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Editorial

Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor:

- The Nuclear Information & Resource Service in the U.S. has launched a new campaign called #NuclearIsDirty.
- We debunk propaganda from pro-nuclear environmentalists regarding the Chernobyl death toll.
- Michael Mariotte writes about nuclear power's crippling economic problems.
- Also on the topic of nuclear economics, we pull together expert commentary discussing how economics was holding nuclear power back before the Three Mile Island, Chernobyl and Fukushima disasters.
- An article on the problems of reprocessing and plutonium stockpiling in East Asia, and the complicity of the U.S. and other nuclear supplier nations.

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:

#NuclearIsDirty

The Nuclear Information & Resource Service in the U.S. has launched a new campaign called #NuclearIsDirty. NIRS is rolling out a series of online events, publications, and social media forums to inform the public of the real environmental impacts of nuclear power, from the mining of uranium and production of reactor fuel, all the way through to the long-term storage and management of radioactive waste.

The series combines technical information with testimony from people whose communities are affected; it combines a series of events with actions people can take and resources to supplement the campaign.

#NuclearIsDirty began with a telebriefing on one of the U.S.'s worst nuclear disasters: the Church Rock uranium waste spill in 1979. It featured presentations by experts and activists working with the largely Native American communities still affected by the spill of 1,000 tons of uranium mill tailings waste. The audio is posted at: www.nirs.org/reactorwatch/week1-briefing-churchrock-20160317.mp3

#NuclearIsDirty has also hosted a webinar with activists from the Clean Up the Mines campaign. There are over 15,000 abandoned uranium mines throughout the U.S., leaking radioactive and toxic waste. And just like Church Rock, Native American communities are disproportionately affected. The webinar is posted at www.youtube.com/user/nirsnet

And #NuclearIsDirty has hosted a telebriefing with Arnie Gundersen from Fairewinds Energy and Education and Mary Olson from NIRS reporting on their month-long visit to Japan.

Next week, #NuclearIsDirty is focusing on the health impacts of ionizing radiation. Visit the website for details:

http://nuclearisdirty.nirs.org/

www.youtube.com/user/nirsnet

#NuclearIsDirty

Facebook: Nuclear Information and Resource Service

Pro-nuclear environmentalists and the Chernobyl death toll

Author: *Jim Green – Nuclear Monitor editor*

NM821.4548 With few if any exceptions, self-styled pro-nuclear environmentalists peddle misinformation regarding the Chernobyl death toll.

Before considering their propaganda, a brief summary of credible positions regarding the Chernobyl cancer death toll (see Nuclear Monitor #785 for a detailed discussion).[1]

Epidemiological studies are not much use: the Chernobyl death toll is lost in the statistical noise of widespread cancer incidence.

Estimates of collective radiation exposure are available – for example the International Atomic Energy Agency (IAEA) estimates a total collective dose of 600,000 person-Sieverts over 50 years from Chernobyl fallout.[2] And the collective radiation dose can be used to arrive at a death toll using the Linear No Threshold (LNT) model.

If we use the IAEA's collective radiation dose estimate, and a risk estimate derived from LNT (0.1 cancer deaths per person-Sievert), we get an estimate of 60,000 cancer deaths. Sometimes a risk estimate of 0.05 is used to account for the possibility of decreased risks at low doses and/or low dose rates (in other words, 0.05 is the risk estimate when applying a 'dose and dose rate effectiveness factor' or DDREF of two). That gives an estimate of 30,000 deaths.

Any number of scientific studies use LNT – or LNT with a DDREF – to estimate the Chernobyl death toll. These studies produce estimates of the Chernobyl cancer death toll varying from 9,000 (in the most contaminated parts of the former Soviet Union) to 93,000 deaths (across Europe).[1,3]

Moreover, LNT may underestimate risks. The 2006 report of the U.S. National Academy of Sciences' Committee on the Biological Effects of Ionising Radiation (BEIR) states: "The committee recognizes that its risk estimates become more uncertain when applied to very low doses. Departures from a linear model at low doses, however, could either increase or decrease the risk per unit dose."[4] Likewise the BEIR report states that "combined analyses are compatible with a range of possibilities, from a reduction of risk at low doses to risks twice those upon which current radiation protection recommendations are based."

So the true Chernobyl cancer death toll could be lower or higher than the LNT-derived estimate of 60,000 deaths.

Those are the credible estimates of the cancer death toll from Chernobyl. None of them are conclusive but that's the nature of the problem we're dealing with.

Another defensible position (or non-position) is that the death toll is unknown and unknowable because of the uncertainties associated with the science. The UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) states:[5]

"The Committee has decided not to use models to project absolute numbers of effects in populations exposed to low radiation doses from the Chernobyl accident, because of unacceptable uncertainties in the predictions. It should be stressed that the approach outlined in no way contradicts the application of the LNT model for the purposes of radiation protection, where a cautious approach is conventionally and consciously applied."

Pro-nuclear environmentalists

So there are two defensible positions regarding the Chernobyl cancer death toll – estimates based on collective dose estimates (with or without a DDREF or a margin of error in either direction), and UNSCEAR's position that the death toll is uncertain because of "unacceptable uncertainties in the predictions".

