Reality Check:
Energy Mix 2030 and Japan's Collapse in Nuclear Power Generation

April 2015, last update in May 2016

In 2015 the Japanese government adopted a long term energy mix for 2030 which at the time were widely seen as unrealistic. One year on and the prospects for achieving its targets have only declined further. The crisis in energy policy that existed in 2015 remains. While the Government is determined to support the return to significant nuclear power generation, the reality is that the future of the industry is even more precarious. Three major developments in the last 12 months have further exposed the wholly unrealistic basis for Japan's energy policy. Historic lawsuits against nuclear reactor operation have profoundly destabilized the nuclear power utilities; 195 states at the 21st UN climate change conference in Paris late last year recognized that we cannot afford the risk of global temperatures rising by more than 1.5°C; and on April 1st 2016 households and businesses with a connection of less than 50kW were able to freely choose their electricity supplier in Japan.

Japan's national target for carbon emissions reduction of 26% from those of 2013 to be achieved by the year 2030, is equal to a 18% reduction over emissions in 1990.[1] However, not only is the Japanese Governments climate target wholly insufficient and significantly less than many other developed nations, such as the 40% reduction target of the EU[2], it is likely that Japan will miss even this low target. The climate target is directly tied to a decision to be made on the energy share planned for 2030, the so-called energy mix. The ambition of the former is directly tied to the reality of the latter.

The justification for the choices made in the 2030 Long Term Energy mix is that they will secure Japan the so-called 3E+S – energy security, economic efficiency, environmental protection, and safety. A review of the current and future status of energy supply in Japan leads Greenpeace to the conclusion that the 2030 policy will guarantee only insecurity, inefficiency, failure to meet climate targets and unsafe reactor operation.

This briefing highlights the reality of Japan's energy crisis and the prospects for both achieving a significant nuclear share of electricity by 2030 and its consequences, including on meeting national climate targets.

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1 Ministry of Foreign Affairs, http://www.mofa.go.jp/press/release/press4e_000811.html

2 2030 Energy Strategy, European Commission, 2015, http://ec.europa.eu/energy/en/topics/energy-

2 2030 Energy Strategy, European Commission, 2015, http://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy

The Japanese government in April 2015 recommended the Long-term Energy Supply and Demand Outlook which set the percentage of energy the nation aim to generate from different sources by the year 2030.[3] In the following months, the Ministry of Economy, Trade and Industry (METI) presented its draft with the proposed nuclear share by 2030 to between 20-22 percent, with renewable energy proposed for 22-24 percent, and fossil fuels of 56 percent.[4] On 1 June 2015, a panel from the Advisory Committee for Natural Resources and Energy (ANRE), formerly affiliated with METI, agreed to endorse the proposal.[5] A 20-22% nuclear share is a few percent less than the nuclear industry was lobbying for, but more than the 15 percent that Prime Minister Abe was reportedly seeking.[6]

Greenpeace's latest analysis of the current state of nuclear power in Japan and the prospects for restart in the coming years, with only two commercial nuclear reactors operating as of May 1st 2016, confirms the conclusion reached by Greenpeace one year ago that the nuclear generation targets proposed by the Japanese government will not be possible to achieve. The reality facing Japan's nuclear utilities and Government is that the percentage share of nuclear generated electricity in 2030 will likely not reach 15 percent, and is more likely to be in the range of 6-8 percent. One scenario indicates the share could be as low as 2 percent of electricity generation from nuclear power by 2030. This compares with a 29 percent electricity share in 2010.

Nuclear Power Current Reality

"Why is a single district court judge allowed to trip up the government's energy policy?"
Kazuo Sumi, vice chairman of the Kansai Economic Federation, March 2016[7]

A total of 42 commercial reactors remain in Japan and are, in theory, capable of operation. Two reactors at Sendai owned by Kyushu Electric Power Company restarted in August[8] and October[9] 2015. The restart of two reactors at Takahama, owned by Kansai Electric Power Company, in early 2016 was short lived. Takahama unit 3 began operation[10] on January 29th, while unit 4 failed[11] to connect to the grid in late February and was shutdown. In a

3 Long-term Energy Supply and Demand Outlook July, 2015 Ministry of Economy, Trade and Industry, http://www.meti.go.jp/english/press/2015/pdf/0716_01a.pdf

4 Nikkei BP CleanTech Institute, "Japan Announces Energy Mix Plan for 2030", 1 May 2015, see http://techon.nikkeibp.co.jp/english/NEWS_EN/20150501/416800/?ST=msbe

5 Japan to raise nuclear power ratio to 20% by 2030, Nikkei Asian Review, 1 June, 2015, see http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-to-raise-nuclear-power-ratio-to-20-by-2030

6 Reportedly, Abe was seeking a nuclear share target of 15 percent, see http://foreignpolicy.com/2015/04/08/japan-bets-on-nuclear-and-coal-for-future-power/

7 Editorial: nuclear power proponents still scoffing at public safety concerns, asahi shimbun 28 march 2016, see http://www.asahi.com/ajw/articles/aj201603280014.html

