

Fukushima Impact

Accelerating the Nuclear Industry's Decline

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"The gap between nuclear rhetoric and nuclear reality has been a fundamental impediment to wise energy policy decisions for half a century now." ~ Peter A. Bradford, Former United States NRC Commissioner²

On 11 March 2015, the people of Japan will mark a tragic and somber anniversary. It will be the 4th year since the Great East Japan Earthquake and tsunami claimed tens of thousands of lives and triggered the beginning of the worst nuclear disaster in a generation: the triple reactor core meltdowns and destroyed containment buildings at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi nuclear power plant.

In addition to the devastating environmental and human costs of this human-made³ nuclear disaster, the ongoing catastrophe also radically reshaped the energy landscape in Japan and will continue to impact the nuclear industry globally.

Perhaps there is no more poetic an indicator of the shift away from nuclear than the Fukushima Prefectural government stating in December 2012 that its first objective to revitalize the disaster-ravaged prefecture was, "building a safe, secure, and sustainable society free from nuclear power."⁴ In 2014, the prefectural government followed through on that goal with a committed to a 100% renewable energy target by 2040.⁵

In Japan, all forty-eight nuclear reactors (discounting Fukushima Daiichi) are in what is considered Long Term Outage.⁶ And on 11 March 2015, Japan will be just shy of a year and a half since it has been completely nuclear free, with the last remaining reactor powered down on 15 September 2013.

The significance, both domestically and globally, of the third largest nuclear power program in the world not generating any electricity from its nuclear reactors for nearly 18 months is more than symbolic. It unequivocally demonstrates that nuclear energy, contrary to government and power company claims, is not an indispensable energy source.

The reality in Japan is mirrored globally, the disaster accelerating the decades long decline of an already outdated and noncompetitive technology.⁷

However, the powerful vested interests in government, utilities, and industry – the infamous 'nuclear village' that created the conditions that led to the March 2011 Fukushima accident – are determined to resume nuclear reactor operations in Japan.

Globally, the nuclear industry and its advocacy organizations continue to present nuclear power as a re-emerging technology that can address the biggest problems facing humanity. Or, as the industry promotional body⁸, the International Atomic Energy Agency (IAEA), states on its site, "Over the past several years, there has

¹ "World Nuclear Industry Status Report 2013", Mycle Schneider and Antony Froggatt et al, London, Paris. July 2013
<http://www.worldnuclearreport.org/-2013-.html>

² Adjunct Professor, Vermont Law School, teaching "Nuclear Power and Public Policy", former Commissioner U.S. Nuclear Regulatory Commission (NRC), former chair of the New York and Maine Utility Regulatory Commissions.

³ "Lessons From Fukushima." Greenpeace International. March 2012. <http://www.greenpeace.org/international/en/publications/Campaign-reports/Nuclear-reports/Lessons-from-Fukushima/>

⁴ *Plan for Revitalization of Fukushima Prefecture (2nd Version)*.
http://www.pref.fukushima.lg.jp/download/1/plan_for_revitalization2_outline.pdf

⁵ "Fukushima Pledges To Go 100% Renewable." 6 February 2014. Ari Phillips. <http://cleantechnica.com/2014/02/06/fukushima-100-renewable-energy/>

⁶ "World Nuclear Industry Status Report 2014", Mycle Schneider and Antony Froggatt et al, London, Paris, Washington DC, July 29th 2014,
<http://www.worldnuclearreport.org/WNISR2014.html>

⁷ Ibid

⁸ "Statute of the IAEA. Articles II and III." International Atomic Energy Agency. <https://www.iaea.org/about/statute>

been a resurgence of interest in nuclear power, both from countries with established nuclear power programmes and countries that are interested in beginning a programme.”⁹

While this may sound quite positive for nuclear power, the reality is far more negative for the nuclear industry. This brief will provide a candid overview of impact of the Fukushima disaster on the nuclear industry, both within Japan and globally.

Fukushima Disaster: Impacts in Japan

The catastrophic nuclear accident at the Fukushima Daiichi nuclear power plant, which began on 11 March 2011, not only crippled four of the reactors at the site, but also vividly and tragically illustrated the vulnerabilities of Japan’s nuclear power dependency. Heightened awareness of nuclear risks and the problems associated with the nation’s reactors led to the long-term shut down of all fifty¹⁰ of Japan’s remaining nuclear reactors.

A massive economic burden has been placed on the Japanese government – and ultimately taxpayers – to pay the enormous costs for Fukushima disaster: in Japan’s budget note for 2014, 652.3 billion JPY (\$6.725 billion USD per March 2014 conversion rates) was listed as the cost solely for reconstruction after the nuclear disaster.¹¹ The true cost of the disaster has yet to be calculated, and there are a number of estimates – one of the most accurate estimates of the economic cost of Fukushima disaster at the moment is \$169 Billion US Dollars, as of February 2013.¹²

The rapid decline of nuclear power in Japan in the wake of the disaster is clear: between 1987 and 2011, nuclear accounted for roughly 30% of Japan’s electricity generation.¹³ On 5 May 2012, Japan’s last operating nuclear power plants post-Fukushima were shut down. Only two reactors, Ohi 3 & 4, were ever restarted. Both were subsequently shut down for scheduled maintenance and restart was halted by a court injunction.¹⁴ The utility, Kansai Electric Power Company (KEPCO), is appealing the verdict, and the NRA has proceeded with processing the application – in spite of the injunction against restart that is still enforce.

From January until September 2013 – when Ohi 4 was shutdown – nuclear accounted for only 13.6 TWh or 1.6 percent of total electricity. This meager contribution continuing the accelerating downward trend of the Japanese nuclear industry, when taken in the context of a historic maximum of 36 percent in 1998, followed by

⁹ International Atomic Energy Agency. <https://www.iaea.org/newscenter/focus/nuclear-power>

¹⁰ While the number of remaining reactors in the Japanese nuclear fleet after the Fukushima Daiichi nuclear catastrophe is frequently stated to be 48, there were also two reactors at the Fukushima Daiichi site – reactors 5 and 6 – that were not declared to be permanently shut down until almost three years after the disaster. TEPCO delayed in making the inevitable shutdown decision until 18 December 2013, and only publicly announced these two reactors’ permanent shut down and decommissioning plans on 31 January 2014. Amazingly enough, the four units at Fukushima Daini, inside the exclusion zone, 15 km from the devastated Fukushima Daiichi, remain officially “in operation”. After the Daiichi-5 and -6 closures, there are in fact now 48 remaining reactors that are all currently in Long-term Outage. Note: the 48 reactor figure is highly conservative, in that it includes the Daiini reactors which can be considered, for all practical purposes, to be shut down – though they have not yet been officially declared so. An additional reactor, the Monju reactor, which has been off-line since 1995 but also never officially closed.

