Program on Science and Global Security at Princeton University*

NM815.4518 In the last decade or so, many people who would likely identify themselves as environmentalists have turned to nuclear power as a way to deal with climate change. Among them are James Lovelock, Patrick Moore, James Hansen, and George Monbiot. Of these, Hansen has to be, and in some circles has been, taken most seriously. He is, after all, arguably the scientist who has done the most for raising concerns about climate change. What is also notable about Hansen is that he argues not just for any kind of nuclear power, but one based on a specific kind of a reactor − a fast reactor.

Climate change is such an important threat to our planet that it is quite justified to assess whether nuclear power should be deployed to a much larger extent as a way of reducing carbon dioxide emissions. This article does not − deliberately − address that question in general, but focuses on whether fast reactors could play a significant role in such a strategy. I argue below that because of the multiple problems with such reactors, relying on fast reactors to combat climate change is misguided.

In his book, *Storms of my Grandchildren*, Hansen explains the details of the reactor and how he came to believe in the potential of this reactor system:

"When asked about nuclear power, I am usually noncommittal, rattling off pros and cons. However, there is an aspect of the nuclear story that deserves much greater public attention. I first learned about it in 2008, when I read an early copy of Prescription for the Planet, by Tom Blees, who had stumbled onto a secret story with enormous ramifications − a story that he delved into by continually badgering some of the top nuclear scientists in the world until he was able to tell it with a clarity that escapes technical experts. I have since dug into the topic a bit more and observed how politicians and others reacted to Blees' information, and the story has begun to make me slightly angry − which is difficult to do, as my basic nature is very placid, even comfortably stolid.

"Today's nuclear power plants are "thermal" reactors, so-called because the neutrons released in the fission of uranium fuel are slowed down by a moderating material. The moderating material used in today's commercial reactors is either normal water ("light water") or "heavy water," which contains a high proportion of deuterium, the isotope of water in which the hydrogen contains an extra neutron. Slow neutrons are better able to split more of the uranium atoms, that is, to keep nuclear reactions going, burning" more of the uranium fuel.

"The nuclear fission releases energy that is used to drive a turbine, creating electricity. It's a nice, simple way to get energy out of uranium. However, there are problems with today's thermal nuclear reactors (most of which are light-water reactors). The main problem is the nuclear waste, which contains both fission fragments and transuranic actinides. The fission fragments, which are chemical elements in the middle of the periodic table, have a half-life of typically thirty years. Transuranic actinides, elements from plutonium to nobelium that are created by absorption of neutrons, pose the main difficulty. These transuranic elements are radioactive materials with a lifetime of about ten thousand years. So we have to babysit the stuff for ten thousand years − what a nuisance that is!

"Along with our having to babysit the nuclear waste, another big problem with thermal reactors is that both light-water and heavy-water reactors extract less than 1 percent of the energy in the original uranium.

"Most of the energy is left in the nuclear waste produced by thermal reactors. (In the case of light-water reactors, most of the energy is left in "depleted-uranium tailings" produced during uranium "enrichment"; heavy-water reactors can burn natural uranium, without enrichment and thus without a pile of depleted-uranium tailings, but they still use less than 1 percent of the uranium's energy.) So nuclear waste is a tremendous waste in more ways than one.

"These nuclear waste problems are the biggest drawback of nuclear power. Unnecessarily so. Nuclear experts at the premier research laboratories have long realized that there is a solution to the waste problems, and the solution can be designed with some very attractive features.

"I am referring to "fast" nuclear reactors. Fast reactors allow the neutrons to move at higher speed. The result in a fast nuclear reactor is that the reactions "burn" not only the uranium fuel but also all of the transuranic actinides − which form the long-lived waste that causes us so much heartburn. Fast reactors can burn about 99 percent of the uranium that is mined, compared with the less than 1 percent extracted by light-water reactors. So fast reactors increase the efficiency of fuel use by a factor of one hundred or more.

"Fast reactors also produce nuclear waste, but in volumes much less than slow (thermal) reactors. More important, the radioactivity becomes inconsequential in a few hundred years, rather than ten thousand years."

All of this description clearly suggests that Hansen thinks of fast reactors as a good, if not perfect, solution. Elsewhere he has expanded on the various other virtues of fast reactors. What Hansen does not talk about, however, are the various problems with fast reactors. And we have about six decades of experience with those problems.