The third of the two defensible positions – unqualified claims that the Chernobyl death toll was just 50 or so – should be rejected as dishonest or uninformed spin from the nuclear industry and some of its scientifically-illiterate supporters. Those illiterate supporters include every last one of the self-styled pro-nuclear environmentalists (PNEs). (We should note in passing that some PNE's have genuine environmental credentials while others – such as Patrick Moore[6] and Ben Heard[7] – are in the pay of the nuclear industry.)

James Hansen[8] and George Monbiot[9] cite UNSCEAR to justify a Chernobyl death toll of 43, without noting that the UNSCEAR report5 did not attempt to calculate long-term deaths. James Lovelock asserts that "in fact, only 42 people died" from the Chernobyl disaster.[10]

Patrick Moore, citing the UN Chernobyl Forum (which included UN agencies such as the IAEA, UNSCEAR, and WHO), states that Chernobyl resulted in 56 deaths.[11] In fact, the UN Chernobyl Forum's 2005 report[12] estimated up to 4,000 long-term cancer deaths among the higher-exposed Chernobyl populations, and a follow-up study[13] by the World Health Organization in 2006 estimated an additional 5,000 deaths among populations exposed to lower doses in Belarus, the Russian Federation and Ukraine.

Australian 'ecomodernist' Barry Brook says the "credible literature (WHO, IAEA) puts the total Chernobyl death toll at less than 60."[14] Ben Heard, another Australian 'ecomodernist' (in fact a uranium and nuclear industry consultant – a fact that, like Patrick Moore, he rarely discloses) gives a Chernobyl death toll of 43.[15]

In 2010, Mark Lynas said the Chernobyl death toll "has likely been only around 65."[16] Two years earlier, Lynas cited a WHO estimate of "a few thousand deaths" (actually 9,000 deaths) but attempted to trivialize the death toll by saying that Chernobyl had an "indiscernible" impact on overall deaths.[17] The WHO uses the term indiscernible in a technical

sense: the Chernobyl death toll can't be picked up by epidemiological studies. When the nuclear industry and its PNE apologists use the term, they're usually trying to leave you with the impression that there is no long-term death toll from exposure to Chernobyl fallout.

There doesn't appear to be a single example of a PNE – or a comparable organisation – providing a credible account of the Chernobyl death toll. The Breakthrough Institute comes closest, stating that "UN officials say that the death toll could be as high as 4,000".[18] However the Breakthrough Institute ignores: the follow-up UN/WHO study[13] that estimated an additional 5,000 deaths in ex-Soviet states; scientific estimates of the death toll beyond ex-Soviet countries[1]; scientific literature regarding diseases other than cancer linked to radiation exposure[3]; and indirect deaths associated with the permanent relocation of over 350,000 people after the Chernobyl disaster.

Ignorance or deceit?

How to explain the misinformation of the PNEs: ignorance or deceit, cock-up or conspiracy? Dishonest cherry-picking certainly seems to be at work. In a review of Robert Stone's 'Pandora's Promise' propaganda film[19,20], physicist Dr Ed Lyman from the Union of Concerned Scientists writes:[21]

"One after another, the film's interviewees talk about how shocked they were to read the 2005 report of the Chernobyl Forum − a group under of U.N. agencies under the auspices of the International Atomic Energy Agency and the governments of Russia, Belarus and Ukraine − and discover that "the health effects of Chernobyl were nothing like what was expected." The film shows pages from that report with certain reassuring sentences underlined.

"But there is no mention of the fact that the Chernobyl Forum only estimated the number of cancer deaths expected among the most highly exposed populations in Ukraine, Belarus and Russia and not the many thousands more predicted by published studies to occur in other parts of Europe that received high levels of fallout. Nor is there mention of the actual health consequences from Chernobyl, including the more than 6,000 thyroid cancers that had occurred by 2005 in individuals who were children or adolescents at the time of the accident. And the film is silent on the results of more recent published studies that report evidence of excesses in other cancers, as well as cardiovascular diseases, are beginning to emerge.[22]

"Insult is then added to injury when Lynas then accuses the anti-nuclear movement of "cherry-picking of scientific data" to support their claims. Yet the film had just engaged in some pretty deceptive cherry-picking of its own. Lynas then goes on to assert that the Fukushima accident will probably never kill anyone from radiation, also ignoring studies estimating cancer death tolls ranging from several hundred to several thousand."

Perhaps some PNEs are deceitful – there's no way of knowing without getting inside their heads. On the other hand, evidence of their ignorance abounds. For the most part, PNEs had a shaky understanding of the radiation/health debates (and other nuclear issues) before they joined the pro-nuclear club, and they have a shaky understanding now. Ed Lyman writes:[21]

"When Lynas says that in his previous life as an anti-nuclear environmentalist he didn't know that there was such a thing as natural background radiation, or Michael Shellenberger [Breakthrough Institute] admitted to once taking on faith the claim that Chernobyl caused a million casualties, the audience may reasonably wonder why it should accept what they believe now that they are pro-nuclear."

