

NUCLEAR MONITOR

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Editorial

Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor:

- An update on the situation in Japan as the fifth anniversary of the Fukushima disaster approaches.
- Kumar Sundaram writes about the dilution of nuclear liability in India.
- A report on the miserable state of the global uranium industry.
- Academics M. V. Ramana and Amy King write about the problems associated with plans for inland power reactors in China.
- A summary of a Royal Commission report recommending that South Australia offers itself up as the world's nuclear waste dump.
- A report on serious nuclear waste problems in the U.S., Germany, and France.

The Nuclear News section has reports on a new study which finds that meeting carbon reduction goals economically means no nuclear power and a summary of the *Bulletin of the Atomic Scientist's* latest 'Doomsday Clock', in particular the *Bulletin's* comments on nuclear power.

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



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Fukushima Fallout: Updates from Japan

Author: Jim Green – Nuclear Monitor editor

Stricken reactors

NM819.4537 Cleaning up the Fukushima plant – and in particular the stricken reactors – will take several decades, at least. "If I may put this in terms of mountain climbing, we've just passed the first station on a mountain of 10 stations," said TEPCO's Akira Ono earlier this month.¹

TEPCO hopes to begin removal of reactor fuel, and melted fuel fused to other materials, in five years or so. But little is known about the state of the fuel – one of many problems is that cameras fail due to the intense radiation.²

TEPCO has little idea how it might remove the nuclear fuel and associated debris. To put the situation in a positive light, the problem will drive innovation in robotics since current technology is not up to the task. Akira Ono says the aim of decommissioning the plant in 40 years may be impossible without a giant technological leap: "There are so many uncertainties involved. We need to develop many, many technologies."³

TEPCO has no idea what it might do with the nuclear fuel and debris if and when it is removed from the reactor buildings. There is no repository for high level nuclear

waste. The Japanese government is considering building a repository under the seabed, about 13 kms off the Fukushima coast. The repository would be connected to the land by a tunnel so it arguably would not contravene international regulations on disposing of nuclear waste into the sea. There is staunch opposition from the fishing industry and many others to the idea of burying nuclear waste at sea in a seismically active area.⁴

Nuclear Regulatory Authority (NRA) Commissioner Toyoshi Fuketa recently questioned whether the plan to remove all fuel and debris will be possible and whether it is the best course of action. "I wonder if the situation would be desired that work is still underway to extract fuel debris 70 or 80 years after," he said, adding that it may be preferable to remove as much fuel and debris as possible and solidify the rest.⁵

Off-site clean-up

As of the end of September 2015, a total of about nine million cubic meters of contaminated solid and other waste were being stored in about 115,000 locations around Fukushima. Government officials estimate that a total of 22 million cubic meters of contaminated soil will eventually be collected.⁶

The off-site contamination work has been punctuated with revelations of sloppy work. The latest was the revelation in early February that 310 cubic meters of contaminated wood waste was illegally dumped in a riverbed in the Shiga Prefecture city of Takashima.⁷

Last September, as many as 439 bags containing contaminated soil, grass and tree branches were swept away when torrential rains hit Iitate Village, Fukushima Prefecture.⁸ Environment Ministry officials said that nearly 400 bags were recovered but many were empty.⁹

The government hopes to secure about 16 sq kms to build interim storage facilities for the contaminated soil in the Fukushima towns of Okuma and Futaba. But less than 1% of the land needed for the facilities has been acquired. The plan is to leave contaminated soil at the interim facilities for a maximum of 30 years before processing it somewhere outside of Fukushima Prefecture.⁶

Another plan being considered is to recycle the material. The government believes that as radioactive decay reduces the hazard posed by contaminated soil, it will eventually be possible to recycle it as construction material for public works projects. In the coming months the Environment Ministry will begin development of the technology and model projects for recycling contaminated soil.¹⁰

Contaminated soil exceeding 8,000 Bq/kg is called 'designated waste' under the Law on Special Measures Concerning Contamination by Radioactive Materials. For this waste, the original plan was to build one disposal site in each of five prefectures – Tochigi, Miyagi, Ibaraki, Gunma, and Chiba. But the plans have met opposition and are a long way from being realized.^{8,11}

In Kami, Miyagi Prefecture, residents forcibly blocked Environment Ministry officials from entering a potential storage site. "What is causing our anxiety is that it remains unclear who will take ultimate responsibility in solving this problem and how," said one local resident.¹²



Reactor #4, Fukushima Daiichi.