For further information see, http://www.tepco.co.jp/en/announcements/2014/1233973_5932.html

¹¹ “Highlights of the Budget for FY2014. Outline of Special Account for Reconstruction from the Great East Japan Earthquake (FY2014).” p.10 <http://www.mof.go.jp/english/budget/budget/fy2014/01.pdf>

¹² “Fukushima Fallout.” Greenpeace International. March 2013.

<http://www.greenpeace.org/international/Global/international/publications/nuclear/2013/FukushimaFallout.pdf>

¹³ “Japan Nuclear Backgrounder Paper.” Center for Strategic and International Studies. 20 November 2014. http://csis.org/files/publication/140912_CSIS_Japan_Background_Paper.pdf p.3

¹⁴ On 21 May 2014, a district court judge found in favor of community members seeking an injunction against the restart of the Ohi 3&4 reactors due to the unacceptable risk posed by the reactors to the lives and livelihoods of surrounding community members. The legal challenge contended that Kyushu Electric not only underestimated both the seismic and volcano risk, but has also failed to develop an effective evacuation plan for the regions citizens. The judge’s opinion stated that, “It is appropriate that, if involved in a business whereby severe damage would be caused to the lives, health, and livelihood of many people should a serious accident occur, an organization should be expected to provide safety and a high degree of reliability in accordance with the size and extent of that damage . . . interests relating to the life, body, soul, and lifestyle of an Individual are fundamental to the individuality of each person, and the entirety of these can be considered to be personal rights. Personal rights are enshrined in the Constitution (Articles 13 and 25), are the foundation for people’s lives, and under the laws of our country there are no rights that have greater value. Accordingly, when there is a risk of a tangible violation of a fundamental aspect of these personal rights, namely the personal right to protect life and maintain one’s lifestyle, a claim can be made for an injunction against violating acts on the basis of these personal rights. Personal rights belong to each individual, but when the form of the violation has the characteristics of simultaneously violating the personal rights of many people, it stands to reason that the claim for an injunction there against is strong.” [Note: opinion translated for Greenpeace].

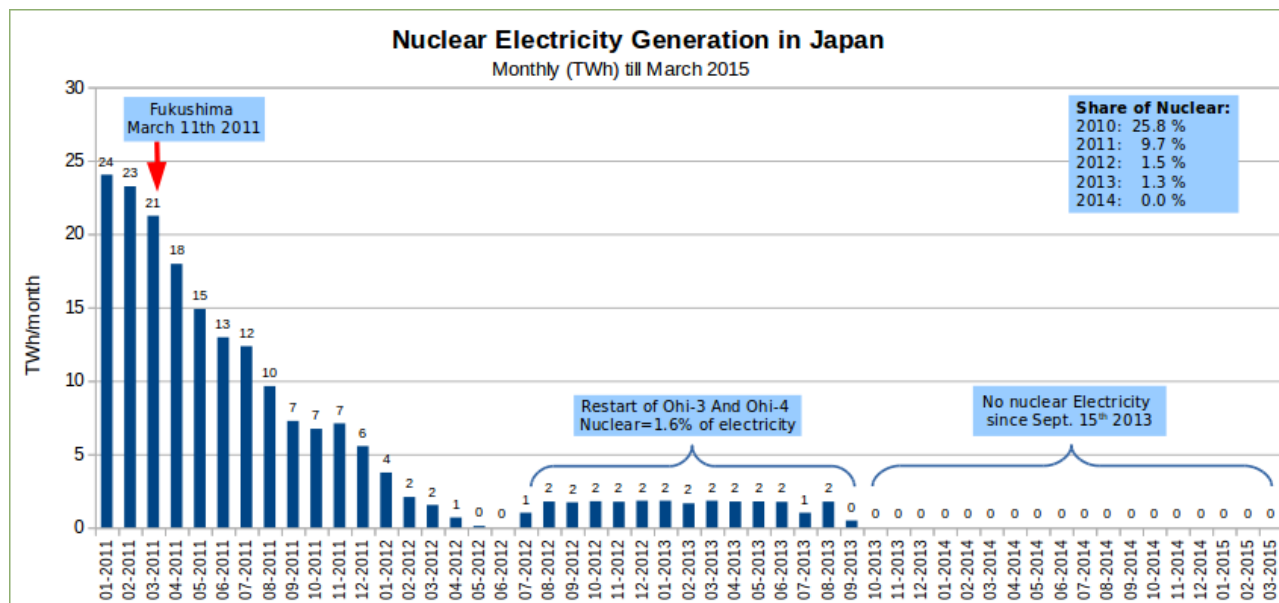
See: *Outline of Judgment on Claim for Injunction on Operation of No. 3 and No. 4 Units at Ohi Nuclear Power Plant Fukui District Court*, May 21 2014.

<http://www.greenpeace.org/international/Global/international/briefings/nuclear/2014/Ohi-ruling-translation.pdf>

See also: *Kansai Electric’s Ohi Nuclear Reactors Restart Barred by Court*. Jacob Adleman and Emi Urabe. 21 May 2014.

<http://www.bloomberg.com/news/articles/2014-05-21/kansai-electric-s-ohi-nuclear-reactors-restart-barred-by-court>

25.8 percent in 2010.¹⁵ For the whole of 2011, nuclear only accounted for 9.7 percent. In 2012, nuclear's share further declined to 1.5 percent, followed by 1.3 percent in 2013.¹⁶ On 15 September 2013, the last reactor operating was shut down. As of 11 March 2015, Japan will have been nearly a year and a half without a single kWh generated by nuclear – and with no blackouts or brownouts¹⁷ as a result.



Data from International Energy Agency¹⁸

The disaster also galvanized majority public opposition to nuclear energy, as the public turned out in record numbers to oppose nuclear power in the ensuing years.¹⁹ Four years after the beginning of the Fukushima disaster, the majority of the public is still opposed to nuclear restarts.²⁰ Given the successive failures to meet declared targets for nuclear restarts²¹ and significant delays, the future of nuclear power in Japan is increasingly uncertain. It certainly cannot be described as a necessary, reliable, and stable energy source as the Abe government has been trying to claim.

Aging Reactors: Legally dead?

In September 2014, the Abe administration asked utilities to decide whether or not to permanently decommission their oldest reactors. Nuclear power utilities will confirm before the end of March 2015 that they

¹⁵ "Japan: Electricity and Heat for 2010". International Energy Agency. <http://www.iea.org/statistics/statisticssearch/report/?country=JAPAN&product=electricityandheat&year=2010>

¹⁶ "Monthly Electricity Statistics", International Energy Agency (IEA), February 2014, <http://www.iea.org/stats/surveys/mes.PDF>, accessed 7 June 2014.

¹⁷ A drop in voltage of a power supply – this can be intentional or unintentional. Intentional brownouts are emergency measures to reduce grid load in an effort to prevent a blackout.

