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Editorial

Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor:

- Nils Epprecht from the Swiss Energy Foundation reviews nuclear power policy development in Switzerland.
- We summarize yet another fall in the uranium price, some ham-fisted public relations efforts by the uranium and nuclear power industries, and the latest financial set-back for companies attempting to commercialize laser uranium enrichment.
- We summarize Chernobyl commemoration events, and a paper which estimates the costs of the nuclear disaster.
- Timothy Mousseau discusses damage to wildlife caused by the Chernobyl and Fukushima disasters.

The Nuclear News section has reports on a plan to issue all Belgians with iodine tablets; a long-running protest at a Finnish nuclear power site and recent police violence; a new report on the failure of high-temperature gas-cooled reactors; and the UK government's latest non-decision about what to do with civil plutonium.

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.

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Monitored this issue:

A chronology of Switzerland's nuclear phase-out: the decision is drawing near

Author: *Nils Epprecht – energy and nuclear campaigner, Schweizerische Energie-Stiftung (Swiss Energy Foundation)*

NM823.4555 Switzerland is approaching an energy policy period with great consequences. Before the summer recess, the passage of the first package of 2050 Strategic Energy Measures promoting the expansion of renewable energy. In autumn, this "compulsory program" is then followed by the "free skating" main event, a national referendum on an orderly exit from nuclear energy. With these decisions, the belated Swiss energy transformation may finally gain momentum – or else the tentative testing of the waters of a renewable future will once again be stifled by the overpowering conservative electricity industry.

Let's review events over the past eight years.

2008: New reactors on the planning horizon

Back in 2008, everything seemed to be taking an orderly course, when the three large Swiss energy suppliers, Axpo, Alpiq and the BKW – each predominantly in public hands – submitted to the government the first of a total of three applications for the construction of a new Evolutionary Power Reactor (EPR). With this, the three aging reactors, which according to the operators were unsafe, in Mühleberg (commencement of operations in 1972) and Beznau I and II (1969 and 1971) should one day be replaced, and together with the two other reactors in Gösgen (1979) and Leibstadt (1984), the foundation for the future of nuclear energy in Switzerland should be laid.

Since in Switzerland, the construction of new reactors is subject to a discretionary referendum, it was reckoned that a vote would be taken in 2012. At the same time, the search by energy producers for a final disposal site for nuclear waste – one of the requirements of the new reactors – was apparently intensified, at least outwardly. The opposition from nuclear critics was intact but not insurmountable from the point of view of the nuclear proponents.

2011: The turning point

The turning point in the chronology took place on 11 March 2011: The Fukushima disaster and its global political fallout. The quick decision of Germany to accelerate the 2000 agreement to phase out nuclear energy had – as is the case with many decisions in that large, neighboring country – an influence on the debate in Switzerland. In June 2011, the Swiss government also decided on a "gradual" phasing out of nuclear energy. New reactors should be forbidden; unlike in Germany, no specific shutdown date for the existing nuclear power plants was set.

With this, the Swiss energy minister anticipated the new political reality: a referendum for a new reactor one year after Fukushima would certainly end in a crushing defeat. As a consequence, a comprehensive strategy was developed by the government that showed how the approximately 33% nuclear energy in the Swiss power mix should be replaced. To do so, an overall package was created in which the medium- and long-term reduction in the dependence on fossil fuels was also integrated. The decision to phase out nuclear energy therefore became an actual about-face in energy policy. No fewer than 10 laws must be revised for this purpose as part of the "first package of 2050 Strategic Energy Measures."

However, the government is not alone in its thirst for action. Just two months after the Fukushima disaster – and thus even before the government's phase-out decision – the Green Party began collecting signatures for a national public initiative for an orderly nuclear power exit. Besides a ban on all new construction, this also provides for a 45-year time limit on the operation of existing reactors. The Green Party initiative proved to be a good campaign resource as well. In the national elections in the fall of 2011, anti-nuclear parties were the clear winners. Political scientists talk about the "Fukushima Effect".

2013: The legislative mill

What followed was the protracted, orderly Swiss legislative process. First a nationwide consultation and review process on one of the first draft laws. Afterwards, beginning in 2013, the government's draft bill was discussed back and forth in both parliamentary chambers during which not all of the original supported intentions remained intact. The phasing out of nuclear energy was also pruned: the laws dealing with the existing reactors are left in their pre-Fukushima version to the greatest extent possible. The requirement of a so-called "long-term operation concept", which provides for a maximum of 10 years extension in each case, was not inserted into the law against the wishes of the Nuclear Supervisory Commission. The principle of "operation as long as safe" remains the maxim for existing reactors.

2015: The great forgetfulness

The laws had not yet been fully discussed when national elections appeared on the agenda in the fall of 2015. Without the nuclear mushroom cloud on the horizon, the general drift to the right in Switzerland's political landscape continued. Instead of nuclear disasters, the topic of migration stands atop the "Swiss Worry Barometer." And the parliament already showed its new vision in the continuation of the consultation proceedings on the 2050 Strategic Energy Measures: the draft bill was watered down bit by bit. The original proponents of the 2050 Strategic Energy Measures appeared ready to swallow the bitter pill under the motto "a bird in hand is worth two in the bush."

