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Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor,

- A detailed review of the global nuclear industry in 2016 – the nuclear power ‘renaissance’; significant national nuclear developments; nuclear utilities in crisis; and the uranium industry (also in crisis).
- Vladimir Slivyak from Ecodefense writes about the nuclear power industry in Russia.
- Charly Hultén from WISE Sweden writes about the nuclear power industry in Sweden.

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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2016 in Review: The nuclear power renaissance – blink and you’ll miss it

Author: *Jim Green – Nuclear Monitor editor*

NM837.4614 Global nuclear power capacity increased by 9.2 gigawatts (GW) in 2016.¹ By contrast, renewable electricity capacity growth was 153 GW in 2015² and almost certainly greater in 2016.

In broad terms, nuclear power has been stagnant for the past 20 years. Using figures from the World Nuclear Association (WNA) and the International Atomic Energy Agency, global nuclear capacity has grown 12.7% over the past 20 years and 5.7% over the past decade. But those figures include idle reactors in Japan and the inclusion of those reactors is, as former WNA executive Steve Kidd states, “misleading” and “clearly ridiculous”.³ The World Nuclear Industry Status Report (WNISR) excludes 34 idle reactors in Japan (and one each in Taiwan and Sweden) from its calculations of current nuclear capacity. Using WNISR figures, nuclear capacity has grown 1.7% over the past 20 years and it has declined by 4.6% over the past decade.

YEAR	GLOBAL NUCLEAR POWER CAPACITY
Dec. 1996 ⁴	347 GW
Dec. 2006 ⁴	370 GW
Dec. 2016	391 GW (WNA – including reactors in long-term outage) ¹
	353 GW (WNISR – excluding reactors in long-term outage) ⁵

If we look more closely at recent figures, the picture is a little confusing. Global nuclear power capacity increased “slightly” in 2016 according to the pro-nuclear WNA¹ while the anti-nuclear WNISR said that a “significant” number of new reactors came online.⁵ If there’s some confusion now as to the trajectory of nuclear power, that confusion is likely to grow in the next few years. To explain, let’s first look at WNA figures on reactor construction starts.

YEAR	Jan. 2007	Jan. 2008	Jan. 2009	Jan. 2010	Jan. 2011	Jan. 2012	Jan. 2013	Jan. 2014	Jan. 2015	Jan. 2016	Jan. 2017
REACTORS UNDER CONSTRUCTION	28	34	43	53	63	61	65	71	70	66	60
COMPARED TO PREVIOUS YEAR		+6	+9	+10	+10	-2	+4	+6	-1	-4	-6

The nuclear power ‘renaissance’ never materialized in the since that the number of ‘operable’ reactors has hovered between 430 and 450 for the past 20 years, with no clear trend in either direction.⁶ (The number of operating reactors is currently 406 according to the WNISR, which excludes reactors in long-term outage.⁵).

But we can see the ‘renaissance’ manifest in the sharp increase in construction starts in the few years preceding the March 2011 Fukushima disaster. Those reactors are starting to come online, and more will come online in the next few years. Thus 10 reactors came online in both 2015 and 2016 (a number not previously reached since 1990). And the number of grid connections over the past five years (32 from 2012–2016) was considerably greater than during the five years before that (17 from 2007–2011).

How will this play out in the coming years? Here are predicted start-up (grid connection) figures compiled by the World Nuclear Association:⁷

2016: 12 grid connections
(only 10 reactors were grid connected)

2017: 18 grid connections anticipated

2018: 10 grid connections anticipated

2019: 8 grid connections anticipated

2020: 7 grid connections anticipated

We may have been premature in declaring the nuclear renaissance dead. Indeed we’re right in the middle of the renaissance. It will likely span 2–3 years and it will be a damp squib. Last year, 10 reactors were grid connected and four were permanently shut down. In 2017–18, the World Nuclear Association anticipates 28 grid connections⁷; even if the number falls short of that figure (as it will), grid connections will exceed permanent shut-downs.

But that’s as good as it gets for the nuclear industry. In truth, the industry is in a world of pain.

The reactor fleet is aging; most reactors are late middle-aged. The average age of the world’s nuclear reactor fleet is 29 years, and more than half have operated for more than 30 years.⁸ Recent statistics on reactor shutdowns are heavily shaped by the 2011 Fukushima disaster – there were 13 permanent shutdowns in that year alone. In the five years before 2011, there were 15 shutdowns; in the five years after 2011, 22 shutdowns. That trend is certain to continue:

- The World Nuclear Association estimates 132 reactor shut-downs by 2035.⁹
- The International Energy Agency anticipates a “wave of retirements of ageing nuclear reactors” and an “unprecedented rate of decommissioning” – almost 200 reactor shut-downs between 2014 and 2040.¹⁰
- According to a recent *Nuclear Energy Insider* article, up to 200 reactors are set to go offline in the next two decades.¹¹

Thus 6–10 reactors will need to be commissioned each year for the next 20–25 years just to maintain current nuclear capacity.