Evacuees

About 100,000 people are still living as evacuees as a consequence of the Fukushima disaster, comprising about 82,000 who previously lived in designated evacuation zones, and about 18,000 evacuees who acted on their own initiative and fled from the 23 municipalities in Fukushima Prefecture that are outside government-designated evacuation zones.¹³

According to *Japan Times*, of the 100,000 evacuees (down from 122,000 in January 2015), 56% moved elsewhere in Fukushima Prefecture and the rest moved beyond the Prefecture. The 100,000 evacuees include those staying in temporary housing facilities or taking shelter at relatives' houses and other places; the figure does not include those who have bought houses and settled elsewhere or who have settled in public housing for disaster victims.¹⁴

The *Asahi Shimbun* newspaper reported last month on the payment of compensation to victims of the disaster:¹⁵

"Compensation payments to victims of the nuclear disaster, such as evacuees and affected businesses, come out of a 9 trillion yen [US\$80 billion; €73 billion] treasure chest provided by the government to TEPCO.

"With its management priority placed on its own early recovery from the consequences of the accident, however, the electric utility has been trying to terminate the payments as soon as possible and keep the amounts within the framework set by the guidelines. The company's compensation policy has been criticized for failing to make the benefit of residents a primary consideration.

"About 10,000 evacuees are involved as plaintiffs in damages suits filed with 21 district courts and branches around the country. This points to the high level of discontent with the compensation payments that have been paid out."

The government's evacuation order is still in place for nine Fukushima municipalities, and the government is expected to lift evacuation orders for three of those municipalities in the first half of 2016.¹⁵ The government hopes to lift other evacuation orders by March 2017 provided that the annual air dose rate is no greater than 20 mSv/yr¹¹, but concedes that "difficult-to-return zones" will still be subject to evacuation orders beyond then.¹⁶

Associated with the lifting of evacuation orders comes the reduction and cessation of housing subsidies. Evacuees have to decide whether to return to their former towns or to rebuild their lives elsewhere; some will have little choice but to return because of their financial situation. Voluntary evacuees will be the first to face the cessation of housing subsidies.¹⁷

The Fukushima-related suicide toll continues to rise, with 19 such suicides in Fukushima Prefecture from Jan–Nov 2015. Police determine if a suicide was related to the Fukushima disaster and subsequent evacuation

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after talking to bereaved family members. As of February 2016, a total of 154 suicides have been linked to the disaster in the three prefectures most heavily hit by the nuclear disaster – Fukushima, Miyagi and Iwate.¹⁸

India: The dilution of nuclear liability that nobody is talking about

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NM819.4538 Once in power, opposition parties rarely retain their dogmas. When the Bharatiya Janata Party (BJP) occupied the opposition benches in the Parliament, it agitated bitterly on the issue of nuclear liability, maintaining that the United Progressive Alliance's position on compensation in case of a nuclear accident placed all the burden on the taxpayer. Now that it is in power, it exhibits none of that resolve.

The international Convention on Supplementary Compensation (CSC) for Nuclear Damage requires that in case of a nuclear accident, liability for paying compensation to the victims falls on the operator of the facility. In India's case, this is the government-owned Nuclear Power Corporation of India Ltd. On February 4, Narendra Modi's government ratified the CSC, giving a free pass to nuclear suppliers in India.

The previous Congress-led government had removed all references to the CSC from the draft of the Civil Liability for Nuclear Damage Act 2010, after it met with resistance from the opposition parties, including the BJP. The 2010 Act simultaneously included a provision to hold suppliers (both domestic and foreign vendors of reactor equipment) indirectly liable – its clause 17(b) specifically allowed the operator a "right of recourse" against the suppliers. But within weeks of this, the

Congress-led United Progressive Alliance government hastily signed (but did not ratify) the CSC, with provisions contrary to the domestic law.

Since then, the US and other nuclear suppliers have been insisting that India harmonises its domestic law with the CSC, and do away with suppliers' liability. The Indian government and its nuclear establishment have also been citing CSC as a reason to amend the liability law.

Their arguments have been a farce.

American exceptions

The CSC did not come into force in 2010 when India signed it. Indeed, at that time, India had an opening to press for progressive changes in the CSC to ensure suppliers' liability – since India is among the few countries in the post-Fukushima world still importing nuclear reactors, it could have used its attractive market to affect pro-people revisions in the CSC template. Obviously, it did not, and India's unconditional accession ended up enhancing CSC's standing. The regime finally entered into force in 2015 following Japan's accession. But all this didn't stop foreign suppliers from asking India to do away with its liability clause in domestic law.

The United States, in particular, has always preferred the CSC over other conventions addressing nuclear liability,

such as the Paris Convention of 1960 or the Vienna Convention of 1963. This is because CSC has a grandfather clause in its annexure 2 that provides an exemption for U.S. domestic laws to supersede in case of an accident on its soil. As a result, in the U.S., criminal liability lawsuits can be initiated against nuclear corporations. The same CSC, however, requires its other signatories to enact domestic laws as per its annexure and strictly limit it to civil liability.