2016: New realities

The Green Party's initiative for a real phasing out of nuclear energy, which was repeatedly tabled by the government as part of the 2050 Strategic Energy Measures, finally comes to a vote in the coming autumn. Apart from the fifth anniversary, there are few reminders of Fukushima during the run-up period. But a new reality emerges: low energy prices and electricity market liberalization create major financial problems for Swiss energy suppliers. In March, an Alpiq paper is leaked in which the ailing corporation presents considerations about the nationalization of nuclear power plants, which are operating at a loss.

The decision made by BKW to definitively shut down its reactor in Mühleberg in 2019 became official with the decommissioning application – the various required retrofits demanded by the regulatory authorities on the basis of the findings from Fukushima are too costly. And the Beznau I reactor has been shut down for almost one year because of anomalies in the reactor pressure vessel; its future is uncertain.

Thus many voters suddenly begin to ask themselves whether an economically moribund technology will be carried to its grave anyhow through the forthcoming vote. There is really no alternative to an exit and it is now a matter of minimizing the – until now only economic – damage as much as possible. The regulatory authorities have already warned about a growing risk of the reactors because of the lack of investments in their final years of operation. The fixed operational time limit of 45 years and the soon deactivation of Beznau linked to that provide the clearest answer to these considerations.

We will vote this fall. Instead of the question: "What is the half-life of the Fukushima disaster in the minds of Mr and Ms Schweizer?", it seems that the question we are perhaps posing much more quickly than thought possible is: "How do we best say goodbye to obsolete technology?" Or if we return to the figure skater's programme mentioned at the outset: After countless pirouettes around the 2050 Strategic Energy Measures, will we finally be able to end the entire compulsory and free programme brilliantly? It would be desirable for an advanced, high-technology and scenically rich Switzerland if she could bid farewell to her ancient collection of reactors.

Uranium on the rocks; nuclear power PR blunders

Author: *Jim Green – Nuclear Monitor editor*

NM823.4556 Uranium mining company Cameco announced on April 21 that is suspending production at Rabbit Lake and reducing production at McArthur River / Key Lake in Canada. Cameco is also curtailing production at its two U.S. uranium mines, both in-situ leach mines – Crow Butte in Nebraska and Smith Ranch-Highland in Wyoming. About 500 jobs will be lost at Rabbit Lake and 85 at the U.S. mines. Cameco now expects its total production in 2016 will be 25.7 million pounds of U3O8 (about 15% of global demand), down from its earlier forecast of 30 million pounds.[1]

"Unfortunately, continued depressed market conditions do not support the operating and capital costs needed to sustain production at Rabbit Lake and the US operations," Cameco CEO Tim Gitzel said. A Cameco statement said that "with today's oversupplied market and uncertainty as to how long these market conditions will persist, we need to focus our resources on our lowest cost assets and maintain a strong balance sheet."

With Cameco's recent announcement, U.S. uranium production in 2016 will likely be the lowest in more than a decade. On April 25, the Uranium Producers of America (UPA) called on the U.S. Department of Energy to stop selling from the federal excess uranium inventory until the market recovers. The Department has been selling more than five million pounds of uranium per year – more than twice what the domestic industry is likely to produce this year according to UPA – to fund the cleanup of contaminated legacy nuclear sites.[2]

The Department's actions "continue to have a negative impact on the uranium market and the domestic uranium industry" according to UPA, but in fact sales of around five million pounds amounts to just 3% of current annual global demand of 170 million pounds and about 10% of U.S. demand. UPA President Harry Anthony said cleaning up legacy nuclear sites is important but should be funded through the regular appropriations process. He noted that the U.S. imports almost 95% of uranium requirements for power reactors.[2]

Christopher Ecclestone, mining strategist at Hallgarten & Company, offers this glum assessment of the uranium market: "The long-held theory during the prolonged mining sector slump was that Uranium as an energy metal could potentially break away irrespective of the rest of the metals space. How true they were, but not in the way they intended, for just as the mining space has broken out of its swoon the Uranium price has not only been left behind but has gone into reverse. This is truly dismaying for the trigger for a uranium rebound was supposed to be the Japanese nuclear restart and yet it has had zero effect and indeed maybe has somehow (though the logic escapes us) resulted in a lower price."[3]

Ecclestone adds that uranium has "made fools and liars of many in recent years, including ourselves" and that "uranium bulls know how Moses felt when he was destined to wander forty years in the desert and never get to see the Promised Land." He states that uranium exploration "is for the birds" because "the market won't fund it and investors won't give credit for whatever you find".

Pro-uranium social media campaign's #epicfail

The Minerals Council of Australia launched a pro-uranium social media campaign on April 20. By that afternoon the twitter hashtag #untappedpotential was trending but – as a mainstream media article noted[4] – contributors were overwhelmingly critical.

Nearly all contributors offered thoughts such as these:

"A week away from the #Chernobyl 30-year anniversary and Minerals Council begins propaganda trip on the #untappedpotential of uranium. Huh?!" said Twitter user Jemila Rushton.

