

# Restart or Not Restart: the Nuclear Question in Japan

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# Japan's Nuclear Energy Industry Pre-2011

- 1966: First commercial NPP in Japan (Tokai NPP)
- 1970-2010: 54 reactors installed, of which
  - 28 BWRs
  - 26 PWRs
  - (30% share in electricity)
- 1998 : Peak nuclear in Japan as it accounts for 36% of electricity generation
- Pre-2011 Nuclear Energy Plan:
  - Boost nuclear share to 40% by 2017
  - Grow domestic nuclear fuel cycle
  - Aim for 45% of electricity from nuclear



# March, 2011: Disaster at Fukushima Dai-Ichi



- Nuclear power industry almost entirely shut down
- Public trust in nuclear shaken
- Radiation leaks lead to mass evacuations
- Fukushima prefecture declares plans to become nuclear-free
- Japan establishes new Nuclear Regulation Authority (NRA)

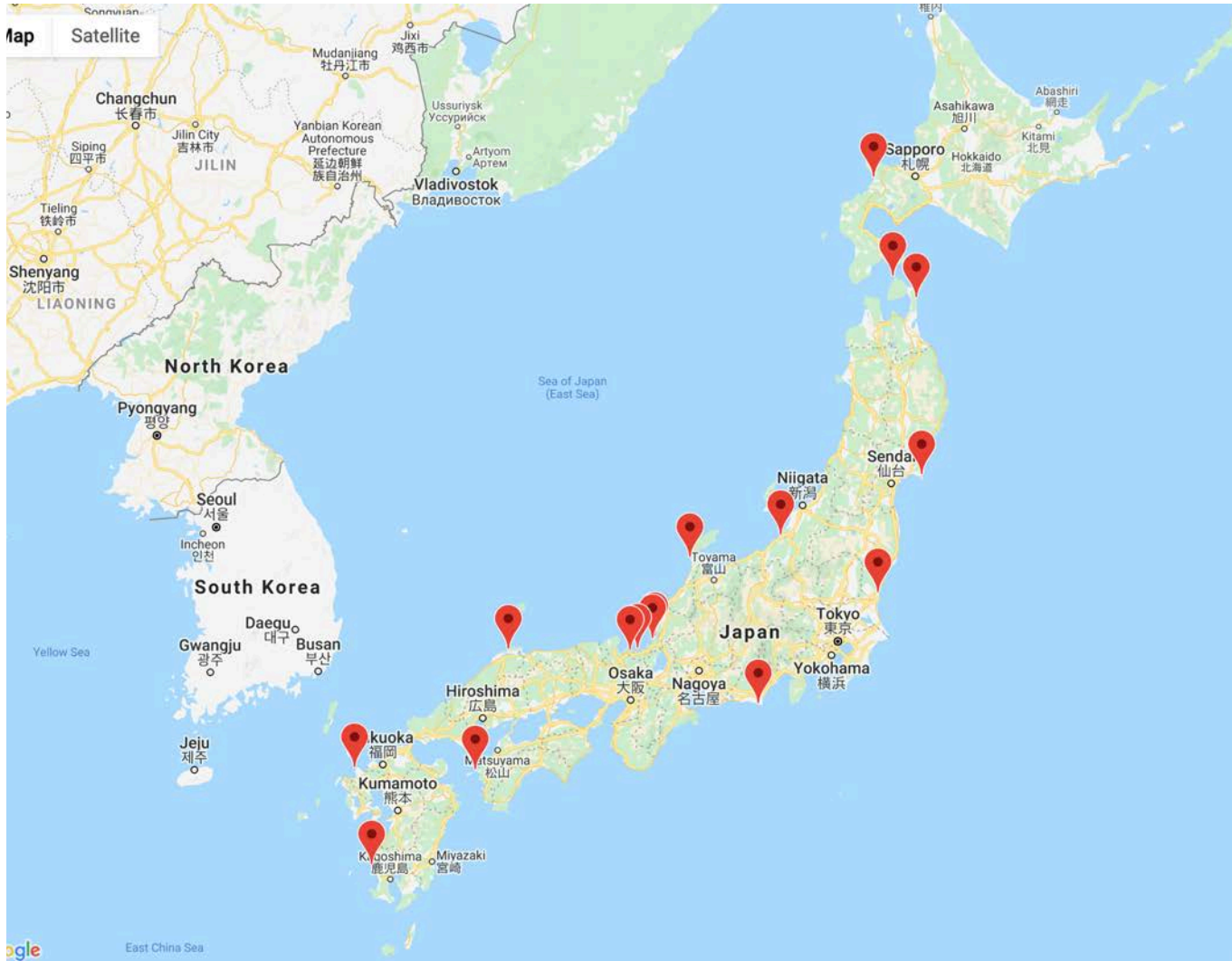
# Current Status of Nuclear Power in Japan