Though eminent jurist Soli Sorabjee has maintained that India's domestic law would prevail over the CSC, it is certain that, in a conflict, foreign suppliers would try their best to walk away without paying damages.

The Modi government had an opportunity to refuse ratifying the CSC, especially since a case is pending in the Supreme Court on the issue of nuclear liability. Senior lawyer Prashant Bhushan, eminent scientist PM Bhargava, Former Navy Chief Admiral L Ramdas, Former Union Power Secretary EAS Sarma and other eminent Indians are party in this case, which urges strengthening of the provisions of the 2010 Act and removal of the liability cap. Ratifying an international convention on an issue which is sub judice is also an attempt to influence the Supreme Court by turning the matter into a fait accompli.

BJP's U-turn

While in opposition, the BJP was fiercely opposed to any dilution of nuclear liability. Noting the shortcomings of the bill presented by the UPA government, it alleged that "the bill was being brought under US pressure mainly to keep the two American multinationals – Westinghouse and General Electric – from paying any liability and making the Indian government liable to pay in case of an accident".

Senior BJP leader Yashwant Sinha had said at the time: "Clearly, the life of an Indian is only worth a dime compared to the life of an American." His colleague Sushma Swaraj had called for an India-specific liability law, while likening the Indo-US nuclear deal to Jehangir who allowed the British East India Company to do business in India. Swaraj is now the External Affairs Minister in the Modi government.

Despite the previous government being a coalition and despite its willingness to serve the interests of the U.S. nuclear lobby, it was the strength of Indian democracy that public pressure ensured enactment of a law safeguarding the interests of citizens. The BJP government, failing Indian interests, has resorted to a perverted twist to effectively undermine a law passed by India's sovereign parliament.

Yellowcake blues

Author: Jim Green – Nuclear Monitor editor

NM819.4539 Those of us living in uranium producing countries are subject to endless rhetoric about the potential for uranium exports to radically improve the economy. Here in Australia, the mantra is that we have the potential to be the 'Saudi Arabia of the South' because of our extensive uranium deposits. That nonsense is trotted out not just by industry spivs but also by politicians, trade union officials and even by academics.¹

Saudi oil export revenue in 2014 was US\$285 billion², while Australia's uranium export revenue was US\$0.48 billion.³ So Australia's uranium export revenue would need to grow almost 600-fold to match Saudi oil revenue!

In fact the entire global uranium trade is pittance in comparison to Saudi oil. The value of annual global uranium requirements in recent years has been around US\$10 billion.⁴

The uranium market has been in the doldrums since the Fukushima disaster. But for industry boosters, the glass is always half full. Either prices are high, or prices are low which makes it a great time to buy. An ETF Trends analyst notes that the Global X Uranium ETF – a fund which 'offers exposure to uranium mining companies worldwide'⁵ – has lost more than 86% of its value since late 2010.⁶ ETF's take? "But finally, maybe, hopefully, uranium stocks could be poised to rebound."

Cameco's share price has dropped 70% since 2011.⁷ Buy, buy, buy! As one uranium booster put it: "The current market turmoil has created a once in a generation opportunity for savvy energy investors."⁸

And of course, the figures can be spun in different directions. Uranium was the best performing mined commodity of 2015 according to Macquarie Bank, and the average spot price in 2015 was up 18% on the previous year.⁹

That's all true, but it's not saying much. As FN Arena put it: "As we move into 2016 we note that 2015 was a year in which the spot uranium price proved a rampant outperformer. The price has hardly moved much in the past few months, thus uranium has left other commodities such as oil, iron ore and copper in its dust."⁹

Moreover the modest bounce was underwhelming since the uranium price was coming off an all-time low in real terms¹⁰ – the spot price fell below US\$30/lb U3O8 in mid-2014 and is now around \$35 (and the long-term contract price is a sickly \$44).¹¹ And the small price increase was partly due to disruptions at two of the world's largest uranium mines, Rossing in Namibia and Olympic Dam in Australia.⁸

The current price is so low that uranium mines are struggling to break even. Greg Peel from FN Arena states that prices are below the cost of production for "many mines."⁹

The price is far too low to encourage investment in new mines. Rob Chang, an analyst with Cantor Fitzgerald, states that the break-even costs for new uranium mines is around \$70–\$80.⁸

The current spot price is about half the pre-Fukushima price and about one-quarter of the peak of the 2005–07 bubble. The industry and its boosters hoped that the end of the US/Russia Megatons to Megawatts program,

which involved converting highly enriched uranium (HEU) from weapons into fuel for power reactors, in December 2013 would lead to increased prices. But that didn't happen. The Ux Consulting Company noted: "In the aftermath of the Fukushima disaster, many reactor projects worldwide have been delayed, and in some cases, new reactors have been cancelled. The decline in demand stemming from the Fukushima accident more than negates the reduction in supply that resulted from the end of the U.S.-Russia HEU deal."¹²

The industry hoped that the restart of reactors in Japan would lead to increased prices. But only three reactors have restarted and the uranium price hasn't bounced.