"We need to better harness the #untappedpotential of solar power", tweeted Upulie Divisekera.

"#untappedpotential to put more communities at risk of nuclear waste dumps," Ace Collective said.

"We concur that uranium has much #untappedpotential ... for disaster, cost and time blowouts and proliferation," Anglesea After Coal said.

No doubt the Minerals Council of Australia anticipated the negative publicity and is working on the basis that all publicity is good publicity. But what the Minerals Council didn't anticipate is the uranium price has recently fallen to an 11-year low. Mining.com noted in an April 20 article that the current low price hasn't been seen since May 2005.[5] The current price, under US26/lb U3O8, is well under half the price just before the 2011 Fukushima disaster, and under one-fifth of the 2007 peak of a bubble.

Mining.com quotes a Haywood Securities research note which points out that the spot uranium price "saw three years of back-to-back double-digit percentage losses from 2011-13, but none worse than what we've seen thus far in 2016, and at no point since Fukushima, did the average weekly spot price dip below $28 a pound." Haywood Securities notes that an over-supplied market continues to inflate global inventories.

Mining.com notes that five years after the Fukushima disaster only two of Japan's nuclear reactors are back online, and that in other developed markets nuclear power is also in retreat. The last reactor start-up in the U.S. was 20 years ago. The French Parliament legislated last year to reduce the country's reliance on nuclear power by one-third. Germany is phasing out nuclear power. As discussed in Nuclear Monitor #821, the European Commission recently released a report predicting that the EU's nuclear power retreat – down 14% over the past decade – will continue. Even if all of Japan's 43 reactors are included in the count, the number of power reactors operating worldwide is the same now as it was a decade ago.

China is a growth market but has amassed a "staggering" stockpile of yellowcake according to Macquarie Bank. India's nuclear power program is in a "deep freeze" according to the Hindustan Times (unfortunately the same cannot be said about its nuclear weapons program), while India's energy minister Piyush Goyal said on April 20 that India is not in a "tearing hurry" to expand nuclear power since there are unresolved questions about cost, safety and liability waivers sought by foreign companies.[6]

Nuclear power propaganda

There is no reason to believe that the nuclear industry will break out of its 20-year pattern of stagnation in the foreseeable future. Yet the latest propaganda piece from the Breakthrough Institute claims that "in 2015 the global nuclear sector quietly had its best year in decades" and "in crucial respects the nuclear renaissance has hit its stride".[7] How on earth does the Breakthrough Institute reach those conclusions? By celebrating 10 reactor start-ups in 2015 and all but ignoring the eight permanent reactor shut-downs. The shut-downs are relegated to a footnote and completely ignored in the subsequent analysis.

If the latest effort from the Breakthrough Institute is disingenuous, the latest from the World Nuclear Association (WNA) is, well, it's an #epicfail. The WNA has come up with a "vision" for the construction of 1,000 power reactors by 2050.[8] What distinguishes this "vision" from the WNA's constant lobbying for massive nuclear expansion? This particular PR campaign has a name: Harmony. In the WNA's words: "Renewables, nuclear and a greatly reduced level of fossil fuel work together in harmony to ensure a reliable, affordable and clean energy supply."

Lest the harmony meme die before it even gets a chance to trend on twitter, the WNA finds different ways to insert the word into sentences that are devoid of merit or meaning. Here's an example: "The harmony of purpose that characterised national nuclear programmes in the early years has to be applied now to the global enterprise."

The targets of 1,000 new reactors and nuclear power supplying 25% of global electricity might seem like ambit claims, but the WNA insists that "a great deal of consideration has gone into them and they were set after extensive consultation with leading nuclear industry figures."

How does the WNA propose to attain harmony? There's nothing new in its rhetoric (except the buzzword): a "level playing field" for all low-carbon technologies, "harmonised regulatory processes", and an "effective safety paradigm".

Former WNA executive Steve Kidd has repeatedly poked fun at vacuous PR campaigns such as the WNA's latest push. For example he said last year: "We have seen no nuclear renaissance (instead, a notable number of reactor closures in some countries, combined with strong growth in China) ... The industry is doing little more than hoping that politicians and financiers eventually see sense and back huge nuclear building programmes. On current trends, this is looking more and more unlikely. The high and rising nuclear share in climate-friendly scenarios is false hope, with little in the real outlook giving them any substance."[9]

After the COP-21 UN climate change conference last December, Kidd wrote: "The future is likely to repeat the experience of 2015 when 10 new reactors came into operation worldwide but 8 shut down. So as things stand, the industry is essentially running to stand still."[10]

Laser uranium enrichment takes a hit

The uranium conversion and enrichment markets have been just as depressed as the uranium market. One casualty is Australian company Silex Systems which is reeling from the decision of GE-Hitachi to pull out of Global Laser Enrichment (GLE), a joint venture to commercialize Silex's laser uranium enrichment technology. GLE is a joint venture between GE (51%), Hitachi (25%) and Cameco (24%).[11]

An 18 April 2016 statement by Silex Systems ascribes GE-Hitachi's decision to changes in business priorities and difficult market conditions". Silex's stock price fell 46% on the news of GE-Hitachi's exit and has remained depressed since.[12]