The number of reactors under construction is slowly dropping. Using WNA figures, 71 reactors were under construction in January 2014 compared to 60 in January 2017. According to WNISR figures, the number is down from 67 to 55 over the same period. Again, that trend seems near-certain to continue because of a sharp drop in reactor construction starts: 50 from 2007–2011 compared to 31 from 2012–2016.¹² Last year, there were just three construction starts.¹²

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2016 in Review: National Nuclear Updates

Author: Jim Green – Nuclear Monitor editor

NM837.4615 France: In 2015, legislation was enacted in the French Parliament to reduce the nuclear share of electricity generation from 75% to 50% by “around” 2025, capping nuclear capacity at 63.2 gigawatts (GW). It’s not certain that the legislated shift away from nuclear in favour of renewables and energy efficiency will be retained beyond the 2017 presidential election, but either way the French nuclear industry is in a world of pain.

France has 58 operable reactors and just one under construction – the Flamanville EPR that is many years behind schedule and three times over-budget. The EPR under construction in Finland is also years behind schedule and three times over-budget, and Areva and Finnish utility TVO have been locked in protracted litigation over the cost blowout.¹

In 2015, concerns about the integrity of some EPR pressure vessels were revealed, prompting investigations that are still ongoing. Last year, the scandal was magnified when the French Nuclear Safety Authority (ASN) announced that Areva had informed it of “irregularities in components produced at its Creusot Forge plant.” The problems concern documents attesting to the quality of parts manufactured at the site. At least 400 of the 10,000 quality documents reviewed by Areva contained anomalies.²

Both Areva and EDF are financially stressed, to put it mildly – hence a taxpayer-funded bailout agreed last year.³ A government-led rescue of Areva and the wider nuclear industry may cost the state as much as €10-billion, Reuters reported in January 2017, and in addition to its “dire financial state, Areva is beset by technical, regulatory and legal problems.”⁴

EDF will need to spend around €100 billion (US\$107 billion) upgrading its fleet of 58 reactors by 2030, the country’s state audit office has said, to meet new safety requirements and to extend the lives of the units beyond 40 years.⁵

The French nuclear industry is in its “worst situation ever” according to former EDF Gérard Magnin, speaking last November.⁶ He cited the spate of reactor closures in France in late-2016 mandated by the regulator to investigate anomalies; the financial problems facing EDF; and the complexities, costs and risks associated with the UK Hinkley Point EPR project. Magnin called Hinkley Point “very risky” when he resigned from the EDF board in July 2016, adding: “Let’s hope that Hinkley Point will not drag EDF into the same abyss as Areva.”

Magnin said in November: “A lot of people in EDF have known for a long time the EPR has no future – too sophisticated, too expensive – but they assume their commitments and try to save the face of France.” He added: “Renewable energies are becoming competitive with fossil fuels and new nuclear, such as Hinkley Point, where EDF will try to build the most expensive reactors in the world and provide electricity at an unprecedented cost.”⁶

French finance authorities raided the offices of EDF in July 2016 as part of a probe into EDF’s disclosure of information to the market regarding domestic nuclear maintenance costs as well as planned reactors in the UK.⁷

Former Areva chief executive Anne Lauvergeon was placed under formal investigation last year over her role in an acquisition of a number of African uranium mines. Following a hearing in May 2016, Lauvergeon fronted national prosecutors over whether she deliberately submitted misleading annual accounts concealing huge writedowns on Areva’s €1.8bn investment in Uramin in 2007. Following the hearing she was placed under formal investigation for the “publication of inaccurate accounts” and the “spreading of false information”.⁸

USA: The pattern of reactor closures continues in the US – the number of operable reactors has shrunk from 104 to 99 over the past five years. The Watts Barr-2 reactor was brought online in 2016, 43 years after construction began – the first reactor start-up in the US since 1996. Four reactors are under construction – all behind schedule and over-budget.

Closures will outstrip grid connections in the coming years – 44 out of 99 reactors have been operating for 40 years or more as of 31 January 2017.⁹ However there has been some movement to subsidise aging reactors to keep them operating – last year, the states of New York and Illinois agreed to prop up aging reactors with massive subsidies.

There are indications that the Trump administration might do more than the Obama administration to prop up aging reactors.¹⁰ But the bill could be up to US\$280 billion by 2030¹¹ and Congress may balk at the administration’s proposals.

A recent article in *Oilprice.com* outlines 10 reasons why Trump won’t lead a nuclear power renaissance.¹² Most revolve around economics – authors Leonard Hyman and Bill Tilles note that producing “a commodity like electricity at a relatively high price in a competitive market is not a winning business strategy.” As for subsidies to prop up aging reactors, they write: “New York and Illinois both launched programs best described as Welfare for the Nuclear Elderly. It’s heart-warming to see such generosity just prior to the holiday season aimed at aging, uneconomic nuclear plants. This sounds to us like a job creation/preservation program for rural areas (where high paying jobs are scarce) masquerading as an environmentally beneficial, carbon mitigating proposal.”