<b>No. of operable nuclear reactors</b>			<b>33</b>
of which	applied for restart		25
	approved by regulator		16
	restarted		9
	in operation today		<b>4</b>
	able to use MOX fuel		4
<b>No. of nuclear reactors under construction</b>			3
<b>No. of reactors slated for decommissioning</b>			27
of which	completed work		1
	started process		4
	yet to start / not known		22

Source: Japan Nuclear Safety Institute and JAIF data, as of August 19, 2020

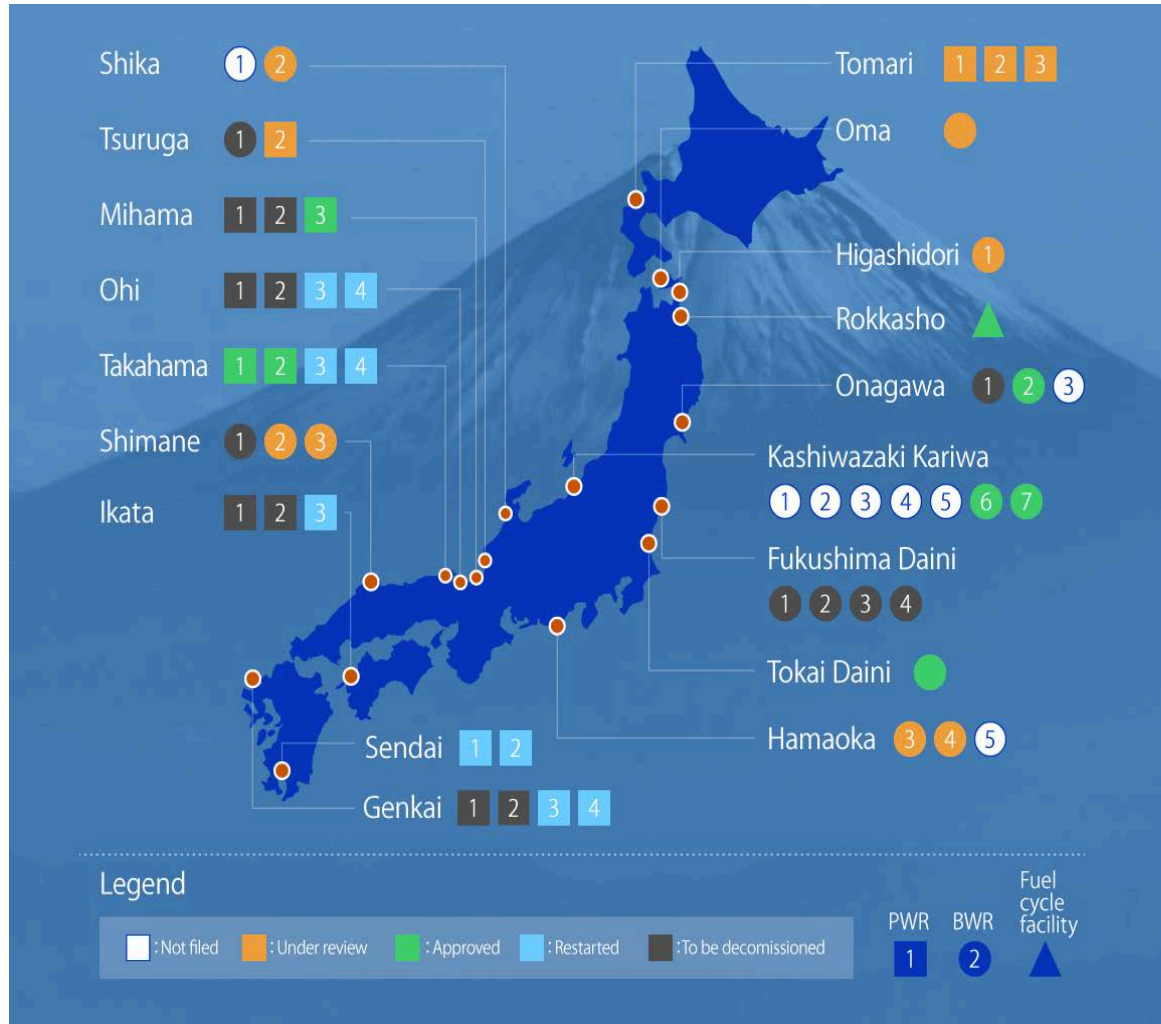
- Gap between no. of operable reactors and those that applied for a restart
- Only about 1/3 of reactors that applied have been able to restart operations so far
- Less than half of those that did restart are in operation as of today
- Nameplate capacity of “operable reactors: 33.08 GW. Capacity of the 4 reactors online today: 4.41 GW.
- Just two EPCOs have nuclear reactors online: Kansai and Kyushu