¹⁸ "Japan: Electricity and Heat for 2010." International Energy Agency. <http://www.iea.org/statistics/statisticssearch/report/?country=JAPAN&product=electricityandheat&year=2010>
 "Japan: Electricity and Heat for 2011." International Energy Agency. <http://www.iea.org/statistics/statisticssearch/report/?country=JAPAN&product=electricityandheat&year=2011>
 "Japan: Electricity and Heat for 2012." International Energy Agency. <http://www.iea.org/statistics/statisticssearch/report/?country=JAPAN&product=electricityandheat&year=2012>
 International Energy Agency (IEA), "Monthly Electricity Statistics", February 2014, (includes 2013 statistics). <http://www.iea.org/stats/surveys/mes.PDF>, accessed 7 June 2014.

¹⁹ "Tens of thousands demonstrate against nuclear power in Japan." Junko Ogura and Jethro Mullen, CNN. 16 July 2012. <http://edition.cnn.com/2012/07/16/world/asia/japan-nuclear-protest/>
 See: Thousands protest in Japan on eve of Fukushima nuclear disaster anniversary. DW. <http://www.dw.de/thousands-protest-in-japan-on-eve-of-fukushima-nuclear-disaster-anniversary/a-16661934>
 See: Thousands in Japan protest nuclear power, conditions at Fukushima. Al Jazeera America. 15 March 2014. <http://america.aljazeera.com/articles/2014/3/15/japan-protesterssaynotonuclearpower.html>
 See: Japanese protesters rally against gov't move to restart plant. Terrence Terashima. CCTV. 31 August 2014. <http://english.cntv.cn/2014/08/31/VIDE1409450883639740.shtml>

²⁰ "Japan's nuclear restart meets public fears." John Boyd. 3 February 2015. Al Jazeera. <http://www.aljazeera.com/indepth/features/2015/01/japan-nuclear-restart-meets-public-fears-150129105332893.html>

²¹ The 414th Forum on Research Work. "Economic and Energy Outlook of Japan for FY2014 Japan is reaching a crucial moment." YANAGISAWA Akira, T. Yoshioka, H. Suzuki, Choi J. W., R. Ikari, S. Iwata, Y. Shibata, K. Ito. 20 December 2013. The Energy Data and Modelling Center The Institute of Energy Economics, Japan http://eneken.ieee.or.jp/en/press/press_131220.pdf

will permanently close 5 reactors.²² However, many more are vulnerable to permanent closure, with 7 additional reactors nearing 40 years old.

Kansai Electric Power Co. (KEPCO) is particularly challenged with aging reactors; though it has announced plans to seek restart review for 9 of its reactors: Mihama (39 years), Ohi 1 (38 years), Ohi 2 (37 years), Takahama 1 (41 years), and Takahama 2 (40 years), as well as the Takahama units 3 and 4, which are already under review. These will face major challenges technically and politically. It remains highly uncertain how many of these will ever actually be restarted.²³ By the end of 2015, four of KEPCO's reactors will be 40 years old. Another three will be at least 35 years old. While the utility may have ambitious restart plans, it is far from certain that this will be achievable.

Indicative of the future of Japan's nuclear fleet, the Japan Atomic Power Co. – a wholly nuclear utility and the only one to have experience operating both Boiling Water Reactors (BWRs) and Pressurized Water Reactors (PWRs) – announced it is considering a major restructuring. In a bid to save its failing business, it is weighing whether to unload nuclear operating functions into two smaller companies, and focus its primary business on helping other utilities decommission their reactors.²⁴

The decision to decommission the nation's oldest reactors would reflect the aging of the reactor fleet in Japan, but is also driven at this moment by both politics and economics. The Abe administration is desperate to soften or even reverse the majority public opinion that remains opposed to any nuclear restart.²⁵ The government is clearly hoping this strategy will provide the appearance that it is committed to nuclear safety and also that it is listening to public opinion.

In reality, it is an appeasement move of sacrificing reactors that were all but legally dead. For the utilities, shutting these reactors down permanently will allow them to avoid the costly investments that would be required to attempt to retrofit these old reactors to meet post-Fukushima guidelines – guidelines that still do not guarantee safety.²⁶ Conversely, this will also trigger further financial pain for the utilities both in terms of lost revenue from future operation and electricity sales, as well as the enormous cost of decommissioning. The decision, if implemented, reflects both the strength of public opinion and the continuing uncertainty in future reactor operations in Japan.

Potential Nuclear Restarts

A total of 21 nuclear reactors are currently under review by the Nuclear Regulatory Authority (NRA) for compliance with the post-Fukushima disaster guidelines. Kyusyu Electric Power Company's Sendai units 1 and 2 reactors in Kagoshima prefecture are the farthest along in the NRA's review process, though restart is still pending final safety reviews and checks.²⁷ Though the restart progression of these two reactors in the review process has been touted as the first to meet new, strict safety guidelines, it in fact has required the NRA to accept restart in spite of noncompliance with their own and international nuclear safety standards.²⁸

The Sendai restarts were originally predicted for summer 2014, then before the end of March 2015, but Kyushu Electric recently announced that it may be into the summer before either reactor restarts.²⁹ While the Takahama

²² "Japan utilities likely to decommission five ageing reactors." Nikkei. 25 December 2014. Reuters. <http://in.reuters.com/article/2014/12/25/japan-nuclear-idINL3N0U904120141225>, The reactors are the Nos. 1 and 2 reactors at KEPCO's Mihama nuclear power plant in Fukui Prefecture; the No. 1 reactor at Japan Atomic Power's Tsuruga plant, also in Fukui; the No. 1 reactor at Chugoku Electric's Shimane plant in Shimane Prefecture and the No. 1 reactor at Kyushu Electric's Genkai plant in Saga Prefecture. - See more at: <http://www.straitstimes.com/news/asia/east-asia/story/japan-retire-5-nuclear-reactors-first-such-move-2011-fukushima-crisis-repo#sthash.6hEeaaYw.dpuf>

²³ "Kansai Electric to apply shortly to restart three more reactors," Asahi Shimbun, 3 February 2015, http://ajw.asahi.com/article/behind_news/social_affairs/AJ201502030042

²⁴ "Japan Atomic Power, reeling from nuke shutdown, eyes major restructuring." 28 January 2015. <http://www.japantimes.co.jp/news/2015/01/28/business/corporate-business/japan-atomic-power-reeling-from-nuke-shutdown-eyes-major-restructuring/#.VNGFGHZcLKB>

²⁵ "After the Fukushima meltdown, Japan's nuclear restart is stalled." Daniel Aldrich and James Platte. Washington Post. 15 August 2014. <http://www.washingtonpost.com/blogs/monkey-cage/wp/2014/08/15/after-the-fukushima-meltdown-japans-nuclear-restart-is-stalled/>

²⁶ "News Navigator: How are nuclear plants determined to be safe?" Mainichi. 19 July 2014. <http://mainichi.jp/english/english/perspectives/news/20140719p2a00m0na006000c.html>

²⁷ "Local consents for Sendai restart." World Nuclear Association. 7 November 2014. <http://www.world-nuclear-news.org/RS-Local-consents-for-Sendai-restart-0711144.html>

²⁸ "The Application and Conformity of the Japanese Nuclear Regulatory Authority's New Safety Standards for Nuclear Power Plants." John H. Large. Large & Associates. 28 January 2015. <http://www.greenpeace.de/sites/www.greenpeace.de/files/publications/r3229-e1-john-large-atomkraft-japan-20150128.pdf>

²⁹ "Japan nuclear restart may be delayed until summer." Kyodo News. 5 February 2015. <http://english.kyodonews.jp/news/2015/02/335131.html>

reactors 3 and 4 are the next in line for potential NRA approval, their restart is now projected to be the last half of 2015.