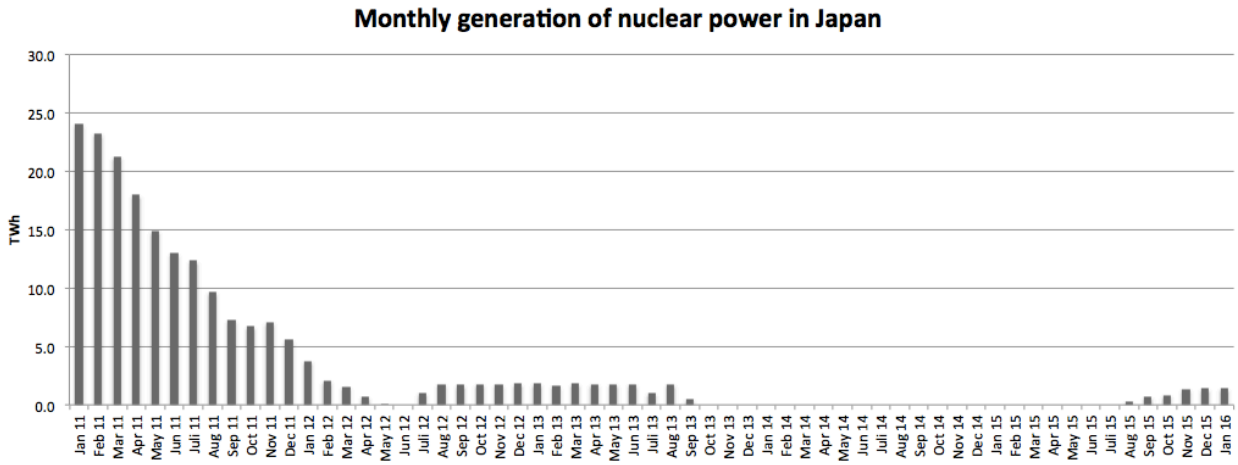
8 32-Year-Old Reactor First to Generate Power in Japan in Nearly Two Years, World Nuclear Industry Status Report, 14 August 2015, see http://www.worldnuclearreport.org/32-Year-Old-Reactor-First-to-Generate-Power-in-Japan-in-Nearly-Two-Years.html

9 Sendai-2 Resumes Power Generation, Japan Atomic Industrial Forum, JAIF, 22 October 2016, see http://www.jaif.or.jp/en/sendai-2-resumes-power-generation/

10 Third Reactor Restarted in Japan—Takahama-3 Restarted/Connected to the Grid, World Nuclear Industry Status Report, 30 January 2016, see http://www.worldnuclearreport.org/Third-Reactor-Restarted-in-Japan-Takahama-3-Restarted-Connected-to-the-Grid.html

11 Takahama-4 Reactor Fails Grid Connection in Japan, World Nuclear Industry Status Report, 2 March 2016, see

groundbreaking legal judgement on March 9th, the District Court in Otsu, in Shiga prefecture, issued an injunction against operations of Takahama units 3&4, supporting the case brought by citizens in the prefecture that their safety and environment was threatened.[12]



The challenge faced by utilities with an ageing nuclear reactor fleet continued to be exposed with the announcement of the permanent closure of the 39 year old Ikata unit 1 reactor owned by Shikoku Electric Power Company.[13] This brings to six the number of reactors announced for decommissioning since March 2015.[14] There is also no prospect that the four Fukushima Daini reactors will ever restart[15], thus the number of reactors as of May 1st 2016 that could potentially operate is 38. Of these, a total of four have completed review by the Nuclear Regulation Authority (NRA), with a further 23 still under review. The Ikata unit 3 reactor is closest to completing all checks by the NRA, with operation planned to resume in July 2016.[16] Construction of the the Ohma reactor has yet to be completed, while the Shimane 3 reactor construction is also not completed and it has yet to be placed under NRA review.

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http://www.worldnuclearreport.org/Takahama-4-Reactor-Fails-Grid-Connection-in-Japan.html

12 Editorial: nuclear power proponents still scoffing at public safety concerns, Asahi Shimbun 28 March 2016, see http://www.asahi.com/ajw/articles/aj201603280014.html

13 Ikata-1 to Be Decommissioned for Economic Reasons, Japan Atomic Industrial Forum, JAIF, 28 March 2016, see http://www.jaif.or.jp/en/ikata-1-to-be-decommissioned-for-economic-reasons/

14 Power Companies Select Aging NPPs to Concentrate Managerial Resources on Restarts Japan Atomic Industrial Forum, March 18th 2015, http://www.jaif.or.jp/en/power-companies-select-aging-npps-to-concentrate-managerial-resources-on-restarts/ and IAEA Power Reactor Information System (PRIS), June 3rd 2015, https://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=JP

15 Tepco May Scrap Second Nuclear Plant July 4, 2012, http://www.wsj.com/articles/SB10001424052702304141204577506531300365556, and Tokyo Electric Power :Restarting Fukushima Daini plant "very difficult": minister, Kyodo News September 25 2015, http://www.globalpost.com/dispatch/news/kyodo-news-international/140925/restarting-fukushima-daini-plant-very-difficult-minist