# Reactors That Filed an Application for Restart



- In theory, it looks like we should have nuclear power back online across the country. The spread of the reactors geographically is fairly even.
- NOTE: This map from JAIF includes reactors that are listed as Under Construction.
- The reality is, geography has played a major part in the restarts.

# Common Factors of Restarted Reactors (1)



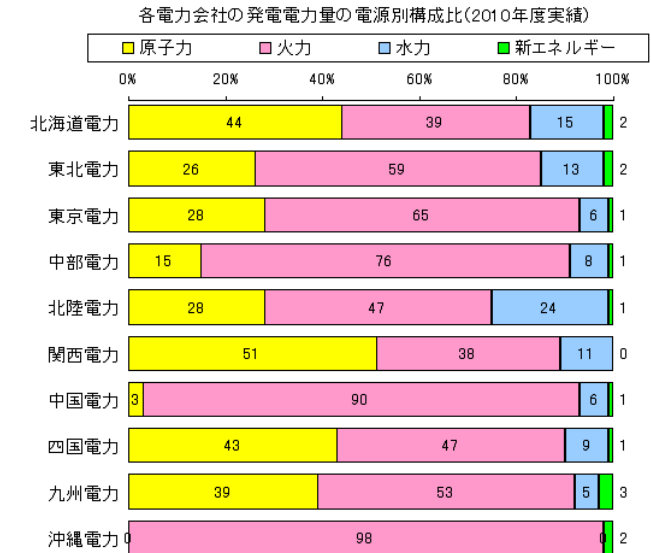
- Only three out of the 10 EPCOs with nuclear assets have permission to operate them as of today (Kyushu, Kansai, Shikoku)
- All are in eastern Japan; nothing east of Osaka. Keeping physical distance from Fukushima and those who felt its impact the most.
- All the restarts are PWRs, no BWRs. Both Fukushima Dai-Ichi and Dai-Ni ran BWR reactors.
- Gap between “operable” and “applied for restart” mainly due to TEPCO. World’s largest NPP, the Kashiwazaki Kariwa is stranded.
- Worst collateral damage: Tohoku, Hokkaido, and Chugoku EPCOs

Source: JAIF

# Common Factors of Restarted Reactors (2)

- Age of reactors is not an issue. Those that have been approved have an average age of 32 years. Avg age of the rest of operable plants? 24.9 years.
- Most reactors that won NRA approval are PWRs, but not all PWRs passed the checks. Tomari NPP (reactors 1-3) in Hokkaido is already waiting for 7 years. Tsuruga NPP (reactor 3) in central Japan is waiting for 5 years to date.
- Four of 16 NRA approvals have come for BWRs. Of those, two are for ABWRs at Kashiwazaki Kariwa NPP, run by TEPCO. But, no BWRs have been started.
- Local reliance on nuclear power is another common factor in the restart pattern. Kansai, Kyushu, and Shikoku EPCOs were three of the four most nuclear-reliant utilities around 2011.
- Based on the above, the clear missing piece is the Hokkaido region. Like Kyushu and Kansai, it is reliant on nuclear and coal.