The industry hoped that the growth of nuclear power would lead to increased prices. But nuclear power has been stagnant.

The industry hoped that the drawing down of inventories would lead to increased prices. But inventories are massive and growing. According to the Ux Consulting Company, global uranium inventories as of last September were upwards of 1.1 billion pounds U3O8 equivalent (423,100 tUeq).¹³ That's enough to satisfy current global demand for 6.3 years.¹⁴

The uranium market will remain driven by inventory for many years, UxC's Jonathan Hinze said last September.¹⁵ In other words, inventories will keep prices down for many years.

Japan is "swimming – some would say drowning – in uranium" according to Jim Ostroff, senior editor of Platts Nuclear Publications.¹⁵ According to nuclear booster James Conca, Japan's uranium inventory will suffice to fuel the country's power reactors "for the next decade".¹⁵ Perhaps more, given the slow pace of the reactor restart process.

China's uranium inventory is estimated at 280 million pounds U3O8e (107,700 tUeq) as well as a significant quantity of enriched uranium.¹³ According to Macquarie

Bank, China has a "staggering" stockpile and in 2016 will have the equivalent of nine years of projected 2020 consumption in inventory.¹⁶

Future prospects

The industry is getting increasingly desperate, looking for a bounce from political conflicts upsetting existing production and supply networks (e.g. the Russia / Ukraine conflict) or from further mine failures and closures. According to a Mineweb.com article: "What could bring a major price surge forward though remains major supply interruptions – either for geopolitical reasons, or for debilitating technical problems at one or more of the key producers."¹⁰

Amongst all the puffery there are some honest assessments of the uranium industry's miserable state. Surprisingly, Nuclear Engineering International (NEI) is one of the better sources of analysis.

Writing in NEI last October, Thomas Meade and Julian Steyn state:

"The sizeable gap between projected production and forecast reference demand through the early 2020s indicates that there may not be much upward pressure on market prices until the next decade. ... Unfortunately for uranium suppliers, excess supply is expected to persist. In an effort to maintain near-term viability suppliers have postponed new mines under development, cut back production activity or completely halted production ... The uranium market continues to struggle with oversupply, which is forecast to continue beyond the current decade. There are several causes, but the decline in demand after Fukushima remains the primary one."¹⁷

Writing in NEI in May 2014, former World Nuclear Association executive Steve Kidd stated that "the case made by the uranium bulls is in reality full of holes" and he predicted "a long period of relatively low prices, in which uranium producers will find it hard to make a living".¹⁸ Kidd's predictions are looking rock solid.

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China: Moving nuclear reactors inland is a bad idea

Authors: M. V. Ramana and Amy King

NM819.4540 Following the Fukushima nuclear disaster, and wider concerns¹ over the safety of Chinese nuclear facilities, China's central government suspended its consideration of proposals for construction of nuclear power plants at inland sites. But in the last couple of years, pressure has been renewed to build nuclear plants at sites away from the coast.

Beijing is now mulling over the decision to build new nuclear plants inland² as an alternative to coal power, which has been the cause of disastrous air pollution in parts of the country.

As we have argued elsewhere³, there is a growing tension between the government's plan for rapid expansion of nuclear power and its commitment to safety. The final decision over inland nuclear construction will decide how this tension is resolved.

For now, Chinese policymakers face a risky decision. All of China's nuclear power plants are currently located in coastal provinces. But in the second half of the last decade, plans were drawn up to start construction of nuclear power plants in inland areas.

The renewed pressure on the central government to reintroduce this plan is coming from local, provincial and county-level governments. The latter argue that they would benefit from greater tax revenues and economic growth generated by future nuclear plants, built and managed by State Owned Enterprises, such as China National Nuclear Corporation and China General Nuclear Power Corporation.

In Hunan province, for example, the general manager of the Hunan Taohuajiang Nuclear Power Company, Zheng Yanguo, told reporters in September 2014 that an investment of 70 billion yuan (US\$11 billion) in the Taohuajiang nuclear power plant would return GDP growth of over 100 billion yuan to Hunan, and generate annual tax income of around 15 billion yuan.⁴

At the March 2015 National Party Congress, delegations from Hunan and Hubei provinces called upon the central government to restart construction of inland power projects at the beginning of the 13th Five Year Plan (2016-2020).⁵

Further adding to these pressures to restart inland nuclear construction are the central government's own ambitious nuclear expansion targets⁶, which are increasingly seen as requiring the opening up of inland sites.

So why is the location of inland plants so controversial? It stems from the fact that inland nuclear power plants pose far higher risks to nearby water sources and to the people dependent on these resources than comparable coastal plants.