It is also critically important to understand that even purported compliance with the NRA guidelines and future restart approvals do not mean that the Sendai nuclear reactors or others under review have been assessed for overall nuclear safety. The NRA chair has admitted that, ***"We cannot say that a disaster will never happen. The regulations cannot guarantee safety."***³⁰ The approval by the NRA confirms that it believes that the plant matches the updated standards but they admit that ***"the plant's safety has improved to a certain extent, but this is not the goal."***³¹ [Bold and Italics added]

The timeframe for restart of nuclear plants, the total number that will be restarted, and the number that will be permanently shutdown is impossible to state precisely at this stage. There are multiple variables, in addition to the on-going NRA review process, such as the legal challenges that have been brought or are currently underway against all 48 officially still operating nuclear reactors in Japan. Given the glacially slow restarts, it is safe to assume that the majority of Japan's nuclear fleet will remain offline for the remainder of 2015.

Abe's flawed energy policy

In April 2014, a new energy plan was approved by the Abe Government. It reversed the previous government's position, announced in September 2012, which called for a zero nuclear power future by the 2030s.³² This new Fourth Strategic Energy Plan is the first formal energy policy issued since the Fukushima Daiichi accident. It describes nuclear power as "low-carbon and quasi-domestic energy" and a "base-load" power source that should be used for continuous, around-the-clock power generation.³³ The April plan set no targets for nuclear generation.³⁴

A panel of experts set up under the Ministry of Economy, Trade and Industry (METI) recently began deliberating on setting 2030 targets for energy generation; 15 or 20% for nuclear have been suggested thus far. While even these targets are likely wishful thinking, they are also a far cry from the 50% nuclear generation by 2030 that the previous energy plan of 2010 had called for.³⁵ It also, however, reflects the reality that the Government simply does not know which, how many, or when any of the currently shutdown reactors will be restarted.

The reality is that every nuclear power plant in Japan has major outstanding safety issues, and the citizens of Japan do not trust the assurances of the government or utilities' claims that these can be operated without risk of severe accident.

The economic failure of nuclear power

In justifying its support for the restart of the nation's shutdown nuclear reactors, in spite of the majority public opposition post-Fukushima disaster, the government has emphasized the nation's growing fiscal trade deficit caused in part by the importation of replacement fossil fuel.³⁶ While the trade deficit has grown since 2011, recent export increases and lower oil prices leave financial analysts predicting that Japan will return to a trade surplus in 2015.³⁷ However, clearly an energy system based on such large imports of fossil fuels neither makes sense for the economy or the environment – and Abe's reliance on nuclear power restarts will not solve the underlying energy policy crisis.

³⁰ Mainichi, op. cit.

³¹ "More needed than NRA safety nod." The Japan Times. 18 July 2014. <http://www.japantimes.co.jp/opinion/2014/07/18/editorials/more-needed-than-nra-safety-nod/#.U9uZHSiaGdw>

³² "Innovative Strategy for Energy and the Environment", The Energy and Environment Council, Government of Japan, 14 September 2012.

³³ "Strategic Energy Plan", METI. April 2014, http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf; and also, Makoto Yagi, "Cabinet Approval of the New Basic Energy Plan", Federation of Electric Power Companies (FEPCO), 11 April 2014, see http://www.fepec.or.jp/english/news/message/_icsFiles/afieldfile/2014/04/15/press_e_20140411.pdf

³⁴ "Government to set ratio for nuclear power", NHK, 11 April 2014, http://www3.nhk.or.jp/nhkworld/english/news/20140411_47.html

³⁵ "Japan looks at 2030 energy targets in shadow of Fukushima cleanup." Reuters. 30 January 2015. <http://www.reuters.com/article/2015/01/30/us-japan-nuclear-idUSKBN0L314M20150130>

³⁶ "Japan logs record trade deficit of 13.75 tril. yen in FY 2013" Nikkei Asian Review, 21 May 2014. See <http://asia.nikkei.com/Politics-Economy/Economy/Japan-logs-record-trade-deficit-of-13.75-tril.-yen-in-FY-2013>. The fossil fuel share of US\$35 billion, or 25% of the total deficit, should be seen in the context of deliberate government policy on of the pillars of 'Abeconomics' with the devaluation of the yen aimed at boosting exports, but which also has the effect of increasing the cost of imports.

³⁷ "Japan exports rise more than forecast, paring record deficit." The Business Times: Government and Economy. 26 January 2015. <http://www.businesstimes.com.sg/government-economy/japan-exports-rise-more-than-forecast-paring-record-deficit>

In the first instance, Abe's policy of yen depreciation has raised the costs of all imports, including fossil fuels. Analysis has pointed to the decline of Japan's nuclear utilities pre-dating the Fukushima Daiichi accident, in particular relative to gas companies.³⁸ By failing to develop major renewable technology, while prioritizing nuclear power, successive Japanese governments have developed an energy system heavily dependent on fuel importation – and highly vulnerable in the event of a major nuclear accident.

Recent decisions by Japan's METI, which allow utilities to block renewable energy access to the grid, only further exacerbate the fragility of Japan's energy system and dependency on fossil fuels.³⁹ The new rule effectively caps the growth of renewable energy by providing priority grid access to the fossil fuels and nuclear energy sources that triggered the current trade deficits and undermine progress on CO₂ emissions reductions.

The Global Impacts of the Fukushima Disaster

It is critically important to note that for decades prior to the Fukushima Daiichi accident in March 2011, the global nuclear industry was in decline. While in Japan the nuclear disaster sparked an abrupt shift away from nuclear power, globally it merely accelerated the downward trend.