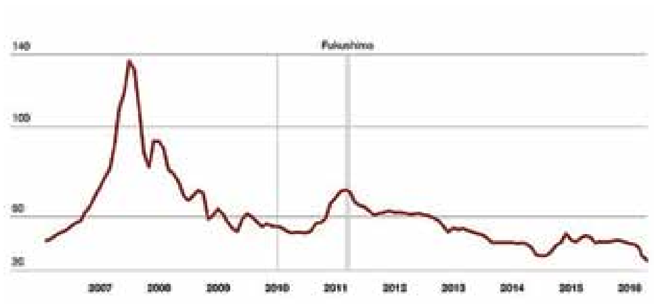
In 2012, GLE received a construction and operation licence for a full-scale laser enrichment facility from the U.S. Nuclear Regulatory Commission. GLE was selected by the U.S. Department of Energy to enter contract negotiations on the construction of a laser enrichment plant at the former gaseous enrichment site at Paducah, Kentucky to re-enrich its inventory of depleted uranium tails. Those negotiations are continuing, but the project hit financial hurdles in 2014 and faces even bigger hurdles now. Silex Systems CEO Michael Goldsworthy said in July 2014: "The global nuclear industry is still suffering the impacts of the Fukushima event and the shutdown of the entire Japanese nuclear power plant fleet in 2011. Demand for uranium has been slower to recover than expected and enrichment services are in significant oversupply."[13]

Responding to the recent announcement, pro-nuclear commentator Dan Yurman said:[14]

"It is becoming clear that the way to make a small fortune in the uranium enrichment business in the U.S. is to start with a large one. GE-Hitachi has spent millions developing the technology, including successfully building a test loop, and getting a license from the NRC to build a full-scale isotope separation plant in Wilmington, NC.

"GEH is the second major nuclear vendor to exit plans for the business without breaking ground. In 2013 French state-owned nuclear giant Areva suspended plans to build a $3 billion advanced gas centrifuge uranium enrichment plan in Idaho after getting an NRC license and a $2 billion loan guarantee from the U.S. federal government's Department of Energy. Areva, which is over-extended financially, said that the lack of outside investors caused it to cancel plans to break ground."

Laser enrichment has long raised proliferation concerns. A 1999 US State Department report stated that a laser enrichment facility ‘’might be easier to build without detection and could be a more efficient producer of high enriched uranium for a nuclear weapons program.’’[15] The *Bulletin of the Atomic Scientists* noted in 2014 that laser enrichment “promises to provide a route to uranium enrichment that is less expensive and harder-to-constrain than the centrifuge enrichment pursued by Iran and North Korea.”[16]



Uranium spot price (US$/lb) from the 2007 bubble until 2016.

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Chernobyl remembered; and costing the nuclear disaster

NM823.4557 Ukrainian President Petro Poroshenko attended a ceremony at the Chernobyl plant on April 26 to commemorate the thirtieth anniversary of the nuclear disaster. “The issue of the consequences of the catastrophe is not resolved,” he said. “They have been a heavy burden on the shoulders of the Ukrainian people and we are still a long way off from overcoming them.”[1]

Poroshenko added: “In a certain sense, Chernobyl accelerated the collapse of the Soviet Union, helping opposition and anti-imperialist movements to emerge in Ukraine and bringing our independence a step closer. At the same time, it created powerful fears of nuclear energy and anti-nuclear sentiments.”[1]

Poroshenko later attended a memorial service in the town of Slavutych, which was built to re-house people evacuated from Pripyat, the town built close to the Chernobyl nuclear plant to house workers and their families.

Speaking at a ceremony in the Ukrainian capital Kiev before heading to Chernobyl, Poroshenko said the nuclear disaster had been Ukraine’s biggest challenge between the Nazi occupation in World War Two and the recent conflict in eastern Ukraine. “At a time when we still need immense resources to tackle the consequences of the Chernobyl disaster, when we need funding for social support to fire-fighters and victims, we have to spend almost one-fifth of our budget expenses on defence and security,” he said.[2]

On the eve of the Chernobyl anniversary, some survivors returned to Pripyat. “I barely found my apartment, I mean it’s a forest now – trees growing through the pavement, on the roofs. All the rooms are empty, the glass is gone from the windows and everything’s destroyed,” said Zoya Perevozchenko.[3]

At a ceremony in their honor in Kiev, some of the former liquidators spoke of their ordeal and surprise that they lived through it. “My soul hurts when I think of those days,” said Dmitry Mikhailov, 56. He was on a crew sent to evacuate a village where residents knew nothing of the accident. “They didn’t understand what was happening,” he said. “I wish I knew where and how they are now. I just can’t forget them.”[4]

One of earliest photos taken after the 26 April 1986 Chernobyl disaster.