George Monbiot [23] berates anti-nuclear campaigners for citing a Russian study that used a flawed methodology to reach a flawed estimate of around one million deaths. But most don't cite the study and some have explicitly rejected it. By contrast, every last one of the PNEs peddles misinformation regarding the Chernobyl death toll.

James Hansen's understanding of the radiation/health debates is shaky, to say the least. He falsely claims there is a "generally accepted 100 millisievert threshold for fatal disease development."[8] But the accepted scientific position is that there is no threshold. Thus a 2010 UNSCEAR report states that "the current balance of available evidence tends to favour a non-threshold response for the mutational component of radiation-associated cancer induction at low doses and low dose rates."[24]

And Hansen claims that his estimate "for global deaths caused by historical nuclear power (~4,900) could be a major overestimate relative to the empirical value (by 2 orders of magnitude)."[8] In fact, his figure is comparable to the very lowest of the estimates of the Chernobyl death toll alone – the UN Chernobyl Forum's estimate of 4,000 deaths amongst those most heavily exposed.[12]

Barry Brook is another example of someone whose understanding was shaky before and after he joined the PNE club. Brook says that before 2009 he hadn't given much thought to nuclear power because of the 'peak uranium' argument.[25] By 2010, Brook was in full flight, asserting that the LNT model is "discredited" and has "no relevance to the real world", and that the "health physics community is preponderantly in agreement that LNT has no valid empirical foundation".[26]

In fact, LNT enjoys heavy-hitting scientific support. For example the U.S. National Academy of Sciences' BEIR report states that "the risk of cancer proceeds in a linear fashion at lower doses without a threshold and … the smallest dose has the potential to cause a small increase in risk to humans."[4] Likewise, a report in the *Proceedings of the National Academy of Sciences states: "Given that it is supported by experimentally grounded, quantifiable, biophysical arguments, a linear extrapolation of cancer risks from intermediate to very low doses currently appears to be the most appropriate methodology."*[27]

On Chernobyl, Brook said: "The credible literature (WHO, IAEA) puts the total Chernobyl death toll at less than 60. The 'conspiracy theories' drummed up against these authoritative organisations rings a disturbingly similar bell in my mind to the crank attacks on the IPCC, NASA and WMO in climate science."[26] But the UN agencies estimated 9,000 deaths in ex-Soviet states in their 2005/06 reports, and more recently UNSCEAR has declined to provide an estimate.

Brook promotes the work of Ted Rockwell from 'Radiation, Science, and Health', a crank organisation that promotes bizarre – and dangerous – conspiracy theories such as this: "Government agencies suppress data, including radiation hormesis, and foster radiation fear. They support extreme, costly, radiation protection policies; and preclude using low-dose radiation for health and medical benefits that apply hormesis, in favor of using (more profitable) drug therapies."[28]

Brook promotes[29] the discredited[30] 'hormesis' theory that low doses of radiation are beneficial to human health. Mark Lynas lends support to the hormesis theory and uncritically quotes a dangerous quack scientist who argues that annual public radiation dose limits should be increased from 1 mSv to 1,200 mSv![31]

Good for wildlife?

If Brook, Lynas and contrarian quack scientists are right, Chernobyl (and Fukushima) have been beneficial by spreading health-giving, life-affirming radiation far and wide. And according to some PNEs, Chernobyl has been a boon for wildlife and biodiversity. The region surrounding Chernobyl is one of Europe's "finest natural preserves" according to Stewart Brand.[32] Lynas says the Chernobyl "explosion has even been good for wildlife, which has thrived in the 30km exclusion zone"[17] (and that restrictions on fishing around the Fukushima plant "will improve the marine environment there"[33]). James Lovelock says the land around Chernobyl "is now rich in wildlife" and he follows this bizarre argument to its logical conclusion: "We call the ash from nuclear power nuclear waste and worry about its safe disposal. I wonder if instead we should use it as an incorruptible guardian of the beautiful places on Earth. Who would dare cut down a forest which was a storage place of nuclear ash?"[34]

According to most PNE's, radiation exposure from Chernobyl has been harmless (except for those exposed to extremely high doses in the immediate aftermath of the disaster), and according to some it has been beneficial to human health. And Chernobyl has been good for wildlife and biodiversity (mutations aside). Follow the PNEs down these rabbit-holes and you come up with Hansen's conclusion that the nuclear industry's safety record is "superior to any other major industry"[35], or Lynas' claim that nuclear power is "extraordinarily safe"[36], or Brook's claim that "nuclear power is the safest energy option".[37]

Nuclear power the safest energy option? Safer than wind and solar? To arrive at that conclusion, Brook and other propagandists understate the death toll from Chernobyl (and Fukushima) by orders of magnitude. They trivialize or ignore the greatest hazard associated with nuclear power – its repeatedly-demonstrated connection to WMD proliferation.[38] And they trivialize or ignore related proliferation/security problems such as conventional military strikes against nuclear plants, nuclear terrorism and sabotage, and nuclear theft and smuggling.