Pre-Fukushima: an industry in decline

Since the inception of civil nuclear programs in the 1950s, there have been two major “waves” of nuclear reactor grid connections: the first peaked in 1974, and the second wave in the 1984-85 period.⁴⁰ By the end of the 1980s, successive net increases in operating nuclear reactors had ended.⁴¹ The year 1990 marked the first time since the beginning of the commercial nuclear power industry that nuclear reactor shut downs exceeded startups.⁴² In the decade of 1991 – 2000, reactor shut downs far outweighed reactor start ups, 52:30.⁴³ Between 2001 and 2010, as many reactors were shut down as were started up, 32:32. Between 2004 and 2007, the capacity of the global nuclear fleet dropped by 2 GW annually.⁴⁴ In 2008 and 2009, capacity gains from “uprating” – retrofitting old reactors in order to generate more electricity – were offset by plant closures, resulting in a net decline in global nuclear capacity.⁴⁵

In 2009 nuclear generation fell for the third year in a row – generating 4% less energy than in 2006.⁴⁶ In 2010, 5.5 GW were added due, in part, to uprating.⁴⁷

While construction slowed to a trickle and net reactor shutdowns have outweighed net reactor startups since 1990, the supposed “nuclear renaissance” appeared to be dead on arrival – in spite of massive government support via loan guarantees, as well as other direct and indirect subsidies in many countries. In June 2009, nearly two years prior to the Fukushima disaster, Moody's Investor Service summarized the risk associated with the nuclear construction plans in the nation with the largest nuclear fleet, the United States:

It has now been three decades since the last, serious nuclear construction cycle . . . Historical rating actions have been unfavorable for issuers seeking to build new nuclear generation. Of 48 issuers that we evaluated during the last nuclear building cycle (roughly 1965-1995), two received rating upgrades, six went unchanged, and 40 had downgrades. Moreover, the average downgraded issuer fell four notches . . . We view new nuclear generation plans as a “bet the farm” endeavor for most companies, due to the size of the investment and length of time needed to build a nuclear power facility . . . We observe, however, that nuclear projects require massive investments, and the long-term recovery of which presents a primary risk factor for issuers actively trying to build new nuclear power plants. Historically, in fact, many of the large nuclear utilities experienced some financial distress while building their plants. Material rating downgrades remain just as distinct a possibility today . . . New nuclear power construction appears to enjoy strong political and regulatory support in a number of jurisdictions, especially in the southeastern [United] [S]tates, where there is now legislation afoot to promote it . . . Nevertheless, regulatory

³⁸ “Japan Prime Energy Sources.” Eurotechnology. <http://www.eurotechnology.com/japan-energy/japan-primary-energy/>

³⁹ “Japanese Utilities Hinder Clean Energy.” Greenpeace Japan. January 2015.

http://www.greenpeace.de/sites/www.greenpeace.de/files/publications/final_engrid_report_jan2015.pdf

⁴⁰ “World Nuclear Industry Status Report 2010-2011”, Mycle Schneider and Antony Froggatt et al. London, Paris. April 2011.

<http://www.worldnuclearreport.org/-2010-2011-.html> pg. 11

⁴¹ *Ibid*

⁴² *Ibid*

⁴³ Schneider, et al., *op. cit.*, 2014, p. 15-16.

⁴⁴ Schneider, et al., *op. cit.*, 2010-11, pg.13.

⁴⁵ *Ibid*

⁴⁶ *Ibid*

⁴⁷ *Ibid.*

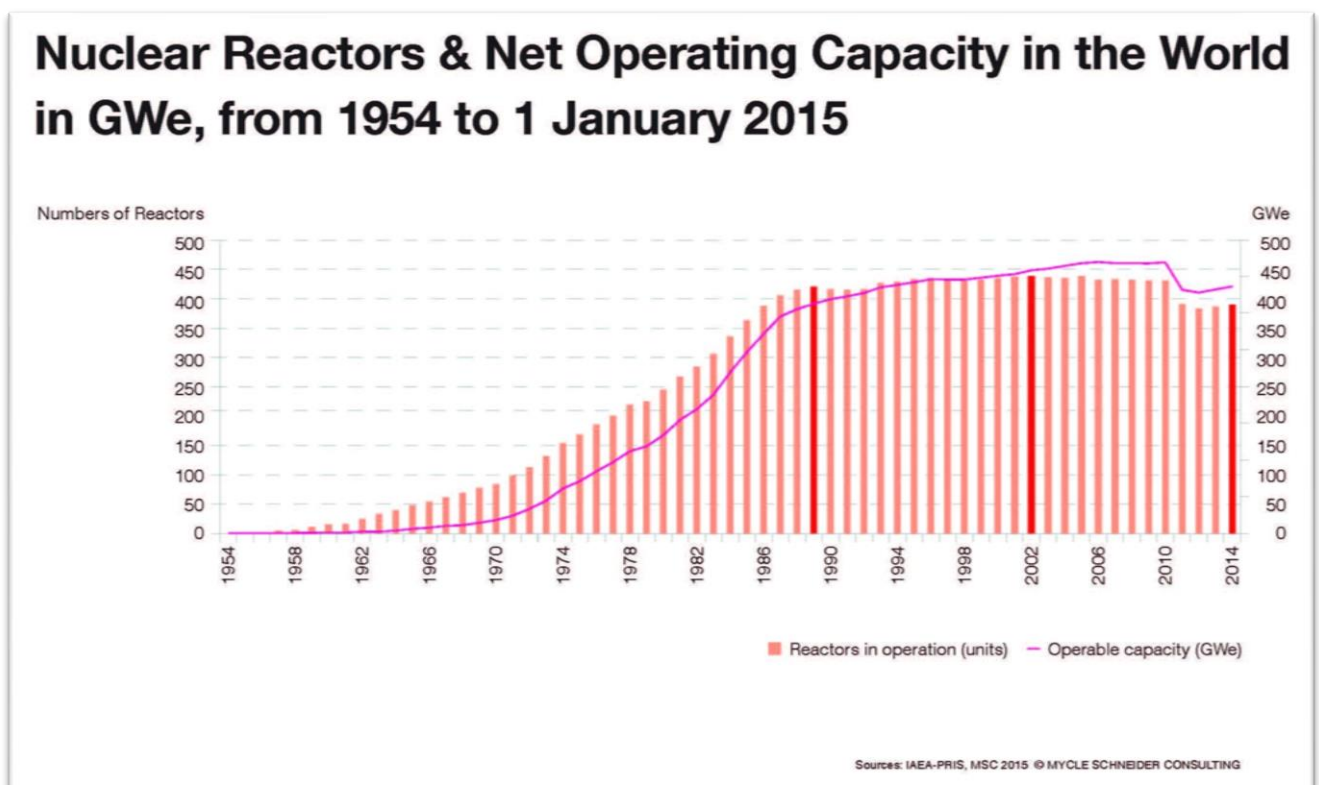
risks will persist over the longer term, and we increasingly think it unlikely that everything will work out as intended. We are concerned with the size of the investments being made even before the NRC [Nuclear Regulatory Commission] grants a COL [Construction and Operating License]; the ongoing potential risks from displacement technology developments over the course of the construction period; and the recovery of sizeable sunk costs, should an issuer abandon a project in the future. The likelihood that Moody's will take a more negative rating position for most issuers actively seeking to build new nuclear generation is increasing.⁴⁸

Fitch Ratings expressed similar sentiments even earlier, in 2006; analysis echoed by Standard and Poor's, which in 2008 declared that for new nuclear construction "risks remain uncertain, but significant."⁴⁹ Citigroup Global Markets also expressed similar negative views on risky investments for new nuclear in 2008.⁵⁰

Post-Fukushima

Although the nuclear industry was already declining for years prior to the Fukushima disaster, and investors were already viewing new-build plans as risky, the impact of the 2011 disaster on the global industry was significant with the full scale likely to only become apparent in the years ahead.