16 NRA Begins Pre-service Inspections of Ikata-3, Final Step before Restart, Japan Atomic Industrial Forum, JAIF, 5 April 2016, see http://www.jaif.or.jp/en/nra-begins-pre-service-inspections-of-ikata-3-final-step-before-restart/

Nuclear Reactors in Japan	Change	permanently shut down	theoretically operable	operating
Pre-disaster			54	
Destroyed in Fukushima	-4	4	50	
Non-recoverable (proximity to Fukushima)	-4	8	46	
Declared for decommissioning in 2014	-2	10	44	
Declared for decommissioning in 2015	-5	15	39	
Declared for decommissioning in 2016	-1	16	38	
Restarts of Sendai Ⅰand Ⅱand Takahama Ⅲ			36	3
Status as of May 15th, 2016		**16**	**36**	**2**
Older than 40 years in 2030	-21			

There are major technical, political, economic and legal uncertainties that make accurately predicting the number of reactors that will eventually restart in Japan impossible: the Japanese government does not know; the utilities don't know; and, the financial markets don't know. What we do know is that the majority of the Japanese public oppose the operation of any nuclear reactors.[17]

Projections from pro-nuclear analysts, including METI related think tanks, on nuclear restart schedules in recent years have proven to be unreliable and of such wide range as to be almost meaningless. Most particularly the influential IEEJ which in December 2013[18] was predicting between 6 and 22 reactors could restart during 2014, and which one year later was giving a range of between 2 reactors and 20 and even a "hypothetical" 32 reactors during 2015.[19] Despite these predictions being proved to be widely inaccurate, the IEEJ continues to project multiple reactor restarts before the end of 2016. In its latest assessment[20], its reference case was for 12 reactors to resume operation, with a high case scenario of 18, and a highest case scenario of 25 reactors operational by end of March 2017.

In contrast, Greenpeace in April 2015 expected two reactors at most to begin operation before the end of December 2015, with perhaps one additional reactor before end of FY 2015. As of end of March 2016 only the two reactors at Sendai were operating. Restart of Ikata unit 3 had been pushed back to summer 2016, while Takahama units 3&4 had been shutdown with the Otsu court ruling. Looking to the next 12 months, barring successful legal challenges, Ikata unit 3 could be the sole additional reactor to rejoin the grid before March 2017. Kansai Electric will have to await the outcome of its appeal process before it knows whether Takahama units 3&4 can resume operation, a legal appeal process that will not be concluded before the end of 2016 – with prospects for the case going to the Supreme Court which would extend the case well into 2017.

17 "4 years after Fukushima, Japan considers restarting nuclear facilities", Los Angeles Times, March 30 2015, http://www.latimes.com/world/asia/la-fg-japan-nuclear-20150330-story.html#page=1

18 see http://eneken.ieej.or.jp/en/press/press_131220.pdf

19 http://eneken.ieej.or.jp/en/press/press141219.pdf

20 Economic and Energy Outlook for Japan through FY2016,Yanagisawa Akira, R. Ikarii, S. Iwata, R. Eto, K. Tomokawa, E.S. Lim, M. Tsunoda, C. Onda, Y. Shibata and K. Ito, The Institute of Energy Economics Japan, IEEJ, 18 December 2015, see https://eneken.ieej.or.jp/data/6515.pdf

What concerns utilities (and the government) so much with the Otsu case that shutdown Takahama units 3&4 is that it could happen again. Both reactors had already been subject of an injunction issued by the Fukui District court in April 2015, which Kansai Electric overturned on appeal in December 2015. Three months later a different court, in a neighbouring prefecture issued an injunction that led to an operating reactor being shutdown within 24 hours. The utilities are right to be concerned that even if they overcome one legal challenge, more will be initiated and force the closure of operating reactors.[21] Given the mounting evidence of major flaws in Japan's nuclear regulation and public opinion it is almost a certainty that legal challenges will increase in the coming years.

For these reasons, estimates on the percentage of electricity share generated by nuclear power in the coming years to 2030 must cover a range of scenarios. However, what is all but certain is that the scale of the challenges facing Japan's electric utilities are so enormous that the electricity share generated by nuclear power in 2030 will be much less than prior to the 2011 Fukushima Daiichi nuclear accident.

Japan's Nuclear Reactor Status 2016 – 2030

Owner	**Reactor**	**Gross Capacity MWe**	**Start up/Age** (incl. when shut down)	**Shut down**	**NRA guidelines compliance**		**TWh in 2010** [22]	**Age in 2030**
					Application	Conclusion of pre-inspection		
Kyushu Electric	Sendai Unit 1 PWR	890	1984 – 32 years	10/05/11	08/07/13	10/09/15	4.9*	46 years
	Sendai Unit 2 PWR	890	1985 – 31 years	01/09/11	08/07/13	17/11/15	5.7*	45 years
	Genkai Unit 1 PWR	559	1975 – 40 years	01/12/11 permanent	N/A	N/A		Shutdown March 2015 (would be 55 years)
	Genkai Unit 2 PWR	559	1981 – 34 years	29/01/11			4.7*	49 years
	Genkai Unit 3 PWR	1180	1984 – 32 years	11/12/10	12/07/13		9.5*	46 years
	Genkai Unit 4 PWR	1180	1997 – 19 years	25/12/11	12/07/13		8.3* (under 40 in 2030)	33 years

21 Japan's energy policy takes a hit with another reactor shutdown, Nikkei Asian Review 26 March 2016, see http://asia.nikkei.com/Politics-Economy/Economy/Japan-s-energy-policy-takes-a-hit-with-another-reactor-shutdown

22 Those marked in red exceed 40 years old by 2030. The Twh is based on taking the near maximum recent output from reactors, not average load factors which could be considered a more realistic reflection of likely future projection but which in many cases would see a lower TWh.