In Minsk, the capital of Belarus, more than 1,000 people held a protest march through the city center. Belarus routinely cracks down on dissent, but authorities allowed the march. “Chernobyl is continuing today. Our relatives and friends are dying of cancer,” said 21-year-old protester Andrei Ostrovtsov.[4]

The Ukrainian government has scaled back benefits for Chernobyl survivors, making many feel betrayed by their own country. “I went in there when everyone was fleeing. We were going right into the heat,” said Mykola Bludchiy. “And today everything is forgotten. It’s a disgrace.”[4]

Estimating the costs of Chernobyl

In a report commissioned by Green Cross Switzerland, Prof. Jonathan Samet and Joann Seo from University of Southern California’s Keck School of Medicine have taken on the near-impossible task of quantifying the costs of the Chernobyl disaster.[5]

The authors note that some of the costs are obvious (even if accurate cost figures are not available or estimates vary widely) including the costs of managing the accident, including decommissioning the plant and decontaminating surrounding areas; destruction and loss of property, e.g., loss of agricultural products; costs associated the relocating many thousands of people; and costs of replacement power. Other costs are less obvious and/or more difficult to quantify, such as loss of economic opportunities, out-migration, and long-term neuropsychological consequences.

The control room of the stricken Chernobyl #4 reactor.

Social costs (e.g., crime, violence, suicide) can be difficult to identify and even more difficult to quantify. Costing premature mortality is particularly fraught, as is the costing of disability and impairment.

As an example of how arbitrary some of the costings necessarily are, Samet and Seo point to arbitrary U.S. Nuclear Regulatory Commission (NRC) costings of the risk of fatality from radiation exposure. The NRC multiplies the value of a statistical life (currently determined to be US$9 million) by a nominal risk coefficient (5.7 x 10-4 per person-rem) giving a result of US$5100 per person-rem (or US$510 per person-millisievert). Unless the figures are inflation-adjusted, our value is decreasing all the time. And for people living outside the U.S., the value of a human life fluctuates with the exchange rate!

Samet and Seo outline the range of different sources of costs and stratify them by timeframe (short- or long-term) and mechanism (direct or indirect). Notwithstanding the many, profound uncertainties, they estimate costs of US$700 billion (€607 billion) over the 30 years since the Chernobyl disaster.

Samet and Seo write:

“Nonetheless, we can make some general comments about the costs by major category based on the data available. First, regardless of uncertainties, the information tabulated shows clearly that the indirect and long-terms costs far exceed the immediate and direct costs. Health costs represent the largest proportion of the indirect costs, particularly when consideration is given to the long-time period over which these costs are manifest – amounting to the full lifespans of those exposed and possibly extending to the next generation.

“Second, although the costs of clean-up and maintenance are the most certain and substantial, they are far lower than the indirect costs. Third, simply extending some of the estimates to cover the full 30 years since the disaster leads to notably high estimates.

“Based on the estimates found in our review, we have made extrapolations to gauge approximately the costs that may have been incurred by the Chernobyl nuclear power plant accident to date. Clearly, the estimates gathered are limited by the degree of documentation, the range of costs covered, and their geographic and temporal coverage.

“For Belarus, there is a national estimate of $235B for 1986-2015 attributed to “aggregate damage” and for Ukraine, there is a 25-year estimate for “total economic loss” of $198B. Scaled to 30 years, the Ukraine estimate of around $240B is quite comparable to that for Belarus.

“In our 2013 report, we identified a population of 10,000,000 as “exposed” in a relatively broad sense to radiation and the disaster, approximately one-third each from Russia, Ukraine, and Belarus. Thus, tripling either the Ukraine or Belarus 30-year estimates to cover the full exposed population leads to a total of around $700B in costs for the 30 years, assuming the same cost figures apply to Russia. This estimate involves a number of assumptions and must be considered as uncertain, but it is based on governmental figures.

"However, regardless of the inherent uncertainty the figure is high and existing estimates would support overall costs of hundreds of billions. Of course, the costs will continue to mount, reflecting the need to maintain the plant, the withdrawn land, and persistent health consequences."

Towards a post-nuclear Ukraine

Jan Haverkamp from Greenpeace and Iryna Holovko from the CEE Bankwatch Network and the National Ecological Centre of Ukraine have published a useful analysis of energy politics in Ukraine and neighboring states.[6] They summarize:

"Thirty years on from the world's largest nuclear catastrophe in Chernobyl, people are often astonished that Ukraine is still highly dependent on an ageing nuclear fleet for its electricity provision. Indeed, Belarus, Russia and Ukraine continue to face the trauma of Chernobyl on a daily basis – both in the form of human tragedy and on-going economic losses.

"You might expect the governments of these states to have turned away from nuclear energy and, in the light of the latest climate science, from fossil fuels too. But Russia continues to promote nuclear power, and Belarus is trying to introduce nuclear reactors at home. Belarus and Ukraine share a high dependence on Russia for nuclear technology, fuel, gas, oil and coal — a problem that has only been exacerbated by the crisis in the Donbas.

"Ukraine could cover its entire energy demand in 2050 with wind, solar and water and a 32% decrease in primary energy need. A move towards clean, renewable energy sources (such as wind, water, sun, biomass and geothermal) would seem a logical route, especially given the potential savings in health costs and increase in energy independence. Here, in these countries most afflicted by Chernobyl, economic realities make this switch to a clean energy future inevitable: the old centralised energy economy is collapsing, slowly but surely, and an awareness movement is growing."