電力会社の電源構成



Source: Mainichi Shimbun, May 5, 2012

		Company	Plant	Restart date
Restarted	9 units	Kyushu Electric Power Co.	Sendai Unit 1	Aug. 11, 2015
		Kyushu Electric Power Co.	Sendai Unit 2	Oct. 15, 2015
		Kansai Electric Power Co.	Takahama Unit 3	Jan. 29, 2016
		Kansai Electric Power Co.	Takahama Unit 4	Feb. 26, 2016
		Shikoku Electric Power Co.	Ikata Unit 3	Aug. 12, 2016
		Kansai Electric Power Co.	Ohi Unit 3	Mar. 14, 2018
		Kyushu Electric Power Co.	Genkai Unit 3	Mar. 23, 2018
		Kansai Electric Power Co.	Ohi Unit 4	May 9, 2018
		Kyushu Electric Power Co.	Genkai Unit 4	June 16, 2018

Source: JEPIC, The Electric Power Industry in Japan, 2020

# How Quickly Can More NPPs Restart

- Step one is approval from the NRA, which has taken 1 to 7 years so far. This process is highly uncertain.
  - Eastern Japan NPPs took 1-4 years to get NRA sign off.
  - Hokkaido EPCO is waiting since July 2013 for approval on all of its 3 reactors at Tomari NPP.
  - Central areas, like Chubu and Hokuriku have waited 5-6 years.
- Commercial restart after the NRA signoff has taken at least a year in nearly all cases.
- Restarts heavily depend on local governor and mayor giving ascent. Not legally required, but seen as socially important.
- Politics and public opinion clearly plays a major role, as well as the immediate energy needs of the region.

2022...?