Shikoku Electric	Ikata Unit 1 PWR	556	1977 – 39 years	04/09/11			3.9*	Shutdown March 2016 (would be 53 years)
	Ikata Unit 2 PWR	556	1982 – 34 years	13/12/12			4.7* (2011)	48 years
	Ikata Unit 3 PWR	890	1994 – 22 years	29/04/11	08/07/13		6.3*	36 years
Hokkaido Electric	Tomari Unit 1 PWR	579	1989 – 27 years	22/04/11	08/07/13		3.9*	41 years
	Tomari Unit 2 PWR	579	1991 – 25 years	26/08/11	08/07/13		4*	39 years
	Tomari Unit 3 PWR	912	2009 – 7 years	05/05/12	08/07/13		7.9*	21 years
Chugoku Electric	Shimane Unit 1 BWR	460	1974 – 41 years	08/11/10 permanent	N/A	N/A		Shutdown March 2015 (would be 56 years)
	Shimane Unit 2 BWR	820	1989 – 27 years	27/01/12	25/12/13		1.9*	41 years
Kansai Electric	Takahama Unit 1 PWR	826	1974 – 42 years	10/01/11	17/03/15		7.1*	56 years
	Takahama Unit 2 PWR	826	1975 – 41 years	25/11/11	17/03/15		6.5*	55 years
	Takahama Unit 3 PWR	870	1984 – 32 years	20/02/12	08/07/13	26/02/16	6.2*	46 years
	Takahama Unit 4 PWR	870	1984 – 32 years	21/07/11	08/07/13	24/02/16	5.3*	46 years
	Ohi Unit 1 PWR	1175	1977 – 39 years	10/12/11			6.5* (2010)	53 years
	Ohi Unit 2 PWR	1175	1978 – 38 years	16/12/11			9.6* (2011)	52 years
	Ohi Unit 3 PWR	1180	1991 – 25 years	02/09/13	08/07/13		8.3*	39 years
	Ohi Unit 4 PWR	1180	1993 – 23 years	15/09/13	08/07/13		6.9*	37 years
	Mihama Unit 1 PWR	340	1970 – 45 years	24/11/10 permanent	N/A	N/A		Shutdown March 2015 (would be 60 years)

	Mihama Unit 2 PWR	500	1972 – 43 years	16/11/11 permanent	N/A	N/A		Shutdown March 2015 (would be 58 years)
	Mihama Unit 3 PWR	826	1976 – 40 years	14/05/11	17/03/15		6.7	54 years
Tokyo Electric	Kashiwazaki-Kariwa Unit 1 BWR	1100	1985 – 31 years	06/08/11			6.2* (2006)	45 years
	Kashiwazaki Kariwa Unit 2 BWR	1100	1990 – 26 years	19/02/07			9.3* (2006)	40 years
	Kashiwazaki Kariwa Unit 3 BWR	1100	1993 – 23 years	19/09/07			7.3* (2006)	37 years
	Kashiwazaki Kariwa Unit 4 BWR	1100	1994 – 22 years	11/02/08			7.1* (2005)	36 years
	Kashiwazaki Kariwa Unit 5 ABWR	1100	1990 – 26 years	25/01/12			9.4*	40 years
	Kashiwazaki Kariwa Unit 6 ABWR	1365	1996 – 20 years	23/06/12	27/09/13		9.5*	34 years
	Kashiwazaki Kariwa Unit 7 BWR	1365	1997 – 19 years	23/08/11	27/09/13		9*	33 years
	Fukushima-Daini Unit 1 BWR	1100	1981 – 35 years	11/03/11				39 years
	Fukushima-Daini Unit 2 BWR	1100	1983 – 33 years	11/03/11				37 years
	Fukushima-Daini Unit 3 BWR	1100	1984 – 32 years	11/03/11				46 years