Hansen actually does refer to the long history of fast reactors in his book, saying:

"The concept for fast-reactor technology was defined by Enrico Fermi, one of the greatest physicists of the twentieth century and a principal in the Manhattan Project, and his colleagues at the University of Chicago in the 1940s. By the mid-1960s, the nuclear scientists at Argonne National Laboratory had demonstrated the feasibility of the concept."

The demonstration of the feasibility of fast reactors actually goes back to the early 1950s, with the Experimental Breeder Reactor constructed in Idaho in the United States. The term breeder is significant. It refers to the fact that in some fast reactors, those neutrons that are escaping the core are captured by a blanket made of "fertile materials", which then eventually get transformed into a new element that is itself fissile, i.e. can be used as a fuel in a reactor core. An example of such a fertile material is uranium-238, which gets converted into a fissile isotope of plutonium, plutonium-239. Uranium-238 is the most common isotope of uranium, constituting about 99.3 percent of naturally available uranium. It is this process of conversion of uranium-238 into plutonium-239 that makes a fast reactor utilize uranium much more efficiently.

If the fast reactor is designed suitably, it could produce more fissile material in its blankets than is consumed in its core. It is then said to "breed" plutonium and these reactors are called breeder reactors. The long-standing attraction of breeder reactors for nuclear power proponents is that when nuclear power was first developed, uranium was thought to be scarce and there was widespread concern that global resources would be insufficient to support the anticipated large expansion of nuclear power. This is why the United States started constructing the EBR-I so early into its nuclear power program.

Nuclear meltdowns

Indeed, on December 20, 1951, EBR-I became the world's first electricity-generating nuclear power plant when it produced sufficient electricity to illuminate four 200-watt light bulbs. On June 4, 1953, the U.S. Atomic Energy Commission announced that EBR-I had become the world's first reactor to demonstrate the breeding of plutonium from uranium. About two years later, on November 29, 1955, the reactor had a partial core meltdown, not something that Hansen appears to talk about in any detail.

A decade later, in October 1966, it was the turn of Fermi-1 (yes, named after the famous physicist), a demonstration fast breeder reactor located in Lagoona Beach, Michigan, which suffered a partial core meltdown. What is more interesting is the cause of the accident. Pieces of zirconium from the "core catcher", a safety system that is supposed to prevent molten fuel from liquid sodium into a part of the core, leading to those fuel elements melting down because they could not be cooled. The implication; additional safety features, could, under some circumstances, end up causing accidents in unexpected ways.

These meltdowns also have a different cause that has to do with operating a nuclear reactor using fast neutrons. In fast reactors, when fuel starts melting locally and coming closer together, it increases the rate at which the chain reaction occurs. If this process were not stopped extremely fast − for example, by the insertion of control rods that absorb neutrons − the runaway reaction would cause the pressure inside the core to rise fast enough to lead to an explosion. Again, it was an illustrious physicist, Hans Bethe, who pointed out this possibility back in 1956. Such an explosion could fracture the protective barriers around the core, including the containment building, and release large fractions of the radioactive material in the reactor into the surroundings. This so-called "core disassembly accident" has therefore been a longstanding safety concern with fast reactors.

A second difference between breeder reactors and the more common thermal reactors is their choice of coolant. Because breeder reactors do not have any moderator to slow down neutrons, their cores, where most of the fissions, and thus energy production, occur are smaller in size as compared to thermal reactors. Thus, their power density will be much higher. Efficient transfer of this heat requires the use of liquid metals rather than the more commonly utilized water. The coolant that has been used in all demonstration breeder reactors to date is a liquid metal that melts at relatively low temperatures − sodium.

Though sodium has some safety advantages, it reacts violently with water and burns ifexposed to air. This makes fast reactors susceptible to serious fires. Almost all fast reactors constructed around the world have experienced one or more sodium leaks, likely because of chemical interactions between sodium and the stainless steel used in various components of the reactor. Finally, since sodium is opaque, fast reactors are notoriously difficult to maintain and susceptible to long shutdowns.

The question of costs

Having to deal with all these properties and safety concerns naturally drives up the construction costs of fast reactors, to the point that they are significantly more expensive than the more common thermal reactors that Hansen talks about. In addition, they also operate with less reliability. Economically, therefore, fast reactors have proved to be uncompetitive with current generation thermal reactors.