Water worries

Water is critical to the functioning of nuclear power plants. Nuclear reactors circulate large quantities of water through their radioactive cores in order to remove the tremendous amounts of heat produced.

For each hour of operation, a typical 1,000 megawatt nuclear reactor has to pull in (or withdraw) about 170,000 cubic metres of water from some external source. Of this, about a thousand cubic metres evaporate and the rest of the water is returned to the external source at a higher temperature.⁷

This is why nuclear reactors are always located near a large body of water – the ocean or a large lake or river. By contrast, 'combined cycle' natural gas plants withdraw only about a quarter of what a nuclear plant does and the net amount of water that would evaporate from a natural gas plant is about 40% of the evaporation level of a nuclear plant.

Wind and solar photovoltaic plants use only very small amounts of water, such as for cleaning or panel washing, and thus have negligible impacts on water resources.

Water is also critical in the event of a nuclear accident, as was demonstrated during the March 2011 Fukushima disaster. While at Fukushima, there was no shortage of water outside the reactor, it was not possible to circulate this water through the reactor—and therefore remove the heat being generated there—because there was no electricity available to run water circulation pumps. The result was a nuclear meltdown and eventually the dumping of enormous amounts of radioactive materials into the Pacific Ocean.

In the event of an accident, nuclear plants located far from the ocean would have to discharge their effluent into a river or a lake. In China, where 70% of rivers and lakes are already contaminated according to the World Watch Institute, this could be disastrous.

Climate change is only making the situation worse. Globally, the number of days per year when inland water body temperatures are too high to effectively cool a nuclear reactor are increasing.⁸

Finally, even without an accident, the sheer amounts of water needed by nuclear plants make it unsuitable for inland locations in China. Water availability is already a big concern—the per capita availability of renewable freshwater is only a third of the global average.⁹ Consulting company McKinsey estimates that demand for water in China will increase by 61% between 2005 and 2030 and outstrip supply by 25% at the end of that period.¹⁰

Holes in the argument

In China, pro-inland expansion groups argue that there is a paucity of coastal sites; that profits inland are favourable; that new reactor designs “can avoid Fukushima-like catastrophes”.¹¹ They add that nuclear power plants have a role in clearing smog and improving air quality¹² because, unlike coal-fired power stations, nuclear plants do not emit smoke or various chemicals.

However, each of these arguments is only partially valid. For instance, the provinces where inland nuclear plants are proposed are not necessarily those most threatened by air pollution. Furthermore, all nuclear reactors can undergo catastrophic accidents, even the so-called third generation ones.¹³ These reactors have all of the same fundamental ingredients that made possible the earlier accidents at Chernobyl and Fukushima: a complex technology with large quantities of radioactive materials at high temperatures and pressures, and where even small errors can quickly spin out of control.

Although the nuclear industry uses a technique called probabilistic risk assessment to argue that the likelihood is very small, there are serious problems with this methodology and its results are simply not reliable.¹⁴

Local opposition

Plans for inland construction have met resistance from citizens. In the aftermath of Fukushima, opposition to the proposed Pengze plant erupted in the adjoining Anhui province. The government of Wangjiang county, which is directly downstream from the proposed site, publicly accused the Pengze project of “falsifying its EIA [Environmental Impact Assessment] report,”¹⁵ and objected to Jiangxi province’s failure to consult its provincial neighbours before deciding where to site the plant.

If the Pengze project goes ahead, Anhui faces the risk of nuclear contamination¹⁶ in the event of an accident, but would not enjoy the majority of any economic or energy benefits from the plant.

While the level of opposition in Anhui is unprecedented, it comes in the wake of a significant increase in the Chinese public’s perception of risk from nuclear facilities, following the Fukushima disaster.¹⁷ This concern is also shared by some elite, retired nuclear experts.¹⁸ More generally, it has been reported that many Chinese people are nervous about the prospect of large nuclear expansion.¹⁹

Five days after the Fukushima nuclear disaster started, China’s State Council stated: “Safety is our top priority in developing nuclear power plants”. As we approach the fifth anniversary of Fukushima, it is worth remembering that just talking about nuclear safety is not enough. If safety is indeed the top priority, it should be demonstrated through firm decisions. Some of these decisions could result in slowing down or limiting nuclear construction.

A ban on inland nuclear construction would be a good start. It would make clear that China’s central government is willing to put the lives and livelihoods of its citizens above the economic interests of local governments and State Owned Enterprises.