	Fukushima-Daini Unit 4 BWR	1100	1986 – 30 years	11/03/11				44 years
JAPCO	Tsuruga Unit 1 BWR	357	1969 – 46 years	26/01/11 permanent				Shutdown March 2015 (would be 61 years)
	Tsuruga Unit 2 – PWR	1160	1986 – 30 years	29/08/11	05/11/15		6.1* (2010)	44 years
	Tokai Unit 2 BWR – 1978	1100	1978 – 38 years	21/05/11	20/05/14		5.1*	52 years
Chubu Electric	Hamaoka Unit 3 BWR	1100	1987 – 29 years	29/11/10	16/6/2015		8*	43 years
	Hamaoka Unit 4 BWR	1137	1993 – 23 years	25/01/12	14/02/14		7.5*	37 years
	Hamaoka Unit 5 ABWR	1380	2005 – 11 years	22/03/12			7.6* (2007)	25 years
Tohoku Electric	Higashidori Unit 1 BWR	1100	2005 – 11 years	06/02/11	10/06/14		9.2*	25 years
	Onagawa Unit 1 BWR	524	1984 – 32 years	10/09/11			2.6*	46 years
	Onagawa Unit 2 BWR	825	1995 – 21 years	06/11/10	27/12/13		5.9*	35 years
	Onagawa Unit 3 BWR	825	2002 – 14 years	10/09/11			5.3*	28 years
Hokuriku Electric	Shika Unit 1 BWR	540	1993 – 23 years	08/10/11			3.1*	37 years
	Shika Unit 2 ABWR	1358	2006 – 10 years	11/03/11	12/08/14		9.2*	24 years
J-Power	Ohma ABWR	1383	Under construction		16/12/14		9.2*	9 years assuming operation from 2021
Chugoku Electric	Shimane Unit 3 ABWR	1373	Under construction – no start date				9.2	10 years – 94 percent complete in March 2011 – 2020 operation ?

	TWh in 2010 [23]	Percentage of electricity supply in 2030 (980-1170TWh)[24]
Of those under NRA review/ applied – as of April 2015	164	14-16.70%
Existing construction completed and operated – 2030	173.2	14.8-17.60%
All available reactors operated including those yet to be reviewed, and beyond 40 years	268.5	22.9-27.30%
On the basis that only reactors less then 40 years operate in 2030	77.5	6.6-7.90%
Excluding those reactors less than forty years of age in 2030, but most vulnerable to never restarting	21.4	1.8-2.10%

Nuclear Power Future Reality

Scenario 1 – High case - 14-27.3% nuclear share by 2030

Under this scenario, all 25 reactors pass NRA review for restart – plus additional capacity with operation of Chugoku's Shimane 3 reactor – generating 164-173TWh or 14-17.6 percent of 2030 electricity output. If a resumption of all other reactors currently not under NRA review and operating beyond 40 years are included, this percentage rises to a generation of 268.5TWh or 22-27.3 percent of 2030's total projected electricity output.

Analysis - not all 26[25] reactors will pass the NRA review for restart. For example, the Tsuruga 2 reactor has been confirmed by the NRA to be located on an active seismic fault, Higashidori remains uncertain in terms of active fault; active fault lines under the Shika nuclear power plant; political block to Kashiwazaki-Kariwa units 6&7 operation; legal rulings against Takahama 3&4 and Ohi 3&4; major political opposition to Tokai-1 and Hamaoka-4 restart; almost all reactors under restart review face ongoing legal challenges, which could prevent multiple reactor restarts. Takahama 1&2, aged 41 and 42 years, have to pass NRA review by July 7th 2016 – and it remains unclear whether Kansai Electric is actually committed to restarting them given age-related and economic issues, the same applies to the Mihama 3 reactor. It is also highly uncertain if, or which, reactors not currently under review will apply to the NRA approval – for example Ohi 1&2 are already 37-38 years old. The two Kashiwazaki-Kariwa reactors (units 6&7) under review remain blocked from restart by political opposition in Niigata and will face legal challenge. The failure to operate these two will also stop any restart for the remaining Kashiwazaki-Kariwa plants. The Hamaoka unit 5 reactor is unlikely to restart operations, and there are major questions over the restart of unit 4 currently under NRA review. The assumption is that there is no new

23 Those marked in red exceed 40 years old by 2030. The Twh is based on taking the near maximum recent output from reactors, not average load factors which could be considered a more realistic reflection of likely future projection but which in many cases would see a lower TWh.

24 METI are proposing a high demand figure of 1170TWh, with a lower target of 970TWh based on demand reduction energy efficiency.

25 Including Sendain 1, 2 and Ohma.

construction beyond the current two (Ohma and Shimane 3), and TEPCO's Higashidori reactor is cancelled.

Conclusion: Such a high nuclear scenario is unrealistic and Japan will not be able to reach 14 percent of its electricity share from nuclear power by 2030. Consequently, there are no prospects of generating the proposed Government target of 20-22 percent or the maximum scenario of 27.30 percent of its electricity from reactor operation. Multiple reactors currently under NRA review will not restart while others will not apply for NRA review, many, if not all, of the older reactors that are currently in the 35 year range as of 2015 are unlikely to be operating in 2030, and a number of reactors will not pass the current NRA review, or will fail to secure legal and or political approval for restart.

Scenario 2 – Low cases – between 1.8-2.1 and 6.6-7.9 percentage nuclear share by 2030

All reactors (those currently under review and those not under review) are operated to a maximum of 40 years – generating 77.5TWh or 6.6-7.9 percent of 2030 electrical output. All reactors forty years or above are permanently shutdown. Taking into account those reactors less than 40 years old but that have major issues – technical, legal and public/political - the electricity share could be as low as 21.4 TWh or 1.8-2.1 percent of the projected 2030 generation.

Analysis: A key to these scenarios are that reactors approaching 40 years will either require too large an investment to bring them up to more modern standards, are of a smaller capacity, are unable to pass NRA review, and/or fail to garner political, public and legal approval.