Finally, PNEs also trivialize Chernobyl by peddling the furphy that the psychological distress was greater than the biological impacts. There's no dispute that, as the WHO states, the relocation of more than 350,000 people in the aftermath of the Chernobyl disaster "proved a deeply traumatic experience because of disruption to social networks and having no possibility to return to their homes."[39]

How to compare that psychological trauma to estimates of the cancer death toll, such as the UN/WHO estimate of 9,000 deaths in ex-Soviet states? Does the psychological trauma outweigh 9,000 deaths? It does for PNE propagandists. Lynas, for example, asserts that "as Chernobyl showed, fear of radiation is a far greater risk than radiation itself in the low doses experienced by the affected populations" and he goes on to blame anti-nuclear campaigners for contributing to the fear.[40]

But the trauma isn't simply a result of a fear of radiation – it arises from a myriad of factors, particularly for the 350,000 displaced people. Nor is the fear of radiation necessarily misplaced given that the mainstream scientific view is that there is no threshold below which radiation exposure is risk-free.

Most importantly, why on earth would anyone want to compare the biological effects of Chernobyl to the psychological trauma? Chernobyl resulted in both. One doesn't cancel out the other.

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Wishful thinking: the basis of new nuclear economics

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NM821.4549 That nuclear power's miserable economics are pretty much killing the industry, especially in the western world, is a reality acknowledged by virtually everyone at this point. After the first burst of reactor construction from the late 1960s until the early 1980s collapsed under the weight of multi-billion dollar cost overruns and lengthy schedule delays, a decade ago the industry argued it had learned and incorporated its lessons and the result would be a nuclear renaissance.

But before even a single reactor launched by this renaissance has begun operating (for a renaissance that began more than a decade ago, this in itself is a telling point), bloated, untenable costs and delays from Georgia to Finland have again put the kibosh on the notion of any meaningful nuclear expansion in the west. And even in China, where transparency in economic data is literally a foreign concept, there are indications that costs and schedules for new reactors are not exactly meeting expectations.

Meanwhile, nuclear utilities from Illinois to Sweden argue that new subsidies – whether in the form of higher rates or tax relief or direct deposits of taxpayer money to their bank accounts are required to keep long-ago paid-for but aging and obsolete reactors simply operating. Some of this is pure greed, of course, with the utilities just wanting more money and they see an opportunity granted by concern about climate change to get some, but some of it is real. Some of these older reactors, which supposedly benefit from all of nuclear's purported cost advantages in terms of low fuel costs, operating experience and so on, just can't compete with newer, cheaper and cleaner technologies.

While it seems that far too many legislators don't yet understand all this, the nuclear industry itself certainly does, and the number one topic in industry-oriented publications these days is how to turn around its economic miseries.

I wrote about what the industry, at least in the U.S., wants for its uneconomic operating reactors–and its sometimes delusional approaches to achieve those goals, a couple of weeks ago.[1] But even if it attains the levels of ratepayer/taxpayer subsidies it wants – and it likely won't – it's not enough for the industry to simply rescue some dinosaurs from their inevitable extinction. Without new reactors, without expansion, the industry will simply wither away by mid-century. While that would be better for society, better for ratepayers, better even for the climate, that, of course is not an industry perspective.

The industry's typical prescription for its revival revolves around a few key tenets: Build safer reactors – i.e.

Generation IV designs; and/or build smaller reactors, which may or may not be Generation IV designs; have more standardization of reactor designs; use modern modular construction techniques; and so forth. And many industry pundits, at least, have derived hope from a recent Breakthrough Institute paper[2] which argues that the industry's experience in South Korea and elsewhere, including the UK, Germany and Japan, demonstrates that the pattern of ever-escalating reactor construction costs is not inevitable.

It's all just wishful thinking. So explains, if not in those words, Steve Kidd, a veteran nuclear industry consultant, in a piece in Nuclear Engineering International that serves as a warning to his industry.[3] Explains Kidd about the Breakthrough Institute paper, "With the exception of South Korea, these apply only in particular time periods." In other words, the authors were essentially cherry-picking data to make their case, and it doesn't hold up when the total picture is examined.

Kidd goes on to explain: "Full data from the UK was conveniently unavailable – the cost escalation record of the 14 AGRs was even worse than the US experience in the 1980s – while the escalating costs of the two EPRs under construction in Europe and the four AP1000s in the US are also ignored. Had Chinese data been available, it would almost certainly back up the South Korean record with little or no cost escalation. This has, however, been reversed in the latest imported foreign designs in China, and it will be interesting if the latest larger Korean 1,400 MW units can maintain the favourable cost record of the previous generation of local 1,000MW units."

At best, the Korean experience shows cost escalation is not inevitable everywhere all the time. That's a small thread on which to hang a mega-billion dollar industry.

Kidd also argues that new, safer reactor designs are essential if there is to be any chance of winning over the public, which he acknowledges is fearful of nuclear power. But, Kidd points out, "innovation is expensive."