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At Chernobyl and Fukushima, radioactivity has seriously harmed wildlife

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NM823.4558 The largest nuclear disaster in history occurred 30 years ago at the Chernobyl Nuclear Power Plant in what was then the Soviet Union. The meltdown, explosions and nuclear fire that burned for 10 days injected enormous quantities of radioactivity into the atmosphere and contaminated vast areas of Europe and Eurasia. The International Atomic Energy Agency estimates that Chernobyl released 400 times more radioactivity into the atmosphere than the bomb dropped on Hiroshima in 1945.[1]

Radioactive cesium from Chernobyl can still be detected in some food products today. And in parts of central, eastern and northern Europe many animals[2], plants and mushrooms still contain so much radioactivity that they are unsafe for human consumption.

The first atomic bomb exploded at Alamogordo, New Mexico more than 70 years ago. Since then, more than 2,000 atomic bombs have been tested, injecting radioactive materials into the atmosphere.[3] And over 200 small and large accidents have occurred at nuclear facilities.[4] But experts and advocacy groups are still fiercely debating the health and environmental consequences of radioactivity.[5]

However, in the past decade population biologists have made considerable progress in documenting how radioactivity affects plants, animals and microbes. My colleagues and[6] I have analyzed these impacts at Chernobyl[7], Fukushima[7] and naturally radioactive regions of the planet.[8]

Our studies provide new fundamental insights about consequences of chronic, multigenerational exposure to low-dose ionizing radiation. Most importantly, we have found that individual organisms are injured by radiation in a variety of ways. The cumulative effects of these injuries result in lower population sizes and reduced biodiversity in high-radiation areas.

Broad impacts at Chernobyl

Radiation exposure has caused genetic damage and increased mutation rates in many organisms in the Chernobyl region.[9] So far, we have found little convincing evidence that many organisms there are evolving to become more resistant to radiation.[10]

Organisms' evolutionary history may play a large role in determining how vulnerable they are to radiation. In our studies, species that have historically shown high mutation rates[11], such as the barn swallow (Hirundo rustica), the icterine warbler (Hippolais icterina) and the Eurasian blackcap (Sylvia atricapilla), are among the most likely to show population declines in Chernobyl.[12] Our hypothesis is that species differ in their ability to repair DNA, and this affects both DNA substitution rates and susceptibility to radiation from Chernobyl.

Much like human survivors of the Hiroshima and Nagasaki atomic bombs, birds[13] and mammals[14] at Chernobyl have cataracts in their eyes and smaller brains[15]. These are direct consequences of exposure to ionizing radiation in air, water and food. Like some cancer patients undergoing radiation therapy, many of the birds have malformed sperm.[16] In the most radioactive areas, up to 40 percent of male birds are completely sterile[17], with no sperm or just a few dead sperm in their reproductive tracts during the breeding season.

Tumors[18], presumably cancerous, are obvious on some birds in high-radiation areas. So are developmental abnormalities in some plants[19] and insects[20].

Given overwhelming evidence of genetic damage and injury to individuals, it is not surprising that populations of many organisms in highly contaminated areas have shrunk. In Chernobyl, all major groups of animals that we surveyed were less abundant in more radioactive areas.[21] This includes birds[22]; butterflies, dragonflies, bees, grasshoppers, spiders;[23] and large and small mammals[24].

Not every species shows the same pattern of decline. Many species, including wolves, show no effects of radiation on their population density. A few species of birds appear to be more abundant in more radioactive areas. In both cases, higher numbers may reflect the fact that there are fewer competitors or predators for these species in highly radioactive areas.

Moreover, vast areas of the Chernobyl Exclusion Zone are not presently heavily contaminated, and appear to provide a refuge for many species. One report published in 2015 described game animals such as wild boar and elk as thriving in the Chernobyl ecosystem.[25] But nearly all documented consequences of radiation in Chernobyl and Fukushima have found that individual organisms exposed to radiation suffer serious harm.[26]

There may be exceptions. For example, substances called antioxidants can defend against the damage to DNA, proteins and lipids caused by ionizing radiation. The levels of antioxidants that individuals have available in their bodies may play an important role in reducing the damage caused by radiation.[27] There is evidence that some birds may have adapted to radiation by changing the way they use antioxidants in their bodies.[28]

Parallels at Fukushima

Recently we have tested the validity of our Chernobyl studies by repeating them in Fukushima, Japan. The 2011 power loss and core meltdown at three nuclear reactors there released about one-tenth as much radioactive material as the Chernobyl disaster.[29]

Overall, we have found similar patterns of declines in abundance and diversity[30] of birds, although some species[31] are more sensitive to radiation than others. We have also found declines in some insects, such as butterflies[32], which may reflect the accumulation of harmful mutations[33] over multiple generations.

Our most recent studies at Fukushima have benefited from more sophisticated analyses of radiation doses[34] received by animals. In our most recent paper, we teamed up with radioecologists to reconstruct the doses received by about 7,000 birds. The parallels we have found between Chernobyl and Fukushima provide strong evidence that radiation is the underlying cause of the effects we have observed in both locations.