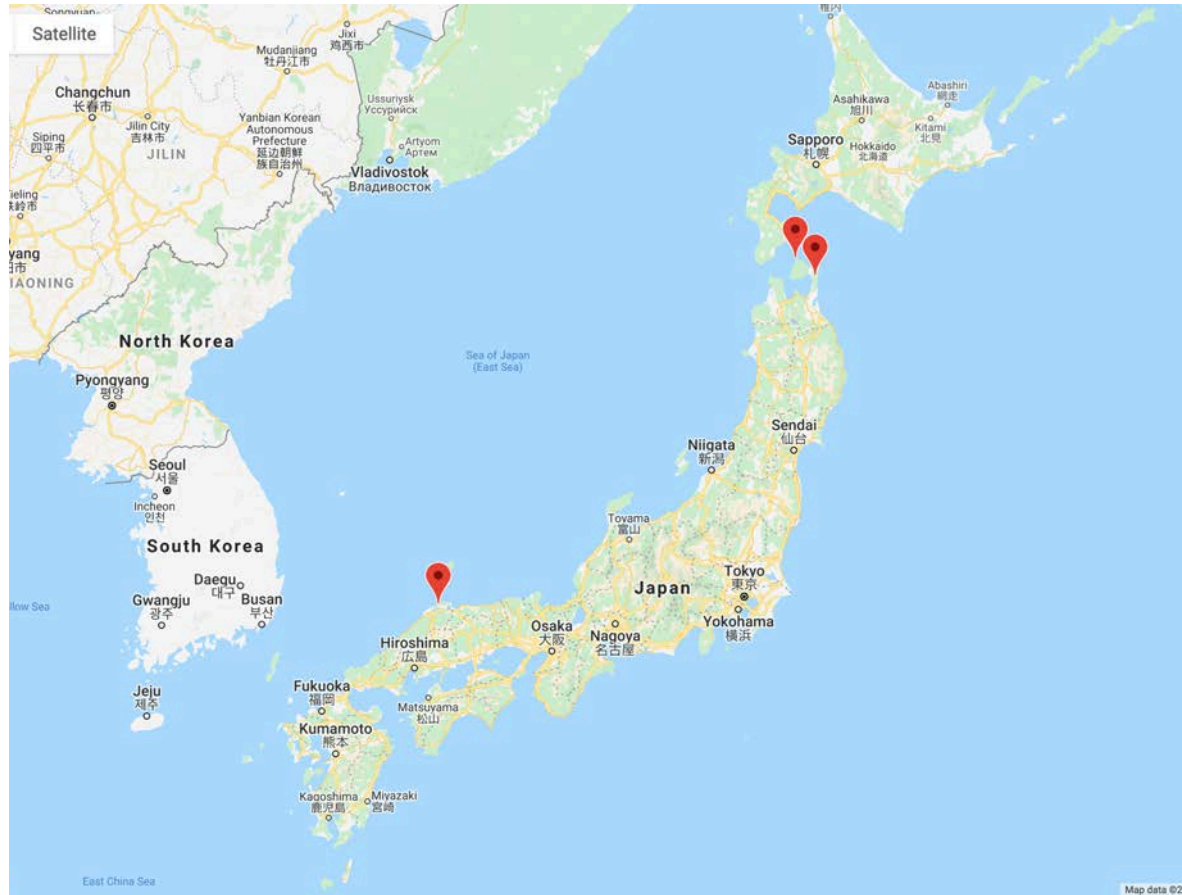


# How Many Reactors Close to a Restart

- Tohoku EPCO, **Onagawa No. 2**, BWR unit. Got NRA approval in February 2020, due to complete safety work in FY2022. Local assembly voted in favor of restart. Miyagi Governor Yoshihiro Murai made positive comments, but passed the buck to local mayor.
- JAPC, **Tokai No. 2**, BWR unit. Had NRA approval in 2018, but still completing safety work due by Dec 2022. Ibaraki governor yet to give final blessing, but process moving.
- Kansai EPCO, **Takahama No. 1-2** and **Mihama No. 3** PWR units, already have license extensions beyond 40 years and NRA approvals, but completing additional safety work which was due around Sept 2020 to April 2021. Issue: *massive scandal around nuclear assets at KEPCO with dozens of managers charged with graft. Also, Covid-19 pandemic has delayed maintenance and construction work.*
- Hokkaido EPCO, **Tomari No. 1-3**. PWR units, No. 3 built in 2009. Issue: *determining if the site lies on top of an active fault. This was due to be examined for at least a year in spring of 2019.*
- TEPCO, **Kashiwazaki Kariwa No. 6-7**, ABWR units. Won NRA approval back in 2017. Issue: *Cannot get local governor to sign off on restart as utility remains deeply unpopular in the region.*



# What About New Nuclear Build?



- Of the 3 reactors under construction, all are ABWR. They would add 4.14GW of nameplate capacity.
- Only one is described by JAIF as “almost complete.” That is the Shimane No. 3 reactor (1,373 MW; Chugoku EPCO), which applied for regulatory approval in Aug 2018.
- The others are the Oma plant (1,383 MW; J-Power), which has listed its start date as “undecided” for 9 straight years, and the Higashidori No. 1 (1,385MW; TEPCO), which stopped construction work in 2011.
- There is occasional media chatter about adding 2-3 reactors at existing NPPs.

# Factors That Favor Restarts (1)

- **COST:** After 2011, power tariffs rose by about 30% for industry and 20% for households due to higher imports of LNG and coal for thermal generation, according to the JAEC. Japan had to spend about \$90 billion more on thermal power fuels.
- **LESS COAL:** The Ministry of Economy, Trade and Industry said this summer it plans to move towards closure of older, inefficient coal plants. This could affect up to 110 coal plants of the 140 or so in Japan. Note, this number of closures came from the media, not from the ministry. Which gives them wiggle room to let some older plants survive the cull. Clearly, some new coal capacity will also be built. However, coal's share in energy mix will shrink.
- **NOT TOO MUCH LNG:** Japan buy around 85% of their LNG on long-term supply contracts. The drop in oil prices led to big losses for Japanese utilities, which makes the industry cautious of being more reliant on LNG.
- **WASTE NOT, WANT NOT:** Utilizing existing nuclear assets is relatively cheap since most of their costs are already sunk in.