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Reprinted from China Dialogue, www.chinadialogue.net/article/show/single/en/8525-Moving-nuclear-reactors-inland-is-a-bad-idea

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Commission recommends international high-level nuclear waste dump for South Australia

Author: Jim Green – Nuclear Monitor editor

NM819.4541 A Royal Commission established by the government of South Australia to investigate options for nuclear expansion has released its interim report.¹ Australia's role in the nuclear fuel cycle is currently limited to uranium mining and export. The Royal Commission is negative about almost all of the proposals it is asked to consider. It concluded that uranium conversion, enrichment and nuclear fuel reprocessing will not be economically viable for the foreseeable future. It found that conventional nuclear power and small reactors will not be economically viable for the foreseeable future.

Significantly, the Royal Commission has dealt a blow to advocates of 'integral fast reactors' (IFR). The Commission faced a major co-ordinated lobbying exercise promoting a plan to import spent fuel and to convert it (well, a small fraction of it) to fuel for IFRs. The illogical nature of the waste-to-fuel plan is neatly debunked in an important recent report by The Australia Institute.²

The Royal Commission could not be clearer on the topic of fast reactors. Its interim report states: "Fast reactors or reactors with other innovative designs are unlikely to be feasible or viable in South Australia in the foreseeable future. No licensed and commercially proven design is currently operating. Development to that point would require substantial capital investment. Moreover, the electricity generated has not been demonstrated to be cost-competitive with current light water reactor designs."

So the waste-to-fuel IFR fantasies are dead and buried ... for the time being.

The Royal Commission promotes a plan for South Australia to accept nuclear waste from power plants around the world for storage and disposal – 138,000 tonnes heavy metal of spent nuclear fuel and 390,000 cubic meters of intermediate-level waste – over about 100 years. It makes absurd claims about the potential profits to be made, claims echoed by the state's one mass circulation newspaper – a Murdoch tabloid.

However the revenue estimates have no basis in reality. There is no comparable overseas model of commercial trade of nuclear waste for disposal. No real idea how many countries might avail themselves of the opportunity to send nuclear waste to Australia for disposal, or how much they might send, or how much they might pay. So there's no way of knowing whether revenue would exceed costs.

The estimated construction costs for a deep underground repository for high level waste are in the tens of billions of dollars. For example the construction cost estimate in France is US\$27.8 billion (€25 billion)³ while in Japan the estimate is US\$31 billion (€28 billion).⁴

Of course, there are significant additional costs associated with operating and monitoring repositories. The US governments estimates that to build a repository and operate it for 150 years would cost US\$96 billion.⁵ The Royal Commission provides a similar figure: costs of \$145 billion over 120 years for construction, operation and decommissioning.

But the above timeframes – 150 years in the U.S. report and 120 years in the Royal Commission study – are nothing compared to the lifespan of nuclear waste. It takes 300,000 years for high level waste to decay to the level of the original uranium ore.⁶ The Royal Commission report notes that spent nuclear fuel (high level nuclear waste) "requires isolation from the environment for many hundreds of thousands of years."

Economist Prof. Richard Blandy commented: "We are bequeathing a stream of costs to our successor generations. They will be poorer as a result, and will have reason to curse their forebears for selfishly making themselves better off at their expense."⁷

Despite the best efforts of the mainstream political parties and the Murdoch press, public opinion is strongly against the plan for a nuclear waste dump in South Australia, and the proposal is likely to meet with fierce opposition from Aboriginal Traditional Owners.

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Nuclear waste nightmares: USA, Germany, France

NM819.4542 On Valentine's Day 2014, a drum of packaged waste from the Los Alamos National Laboratory (LANL) ruptured 2,150 feet (655 metres) underground in New Mexico's nuclear waste repository known as the Waste Isolation Pilot Plant (WIPP) which is carved from ancient salt beds. The incident was described as a heat-generating chemical reaction – the US Department of Energy (DOE) called it a deflagration rather than an explosion.

Explosion or not, the chemical reaction compromised the integrity of a barrel and spread contaminants through more than 3,000 feet of tunnels, up the exhaust shaft, into the environment, and to air monitoring equipment approximately 3,000 feet north-west of the exhaust shaft. The accident resulted in 21 workers receiving low-level internal radiation exposure.

It later transpired that LANL had improperly packaged hundreds of waste drums with a combustible mix of nitrate salts – a byproduct of nuclear weapons production – and organic cat litter, causing a hot reaction in one drum that cracked the lid. The rupture released americium and plutonium into the deep salt mine and, in small amounts, into the environment.¹ The repository is still closed two years later, and a March 2016 date for re-opening has been pushed back to later this year.

"These accidents during the first 15 years of operation really illustrate the challenge of predicting the behavior of the repository over 10,000 years," said Rod Ewing, the Frank Stanton Professor in Nuclear Security at Stanford and a senior fellow at the Center for International Security and Cooperation.