This is the main reason that decades after breeder reactors were piloted, no country has successfully built a commercial breeder reactor. France, the country that is most reliant on nuclear power in the world, did try. The Superphenix started operating in 1986, experienced a series of accidents, and was shut down in 1997. During this period, it generated less then 7% of the electricity of what it could have done at full capacity. Currently, only a few demonstration reactors are being built or operated, the Prototype Fast Breeder Reactor that is being constructed in Kalpakkam in Tamil Nadu being one such reactor. This result is not for want of trying; just the OECD countries, between themselves, have spent about US$50 billion (in 2007 dollars) on breeder reactor research and development and on demonstration breeder reactor projects.

In today's electricity markets, with nuclear power rapidly losing ground to cheaper renewables, the idea that fast reactors would establish an economically viable path forward for nuclear power is far-fetched, to say the least. Hansen's advocacy of fast reactors therefore seems a little at odds with current economic realities.

What of nuclear waste?

What of the other argument Hansen makes; about the ability of fast reactors to deal with the nuclear waste problem. Here again, what is not mentioned is as important, if not more important, than what is said. First, actinides are not the only long-lived radioactive materials produced in a nuclear reactor. There is also what is called fission products, some of which have a very long radioactive half-life; Technetium-99, for example, has a half-life of 200,000 years.

Second, there are so many actinides and they have a variety of nuclear reactions that are trying to "transmute" (i.e., convert) them into elements that have shorter lifetimes, or even radioactively stable elements, requires an elaborate strategy involving the reprocessing of spent fuel, multiple rounds of special fuel fabrication, and irradiation in fast reactors. In 1996, the U.S. National Academy of Sciences examined the potential benefits of such a scheme and concluded: "none of the dose reductions seems large enough to warrant the expense and additional operational risk of transmutation".

Third, just in the process of doing this transmutation, a large quantity of radioactive materials that are currently held within the spent fuel from nuclear reactors will be released into the biosphere in the form of liquid or gaseous wastes. This is what happens at all reprocessing plants and estimates of the radiation dose to populations around the world from just the gaseous fission products routinely released by reprocessing plants suggest that these exceed the doses from future leakage from geological repositories.

To conclude, James Hansen's advocacy of a nuclear solution to climate change based on fast reactors is misplaced. The six decades of global experience with breeder reactors shows that they are very problematic, much more so than nuclear power in general. So any strategy based on rapid construction of these untested technologies is very likely to suffer from setbacks. There is simply not enough time for us to go down these blind alleys.

Australian government green-lights yellowcake sales to India

Author: *Dave Sweeney − Nuclear-Free Campaigner, Australian Conservation Foundation*

NM815.4519 Civil society groups have condemned the Australian federal government's recent completion of contested uranium supply deals with both the United Arab Emirates and India.

The deal is in direct conflict with a finding in September by a government-controlled Parliamentary review that "Australian uranium not be sold to India" until unresolved safety, security, legal and nuclear weapons issues were addressed.

The Joint Standing Committee on Treaties (JSCOT) recommended that no uranium sales take place at this time or under the current terms of the Australia-India Nuclear Co-operation Agreement.

It further argued that uranium must not be sold to India until key checks and balances including evidence of improved safety, monitoring and regulatory standards, the establishment of an independent Indian nuclear regulator and full separation of the military and civil dimensions of India's nuclear sector were put in place.

Despite this clear call for caution only two months later in late November the federal government issued a response that "the Government does not accept the Committee's recommendation that exports of uranium to India should be deferred" and further announced that all formalities had been completed so that 'uranium exports can begin immediately'.

The development, which was only briefly in the mainstream Australian media, drew anger from environment, faith, public health and peace groups who described the fast-tracking of uranium sales as a derelict and dangerous move that puts nuclear interests ahead of the national interest.

In the shadow of the Australian uranium-fuelled Fukushima nuclear disaster the countries under-performing but politically favoured uranium sector is under increased scrutiny and pressure with production rates, employment and share value all declining.

With both the industry and federal government now seeking to fast track new sales Australia increasingly risks being globally regarded as an irresponsible supplier of one of the riskiest substances on the planet, providing the source material for nuclear power, weapons and waste without proper scrutiny and against the recommendations of its own review processes.

Critics of the new sales deal have highlighted that India is actively expanding its nuclear arsenal and weapons capabilities through missile tests, increased uranium enrichment capacity and work around multiple weapons launch platforms, including advancing improved submarine launch capabilities.

The newly approved uranium sales treaty places no practical, political or perception barrier to any of these activities. Instead it effectively gives a green light to India's nuclear weapons ambitions.