Some members of the radiation regulatory community have been slow to acknowledge how nuclear accidents have harmed wildlife. For example, the U.N.-sponsored Chernobyl Forum instigated the notion that the accident has had a positive impact on living organisms in the exclusion zone because of the lack of human activities.[35] A more recent report of the United Nations Scientific Committee on the Effects of Atomic Radiation predicts minimal consequences for the biota animal and plant life of the Fukushima region.[36]

Unfortunately these official assessments were largely based on predictions from theoretical models, not on direct empirical observations of the plants and animals living in these regions. Based on our research, and that of others, it is now known that animals living under the full range of stresses in nature are far more sensitive to the effects of radiation than previously believed.[37] Although field studies sometimes lack the controlled settings needed for precise scientific experimentation, they make up for this with a more realistic description of natural processes.

Our emphasis on documenting radiation effects under “natural” conditions using wild organisms has provided many discoveries that will help us to prepare for the next nuclear accident[38] or act of nuclear terrorism[39]. This information is absolutely needed if we are to protect the environment not just for man, but also for the living organisms and ecosystem services that sustain all life on this planet.

There are currently more than 400 nuclear reactors in operation around the world, with 65 new ones under construction and another 165 on order or planned. All operating nuclear power plants are generating large quantities of nuclear waste that will need to be stored for thousands of years to come. Given this, and the probability of future accidents or nuclear terrorism, it is important that scientists learn as much as possible about the effects of these contaminants in the environment, both for remediation of the effects of future incidents and for evidenced-based risk assessment and energy policy development.

Reprinted from The Conversation, https://theconversation.com/at-chernobyl-and-fukushima-radioactivity-has-seriously-harmed-wildlife-57030

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NUCLEAR NEWS

All Belgians likely to be issued with iodine tablets

The entire population of Belgium is likely to be issued with iodine tablets, which help reduce radiation build-up in the thyroid gland in the event of a nuclear accident or terrorist attack.

“Before, the iodine pills were only given to people living in a perimeter of 20 kms — now we are going to take measures for people within 100 kms,” Health Minister Maggie De Block said on April 28. “We will provide iodine pills in the whole country.”

All 11 million Belgians live within 100 km of a nuclear power plant when reactors in Belgium, France and the Netherlands are taken into account.

The announcement followed advice from Belgium’s Superior Health Council. The Health Ministry said it would take the advice into account as it revises safety protocols to be finalized before the end of the year, but the Minister’s statements indicate that a firm decision to accept the advice has already been taken.

“We are a very small and densely populated country surrounded by nuclear power plants both in our country and neighboring countries” and iodine pills are “cheap and efficient,” said Nele Scheerlinck, a spokeswoman for the Federal Authority for Nuclear Control.

Belgium’s nuclear industry has been subject to numerous security threats and scares as discussed in Nuclear Monitor #822. In addition, there are serious safety concerns including multiple cracks discovered in the Doel 3 and Tihange 2 pressure vessels and a controversial decision to allow the reactors to restart. German Environment Minister Barbara Hendricks said last month that Belgium should take offline Doel 3 and Tihange 2, which are close to the German border, because of safety concerns.

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Protesters break into Finnish nuclear site, police attack

On Chernobyl Day, April 26, anti-nuclear protesters broke in to a Finnish construction site for a nuclear reactor to be supplied by Russia's Rosatom. Protesters said more than 100 people participated, while police estimated that close to 50 protesters gathered near the Fennovoima site and around 40 were detained. One group broke into the site while others lay down on the road leading to the site's entrance.

"We want to remind people that the Chernobyl plant was built by Rosatom's predecessor. I wouldn't do business with anyone with that kind of history," said Venla Simonen from the Stop Fennovoima protest group.

Site works have been ongoing for one year, and a protest camp has recently celebrated its first anniversary. The camp was able to stay inside the construction area over five months and was able to slow down construction works. During the summer of 2015, dozens of blockades took place. In September, after an eviction that lasted eight days, the camp moved outside the construction site to continue its activities with help from local supporters. Blockades and other activity against nuclear power did not stop at any point.

Protesters organized multiple actions in the week around Chernobyl Day. They blocked the road to the Fennovoima-Rosatom site on April 28 before the police attacked. Some people locked themselves together with pipelocks and some of the people locked on to heavy barrels. The activists had locked themselves to locks inside the barrels, and there were activists locked on to the barrel-activists, so they formed a human chain to block the traffic on the road.

It took almost three hours for the police to arrive at the blockade. But when they came there was a lot of them and they had riot equipment and police dogs. A helicopter circulated around the area. Police used rubber bullets and pepper spray and dismantled the blockade. Many protesters were taken to the custody. Police also attacked and destroyed two protest camp sites at the Fennovoima site.

Protesters said: "We don't accept giving in to repression and police violence, and the struggle against Fennovoima will continue. Now we'll need everyone to help build up the camp again, and to continue the fight and actions against Fennovoima. We invite comrades to this fight where ever you are – let's aim our actions towards the companies which are working with Fennovoima, the embassies of Finland, or the local police."