There are also indications that the Trump administration may try to revive the Yucca Mountain high-level waste dump – but any attempt to do so will be protracted and strongly contested.¹³ Outgoing Energy Secretary Ernest Moniz recently noted that “forcing an unwanted facility on an unwilling population” is no more likely to be successful in the future than it has been in the past.¹⁴

Japan: Only two of the country's 42 'operable' reactors are actually operating – Sendai-1 and Ikata-3. Sendai-2 restarted but is offline for routine maintenance. Takahama-3 and -4 were restarted but were taken offline after a court ruling.

The future of Japan's nuclear program remains a guessing game, but projections are being steadily reduced. According to the OECD's Nuclear Energy Agency and the IAEA, installed capacity of 42.4 GW in 2014 could fall to as little as 7.6 GW by 2035 "as reactors are permanently shut down owing to a range of factors including location near active faults, technology, age and local political resistance."¹⁵ Before the Fukushima disaster, Tokyo planned to add another 15–20 reactors to the fleet of 55, giving a total of 70–75 reactors (65–70 GW).

Another reactor was permanently shut down in 2016 (Ikata-1) in addition to five shut-downs in 2015 and the six Fukushima Daiichi reactors shut down in the aftermath of the March 2011 disaster. Japan also decided last year to permanently shut down the troubled Monju fast breeder reactor. As we reported in *Nuclear Monitor*, for all the rhetoric about Generation IV fast reactors, and the US\$100+ billion invested worldwide, only five such reactors are operating worldwide (three of them experimental) and only one is under construction (in India).¹⁶

Late last year, Japan's Ministry of Economy, Trade and Industry revised the estimated cost of decommissioning the Fukushima Daiichi nuclear plant, and compensating victims of the disaster, to around ¥21.5 trillion (US\$187 bn; €175 bn).¹⁷ The latest estimate is four times greater than estimates provided in 2011/12. Indirect costs (e.g. fuel imports, adverse impacts on agriculture and fishing, etc.) are likely to exceed the direct clean-up and compensation costs.

China: With 35 operable power reactors (up from 30 at the start of 2016), 22 under construction, and many more in the pipeline, China remains the only country with significant nuclear expansion plans. There are indications of a slow-down with only two construction starts in 2016. There were 25 construction starts from 2008–2010 and 15 in the six years since.¹⁸

Public opinion may increasingly shape China's nuclear program.¹⁹ Thousands participated in protests against a proposed nuclear reprocessing plant in the city of Lianyungang in August 2016, disregarding warnings from the local government and police that they were breaking the law. The Lianyungang local government responded by suspending site selection and preliminary work on the project. In 2013, plans for a nuclear fuel fabrication plant in Guangdong province were shelved after public protests. Plans for inland nuclear power plants are provoking strong public opposition.

Growth could be derailed by a serious accident, which is all the more likely because of China's inadequate nuclear safety standards, inadequate regulation, lack of transparency, repression of whistleblowers, world's worst insurance and liability arrangements, security risks, and widespread corruption. He Zuoxiu, a leading Chinese scientist, said in 2015: "There were internal

discussions on upgrading standards in the past four years, but doing so would require a lot more investment which would affect the competitiveness and profitability of nuclear power. Nuclear energy costs are cheap because we lower our standards."²⁰

The nuclear industry never tires of bleating about all the lessons it has learned from the Fukushima disaster. Surely one of those lessons is that it is not a good idea to turn a blind eye to countries with inadequate nuclear safety and regulatory standards?

India has 22 operable reactors (6.2 GW capacity) and five under construction. In early 2015, India claimed to have resolved one of the major obstacles to foreign investment by announcing measures to circumvent a liability law which does not completely absolve suppliers of responsibility for accidents. But that hasn't led to any construction starts; indeed the last construction start was in 2011. Strong public opposition – and the Indian state's aggressive response to that opposition – will likely continue to slow nuclear expansion.

As in China, safety and regulatory standards are clearly inadequate in India.²¹ The nuclear industry never tires of bleating about all the lessons it has learned from the Fukushima disaster. Surely one of those lessons is that it is not a good idea to turn a blind eye to countries with inadequate nuclear safety and regulatory standards?

Nuclear security is also inadequate in India. The latest assessment by the Nuclear Threat Initiative placed India 21st out of 25 countries with weapons-usable nuclear materials. Improvements are needed in on-site physical protection, control and accounting, mitigating insider threats, ensuring protection of materials during transport, establishing an independent regulator, dealing with high levels of corruption among public officials, and the presence of groups interested in and capable of illicitly acquiring nuclear materials.²²



Protest at India's Koodankulam nuclear plant.