Aging challenge

While Kansai Electric appears determined to complete the NRA review for three reactors that are in the 40 year range (Takahama 1&2 and Mihama 3) it is by no means certain that a/they will pass the review and legal challenges[26], and b/ that Kansai Electric will actually restart these reactors. Japanese utilities are faced with one of the oldest nuclear power programs in the world – as of April 2016 Japan's remaining nuclear reactor fleet (including Fukushima Daini) has an average age of 30.3 years, with six reactors 38 years or older (not including the five reactors permanently shutdown in March 2015 and Ikata unit 1 shutdown permanently in March 2016). The average age of reactors worldwide in 2014 was 28.5 years.

Globally the age structure of reactors of the 153 reactor units already shut down (not including the five announced shutdown in Japan in March 2015) highlights the reality that many, if not all, reactors in Japan will likely shutdown due to age in the coming decade.

26 Anti-nuclear Groups Sue in Nagoya District Court to Block Extended Lifetime for Takahama Units 1&2, Japan Atomic Industrial Forum JAIF, 18 April 2016, see http://www.jaif.or.jp/en/nuclear-opponents-sue-in-nagoya-district-court-to-block-extended-lifetime-for-takahama-units-12/

As of July 2014, the average age of the 153 reactors that were permanently shutdown for decommissioning was 24 years. In total, 45 reactors worldwide operated for 30 years or more, and of those, 20 reactors operated for 40 years or more. The majority of these were Magnox reactors located in the U.K. As they were designed to produce weapons-grade plutonium, these were all small reactors (50–490 MW) that had operated with very low burn-up fuel and very low power density (watts of heat per liter of core volume). Therefore there are significant differences from the large 900 MW or 1,300 MW commercial reactors whose high burn-up fuel and high power density generate significantly more stress on materials and equipment.[27] Many reactor units of the first generation operated for only a few years.
Plans to extend the operational lifetime of large numbers of reactor units to beyond 40 years globally, but particularly in Japan, are both unrealistic and dangerous. In addition, utilities have to make a judgement if they can justify the billions of dollars of financial investment for retrofitting their older reactors, with a limited operational life even if they secure an additional extension. This appears to have been a major factor which led to Shikoku Electric's decision to permanently shutdown Ikata 1, and has been raised as a factor for a future decision on Mihama 3.[28]

Of Japan's newest reactors, those that will not reach their 40 year age by 2030, there are a significant number that are most vulnerable to never restarting operations due to a combination of factors including public and political opposition, technical obstacles – including seismic related, and as a consequence of successful legal challenges. These are:
Shika units 1 and 2 (3.1 and 9.2TWh) Hamaoka 5 and possibly 4 (7.4 and 7.5TWh) Higashidori 1, Onagawa 3 (5.3TWh) Kashiwazaki-Kariwa units 3 and 4 (7.3 and 7.1TWh)

Conclusion: The significance of these newer reactors not restarting is that they are some of the largest capacity nuclear plants in Japan. Failure to operate these will significantly reduce nuclear electrical output. In total, non-operation of these reactors through 2030 will reduce nuclear generation by as much as 56.1TWh, which in percentage terms would be 1.8 percent of Japan's electrical output as projected by METI.

Renewable energy – current reality and future potential

In September 2011, Greenpeace released its Energy Revolution Japan Scenario which showed that by 2030, renewable energy sources could supply 56.8 percent of the nations electricity generation.[29] In 2015 the Ministry of Environment proposed that Japan could generate as much as 36 percent of its electricity by 2030.[30] But these more ambitious but

27 World Nuclear Industry Status Report 2014, Mycle Schneider, Antony Froggatt, July 2014, http://www.worldnuclearreport.org/IMG/pdf/201408msc-worldnuclearreport2014-hr-v4.pdf

28 The reported cost for retrofitting Mihama 3 has increased to 270 billion yen, see KEPCO: Nuclear Restart Plans Upset, Mihama No. 3 Closure a Possibility Nikkei Online, March 19, 2016, see http://www.nikkei.com/article/DGXLZO98651920Y6A310C1TI1000/ (in Japanese)

29 The Advanced Energy Revolution: A Sustainable Energy Outlook for Japan, Greenpeace, September 2011, http://www.energyblueprint.info/fileadmin/media/documents/national/2012/10_japan_E_R__national_report_lr.pdf

30 "Japan Could Triple Power From Renewables by 2030, Study Shows", Bloomberg April 5th 2015, http://www.bloomberg.com/news/articles/2015-04-06/japan-could-triple-power-from-renewables-by-2030-study-shows

achievable targets were rejected by METI which instead opted for 22-24 percent.[31] However, beneath the surface lies the deliberate policy of METI to under-develop renewables. In 2012, 95.8 TWh or 10.3 percent of Japan's electricity was supplied by renewable energy, which, when broken down by technology, shows that of this total 87 percent (83.6TWh) was generated by hydro.[32] Even if between 2016 and 2030 most new renewable is solar photovoltaic development, which it likely will be, METI is proposing to increase renewable generation by between 119.2TWh and 184TWh[33] [34]

Solar growth in Japan has been strong in the last few years. In 2012 Japan generated 3.1TWh solar electricity; in the year to March 2014 this increased to 13.6TWh. In 2015 Japan installed 12.3GW of solar photovoltaic.[35] The potential to install additional capacity that would generate up to 70TWh on the present trend is clearly there but the prospects are looking less likely, with predictions of a decline in new installation from 2017.[36] Biggest reason is reduction of Feed In Tariff price for solar electricity, however, other reason being that nuclear utilities backed by METI are putting up obstacles to block this growth rate.