**Coal power generated by Japan's top utilities in fiscal 2018**

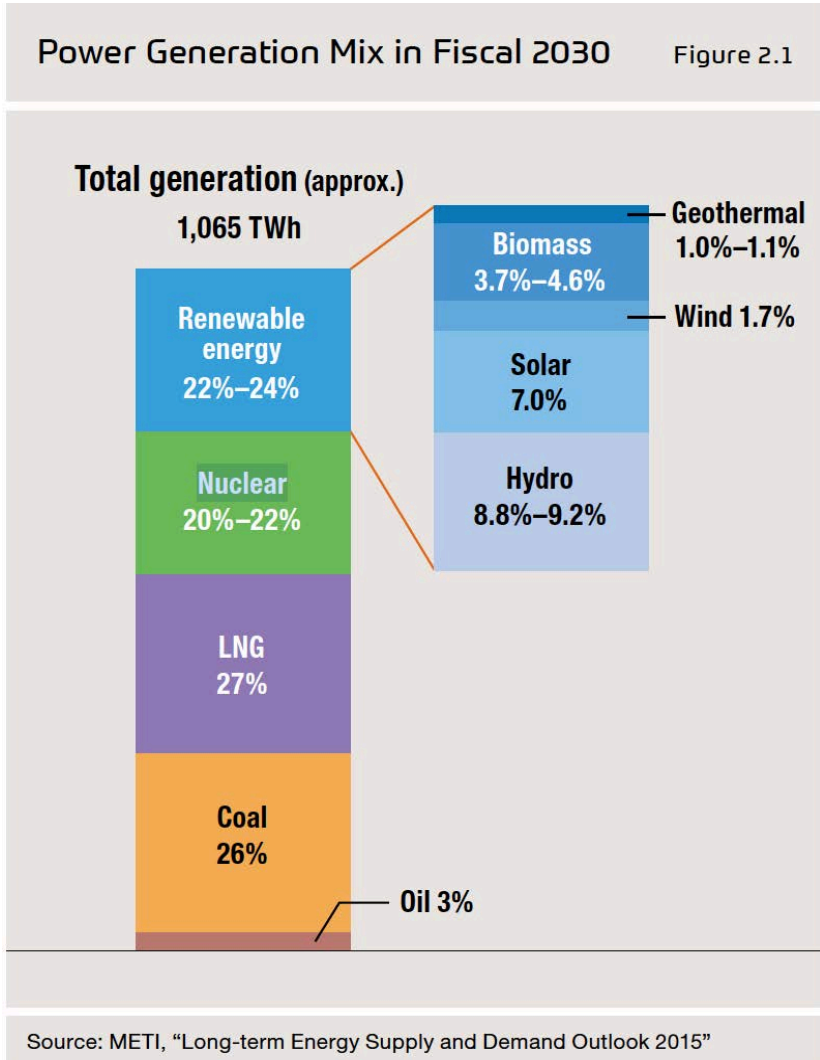
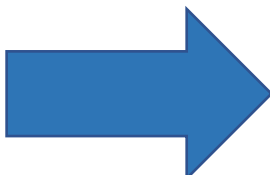
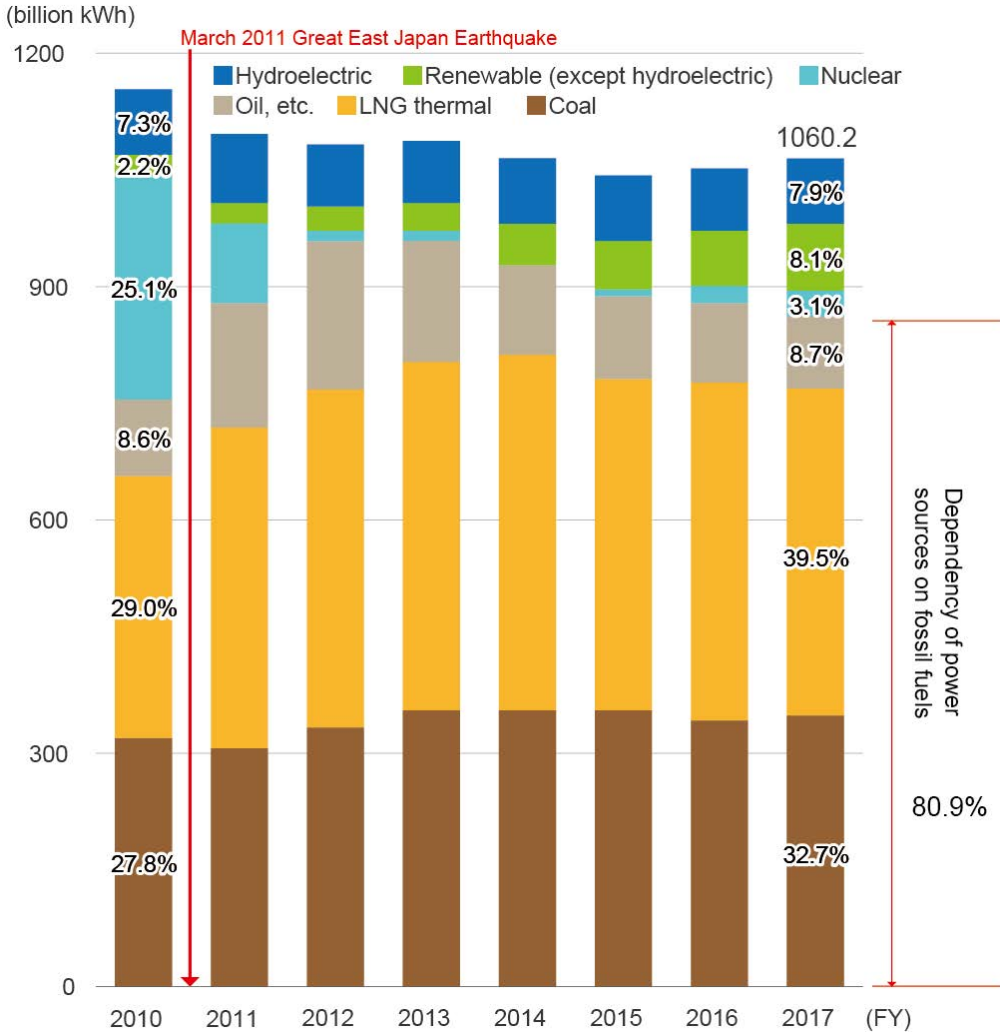
Utility	Number of coal units: total (old)	Ratio of power generated by coal in fiscal 2018
Hokkaido Electric	7 (6)	52%
Tohoku Electric	5 (1)	37%
Hokuriku Electric	6 (3)	50%
Kansai Electric	2 (0)	10%
Chugoku Electric	6 (5)	47%
Shikoku Electric	3 (2)	48%
Kyushu Electric	5 (2)	25%
Okinawa Electric	4 (4)	60%
Jera	9 (2)	about 20%*
J-Power	14 (8)	Undisclosed