Russia has 35 operable reactors and seven under construction. The Russian government published a decree in August 2016 outlining plans to build 11 new reactors by 2030, in addition to those under construction. But similar plans have been announced previously and reality has fallen well short of governmental decrees.²³

Already there is some backsliding from the August 2016 announcement. In December, Alexander Lokshin,

first deputy general-director of Rosatom, said the aim is to maintain the nuclear share at around 18% of total electricity production.²⁴ He cited stagnant energy demand as the reason to downwardly revise nuclear plans. In January 2017, Rosatom announced that it is deferring the planned Brest-OD-300 lead-cooled fast reactor – one of the 11 new reactors trumpeted in the August 2016 decree.²⁵

Russia continues to sign nuclear cooperation agreements with other countries, promising billions in loans that it can't afford. Russia's export ambitions faced setbacks last year with Vietnam abandoning its nuclear power plans, and South Africa deferring its plans.

UK: In 2016 the British government approved the Hinkley Point C project to build two EPR reactors. Whether that is a blessing or a curse for the industry remains to be seen. Other EPR projects face mounting problems – long delays; spectacular cost increases; ongoing inquiries into the integrity of EPR pressure vessels; and in the case of the EPR under construction in Finland, litigation.

Eight of the UK's 15 power reactors are scheduled to be shut down over the next decade, and it's unlikely that new reactors will keep pace with closures. The OECD Nuclear Energy Agency and the IAEA are hedging their bets, projecting that the UK will have 0–12.2 GW of nuclear capacity by 2035, compared to 8.9 GW now.¹⁵

Newcomer countries: The World Nuclear Association claims that “over 45 countries are actively considering embarking upon nuclear power programmes.”²⁶ There's no truth to the claim. Only two ‘newcomer’ countries are actually building reactors – Belarus and the United Arab Emirates. Numerous potential newcomers have deferred or abandoned their nuclear plans over the past two years, including Chile, Indonesia, Vietnam and Lithuania (which operated reactors until 2009).

Other countries might join the nuclear club but newcomers will be few and far between. Moreover, some countries – including Germany, Belgium, and Taiwan – are deliberately phasing out nuclear power, while nuclear power faces attritional phase-outs in some other countries (e.g. Switzerland). Last year, Taiwan reaffirmed its plan to phase-out nuclear power by 2025. “There is no room for discussion. When 2025 comes, nuclear power will be abandoned,” Economics Minister Lee Shih-guang said in May 2016.²⁷

The July 2016 World Nuclear Industry Status Report noted that over the past two decades, only two countries started power reactors for the first time (Romania in 1996 and Iran in 2011) while two countries closed theirs (Kazakhstan and Lithuania).²⁸

Hollow, pyrrhic victories

Most of the nuclear industry's wins in 2016 may turn out to be hollow and pyrrhic.

The decision to go ahead with EPR reactors at Hinkley Point in the **UK** may be a blessing or a curse for the industry. Even if construction goes to plan and to budget, the obscene subsidies will turn the British public against nuclear power for decades to come. Most of the British Establishment – and even the Aristocracy – are already

opposed to Hinkley Point so they'll be quick to criticize if and when the project faces delays and cost blow-outs.

Russia announced plans for 11 new reactors but there is no likelihood that all will be built and every likelihood that few if any will be built.

In a November 27 referendum, voters in **Switzerland** rejected a proposal to impose time limits on the operation of the country's five power reactors.²⁹ Nonetheless, pre-Fukushima plans for new reactors have been abandoned. Switzerland is tracking towards a nuclear phase-out by attrition. One of its five reactors is to be closed in 2019, and the others will likely all be closed by the end of the 2020s (or by 2034 according to *Nuclear Energy Insider*³⁰) ... much the same outcome as that envisaged in the defeated referendum proposal.

The nuclear industry in **Sweden** certainly had some wins in 2016, but they may not amount to much. There is no longer an end-date for nuclear energy in Sweden other than a non-binding aspiration to exit the industry by mid-century and a (contradictory) aspiration to be 100% renewable-energy powered by 2040; existing reactors can be replaced with new ones (at the same sites); and a nuclear capacity tax will be abolished.³¹

But there are no plans for new reactors and no likelihood of any in the foreseeable future. Keeping existing reactors operating is proving quite a challenge. One reactor closed in 2015 (leaving Sweden with nine), and three more closures are scheduled by the end of 2020. Magnus Hall, CEO of Vattenfall, Sweden's main nuclear operator, said in June 2016: “Even with the abolishment of the capacity tax, profitability will be a challenge. Low electricity prices put all energy producers under pressure and we will continue to focus on reducing production costs.”³²

‘**South Africa** formally launches new build programme’, *Nuclear Engineering International* reported in December 2016.³³ But in fact, plans to build new reactors have been deferred – the latest projection is 1.4 GW of new nuclear capacity by 2037 followed by more later – and plans for new reactors may be scrapped altogether once President Jacob Zuma is ousted.³⁴

Corruption has undermined South Africa's nuclear new-build program³⁴, and developments in a widespread kick-back and bribery corruption scandal in **Brazil's** nuclear program was one of the biggest stories of 2016.³⁵ Corruption has claimed numerous scalps – not least Othon Luiz Pinheiro da Silva, considered the father of Brazil's nuclear program, who was sentenced to 43 years in prison in August 2016. The partially-built Angra-3 reactor remains frozen due to the corruption scandal and a lack of funding.