Kidd concludes with his recommendations, written from a UK perspective but applicable everywhere, but doesn't sound too optimistic about their implementation:

"Ultimately, as I have said before, the world must move to a small number of reactor designs that can be built cheaply in large numbers, using a fully internationalised supply chain. In normal industries this would come about by natural wastage of unsuccessful companies being taken over by those who are thriving and profitable, but this currently seems a forlorn hope in nuclear. National governments see nuclear as a strategic industry and will not let jobs wither away to competitors. Selling nuclear reactors to other countries becomes an arm of foreign policy. This will merely lead to a continuation of the current situation, where there are too many reactor designs offered by lots of different companies, all with a small number of orders and all of which are too expensive. It is doubtful if some of today's designs can be built anywhere economically."

In other words, the notion that new nuclear power could potentially be economically competitive is not entirely absurd, at least in a fantasy world where everything went exactly as the industry needs. But in the real world, the idea that nuclear power will become economically competitive with the safer, cleaner and cheaper energy sources and technologies of the 21st century is simply wishful thinking.

Michael Mariotte regularly writes at www.safeenergy.org

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Did Three Mile Island, Chernobyl and Fukushima kill nuclear power?

NM821.4550 Several experts have recently commented on the impacts of nuclear disasters on the growth of nuclear power – all of them downplaying the impact of accidents and emphasizing economics instead.

Commenting on the March 1979 Three Mile Island accident, Amory Lovins from the Rocky Mountain Institute writes:[1]

"Three months earlier, on Christmas Day 1978, Business Week's scathing 10-page cover story described how nuclear power's US sales had collapsed – and it faced in Europe and Japan "the most serious crisis in its 30-year history" – for lack of a market. US orders had plummeted from 41 in 1973 to zero in 1978; 40 per cent of their cancellations occurred before 1979, leaving many others teetering on the brink and cancelled soon thereafter. Similarly, orders in the past decade so dwindled that global nuclear capacity shrank in two of the three years before the Fukushima disaster.

"The nuclear industry blames Three Mile Island, Chernobyl and Fukushima for scaring off the public. But capital markets had already fled to better returns and lower risks in renewable competitors that got [US]$380bn of investment last year (more than 10 times nuclear's), produce more electricity, and enjoy

public enthusiasm. Any remaining pockets of nuclear enthusiasm rely on theology not economics and on conscripted not voluntary investment."

Physicist Frank von Hippel commented on the Chernobyl disaster in Scientific American:[2]

"Superficially, it is reasonable to leap to the conclusion that fear generated by the Chernobyl disaster turned the public against nuclear power – so strongly that even now, three decades later, there is serious doubt that it will ever be a major alternative to climate-threatening fossil fuels. In the 15 years before the Chernobyl accident, an average of about 20 new nuclear power reactors came online each year. Five years after the accident, the average had dropped to four a year. But the full story is more complex."

von Hippel notes that widespread public concern was not the only reason for the sharp drop in nuclear construction post-Chernobyl:

"Such worries contributed to the drop in new plant construction post-Chernobyl, but there were other reasons. One was that the growth of electric power consumption in developed countries slowed dramatically at around the same time because the price of electricity stopped falling. In 1974 the U.S. Atomic Energy Commission was projecting that the U.S. would require the equivalent of 3,000 large nuclear power reactors by 2016. Today it would take just 500 such plants to generate as much electricity as we consume on average – although more capacity would be required for times of peak consumption.

"Another factor is that, contrary to the claims of boosters in the 1950s that nuclear power would be "too cheap to meter," it is quite expensive. Fuel costs are low, but construction costs are huge, especially in North America and Europe – [US]$6 billion to $12 billion per reactor. This expense has been driven in part by more stringent safety standards but also by the fact that, with fewer plants being built, there are fewer construction workers qualified to build them, resulting in costly construction delays for corrections of mistakes. …

"On the scale needed to shift human energy use away from fossil fuels, therefore, nuclear power has become a helpful but relatively marginal player. Chernobyl damaged its prospects, but it was not the only reason for the technology's decline."

Peter Bradford, a former member of the U.S. Nuclear Regulatory Commission, recently wrote in the Bulletin of the Atomic Scientists:[3]

"Fukushima did not undermine a budding nuclear renaissance. For economic reasons, there was none. The 30-plus reactors that had applied for licenses in the United States in 2008-09 had shrunk by two-thirds before March 2011. The cost overruns at Olkiluoto and Flamanville were well underway and owed nothing to events in Japan. But Fukushima did tilt many nations away from the needed governmental benevolence sharply."

Projections for global nuclear growth have fallen sharply since Fukushima – the IAEA's current 'low' estimate for nuclear capacity in 2030 is down 29.5% from the pre-Fukushima low estimate, while the high estimate for 2030 is down 21%[4] – but as the above authors point out, Fukushima isn't the only reason for the retreat.

Lovins is a nuclear critic whereas von Hippel and Bradford are nuclear-neutrals. How do nuclear advocates explain the stagnation of nuclear power and the failure of the nuclear renaissance to materialize? There are plenty of explanations, including blaming (or crediting) anti-nuclear campaigners – often dramatically overemphasizing the impact of anti-nuclear campaigners. Many of the explanations emphasize economics and boil down to the failure of governments to provide sufficient subsidies. Some explanations concentrate on the difficulty of financing capital costs.