Figures based on interviews with each utility. Data on coal operations run jointly by a group of utilities only included in coal power ratios. \*Coal power ratio for fiscal 2019

# Factors That Favor Restarts (2)

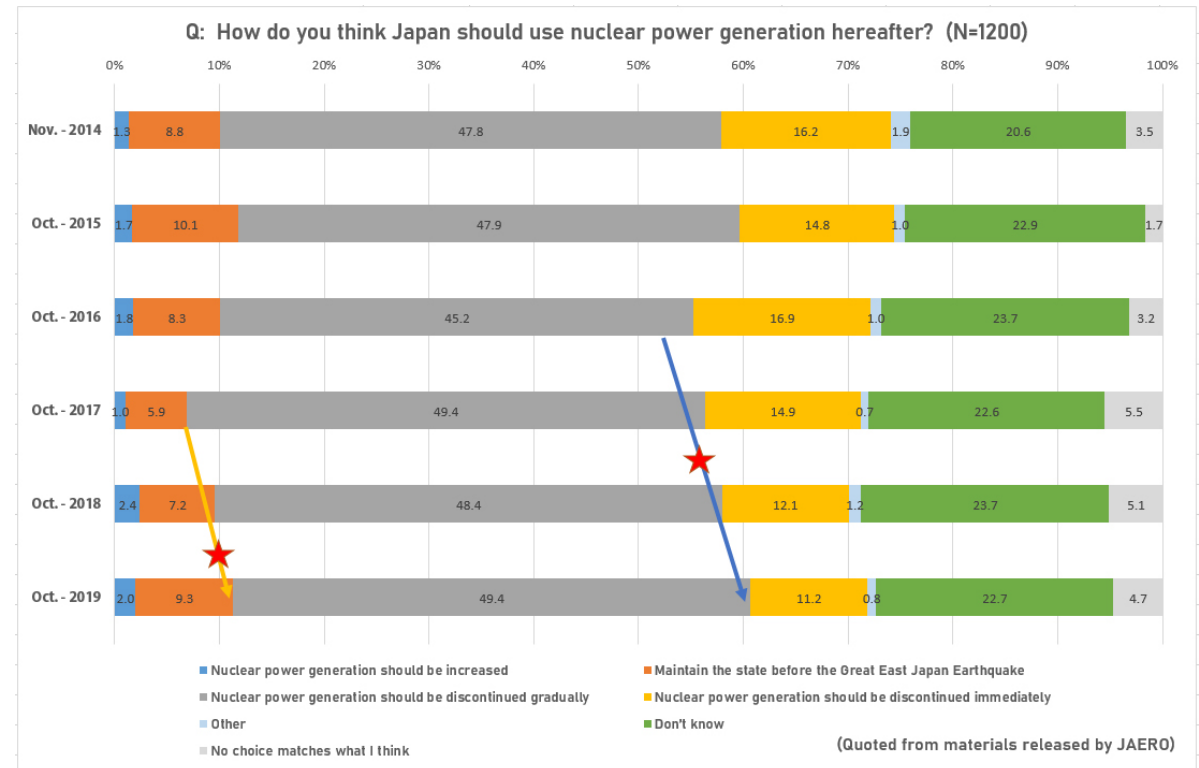
- **EMISSIONS:** Japan needs more non-emissions generation to meet its Paris accord targets. Cutting greenhouse gas emissions by 26% vs mid-2000 levels before 2030 seems nigh impossible without nuclear.
- **INDEPENDENCE:** Nuclear is seen as a way to gain energy security in geopolitically turbulent times like these.
- **SYSTEM STABILITY:** This week's California power grid failure, which was based on not having enough capacity to meet peaks when solar generation wound down, will give upper hand to those who argue that allowing renewables too much total share will disrupt the system. The argument will be that nuclear is a key resource to retain a balance in the energy mix. U.K.'s decision to revisit nuclear financing will also be noted.
- **WASTE SOLUTION?:** The Rokkasho complex won approval for start of reprocessing of spent nuclear fuel. This would be the first commercial scale facility in Japan and have capacity to handle 800 tons a year. Reviving the Rokkasho-centric nuclear fuel process is seen as one way out of the problem of spent fuel storage.
- **WANING PUBLIC FOCUS?:** After March 2021, the news cycle around Fukushima is likely to start to abate, making less of a negative impression among the public.
- **AVOIDING BRAIN DRAIN:** Japan wants to keep its nuclear engineer cadre as the industry develops smaller nuclear modules and nuclear fusion. Japan is one of the countries involved in the ITER project.