Belgium: 10-year extensions for two of Belgium's seven reactors were approved in late-2015. But all reactors are still scheduled to closed by the end of 2025. There has been ongoing controversy over the safety of Belgium's reactors – in particular Doel-3 and Tihange-2 – including strenuous efforts by politicians and the public in neighboring countries to force the closure of the reactors. Also in the news last year: Belgium's nuclear regulator said utility Engie Electrabel is ‘shameless’ over lax safety standards³⁶; nuclear security scares³⁷; and all Belgians are to be issued with iodine tablets.³⁸

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2016 in Review: Nuclear utilities in crisis

NM837.4616 Troubled utility Toshiba Corp. will cease taking orders related to the building of nuclear power stations, according to recent news reports, in a move that would effectively mark its withdrawal from the nuclear plant construction business. Pro-nuclear commentator Dan Yurman provided some context in a 29 January 2017 post:¹

“Toshiba Corp. will take no new orders related to the construction of nuclear power stations, with the company’s chairman expected to resign over the massive write-down that has doomed the company’s U.S. nuclear business. The Financial Times, London, reported that “Toshiba’s nuclear climbdown deals a blow to Japan’s broader ambitions of bidding for nuclear construction projects around the world – a key aim of Prime Minister Shinzo Abe’s “Abenomics” economic revival program and a driving force behind his unprecedented global diplomatic push.”

“The newspaper points out that the exit from new nuclear builds is another example of its shrinking global footprint and adds pain to a company recovering from a 2015 accounting scandal in which it padded reported profits by about US\$1.3bn over seven years. Also, the company was forced to make huge cuts to headcount – a measure analysts say is likely to have hurt the company’s competitiveness.

“Delays and cost overruns on Westinghouse nuclear construction projects in the US will now be expressed as writedowns that analysts estimate could be as high as US\$7bn. The company’s decision to cease taking orders effectively marks its withdrawal from the nuclear energy business. It also apparently ends the so-called nuclear renaissance in the U.S. for full size reactors. During 2007-2010 there were more than two dozen applications expected for new reactors, but now only a few licenses that have been completed and they do not have any links to near term plans to build the units. ...

“After Toshiba ceases taking new orders, it will focus on maintenance and decommissioning operations. The company will continue work on four nuclear plants under construction in the United States that are expected to be completed by 2020. Two are in Georgia and two more are in South Carolina. It is expected that Toshiba may license its AP1000 technology to other firms as it has done in China. ...

The Japanese industrial conglomerate may announce company chairman Shigenori Shiga’s resignation as soon as 02/14/17, when it reports its April-December financial results. Shiga once served as president of the

U.S. nuclear unit, Westinghouse Electric Co., which Toshiba has said could face a multibillion-dollar loss due to cost overruns from delays in US plant projects.”

The July 2016 World Nuclear Industry Status Report summarized troubles facing nuclear utilities around the world:²

“Many of the traditional nuclear and fossil fuel based utilities are struggling with a dramatic plunge in wholesale power prices, a shrinking client base, declining power consumption, high debt loads, increasing production costs at aging facilities, and stiff competition, especially from renewables.

- *In Europe, energy giants EDF, Engie (France), E.ON, RWE (Germany) and Vattenfall (Sweden), as well as utilities TVO (Finland) and CEZ (Czech Republic), have all been downgraded by credit rating agencies over the past year. All of the utilities registered severe losses on the stock market.*
- *French utility AREVA has accumulated €10 billion (US\$10.9 billion) in losses over the past five years. Share value 95% below 2007 peak value. Standard & Poor’s downgraded AREVA shares to BB+ (‘junk’) in November 2014 and again to BB- in March 2015. The company is to be broken up, with French-state-controlled utility EDF taking a majority stake in the reactor building and maintenance subsidiary AREVA NP will then be opened up to foreign investment. The rescue scheme has not been approved by the European Commission.*
- *The AREVA rescue scheme could turn out to be highly problematic for EDF as its risk profile expands. EDF struggles with US\$41.5 billion debt, downgraded by S&P, shares lost over half of their value in less than a year and 87% compared to their peak value in 2007.*
- *RWE shares went down by 54% in 2015.*
- *In Asia, the share value of the largest Japanese utilities TEPCO and Kansai was wiped out in the aftermath of the Fukushima disaster and never recovered. Chinese utility CGN (EDF partner for Hinkley Point C), listed on the Hong Kong stock exchange since December 2014, has lost 60% of its share value since June 2015. The only exception to this trend is the Korean utility KEPCO that operates as a virtual monopoly in a regulated market.*
- *In the U.S., the largest nuclear operator Exelon has lost about 60% of its share value compared to its peak value in 2008.”*