In the wake of the Fukushima disaster, the global downward trend for nuclear generation accelerated. In 2011 there was a record drop, with a 4% decrease in nuclear generation. In 2012, this was further compounded with a second record drop of 7%.⁵¹ While 75% of this decrease was due to the majority of the Japanese nuclear fleet being offline, 16 other countries, including the top 5 nuclear generators, saw decreases in their nuclear generation.⁵²



Many countries also chose to either phase out existing nuclear power or rejected previous plans to resurrect civil nuclear programs. In 2011, Germany took a major step forward in the already ongoing energy transition by shutting down eight reactors – 7 of its oldest, and Krummel – and announcing a complete nuclear phase-out by 2022. Switzerland and Belgium also announced nuclear phase-out plans.⁵³ Sweden followed suit in 2014, with

⁴⁸ *Special Comment: New Nuclear Generation: Ratings Pressure Increasing*. Moody's Global Infrastructure Finance. June 2009.

⁴⁹ *Greenpeace Climate Vision*. 27 May 2008. <http://www.greenpeace.org/international/Global/international/planet-2/report/2009/11/nuclear-power-an-obstacle-to.pdf>

⁵⁰ *Ibid*

⁵¹ Schneider, et al., *op. cit.*, 2013.

⁵² *Ibid*

⁵³ "World Nuclear Industry Status Report 2012", Mycle Schneider and Antony Froggatt et al. London, Paris. pg. 4 <http://www.worldnuclearreport.org/-2012-.html>

a decision to set up an energy commission to phase out nuclear and achieve a 100% renewable energy target.⁵⁴ In the wake of the decision, Sweden's State-owned utility, Vattenfall, and the federal nuclear regulator, SSM, halted all preparations for new nuclear construction.⁵⁵

New Build

Four countries that had considered reviving nuclear programs, scrapped them as of June 2012, including: Italy, Egypt,⁵⁶ Kuwait, and Thailand.⁵⁷

Many predicted newcomer nations have had their plans impacted by the Fukushima accident – delayed, if not still on hold – including: Bangladesh, Belarus, Jordan, Turkey, Lithuania, Poland, Saudi Arabia, and Vietnam.⁵⁸

For nearly two years after the Fukushima disaster began, China froze all nuclear construction. Although it currently has the largest number of reactors listed as under construction, the freeze seems to have reigned in some of China's ambition: reports of the 2020 target for nuclear have ranged from 40 GW to 120 GW;⁵⁹ it now seems highly unlikely that the low end target of 40 GW will be exceeded by any significant amount by 2020.⁶⁰

Poland is still purportedly moving forward with their 2005 decision to pursue the nuclear option. In 2009, the country created a plan to have operating reactors by 2020; the plans were subsequently updated twice (2011 and 2013), and have "slipped" at least 3 years.⁶¹

In early 2014, the Prime Minister of Vietnam, Nguyen Tan Dung, announced that the country would delay construction of its first nuclear reactor to 2020 to ensure "safety and efficiency."⁶²

As of June 2014, the World Nuclear Association listed eight potential newcomer countries that had begun construction, signed contracts, or committed to nuclear programs.⁶³ Some of these have had plans for new build for decades without them ever being realised.

Retrofitting the World's Aging Reactor Fleet

The impact of post-Fukushima disaster retrofits for older reactors, and the ensuing costs associated with those retrofits, vary greatly from country to country. In some countries, such as France and Japan, these retrofits will significantly impact the competitiveness of the nuclear fleet.⁶⁴ France's Court of Account's estimated in 2012 that safety upgrades for France's 58 reactors could reach a total of €55 billion, of which an estimated €10 billion was required for post-Fukushima disaster retrofits.⁶⁵ This €55 billion figure is almost certainly a significant

⁵⁴ "Sweden faces future without nuclear." World Nuclear Association. <http://www.world-nuclear-news.org/np-sweden-faces-future-without-nuclear-01101401.html>

⁵⁵ "Vattenfall halts new nuclear plans as Sweden shifts to RE." Recharge News. Bernd Radowitz. 26 January 2015. <http://www.rechargenews.com/wind/1389639/vattenfall-halts-new-nuclear-plans-as-sweden-shifts-to-re>

⁵⁶ Under new governance, Egypt has signed a memorandum of understanding (MOU) with the Russian State nuclear corporation, Rosatom. The MOU provides for the potential building of two reactors, with potentially an additional two, and a desalination facility. They have not yet signed agreements on financing or construction, though Egypt has expressed a desire to rush this project. "Egypt and Russia agree to build nuclear reactors." World Nuclear Association. 10 February 2015. <http://www.world-nuclear-news.org/NP-Egypt-and-Russia-agree-to-build-nuclear-reactors-10021501.html>

⁵⁷ Schneider, et al., *op. cit.*, 2012.

⁵⁸ By July 2013, all newcomer countries listed had delayed nuclear programmes. Subsequently, Bangladesh, Belarus, Turkey, Jordan, and Poland are purportedly moving forward with new build plans. Of these, Bangladesh, Belarus, Turkey, and likely Jordan are dependent upon funding and infrastructure provided by Russia's state nuclear corporation, Rosatom. Although Rosatom has an extremely aggressive nuclear export strategy, analysts have questioned whether even this state-backed corporation can financially support it. In addition to potential financial constraints – and even excluding potential political, legal, and/or public opposition barriers in each of these countries, Rosatom's own track record of overpromising and under delivering certainly raises questions as to which and how many of these programs would be able to move forward, at least in the framework in which they are now pursued. For more information on Rosatom, see Suppliers section of this briefing (pgs. 10-12).

See also: "Rosatom Risks: the Risks of Nuclear Politics." Greenpeace International. October 2014. pg. 25 -26. http://www.greenpeace.org/hungary/PageFiles/636986/rosatom_risks.pdf

For more information regarding the status of newcomer countries, see: Schneider, *op. cit.* 2013 and 2014.

⁵⁹ Schneider, et al., *op. cit.*, 2014, pg. 25.

⁶⁰ *Ibid*

⁶¹ "Nuclear Power in Poland." World Nuclear Association. 'Plans for nuclear capacity.' <http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Poland/>

⁶² "Significant Further Delay for Vietnam's Nuclear Plans [Updated]." World Nuclear Industry Status Report. 17 January 2014. Updated 1 February 2014. <http://www.worldnuclearreport.org/Significant-Further-Delay-for.html>

⁶³ Schneider, et al., *op. cit.*, 2014, pg. 8.

⁶⁴ *Ibid*, p. 25

⁶⁵ *Ibid*, p. 39

underestimate of the total cost to the French utility EDF, which could, in reality, range from €2-4 billion per reactor depending on the targeted safety level.⁶⁶

In most countries, implementation of post-Fukushima disaster safety upgrades has been unacceptably delayed or not even requested.⁶⁷ Resistance to quickly and fully addressing technical and safety issues highlighted by the Fukushima disaster is almost exclusively due to concern for minimizing the financial costs to nuclear operators for safety upgrades.