Former World Nuclear Association executive Steve Kidd is one of a small number of nuclear advocates who speaks openly and honestly. Kidd writes:[5]

"[T]here is no unique financing mechanism that the relevant institutions can come up with to rescue a nuclear project that has questionable returns or too high a degree of risk for investors. This is the real problem: nuclear projects have largely become too expensive and risky to offer lenders the degree of assurance they require. ... Even with government incentives such as loan guarantees, fixed electricity prices and certain power offtake, nuclear projects today struggle to make economic sense, at least in the developed world. ... World interest rates are currently low, which removes one disadvantage of capital intensive projects. These low rates indicate that there is funding available but a possible shortage of viable projects."

A recent column in the Financial Times illustrates how safety concerns and economics have come together in the mess that is the European Pressurised Reactor (EPR):[6]

"When French and German scientists began in the mid-1990s to design a new reactor, they were also seeking to engineer public opinion. The fruit of their work, the European Pressurised Reactor, was designed to be safer than any that had gone before. ... It is those very safety features, say critics, that are responsible for making the EPR, in the words of Greenwich University energy expert Steve Thomas, "a bastard to build". Projects to construct EPRs in France and Finland have been fraught with difficulty, although another in China appears to be progressing better. ...

"Today, the Finnish plant on Olkiluoto Island is nine years behind schedule and €5.2bn over budget. The project is led by Finnish utility TVO, which has fallen out so badly over costs with main contractor Areva that the two companies have gone to court. The protracted difficulties in Finland helped bring Areva to its knees, prompting January's plan to sell its reactor business to EDF. This has added more stress to EDF, whose finance director Thomas Piquemal resigned this month, saying Hinkley Point could sink the company. ...

"The sheer bulk required by the EPR's design also caused problems once a project to build one in France finally got under way after the avidly pro-nuclear Nicolas Sarkozy replaced Mr Chirac as president in 2007. The project at Flamanville on the Channel coast is, unlike its

Finnish cousin, led by EDF. But it has fared little better. It is six years behind schedule and €7.2bn over budget."

The U.S. has been spared the EPR fiasco. A total of seven EPRs were planned at six sites in the U.S.[7] *Four EPR construction licence applications were submitted to the Nuclear Regulatory Commission (NRC) but all four applications have been abandoned or suspended. In February 2015, Areva asked the NRC to suspend work on EPR design certification until further notice.*[8]

But nuclear power's economic problems are just as acute in the U.S. A recent article in Power Magazine quoted New York Times reporter Eduardo Porter saying that "nuclear energy is toast" and is "dropping dramatically as a share of global electricity", and nuclear economics are "dismal".[9]

A recent article published by the U.S. Institute of Electrical and Electronics Engineers asks whether nuclear power's 'death spiral' has begun in the U.S.[10] *It begins: "U.S. nuclear power plant operators are fighting a war on two fronts: Crashing prices for natural gas and accelerating market penetration of renewable energy have both contributed to dramatic drops in wholesale power price levels – in some states, they've fallen by more than two-thirds over the past decade. This has left nuclear power, whose operating costs are pretty much fixed, with few options other than surrender."*

The IEEE article quotes former NRC chair Gregory Jaczko: "It's been a widely held belief that nuclear is incredibly cheap to operate. That was the case 10 years ago, when nuclear plants were cash cows. That's not the case today, especially as the plants age."

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Reprocessing and plutonium stockpiling in East Asia

Author: *Jim Green – Nuclear Monitor editor*

"Reprocessing provides the strongest link between commercial nuclear power and proliferation."

– US Congress, Office of Technology Assessment, 'Nuclear proliferation and safeguards', June 1977.

NM821.4551 U.S. Republican candidate Donald Trump recently said that he would support a decision by Japan to build nuclear weapons. "You may very well be better off if that's the case," Trump said. "In other words, where Japan is defending itself against North Korea, which is a real problem. You very well may have a better case right there."[1]

Trump's comments were criticized both in Japan and in the U.S. But the position of successive U.S. governments has also been highly problematic – publicly criticizing Japan's stockpiling of ever-greater amounts of separated plutonium and voicing concern about Japan's plan to start up the Rokkasho reprocessing plant ... but doing absolutely nothing about those problems.

Japan continues to expand its stockpile of 48 tonnes of separated plutonium (10.8 tonnes in Japan, 20.7 tonnes in the UK and 16.3 tonnes in France) and it continues to advance plans to start up the Rokkasho reprocessing plant in 2018. Rokkasho would result in an additional eight tonnes of separated plutonium annually.