In October 2014, five utilities announced they were suspending access to their electricity grids for renewable energy.[37] The utilities claimed that further feed-in of renewable energy could endanger the stability of their grids. This sudden move to block renewable energy was a shock to the renewable energy industry and led to METI setting up a special working group to assess the issue. The result in early 2015 was the passing of regulations based on a system with a new renewable energy output-control scheme and a revision of the current operation system for the Feed In Tariff scheme.[38]

The fundamental problem with the new rule is that it effectively caps the growth of renewable energy by giving priority to nuclear and fossil fuel rather than to renewables. The cap amount is based on a calculation involving restarting all existing nuclear reactors, which would mean energy from nuclear plants would be the same as it was over the last 30 years and before the Fukushima disaster. Even the discredited new energy mix from METI is not proposing a return to this level of nuclear generation.[39] The new regulations ignore the range of technological adaptation measures available to extensively increase the capacity of grids and that Japanese utilities have applied a narrow definition for their capacity limits for feeding in renewables, choosing criteria that reduce the amount of

31 "Japan's CO2 emissions goal to use 2013 as base year", Nikkei Asian Review, April 26 2015, http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-s-CO2-emissions-goal-to-use-2013-as-base-year

32 JREF table based on the ANRE/METI (2014) Energy Balances 2012, and ANRE/METI (2012) Status Report 2011 on Special Measures Law Concerning the Use of New Energy by Electric Utilities, http://www.jref.or.jp/en/energy/statistics2/energy_01.php#energy_0102

33 Depending on percentage share achieved and total generation demand – between 1170TWh or 980TWh.

34 In the year to March 2013, Japan generated an additional 2.4TWh of solar and 0.184TWh of wind electricity - http://www.jref.or.jp/en/energy/statistics2/energy_02.php#energy_0202

35 Japan Solar Installations To Peak This Year At 14.3gw, Bnef Says, 18 February 2016, see http://about.bnef.com/bnef-news/japan-solar-installations-to-peak-this-year-at-14-3gw-bnef-says/

36 17.3 GW Of Approved FiT Solar PV Projects In Japan Being Canceled Due To "Insufficient Grid Capacity" December 31st, 2014 http://cleantechnica.com/2014/12/31/17-3-gw-approved-fit-solar-pv-projects-japan-canceled-due-insufficient-grid-capacity/

37 Hokkaido, Tohoku, Shikoku, Okinawa and Kyushu Electric.

38 http://www.meti.go.jp/english/press/2014/1218_01.html

39 http://www.meti.go.jp/committee/sougouenergy/shoene_shinene/shin_ene/keitou_wg/pdf/003_09_00.pdf

renewable energy their grids can actually integrate.[40] This shows the clear preference of METI and the nuclear utilities for the existing energy system and their clear aim to maintain the predominance of nuclear and fossil fuel generation. The commitment to a 60 percent base load target for 2030 encapsulates the current flawed government policy.[41]

The situation for wind energy growth is even more critical. In 2012 wind generated electricity supplied 4.83TWh, in 2013 this had increased by 0.143TWh to 4.98TWh. In contrast, also in 2013, Germany generated 53.4TWh from wind energy, and a total of 8.9 percent of the nations electricity.[42] In 2015 alone, Germany increased wind generation by 29TWh, nearly six times the total installed capacity in Japan. The Greenpeace Energy Revolution Scenario calculated that Japan could generate 179TWh of electricity from wind power by 2030. On present growth rates it would take Japan over 1200 years to reach this generation – but with the right policies Japan could install a significant percentage share of wind generation – and by 2030.

In the sixteen years to the end of 2015, Germany increased its wind generation output from 4.5TWh to 86TWh.[43] Japan, with the benefit of major cost reductions in wind power and economies of scale – significantly larger turbines are available today than 15 years ago – could be a beneficiary. Without ambitious renewable target and proper energy policy, this will not materialize. On-shore wind energy development is currently being held up by requirements to conduct environmental impact assessments which take 4-5 years. The prospect for off shore wind development might be better, both in terms of potential resource and less restrictive planning regulations. However, the government should set out clear pathway toward renewable society and address issue of long environmental impact assessment as soon as possible for wind development.