The Stanford experts also suggest more attention should be paid to how the buried materials may interact with each other, particularly with salty brine, over centuries. A single storage drum may contain a variety of materials, such as lab coats, gloves and laboratory instruments; thus, the chemistry is complex. Ewing said that the complacency that led to the accidents at WIPP can also occur in the safety analysis. Therefore, he advises, it is important to carefully review the safety analysis as new proposals for more plutonium disposal are considered.²

Asse, Germany

Now, 500 metres beneath the forests of northern Germany, in an old salt mine, another nightmare is playing out, according to Fred Pearce in the *New Scientist*. Enough plutonium bearing radioactive waste is stored here to fill 20 Olympic swimming pools. When engineers backfilled the chambers containing 126,000 drums in the 1970s, they thought they had put it out of harm's way forever. But now, the walls of the Asse mine are collapsing and cracks forming, thanks to pressure from surrounding rocks. So the race is on to dig it all up before radioactive residues are flushed to the surface. It could take decades to resolve. In the meantime, excavations needed to extract the drums could cause new collapses and make the problem worse.³

Some 300,000 cubic metres of low and intermediate-level waste, including the waste dug from the Asse mine, is earmarked for final burial at the Konrad iron mine in Lower Saxony. But Germany still has no plan for dealing with high-level waste and spent fuel. Later this year, a Final Storage Commission of politicians and scientists will advise on criteria for choosing a site where deep burial or long-term storage should be under way by 2050.

But its own chairman, veteran parliamentarian Michael Muller, says that timetable is unlikely to be met. "We all believe deep geology is the best option, but I'm not sure if there is enough [public] trust to get the job done," he says. Many anti-nuclear groups are boycotting the Commission. The problems at the Asse salt mine have led to further distrust of engineers and their solutions.

The problems at Asse became public knowledge in 2008. Despite hurried backfilling of much of the mine, the degradation continues. Brine seeps in at a rate of around 12,000 litres a day, threatening to flush radioactive material to the surface. In 2011, the Federal Office for Radiation Protection (BfS) ruled that the waste had to be removed. But this is likely to take decades.

Just checking the state of the 13 chambers holding the waste drums is painfully slow. Engineers drilling to reach them through 20 metres of rock don't know whether the drums have leaked, and of course they cannot risk a release of radioactivity. And unless care is taken to keep clear of the geological barrier, the excavations risk allowing more water in, and flooding of the mine can't be ruled out.

Nothing will be moved until at least 2033. Meanwhile the bill keeps rising. It costs €140 million a year just to keep the mine safe for work to continue. The final bill will run into many billions. Is it worth it? Many experts fear that digging up the drums, with consequent risks of radioactive leaks, could create a much greater hazard than leaving them where they are.

Tunnel collapse and fatality at French repository site

Meanwhile one worker has been killed and another injured in a tunnel collapse at France's planned nuclear waste repository at Bure, in north-eastern France. According to French waste management agency Andra, geophysical surveys were being carried out at the time of the collapse and the rockfall is believed to have happened as drilling was taking place. Scheduled for an authorization decree in 2018 and industrial commissioning in 2025, the facility – if approved – is expected to bury France's highly-radioactive nuclear waste.⁴

Repository cost escalation in France

Reuters reported on January 12 that shares in French utility EDF sank to an all-time low after Andra said that the cost of a national nuclear waste repository for intermediate- and high-level waste could be higher than EDF's estimates. Andra says that costs for the deep

geological storage project could range from €20 billion to €30 billion.⁵

French energy minister Ségolène Royal signed a decree setting the 'reference cost' for the repository at €25 billion. In 2005, Andra estimated the cost of the facility at between €13.5 and €16.5 billion. In 2009 Andra re-estimated the cost at around €36 billion. In a confidential 2014 file, which was recently leaked, Andra gave a cost estimate of €34.4 billion, based on 2012 prices, with construction accounting for 58% of the costs and operational costs over 100 years accounting for 26% of the total.⁶

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NUCLEAR NEWS

New study: Meeting carbon reduction goals economically means no nuclear power

Mark Cooper, who for years has been writing extensively about the transition to a clean energy future from an economist's perspective, has published an important new report.

Cooper examines three recent global studies taking different approaches to achieving deep decarbonization of our electrical system, two that reject nuclear power as part of the means of attaining massive carbon reductions and one that accepts nuclear power and fossil fuels with carbon capture and storage (CCS) as pieces of the approach. He then lays over that two recent studies of the economics of electricity generation, along with the political structure for attaining carbon reductions established by the COP21 climate agreement, to reach his conclusions.

The central finding is this: the best way to achieve a carbon-free future from an environmental perspective is also the best way from an economics perspective. And the best way means rejecting nuclear power entirely.

In other words, a nuclear-free, carbon-free approach to a clean energy future is not only environmentally preferable – avoiding radioactive waste generation, environmental damage from uranium mining and the rest of the nuclear fuel chain, proliferation concerns, and the constant threat of more Chernobyls and Fukushimas, and so on – it is cheaper as well.