Limiting Accident Liability: making the public pay

In the wake of the Fukushima catastrophe, the nuclear industry and their allied governments redoubled efforts to shore up any gaps in liability laws that could leave suppliers responsible for the risks their technology and products create. The nuclear industry, and particularly nuclear suppliers, has enjoyed significant protection from the enormous potential costs of a nuclear disaster in many countries.⁶⁸ The Convention on Supplementary Compensation has been the industry's vehicle for these post-Fukushima ambitions, and would shield suppliers in almost all instances from liability for damages caused by their equipment and technologies in the event of a catastrophic failure. It also limits the amount of funding available to nuclear victims – as well as liability in the event of cross-boundary fallout, as witnessed by Chernobyl.⁶⁹ In November 2014, Japan passed legislation to allow the country to join the CSC.⁷⁰ In January 2015, it was ratified, which will bring the international treaty into force.⁷¹

International Regulation: protecting the industry

Internationally, and with the regulatory bar set low, the European Union appeared to be pushing for higher nuclear safety standards – but the proposal was still woefully weak, delayed, and failed to ensure the safe operation of reactors.⁷² The two other countries in the world who have themselves or their predecessors experienced a partial meltdown or catastrophic nuclear meltdown at civil reactors also led the charge to keep international post-Fukushima disaster safety standards as weak as possible: the United States and Russia.⁷³ Reportedly, this was due to concern for increasing the economic costs to nuclear utilities.⁷⁴

Ultimately, the declaration⁷⁵ passed by the 77-member nation convention was weaker still than the EU proposal – laying out basic principles, but failing to have any force of law.⁷⁶ And as predicted, this was due in large part to U.S. – Russian opposition.⁷⁷

However, with continuing international and domestic uncertainty regarding when and how Fukushima disaster upgrades and design changes will be implemented, it is impossible to predict the full economic impacts of

⁶⁶ "The cost of producing future of nuclear power operated beyond 40 years." Greenpeace France, June 2014, https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/the_cost_of_producing_future_of_nuclear_power_operated_beyond_40_years.pdf

See also: "French nuclear more costly than renewables by 2020: Greenpeace." Michel Rose. Reuters. 12 July 2014. <http://www.reuters.com/article/2014/06/12/us-france-nuclear-idUSKBN0EN1OT20140612>

⁶⁷ "NRC's Implementation of the Fukushima Near-Term Task Force Recommendations and Other Actions to Enhance and Maintain Nuclear Safety." U.S. Senate. Committee on Environment and Public Works. 113th Congress, 2nd Session. Statement of Senator Barbara Boxer. 4 June 2014. <https://www.hsdl.org/?view&did=755539>

⁶⁸ "Running from Responsibility: How the Nuclear Industry Evades Responsibility." Greenpeace International. February 2014. <http://www.greenpeace.org/korea/Global/korea/publications/reports/climate-energy/2014/mar-2014-running-from-responsibility-eng.pdf>

⁶⁹ *Ibid*

⁶⁹ "Diet approves bill on collective compensation for nuclear accidents." The Japan Times. 19 November 2014.

⁷¹ "Japanese Ratify Convention on Supplementary Compensation for Nuclear Damage (CSC)." U.S. Department of Energy. 15 January 2015. <http://www.energy.gov/ia/articles/japanese-ratify-convention-supplementary-compensation-nuclear-damage-csc>

⁷² "A Critical Review of the EU Stress Test Performed at Nuclear Power Plants." Antonia Wenisch and Oda Becker. Commissioned by Greenpeace. May 2012. <https://www.greenpeace.de/sites/www.greenpeace.de/files/20120613-Critical-Review-of-EU-Stress-Test-Greenpeace.pdf>

See also: "Updated Review of EU Stress Tests." Greenpeace. 12 April 2013.

http://www.greenpeace.org/belgium/Global/belgium/report/2013/20130412_Briefing_EU_Stress_tests.pdf

⁷³ "EU Said to Bow to U.S. Resistance on Nuclear Safety Fixes. Bloomberg Business." Jonathan Tirone. 2 February 2015.

<http://www.bloomberg.com/news/articles/2015-02-02/eu-said-to-bow-to-u-s-resistance-on-nuclear-safety-fixes>

⁷⁴ *Ibid*

⁷⁵ "Vienna Declaration on Nuclear Safety." International Atomic Energy Agency.

https://www.iaea.org/sites/default/files/cns_viennadeclaration090215.pdf

⁷⁶ "Swiss Abandon Nuclear-Safety Push Amid U.S.-Russian Opposition." Bloomberg Business. Jonathan Tirone. 10 February 2015.

<http://www.bloomberg.com/news/articles/2015-02-09/swiss-abandon-nuclear-safety-push-amid-u-s-russian-opposition>

⁷⁷ "U.S. derails amendment to toughen nuclear safety pact: diplomats." Reuters. Shadia Nasralla. 9 February 2015.

<http://www.reuters.com/article/2015/02/09/us-nuclear-safety-idUSKBN0LD22520150209>

further post-Fukushima disaster safety retrofits both for operating reactors and modifications of newer designs. While the industry and their allied governments are pushing for the weakest possible standards, it is safe to say that it will be impossible for the industry to ignore Fukushima catastrophe, and any retrofit or upgrade further exacerbates the economic troubles of an industry with a track record⁷⁸ of significant delays, massive financial overruns, and significantly increasing operating costs due to aging related problems.

Suppliers

The global industry has been experiencing the problems of a slowly dying industry for decades: few reactor orders have meant manufacturing abilities of reactor components were lost or outsourced in much of the OECD, construction knowledge has atrophied, and human resources are aging without a new generation of nuclear engineers and workers ready or willing to take their places.⁷⁹

Amidst this rather bleak landscape, nuclear suppliers have struggled to maintain a profitable business – and in many cases, are trying and failing. Many of the suppliers most aggressively seeking contracts abroad are state-backed or owned entities such as South Korea's KEPCO, Russia's Rosatom, and France's Areva and EDF.

However, even vested state interest does not mean financial solvency: for example, Areva – one of the largest nuclear suppliers globally, with the French State ownership of its shares standing at 87% – is in precarious financial straights, and the situation seems to be deteriorating rapidly.⁸⁰ Post-Fukushima disaster, the company has seen its business atrophy, recording losses for the past three years.⁸¹ In November 2014, the nuclear giant announced that it was suspending its financial outlooks for 2015 and 2016 altogether, citing significant delays in its Finnish new build project and a “still lackluster” global nuclear market for its decision.⁸² In spite of this move, Standard & Poors downgraded Areva's credit rating to BB+, stripping the company of its investment grade status and downgrading it to junk.⁸³ In February 2015, according to sources, Areva is drafting plans to allow EDF, the French state-backed utility, a stake in its business.⁸⁴ The plan reportedly would include joint reactor export and fuel reprocessing ventures.⁸⁵

In order to survive in current markets, some nuclear suppliers are pushing new drastic schemes to finance new reactor construction projects.