Japan's Energy Mix Reality – Failed Nuclear and Renewable Policy and Implications

As a consequence of its current energy policy, based on an impossible nuclear share and a low, but possibly unattainable, renewable target, Japan by 2030 will miss even its very low carbon emission target. Fossil fuel use will continue to be the predominant energy source, with dozens of new coal power plants planned. Japanese NGO Kiko Network currently counts 47 planned coal power plants with a combined capacity almost equaling the existing capacity.[44] This is particularly unfortunate as the 2014 preliminary figures of Japan's Ministry of Environment show that the country's greenhouse gas emissions almost returned to "pre- Fukushima" levels in FY 2014.[45] For this reason among others, the think tank E3G in 2015 assessed Japan to be "the worst performer among the G7 across every category" of

40 See, Japanese Utilities Hinder Clean Energy, Greenpeace Japan Briefing January 2015, http://www.greenpeace.de/sites/www.greenpeace.de/files/publications/final_engrid_report_jan2015.pdf

41 LDP stealthily seeking to raise nuclear energy dependence, Asahi Shimbun, April 3rd 2015, http://ajw.asahi.com/article/behind_news/politics/AJ201504030042

42 International Energy Agency Wind Energy Country report Germany, 2014, https://www.ieawind.org/annual_reports_PDF/2013/Germany.pdf

43 Power generation from renewable energy in Germany – assessment of 2015, Prof. Dr. Bruno Burger Fraunhofer Institute for Solar Energy Systems ISE Freiburg, Germany, 11 January 2016, see https://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/power-generation-from-renewable-energy-in-germany-assessment-of-2015.pdf

44 Coal Plant Tracker, http://sekitan.jp/plant-map/en/v2/table_en

45 Japan's Ministry of Environment (Japanese only) at https://www.env.go.jp/press/files/jp/28580.pdf

its coal phase out scorecard.[46] The opportunity to create an energy transition in Japan with an economy based on reliable, affordable renewable energy and energy efficiency will have been missed. The evidence is clear: Japan has the potential to be nuclear free, generating a high percentage share from renewable energy, combined with a major reduction in energy demand. An energy policy based on these principles would see Japan, by 2030, well on the way to substantial and essential reductions in its carbon emissions and less dependent on the import of fossil fuels.

Japan's reliance on nuclear power to generate 20-22 percent of its electricity by 2030 will not be achievable in the coming years. A more likely share will be in the range 2-8 percent. While this cannot be admitted by the Abe government, METI or the nuclear utilities, in energy planning terms its what should be a major determinant for the present energy mix debate, and its implications for setting a national climate commitment. Unfortunately it is not. The consequences are that the low 2030 renewables target of 22-24 percent adopted in 2015, with an unrealistically high nuclear share of 20-22 percent. The Government set a fossil fuel electricity generation figure of 56%, largely coal and LNG.

One obvious consequence of setting a energy mix and carbon reduction target based on an unattainable nuclear share and unambitious renewable target, as a result of industrial and government policy, is that when it fails to materialize, Japan could be faced with a potential 20 percentage shortfall of electricity generation. Given the determination of major forces in METI and the nuclear utilities to place limits on renewable growth, the only likely option they will then adopt will be to increase fossil fuel use.

In tying its carbon reduction plans to wholly unrealistic nuclear generation targets, and by restricting renewable growth, the Japanese government is trying to deceive not only its own people but also the international community.

Immediate measures needed

In order to attain a sustainable, reliable and affordable electricity system, the Japanese government urgently needs to change course and streamline its policies. It needs to put the interests of the Japanese people before those of the utilities and carry out the following measures as a matter of priority:

Stop the efforts wasted on attempts to restart nuclear plants

Nuclear power plant owners are currently wasting an incredible amount of financial and human resources in an effort to restart their reactors, the end result of which will be to again jeopardize the safety of the Japanese people. These resources should instead be invested in the development of clean and safe alternatives, energy savings and smart solutions to grid expansion and demand-side management, as well as safe decommissioning of the nuclear reactors and radioactive waste storage. Planning for the energy transition would be greatly facilitated – and the costs for Japanese society as a whole as a result much smaller – if nuclear energy was abandoned once and for all.

46 Snapshot of Japan Coal Phase Out progress, E3G, October 2015, see https://www.e3g.org/library/snapshot-of-japan-coal-phase-out-progress

Keep the FIT system and give renewables priority access to the grid

The boom of solar has shown what is possible if the conditions are made right. The same now needs to happen with, geothermal and in particular wind power by setting an appropriate FIT system. Utilities should focus on – and be rewarded for – the necessary measures to integrate the renewable energy from producers who are ready to contribute their part to a sustainable system. They, together with the newly established Organization for Cross-Regional Coordination of Transmission Operators (OCCTO), are best positioned to find the most cost effective combination of grid expansion, grid modernization (smart-grids), demand-side management including efficiency measures, and storage capacity increases.

Improve the electricity market: ensure true costs

On 1 April 2016, households and businesses with a connection of less than 50kW became able to freely choose their electricity supplier. At this point, suppliers which supply 100% renewable haven't appeared. For this to change, the government of Japan will need to fully unbundle the utilities' grid and power supply operations, a development that is under way. More importantly, however, it will have to create a level playing field between the different sources of energy by ensuring that their prices reflect the true costs they cause for society and environment.

Stop investments in coal power plants that lock in climate destruction

The plans to build new coal power plants are in total contradiction with the agreement concluded at the COP21 in Paris last year and even Japan's unambitious targets. Building coal power plants – the worst emitters of CO2 in power generation – means locking in CO2 emissions for decades to come. If Japan wants to prevent embarrassment in front of the international community in the coming years, it should not build a single additional coal power plant.

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