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2016 in Review: “It has never been a worse time for uranium miners”

Author: Jim Green – Nuclear Monitor editor

NM837.4617 “It has never been a worse time for uranium miners”, said Alexander Molyneux from Paladin Energy in October 2016.¹

“No major commodity had a worse 2016 than uranium,” Bloomberg said in January 2017. “In fact, the element used to make nuclear fuel has had a pretty dismal decade.”²

One of the casualties in 2016 was Cameco, which announced in April 2016 its decision to suspend production at its Rabbit Lake mine and mill and reduce production at McArthur River / Key Lake in Canada. Cameco also curtailed production at its two US uranium mines – Crow Butte in Nebraska and Smith Ranch-Highland in Wyoming. About 500 jobs were lost at Rabbit Lake and 85 at the US mines.³ Cameco expects to post a loss for 2016 and another difficult year lies ahead with a further 120 workers at the Canadian mines to be sacked by May 2017.⁴ Cameco’s battle against the Canada Revenue Agency commenced in the Tax Court of Canada in October 2016 – at stake is a C\$2.2-billion tax bill, with Cameco accused of setting up a subsidiary in Switzerland and selling it uranium at a low price to avoid tax.⁵

Uranium mining ramped up 5–10 years ago in anticipation of the nuclear renaissance that never materialized. Hence a glut, hence the low price. The price has fallen for seven of the past nine years. The spot price fell 41% in 2016, sinking to a 12-year low (US\$18 / lb U3O8 in November).²

The spot price averaged about \$26 last year, and is expected to average just \$23 in 2017 according to the median forecast of analyst estimates compiled by Bloomberg in December 2016.^{2,6}

“I don’t think there’s a mine profitable at current spot prices,” Leigh Curyer from Canadian uranium miner NexGen Energy told Bloomberg.²

The long-term contract price fell from \$44 in January 2016 to \$30 in December.⁷ It would need to double to encourage the development of new mines. KPMG noted in December that “uranium producers are expected to reduce production and cut costs through 2017 and 2018, with high cost mines likely to scale back or close. New projects are expected to remain on hold.”⁸ RBC expects the sector will be oversupplied until around 2024.⁹

A slight reprieve in the uranium slump occurred in December 2016, apparently motivated by US president-elect Donald Trump’s tweet that the US needs to “greatly strengthen and expand its nuclear [weapons] capability”.¹⁰ But the US already has vast amounts of fissile materials available for weapons.

A further reprieve came in January 2017, with Kazakhstan – which has accounted for more than one-third of the world’s total uranium production in recent years – announcing that it would produce 10% less uranium in 2017 than previously planned in response to ongoing oversupply in the uranium market.¹¹

The uranium enrichment industry is in much the same place as uranium mining. The spot uranium enrichment price has fallen consistently since the 2011 Fukushima disaster, and it fell by a third between early 2015 and late 2016 to reach an all-time low.¹²

And since cheap, abundant enrichment capacity can substitute for newly mined uranium (either by extracting more uranium-235 during uranium enrichment, or re-enriching tails), this has and will continue to keep uranium prices down. Former World Nuclear Association executive Steve Kidd wrote in December 2016:¹²

“Since the beginning of the commercial nuclear era in the 1950s, there have always been fears of a shortage of uranium. The anticipated need to move quickly to fast



breeder reactors didn't happen as higher uranium prices stimulated an enhanced exploration effort, leading to significant increases in proven resources. There remains a general expectation, however, that at some point increased uranium demand will create the need to exploit higher cost deposits, necessitating uplifts to prices. This now looks highly unlikely.

"A lower enrichment price means that more enrichment will be used as opposed to uranium in creating the required enriched uranium and this will be reflected in the selection of lower tails assays at the plants. There is an optimum for the buyer for every mix of uranium and enrichment prices, and uranium demand will now be notably lower. Hence there is an important impact on uranium prices which themselves should be pushed down by lower enrichment prices."

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Russia and its nuclear industry in 2016

Author: *Vladimir Slivyak – Co-chair of Ecodefense*

NM837.4618 Although many important events related to the Russian industry and anti-nuclear movement happened in 2016, there was not much publicity. Probably the main reason was state pressure on both the media and public movements – pressure that has escalated for three years in a row. Back in 2014, the Russian government introduced a new version of the so-called “law on foreign agents”, the main instrument to put heavy pressure on human rights and environmental movements.