The U.S. has a long history of publicly and privately voicing concern about Japan's plutonium stockpiling, and an equally long history of inaction. Diplomatic cables in 1993 and 1994 from US Ambassadors in Tokyo described Japan's accumulation of plutonium as "massive" and questioned the rationale for the stockpiling of so much plutonium since it appeared to be economically unjustified.[2]

A March 1993 diplomatic cable from US Ambassador Armacost in Tokyo to Secretary of State Warren Christopher, obtained under the US Freedom of Information Act, posed these questions: "Can Japan expect that if it embarks on a massive plutonium recycling program that Korea and other nations would not press ahead with reprocessing programs? Would not the perception of Japan's being awash in plutonium and possessing leading edge rocket technology create anxiety in the region?"[2]

At the 2012 Nuclear Security Summit, U.S. President Obama said: "We simply can't go on accumulating huge amounts of the very material, like separated plutonium, that we're trying to keep away from terrorists."[3]

In 2014, a U.S. National Nuclear Security Administration report noted that "global civilian plutonium inventories have risen sharply over the last 20 years" and that "further international engagement is needed to stop plutonium accumulation and start drawing down inventories."[4]

The Communiqué of the 2014 Nuclear Security Summit, endorsed by 53 nations, stated: "We encourage States to minimise their stocks of HEU [highly enriched uranium] and to keep their stockpile of separated plutonium to the minimum level, both as consistent with national requirements."[5]

In 2014, with no hint of irony, a joint US/Japan statement announcing the plan to send some HEU and separated plutonium from the Fast Critical Assembly at Tokai to the U.S. concluded: "Our two countries encourage others to consider what they can do to further HEU and plutonium minimization."[6] The amount of plutonium held at Tokai was 331 kg, yet Japan plans to separate 8,000 kg of plutonium every year at Rokkasho.

Ahead of the recently-concluded 2016 Nuclear Security Summit, the U.S. government was once again making strong statements about reprocessing and plutonium stockpiling. In mid-March, U.S. Assistant Secretary of State Thomas Countryman, who heads the State Department's Bureau of International Security and Nonproliferation, told a Senate Foreign Relations Committee hearing that reprocessing "has little if any economic justification" and raises proliferation concerns.[7]

Countryman said "there are genuine economic questions where it is important that the US and its partners in Asia have a common understanding of the economic and nonproliferation issues at stake before making a decision about renewal of the 123 [civilian nuclear cooperation] agreement, for example, with Japan."[8]

Countryman focused his criticisms on moves by China, Japan and South Korea to develop reprocessing programs while also expressing blanket opposition to civil reprocessing programs: "I would be very happy to see all countries get out of the plutonium reprocessing business."[9]

Countryman said the U.S. has raised with France its concerns about the dynamics in Asia. France's Areva is heavily involved in the reprocessing plans in both China and Japan.[7]

Japan's bilateral nuclear cooperation agreement with the U.S. expires in 2018. The current agreement, which will remain in force beyond 2018 unless amended, does nothing to curb or prevent Japan's plutonium stockpiling or its reprocessing plans.[10]

Washington could apply constraints to Japan's plutonium stockpiling and reprocessing insofar as it involves U.S.-obligated nuclear materials. But that seems highly unlikely. An indication of the *realpolitik came in late March when Thomas Countryman, presumably pressured by higher-ups, reversed his earlier statements. Countryman 2.0 claimed that Japan's reprocessing plans and plutonium stockpiling do not raise proliferation concerns and that no other country was closer or more important as a partner to the U.S. than Japan.*[11]

Nuclear commentator Dan Yurman suggests the whole thing was a set-up: "On one hand, the first round of comments by Countryman appear to address China's concerns about Japan's [plutonium] stockpile. China's delegation to the Nuclear Security Summit was led by Xi Jinping, President of the People's Republic of China. On the other, the state department official's reversal appears to also appease the Japanese delegation which undoubtedly did not take kindly to having such a direct set of remarks expressed ahead of their visit to Washington."[12]

South Korea

Washington and Seoul came to an agreement last year which continues the prohibition on domestic reprocessing in South Korea while permitting research into pyroprocessing – separating fission products from spent fuel, leaving plutonium mixed with other actinides.[13]

Pyroprocessing is promoted as a proliferation-resistant alternative to conventional reprocessing. But it can also be a stepping-stone to weapons-usable material. South Korea's Chosun Media quotes a nuclear engineering professor saying that "if spent fuel is first reprocessed using pyroprocessing and then dissolved using nitric acid – which is the typical method – then it is possible to obtain more fissile material in a shorter amount of time."[14]

In a country with reprocessing, a switch to pyroprocessing would be a stepping-stone to non-proliferation. In a country without reprocessing – such as South Korea – pyroprocessing is a stepping-stone to proliferation.