This cavalier approach is not in the best interests of Australia or the region and undermines both collective safety and Australia's domestic legal and existing international treaty obligations, particularly under the provisions of the 1985 South Pacific Nuclear Free Zone Treaty (the Treaty of Rarotonga).

Australia clearly has a role to play in providing clean energy solutions to assist in meeting India's energy aspirations, especially given the large number of rural poor remain living in energy poverty.

Using Australian expertise to facilitate India's renewable sector would allow the country to leapfrog the dangerous and dirty old energy sources that threaten public health and regional stability and provide fast, flexible and secure power that keeps village lights on and global Geiger counters off.

In fast-tracking poorly considered uranium sales and ignoring the non-partisan advice of its own expert parliamentary committee the government of new Prime Minister Malcolm Turnbull has failed its first nuclear test and set itself up for escalated community contest on nuclear issues.

Reference:
1. www.aph.gov.au/Parliamentary_Business/Committees/Joint/Treaties/28_October_2014/Report_151

NUCLEAR NEWS

The alternative is now the mainstream

According to Lazard, the most cost-effective options to reduce carbon emissions are wind and utility-scale solar. Rooftop solar might fit there, except that Lazard found that the cost of installing rooftop solar in the U.S. runs twice that of the rest of the world.

Back in the day − OK, even five years ago − solar and wind power were often described as "alternatives." Alternatives to coal, or nuclear, or whatever energy source they were being compared to. The implication of being an "alternative" is that it isn't quite mainstream yet, perhaps not yet ready for the big time.

If that's the case, perhaps the Nuclear Energy Institute should set up a new section promoting nuclear power on its website titled Alternatives to Clean Energy. Because clean energy is now the mainstream and the electricity production sources of the 20th century are, at most, alternatives.

In November, the International Energy Agency (IEA) pointed out that renewables are now the second largest generation source in the world, topped only by coal, and that renewables accounted for half of all new generation in 2014.[1]

But more forward-looking − and even more compelling − is a report released from the investment bank Lazard, which examines the levelized costs of the various energy technologies.[2] Wind and solar are not only beating nuclear − as would be expected − but also coal and even natural gas. Remember that next time you read about some utility exec (or uninformed journalist) complaining that nuclear reactors are closing because of competition from low-priced gas.

Sure, the ready availability of gas right now due to large-scale fracking means there is ample supply at low cost − but the real competition on the price end from here to eternity, what the nuclear utilities know lies ahead for them, is that nuclear REALLY can't compete with renewables. In fact, according to Lazard, wind and solar are now less than half the price of new nuclear. "And the curve is still heading down" for renewables, "while nuclear is the only technology to show a significant increase."

In the only glimmer of hope for nuclear power (and for fossil fuels too, for that matter), Lazard somehow concludes that "alternative energy systems alone will not be capable of meeting the baseload generation needs of a developed economy for the foreseeable future."

At the same time, Lazard issued a second report[3], which concludes that energy storage technologies are now at an "inflection point." The bank found that storage is already competitive, without subsidies, for some applications, such as grid stability. But the report also states that storage costs will continue to drop dramatically over the next five years, meaning that other applications for storage will become cost-competitive as well, and quickly. Still, the bank states that we're not yet at the point where storage can economically meet the "transformational scenarios envisioned by renewable energy advocates."

Taken together, the reports lead to only one conclusion: clean energy is no longer the "alternative," it is already the mainstream. Whether that transformation hits full steam two years from now, or five years, or even ten years is less relevant than the reality that it is unstoppable. All the nuclear-powered ideology in the world isn't going to put a dangerous, obsolete technology on top, especially when it is already the most expensive option available and the gap is only widening.

− Michael Mariotte,
Nuclear Information & Resource Service

1. www.theguardian.com/environment/2015/nov/10/renewable-energy-made-up-half-of-worlds-new-power-plants-in-2014-iea

2. http://reneweconomy.com.au/2015/wind-and-solar-beating-conventional-fuels-on-costs-lazard-26273

3. http://reneweconomy.com.au/2015/lazard-energy-storage-sector-at-inflection-point-as-costs-fall-39784

Energy efficiency could slash US$250 billion annually from decarbonization costs

A new report − 'How Energy Efficiency Cuts Costs for a 2° C Future' − analyzes how energy efficiency policies and programs in Brazil, China, Europe, India, Mexico, and the U.S. can reduce the cost of economy-wide decarbonization by up to US$250 billion (€235b) per year for these regions, with no net cost to society through to 2030. The report was commissioned by ClimateWorks and the research was carried out by a consortium of groups led by Fraunhofer ISI.