The first environmental group labeled as a foreign agent was Ecodefense for the campaign “to stop construction of the Baltic nuclear power plant near Kaliningrad”, according to the Ministry of Justice. This campaign was going on since 2009 until the Russian government halted construction of the plant in 2013. Although the Russian nuclear industry was talking about possible restart of this project in three years' time, it remained frozen in 2016. Ecodefense faced several new court cases based on the “foreign agent law”. However, the organization managed to survive in 2016, thanks to the Public Verdict Foundation, a human rights group that sent lawyers to defend Ecodefense in court.

During 2016, dozens of non-governmental groups found themselves on the list of a foreign agents, including several organizations criticizing the nuclear power industry. Some of the groups, including “Green World” in Sankt-Petersburg region, declared they are closing down. Another group – Foundation for Nature, in the

city of Chelyabinsk – asked the local court to close it down, which happened in late 2016. In the region of Krasnoyarsk, Siberia (where Rosatom is planning to build a geologic repository for spent nuclear fuel), local activist and journalist Fyodor Maryasov faced a criminal case against him for criticizing nuclear plans.

2017 was declared a “year of environment” by the Russian government, which may be a signal for further repression against environmental groups. There is a general belief among environmentalists that pressure on anti-nuclear activists is good for Rosatom, which is trying to sell as many nuclear reactors as possible worldwide. Criticism of nuclear technology at home may negatively affect Rosatom's export plans.

2016 wasn't very good in this regard with the decisions approved in Vietnam and South Africa. The Vietnamese government said it will not build two Russian reactors in the near future as was agreed earlier with Rosatom. The main reason was the availability of cheaper alternatives to nuclear power. South Africa said it will postpone its nuclear program to the late 2030s. The Russian and South African governments agreed to a large-scale nuclear program in 2014 which included 9.6 GW of new nuclear capacity to be built over a decade. Additionally, a uranium enrichment plant, a research reactor and production of some reactor components were under discussion.

Rosatom's so-called “portfolio” of new reactor orders,

worth of around US\$120 billion, has been a matter of pride for the state utility for a long time. However critics question how many binding vs. non-binding agreements were included under this number. There is no official estimate in this regard. According to an Ecodefense estimate, binding contracts in this portfolio account for up to 20%.

Radioactive wastes

Management of radioactive wastes was another important direction of activity for Rosatom in 2016. There is up to 500 million tons of wastes stored at various sites across Russia requiring the attention of the corporation. Several public hearings were conducted during the year, including in closed towns such as Ozyorsk and Novouralsk. Ozyorsk is infamous for its nuclear reprocessing facility “Mayak”, the site of the largest pre-Chernobyl nuclear accident with the explosion of a tank of high-level radwaste in 1957. Novouralsk is home to a uranium enrichment facility where the European company Urenco was exporting its toxic uranium tails in the 1990s and 2000s.

Closed towns are the legacy of the Soviet nuclear program, places behind barbed wire with military facilities inside. Organizing dumping sites for radioactive wastes in such places, Rosatom excludes the citizens of nearby towns and villages from the process of decision making. People from outside usually can't get inside those closed towns without special permission, which is almost impossible to obtain. By refusing the right to participate in public hearings for people from outside areas, Rosatom creates the ground for future social conflicts as local citizens are usually not willing to live next to a nuclear dump site.

Other important things that deserve to be mentioned include:

- The accidental dropping of a reactor vessel during transportation to the construction site of a nuclear plant in Ostrovets, Belarus. It's rumored that the vessel will be replaced, and the current one will be used somewhere else.
- An accident at a VVER-1200 reactor shortly after start-up. This is first unit of that type in operation, and Rosatom is keen to sell them worldwide.
- At the same Novovoronezh nuclear plant, 500 km south of Moscow, an old VVER-400 reactor was disconnected from the grid forever. Rosatom announced it will make it the example of good decommissioning and then go with this experience for the world market. There are two VVER reactors at this plant shut down and disconnected from the grid in 1984 and 1990. None of them have been decommissioned so far.

Concluding on 2016 events, propaganda by the nuclear industry in Russian media was similar to previous years – great worldwide expansion, radwaste management progressing, “constructive dialogue” with communities going well. The reality is however different. Old reactors are still not decommissioned, radwaste not isolated, safety of new reactors under question, worldwide expansion slowing down. And there is widespread repression against activists, almost allowing the nuclear industry to control criticism. There are even a few environmental groups helping Rosatom with “constructive dialogue” and earning various benefits for that help. No criticism – no problem.

But every house of cards will fall apart, sooner or later. With Russia descending into a deeper and deeper financial crisis, sooner more likely than later.