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The checkered history of high-temperature gas-cooled reactors

Princeton University academic M.V. Ramana has written a useful summary of the troubled history of high-temperature gas-cooled reactors (HTGR) including the pebble-bed reactor sub-type. In the past, both Germany and the United States spent large amounts of money to design and construct HTGRs, four of which fed electricity into the grid. Other countries have also invested in HTGR technology. Ramana's analysis is of more than historical interest as several countries are either considering the construction of new HTGRs or pursuing research into the field.

Ramana writes:

"Proponents of HTGRs often claim that their designs have a long pedigree. ... But if one examines that very same experience more closely – looking in particular at the HTGRs that were constructed in Western Europe and the United States to feed power into the electric grid – then one comes to other conclusions. This history suggests that while HTGRs may look attractive on paper, their performance leaves much to be desired. The technology may be something that looks better on paper than in the real world ...

"Although Germany abandoned this technology, it did migrate to other countries, including China and South Africa. Of these, the latter case is instructive: South Africa pursued the construction of a pebble-bed reactor for a decade, and spent over a billion dollars, only to abandon it in 2009 because it just did not make sense economically. Although sold by its proponents as innovative and economically competitive until its cancellation, the South African pebble-bed reactor project is now being cited as a case study in failure. How good the Chinese experience with the HTGR will be remains to be seen. ...

"From these experiences in operating HTGRs, we can take away several lessons – the most important being that HTGRs are prone to a wide variety of small failures, including graphite dust accumulation, ingress of water or oil, and fuel failures. Some of these could be the trigger for larger failures or accidents, with more severe consequences. ... Other problems could make the consequences of a severe accident worse: For example, pebble compaction and breakage could lead to accelerated diffusion of fission products such as radioactive cesium and strontium outside the pebbles, and a potentially larger radioactive release in the event of a severe accident. ...

"Discussions of the commercial viability of HTGRs almost invariably focus on the expected higher capital costs per unit of generation capacity (dollars per kilowatts) in comparison with light water reactors, and potential ways for lowering those. In other words, the main challenge they foresee is that of building these

reactors cheaply enough. But what they implicitly or explicitly assume is that HTGRs would operate as well as current light water reactors – which is simply not the case, if history is any guide. ...

"Although there has been much positive promotional hype associated with high-temperature reactors, the decades of experience that researchers have acquired in operating HTGRs has seldom been considered. Press releases from the many companies developing or selling HTGRs or project plans in countries seeking to purchase or construct HTGRs neither tell you that not a single HTGR-termed "commercial" has proven financially viable nor do they mention that all the HTGRs were shut down well before the operating periods envisioned for them. This is typical of the nuclear industry, which practices selective remembrance, choosing to forget or underplay earlier failures."

M. V. Ramana, April 2016, 'The checkered operational history of high-temperature gas-cooled reactors', Bulletin of the Atomic Scientists, http://dx.doi.org/10.1080/00963402.2016.1170395

Reactor delays put Sellafield's plutonium decision on back-burner

Cumbrians Opposed to a Radioactive Environment summarize the latest developments in the saga over the management of civil plutonium in the UK:

As well as dominating the news headlines, the delays to EDF's Hinkley Point C reactor project are also creating waves over 300 miles to the north at Sellafield and the fate of its stockpile of 140 tonnes of separated plutonium recovered from decades of spent fuel reprocessing. A Government decision on how this stockpile is to be dealt which has been expected for some time has been put back for a decade – until around 2025 at the earliest.

At a meeting on the 27th April of the Spent Fuel and Nuclear Materials Working Group (a sub-group of West Cumbria Sites Stakeholder Group) the Nuclear Decommissioning Authority (NDA) outlined why it was now considered the UK Government was unlikely to come to a decision on the stockpile much before 2025. The reasoning behind the NDA's projection is that the Government's currently preferred option of re-using plutonium as Mixed Oxide (MOX) fuel envisages the fuel being used in UK's fleet of new-build reactors. Given that the first of these would not realistically be in operation until 2025 at the earliest – and would then need to operate for up to 10 years to reach a 'steady state' burning conventional uranium fuel, any decision by the operator in favour of using MOX was unlikely to be made until 2035. To contemplate building a new commercial MOX plant (last estimated at £5–6 billion by the NDA in 2011) before new-build reactors were up and running and a firm interest in using MOX fuel shown by their operators would represent poor business practice.

Options on how to manage Sellafield's plutonium stockpile have been the subject of numerous consultations since the NDA launched a Plutonium Options – for Comment Paper in 2008, The Government, via its first public consultation in 2011 which looked at three 'high level' management options (plutonium re-use, its immobilisation for direct disposal and its long-term storage at Sellafield) concluded that its preferred option was to re-use the material as MOX fuel. That preference remains today despite the belated addition to the list in 2012 by the NDA of two new options – a proposal by GE Hitachi to get rid of the plutonium through a PRISM fast reactor to be built at Sellafield and a proposal by Candu Energy to burn it in its Enhanced Candu 6 reactors (EC6) as Canmox.

http://corecumbria.co.uk/briefings/new-build-reactor-delays-put-sellafields-plutonium-decision-on-the-back-burner/

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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