The study modeled several pathways to identify the contribution of energy efficiency to achieving a 2°C upper limit for climate change. It found that between now and 2030, energy efficiency can reduce the global cost of limiting warming by up to US$2.8 trillion (€2.64t) compared to a more energy intensive pathway. The potential annual savings of the energy efficiency pathway vary by nation, ranging from 0.1−0.4% of annual GDP.

In addition, the economic benefits of energy efficiency can help eliminate energy poverty. Recent research by the World Bank shows that the world can achieve universal access to electricity through investments of between US$40−100 billion (€38−94b) annually. The major savings from energy efficiency could help finance this critical goal.

As well as reducing the costs of decarbonization, energy efficiency in the regions studied could reduce annual greenhouse gas emissions by 11 billion metric tons (Gt) of CO2e in 2030 − roughly two-thirds of the reductions needed in these regions to limit warming to 2°C.

ClimateWorks, 2015, "How Energy Efficiency Cuts Costs for a 2° C Future", www.climateworks.org/report/efficiency/

Nuclear Phaseout Congress 2016

The Nuclear Phaseout Congress 2016, organized by the Swiss Energy Foundation, will be held on 21 March 2016 in Zurich. Speakers will include:

- Naoto Kan, former Japanese Prime Minister
- Gregory Jaczko, former Chairman of the U.S. Nuclear Regulatory Commission
- Jürgen Trittin, Member of the Bundestag, German Federal Minister for the Environment (1998−2005)
- Other experts including Yves Marignac, Oda Becker, and Mycle Schneider.

The congress is to discuss the global development of nuclear energy, the risks posed by aging reactors and the challenges faced by the nuclear regulators, those within the political sphere and society as a whole. The congress will be held in German and English.

More Information: www.energiestiftung.ch/service/fachtagungen/fachtagung16/en/

Contact: Myriam Planzer, myriam.planzer@energiestiftung.ch

Ukraine nuclear plants without power as towers feeding energy to Crimea blown up

A senior Ukrainian energy official revealed that a November 20 attack on transmission towers that cut off the delivery of electricity from Ukraine to Crimea also created an emergency situation at nuclear power plants.

The apparent act of sabotage in Ukraine's Kherson region forced an emergency power unloading at several Ukrainian nuclear power plants according to the first deputy director of Ukraine's energy company Ukrenergo, Yuriy Katich.

Russia's Crimea was forced to switch to autonomous reserve power after transmission towers in the adjacent Ukrainian region were blown up, causing a blackout. Meanwhile, the repairs were delayed by Right Sector and Crimean Tatar "activists" attempting to block crews from getting to the scene. None of the groups have accepted responsibility.

Katich said: "All of these events have led to an additional emergency shutdown of the electrical network of two units at thermal power plants – the Dnieper and Uglegorskaya – and the emergency unloading by 500 MW of nuclear power plants in Ukraine. This includes Zaporozhskaya NPP and the South Ukrainian NPP. I want to stress that such emergency unloading of a nuclear plant – it is very dangerous."

Crimea's chief prosecutor, Natalia Poklonskaya, has called the blowing up of the transmission towers sabotage, which "has created a threat to lives and wellbeing of some two million people of various nationalities," while a regional authority suggested qualifying it as "an act of terror."

23 Nov 2015, 'Ukraine nuclear power plants 'dangerously' without power as towers feeding energy to Crimea blown up', www.rt.com/news/323060-ukraine-nuclear-plants-danger/

21 Nov 2015, 'State of emergency, blackout in Russia's Crimea after transmission towers in Ukraine blown up', www.rt.com/news/323012-crimea-blackout-lines-blown-up/

WISE/NIRS Nuclear Monitor

The World Information Service on Energy (WISE) was founded in 1978 and is based in Amsterdam, the Netherlands.

The Nuclear Information & Resource Service (NIRS) was set up in the same year and is based in Washington D.C., US.

WISE and NIRS joined forces in the year 2000, creating a worldwide network of information and resource centers for citizens and environmental organizations concerned about nuclear power, radioactive waste, proliferation, uranium, and sustainable energy issues.

The WISE / NIRS Nuclear Monitor publishes information in English 20 times a year. The magazine can be obtained both on paper and as an email (pdf format) version. Old issues are (after 2 months) available through the WISE homepage: www.wiseinternational.org

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