Washington has been more proactive in its negotiations with South Korea than it has been with Japan. But Washington's refusal to do anything about Japan's reprocessing plans and plutonium stockpiling creates a double-standard which is near-impossible to maintain. Christopher Hill, a former American ambassador to Seoul, said in 2013: "If the Koreans are left with the impression that Japan can do things that South Korea can't, then it's not a sustainable concept."[15]

Proliferation expert Henry Sokolski notes that those South Koreans who want a nuclear weapons option as a countermeasure against North Korea "complain that Washington has authorized Japan, America's other East Asian security ally, to reprocess spent US-origin fuel (fuel made in the United States but burned in reactors in Japan) to produce plutonium. This grates on Seoul, given the historical enmity between Japan and South Korea. Washington has yet to grant South Korea similar recycling rights."[16]

Shortly after North Korea's nuclear weapon test on January 6, leaders of the South Korean National Assembly's ruling party publicly urged President Park Geun-hye to consider reprocessing fuel from nuclear power plants to extract plutonium, as a hedge against North Korea's nuclear weapons program.[16]

Elsewhere, the U.S. established a 'gold standard' with a bilateral agreement with the United Arab Emirates which

prohibits enrichment and reprocessing in the UAE. But the U.S. then abandoned the 'gold standard' and is now willing to conclude nuclear trade agreements with (at most) voluntary, unenforceable commitments to forego enrichment and reprocessing.[17]

Of course, the U.S. is not the only country at fault. France could put international security and non-proliferation objectives ahead of commercial nuclear imperatives ... but that would be a first. Australia has its own unique way of pretending to be concerned about the security and proliferation risks associated with reprocessing and plutonium stockpiling, while ensuring that commercial imperatives and Big Power politics come first. Australia insists on prior consent before Australian-obligated nuclear material is reprocessed. So far, so good – but Australia has never once invoked its right of veto to prohibit reprocessing, even when it leads to plutonium stockpiling.

China's reprocessing plans

At an October 2015 session of the First Committee session of the U.N. General Assembly, China criticized Japan's reprocessing plans, noting that Japan has enough plutonium to produce a large number of nuclear weapons, and that some Japanese advocate weapons production.[10]

But China doesn't bring a great deal of moral authority to the debate. An editorial in the Japanese *Yomiuri Shimbun* newspaper said: "China criticizes Japan for possessing enough plutonium 'to produce a large number of nuclear weapons.' Is China, which keeps the actual situation concerning its nuclear weapons secret and is reportedly enhancing its nuclear capability, in a position to criticize Japan?"[9]

Moreover China is planning to massively increase domestic reprocessing. China National Nuclear Corp. (CNNC) and Areva envisage a commercial-scale plant processing 800 tonnes of spent fuel annually, with capital costs of CNY 100 billion (US$15.4 billion, €13.8 billion).[18]

In mid-March, U.S. Senate Foreign Relations Committee chair Bob Corker accused the Obama administration of encouraging reprocessing despite the concern over proliferation, pointing to the renegotiation of a nuclear cooperation agreement with China last year that allows the reprocessing of fuel from U.S.-designed reactors. "We're not calling for a plutonium time-out like we could have done," Corker said.[7] Democratic Senator Ed Markey warned of a domino effect in East Asia, saying if Japan and China went ahead with their reprocessing plants, there would be pressure on South Korea to pursue its own reprocessing efforts, which wold in turn undermine efforts to get North Korea to give up its nuclear weapons.[7]

In Beijing, U.S. Energy Secretary Ernest Moniz voiced concern about China's plans for its first commercial-scale reprocessing plant. He told the Wall Street Journal that China's recent announcement that it would press ahead with a reprocessing program "certainly isn't a positive in terms of non-proliferation" and that "we don't support large-scale reprocessing". Moniz continued: "I don't think in any way we've been coy about our arguments with all of our partners. We just see so many problems. It's just, on objective grounds, very difficult to understand."[19]

Areva didn't respond to a request from the Wall Street Journal for comment on Moniz's remarks and CNNC said its press officers weren't available.[19]

Mark Hibbs from Carnegie's Nuclear Policy Program said China's decision to pursue reprocessing couldn't be justified on economic grounds but China may be acting strategically, guaranteeing future fuel supply by recycling.[19] In addition to reprocessing, Beijing plans to expand its limited MOX production capability (most likely with the involvement of Areva) to produce MOX fuel for light water reactors and possibly also fast reactors.[18]

Moreover there are reports that Beijing may attempt to emulate Russia's build-own-operate nuclear export model and that such an endeavor might be more practical or palatable if spent fuel from overseas reactors is taken back for reprocessing rather than direct disposal.[20]

Sokolski suggests a more sinister motivation:[16]

"If China builds and operates this plant, it plans to stockpile plutonium for 10 to 20 years – ostensibly for advanced reactor fuel – producing enough plutonium for between 15,000 and 30,000 bombs, roughly the number of weapons' worth of nuclear explosives that the United States or Russia could remilitarize if they weaponized the massive amounts of surplus nuclear weapons fuel in their respective stockpiles.

"This could be militarily significant. Currently, China's nuclear arsenal is believed to be only 200 to 400 weapons. Its surplus plutonium stockpile, moreover, is only large enough to produce some additional hundreds of bombs, and China lacks any working military plutonium production reactor. Would a Chinese commercial plutonium program serve as a work-around? This may not be China's intention now, but if tensions in the region increased, might this change? One has to hope not.

"What makes these civilian plutonium-recycling efforts all the more dubious is how little economic and technical sense they make. They are not only unnecessary to promote nuclear power or manage nuclear waste, but also clear money losers. Privately, Chinese, Japanese, and South Korean officials and other government advisers concede these points; publicly, they don't."

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