For example, EDF's new build project, Hinkley Point C, in the United Kingdom requires unprecedented subsidies at the expense of consumers in order to move forward. In October 2014, the European Commission gave the green light to the massive ratepayer recovery scheme, stating that it did not violate EU state aid laws. The terms would guarantee EDF £92.50 per megawatt hour, twice the current bulk rate of electricity, for a 35 year period.⁸⁶ Consumer advocacy groups say the move could add as much as £5 billion a year to consumers' bills.⁸⁷

The European Commission's decision will be challenged by the Government of Austria, which will further undermine the prospects for this nuclear project, including investment decisions over the next several years.⁸⁸

Rosatom, Russia's nuclear state corporation, has touted aggressive goals for both domestic and foreign expansion. However, a careful analysis of this State entity's track record reveals significant delays, inflated new

⁷⁸ “*The Economics of Nuclear Power*.” Stephen Thomas, Peter Bradford, et al. Greenpeace International. November 2007. <http://www.greenpeace.org/international/en/publications/reports/the-economics-of-nuclear-power/>

⁷⁹ “*The World Nuclear Industry Status Report 2009: With Particular Emphasis on Economic Issues*.” The World Nuclear Industry Status Report 2009 With Particular Emphasis on Economic Issues. Mycle Schneider and Antony Froggatt et al. August 2009. Paris. pg. 6. <http://www.worldnuclearreport.org/IMG/pdf/2009MSC-WorldNuclearReport-EN-V2.pdf>

⁸⁰ “*UPDATE 2-Areva warns of significant extra provisions for 2014*.” Geert De Clercq. Reuters. <http://www.reuters.com/article/2015/02/02/areva-results-idUSL6NOVC43B20150202>

⁸¹ “*Exclusive - Areva drafts plan to let EDF take stake in some businesses: source*.” Benjamin Mallet. Reuters. 5 February 2015. <https://uk.news.yahoo.com/exclusive-areva-drafts-plan-edf-stake-business-units-135848582--sector.html#3zfl7go>

⁸² “*Areva shares plunge after it drops financial targets*.” BBC New Business. 19 November 2014. <http://www.bbc.com/news/business-30114326>

⁸³ “*Areva cut to junk by S&P*.” Financial Times. November 2014. <http://www.ft.com/fastft/239772/areva-cut-junk-sandp>

⁸⁴ Mallet., *op cit*.

⁸⁵ *Ibid*

⁸⁶ “*EU approves Hinkley Point nuclear power station as costs raise by £8bn*.” Terry Macalister. The Guardian. 8 October 2014. <http://www.theguardian.com/world/2014/oct/08/hinkley-point-european-commission-nuclear-power-station-somerset>

⁸⁷ *Ibid*

⁸⁸ “*Austria to launch lawsuit over Hinkley Point C nuclear subsidies*.” Arthur Nelsen. The Guardian. 15 January 2015. <http://www.theguardian.com/environment/2015/jan/21/austria-to-launch-lawsuit-hinkley-point-c-nuclear-subsidies>

build figures, consecutive downward revision of targets, and troubling safety and quality control issues.⁸⁹

In an effort to boost nuclear exports and entice new orders, Rosatom has increasingly been pushing its Build, Own, Operate” or “BOO” model which offers to finance, build, and operate reactors abroad. Rosatom recently expanded its export focus from countries with smaller programs that were aiming to scale up their capacity (India, China, and South Africa), to both established nuclear nations (Finland, Hungary, and the UK) as well as completely newcomer nations (Vietnam, Belarus, Bangladesh, Jordan, Egypt and Turkey). Under this scheme, Rosatom projects that it will have orders for 80 reactors abroad by 2030.⁹⁰ However, financial analysts have raised doubts about the economic feasibility of such ambitions, suggesting that it would be difficult for Rosatom to financially support so many expensive nuclear projects – even with state funding.⁹¹

As Nadira Barkatullah, a former International Atomic Energy Agency (IAEA) economist, stated, “Equity investment by vendors is the new emerging trend based on market conditions post-financial crisis. But it is not feasible for one vendor to take on a lot of projects.”⁹²

These inflated ambitions, the company’s track record, and the general flagging interest, and financial challenges of the industry as a whole certainly raise doubts about the ability of Rosatom to deliver on its targets and its contracts.

Conclusion

The impact of the catastrophic TEPCO’s Fukushima Daiichi disaster on the nuclear industry, both in Japan and internationally, has been significant. And in many ways, the full effects are yet to be seen. Like Chernobyl two and a half decades before, the Fukushima Daiichi disaster yet again highlights the enormous human and environmental costs of a nuclear catastrophe within the global arena. And, it also publicly exposed both the devastating economic consequences – with the bill estimated in 2013 at \$169 billion USD, with decades of continuing work ahead – as well as the major vulnerabilities of nuclear reactors.

In contrast, renewables are already outcompeting nuclear in international markets, being modern technology and faster, cheaper, and significantly less risky – economically, environmentally, and for communities – than nuclear.

Yet, the nuclear industry will certainly not go quietly into the pages of history, where it belongs. Since its inception, it has enjoyed unprecedented levels of government protection, indemnification, R&D funding, direct and indirect subsidies, and vast amounts of consumer dollars. As we have seen in the past four years, the industry is fighting for its survival, meaning it is desperate to weaken regulations, shore-up liability “gaps,” and take full advantage of consumers’ and taxpayers’ money, if governments and regulators permit it.

All of these nuclear industry efforts place the public at risk: financially, as well as safety. Nuclear power also stands in the way of the rapid renewable energy transition needed to address energy service security issues and climate change by sucking up vast amounts of government and consumer funds and limiting the amount of room on the grid available for these modern technologies – effectively capping them.

One of the ultimate lessons of the Fukushima catastrophe is that nuclear power is not safe, it is not cheap, and when it fails, the results can be devastating. With today’s safer, quicker, low-carbon technologies, there is no reason to accept nuclear costs or nuclear risks.

Some facts are very clear, however: In Japan, nuclear power’s return to pre-Fukushima disaster levels already looks impossible. Globally, the industry will continue to decline.

The question that remains is whether nuclear will be able to hang on long enough to severely hinder decentralized and local renewable development, stymieing meaningful action to address climate change, while putting communities across the planet at unnecessary financial and safety risk.

⁸⁹ Greenpeace International., Rosatom Risks, op cit.

⁹⁰ “Russian nuclear ambition powers building at home and abroad.” Alissa de Carbonnel. Reuters. 22 July 2013. <http://www.reuters.com/article/2013/07/22/russia-nuclear-rosatom-idUSL5N0F90YK20130722>

⁹¹ *Ibid*

⁹² *Ibid*