Sweden: Energy Commission files final report

Author: Charly Hultén – WISE Sweden

NM837.4619 The multiparty Energy Commission, whose members announced an overall agreement on Swedish energy policy in June 2016, published their final report on 9 January 2017 (SOU 2:2017 in the Government Official Reports series). The details of that announcement were reported in *Nuclear Monitor* #825. Neither the goals set out in June 2016 nor the internal inconsistencies between them have changed since then.

The present document includes critical comments from the three parliamentary parties that did not participate in the Commission. Otherwise, the few new developments are basically matters of emphasis. Energy efficiency is one such area. Alongside the goal of 100% reliance on electricity from renewable sources by 2040, the members of the Commission are agreed that: “Sweden shall have achieved a 50% in energy efficiency, relative to efficiency in 2005, by 2030.” Their measure of energy efficiency is the ratio of “energy supplied in relation to GNP”.*

The Swedish Energy Agency will soon open dialogues with the respective branches of industry to draft appropriate strategies and measures for each. Electricity-intensive industries will be given priority, as will measures

to reduce electricity use for heating of indoor space. (Cooling needs are relatively minor here in Scandinavia.) A budget to support research and development efforts to improve efficiency will be drawn up during 2017.

Nuclear energy

Since June 2016, the government has abolished the tax on nuclear reactor capacity. The June announcement spoke of a compensatory increase in the tax on electricity use of SEK 0.04. The figure is now a bit higher, SEK 0.042. Electricity-intensive industry, which enjoys a reduced tax rate today, will be exempted from the increase.

As noted back in June 2016, there is no longer an end-date for nuclear energy in Sweden. Existing reactors may be replaced (at current sites only) when their “economic lifetime” has expired, i.e., even after 2040. But, the Commission states, government support for new reactors “in the form of subsidies, direct or indirect, cannot be taken for granted.”

Prospective deficits in Sweden's Nuclear Waste Fund and the implications for waste management posed by both recently announced decommissioning of some

reactors and probable extension of production in others have been debated far longer than the Commission has been working. The report notes that the government has instructed the Radiation Safety Authority to review the schedule of payments in the light of changes in the length of time Swedish reactors may be expected to operate. The Authority proposes extending the expected lifetime of reactors by 25%, from 40 to 50 years – which, the report indicates, is acceptable to the ‘Red-Green’ Cabinet.

According to press sources, a revised schedule of payments will be announced “in early 2017”.

Dissenting views

Three parties stood outside the Commission: the Sweden Democrats (12.9% of the electorate in 2014), the Left Party (5.7%) and the Liberal Party (5.4%). All three submitted comments that were critical of the Commission’s proposals, and these were included as “reservations” in the Commission’s report.

The Left Party rejects all aspects that permit or encourage continued use of nuclear energy, particularly the repeal of the capacity tax, the presumed extended life expectancy of reactors, and the (albeit unlikely) prospect of ‘new build’. On the other hand, they applaud all the provisions that favor renewable energy sources. In addition, they propose two reforms that do not figure in the Commission’s report. First, that the grid be de-privatized and put wholly in the public sector. The prime reason given is that since new technology allows more and more users of electricity to also deliver electricity to the grid, commercial interests should not be allowed to guide distribution infrastructure or policy. Second, research to improve energy storage capacity should be a top priority.

The Liberals, along with the Sweden Democrats, champion continued use of nuclear power. Both are strongly critical of proposed and continued public subsidies to wind and solar power.

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The Liberals have no faith in the ability of intermittent and “weather-dependent” energy sources to reduce carbon emissions. They point out that whereas lifting the capacity tax on nuclear reactors makes it possible for owners to increase reactors’ capacity, “vigorous subsidization” will allow wind power to out-compete renovated nuclear energy. What is more, they argue, subsidization of renewables will depress the price of EU emission rights, thereby increasing the profitability of coal in the European market.

The Sweden Democrats reject, with one exception, all form of subsidies in the energy market; subsidies (not least the system of ‘green electricity certificates’) encourage “production for which there is no market demand”. They are what has caused the drop in power prices – termed an “energy market crisis” – which we currently experience. Therefore, instead of expanding the certificates, as the Commission proposes, the Sweden Democrats would rather abolish them.

The party follows a consistently market-liberal line of reasoning – until, that is, they turn to nuclear energy. Sweden’s nuclear reactors are, they say, the mainstay of Swedish competitive strength. They strongly object to the Commission’s agreement to (possibly) refrain from subsidizing replacement nuclear capacity, which in the Sweden Democrats’ vision would be so-called ‘fourth generation’ breeder reactors. But, in the next breath – with regard to hydroelectric capacity – they state: “If we are to achieve long-term sustainability in the electricity market, the lodestar for all actors, large and small, must be that all investments are based on economically rational decisions, where the ... price of electricity is decisive”.

Having the British government’s decision to go ahead with the Hinkley Point project – despite expected prices that are triple current rates to consumers – freshly in mind, I, for one, find it hard to reconcile this lofty principle with ‘fourth-generation nuclear power’.

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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