Cooper places these findings in the context of the COP21 agreement and argues that the nuclear-free, carbon-free approach fits in perfectly with the agreement. Moreover, as the agreement stresses the urgency of addressing climate change and reducing carbon emissions, so does Cooper argue that from a purely economics perspective nuclear power cannot possibly meet that urgency.

EDF said that the new €25 billion reference cost will "substitute the estimated benchmark cost of €20.8 billion on which EDF Group relied in its consolidated financial statements at the end of December 2014 and at the end of June 2015". EDF said the increase in provisions will have a negative impact of around €500 million post-tax on net income group share in 2015.⁶

Reprinted from nuClear news with additions from Nuclear Monitor.

nuClear news, No.82, February 2016, www.no2nuclearpower.org.uk/nuclearnews/NuClearNewsNo82.pdf

Therefore, expending resources on nuclear power (and carbon capture and storage) would be counterproductive at reducing carbon emissions.

Cooper's paper – titled 'The Economic and Institutional Foundations of the Paris Agreement on Climate Change: The Political Economy of Roadmaps to a Sustainable Electricity Future' – is online at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2722880

Nuclear power and weapons: It's three minutes to midnight

The *Bulletin of the Atomic Scientists* announced on January 26 that its Doomsday Clock will remain at three minutes to midnight. The *Bulletin's* Science and Security Board expressed its "dismay that world leaders continue to fail to focus their efforts and the world's attention on reducing the extreme danger posed by nuclear weapons and climate change. When we call these dangers existential, that is exactly what we mean: They threaten the very existence of civilization and therefore should be the first order of business for leaders who care about their constituents and their countries."

The *Bulletin's* annual Doomsday statement notes problems associated with the nuclear fuel cycle:

"But the international community has not developed coordinated plans to meet cost, safety, radioactive waste management, and proliferation challenges that large-scale nuclear expansion poses.

"Nuclear power is growing in some regions that can afford its high construction costs, sometimes in countries that do not have adequately independent regulatory systems. Meanwhile, several countries continue to show interest in acquiring technologies for uranium enrichment and spent fuel reprocessing – technologies that can be used to create weapons-grade fissile materials for nuclear weapons.

"Stockpiles of highly radioactive spent nuclear fuel continue to grow (globally, about 10,000 metric tons of heavy metal are produced each year). Spent fuel requires safe geologic disposal over a time scale of hundreds of thousands of years.

"The US programs for handling waste from defense programs, for dismantling nuclear weapons, and for storing commercially generated spent nuclear fuel continue to flounder. Large projects – including a mixed-oxide fuel-fabrication plant at the Savannah River Site, meant to blend surplus weapons-grade plutonium with uranium so it can be used in commercial nuclear power plants – fall ever further behind schedule, and costs continue to mount, with the US Energy Department spending some \$5.8 billion each year on environmental management of legacy nuclear waste from US weapons programs.

"Because of such problems, in the United States and in other countries, nuclear power's attractiveness as an alternative to fossil fuels has decreased, despite the clear need for carbon-emissions-free energy in the age of climate change."

Sharon Squassoni, a member of the Bulletin's Science and Security Board, said: "North Korea's recent nuclear test illustrates the very real danger of life in a proliferated world. Nuclear proliferation isn't a potential threat – we still have few controls over the kinds of capabilities that Iran succeeded in acquiring. In addition, regional tensions and conflict increase the risk of theft or use of these weapons."

A Bulletin Editorial in January 2010 addressed the nuclear power/weapons conundrum:

"As we see it, however, the world is not now safe for a rapid global expansion of nuclear energy. Such an expansion carries with it a high risk of misusing uranium enrichment plants and separated plutonium to create bombs. The use of nuclear devices is still a very dangerous possibility in a world where Russian and U.S. ballistic missiles are on hair trigger and long-standing

conflicts between countries and among peoples too often escalate into military actions. As two of our board members have pointed out, 'Nuclear war is a terrible trade for slowing the pace of climate change.'"

The *Bulletin's* January 2016 statement identifies the following priorities:

- Dramatically reduce proposed spending on nuclear weapons modernization programs.
- Re-energize the disarmament process, with a focus on results.
- Engage North Korea to reduce nuclear risks.
- Follow up on the Paris accord with actions that sharply reduce greenhouse gas emissions and fulfil the Paris promise of keeping warming below 2 degrees Celsius.
- Deal now with the commercial nuclear waste problem. ("Reasonable people can disagree on whether an expansion of nuclear-powered electricity generation should be a major component of the effort to limit climate change. Regardless of the future course of the worldwide nuclear power industry, there will be a need for safe and secure interim and permanent nuclear waste storage facilities.")
- Create institutions specifically assigned to explore and address potentially catastrophic misuses of new technologies.

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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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