# Japan Energy Mix Vision, As of Now



# Factors Against Restarts: the Public

- **Every restart, even after maintenance, has been a struggle.** Example: Shikoku EPCO's Ikata No. 3 restarted in 2018. It had to shut for a periodic inspection on Dec 2019. The inspection was delayed. The local Hiroshima High court made a provisional injunction against the restart in January 2020. Utility filed an objection. Case yet to be resolved.
- Public opinion remains largely against due to:
  - Cost of Fukushima cleanup (¥22 trillion or USD 206 billion);
  - State continuing to fund cleanup / TEPCO, which means it is taxpayer money;
  - Almost 1% of population drawn into the cleanup operations;
  - Embarrassing mistakes at Fukushima site (i.e. muddling *mili* and *micro* sieverts);
  - 30 class action lawsuits remain in place;
  - Local politicians find it awkward to voice support for the industry.



Source: JAIF

# Factors Against Restarts: the Market

- **Losing the cost advantage.** Japan's official calculations, as per 2014, show that nuclear power cost is ¥10.1 / kWh and that is the cheapest energy cost. Solar was then seen at ¥24 - ¥ 29 / kWh. Since then, the number of regulations for nuclear have increased, raising capital outlay. Meanwhile, Japan's solar FIT is down to around ¥12 / kWh. Further advances in battery and heat storage could erase nuclear's lead further.
- **The case for new construction is weak.** In addition to above, any nuclear investor in Japan needs to grapple with a shrinking population and a deregulated power market.
- **The industry lacks leadership.** Toshiba sold off Westinghouse and effectively walked out on plans to build nuclear plants abroad. Hitachi froze its UK project, though this is under reconsideration. TEPCO planned to form a new national nuclear champion by joining with Chubu EPCO, Toshiba and Hitachi but talks have not progressed as the latter fear getting dragged into Fukushima liabilities.

The nuclear industry in Japan seems to be very disparate. Many organizations offering at times conflicting information on the state of the industry. That only adds to confusion and distrust.

# Factors Against Restarts: Technical Issues

- **Little space to put nuclear waste.** The Rokkasho facility has received almost 3,400 tons of spent fuel for storage. It was initially seen as storing just 3,000 tons. The nuclear stations themselves also store spent fuel, but their pools already hold around 16,000 tons. How much more waste they can accept? KEPCO and TEPCO both had plans to build temporary additional storage facilities, but this has not progressed.
- **Rokkasho could face more delays** as the facility has yet to win approval for its design and some operational measures. Some Japanese media suggest this will take “years.”
- **Processing fuel will create more plutonium** that Japan will be hard pressed to utilize. The country already has the world’s 4th largest stockpile. That’s a proliferation risk. It also encourages other countries, like South Korea, to demand to have the same rights to store plutonium.
- **MOX program poses too many questions.** Part of the processed plutonium is meant for MOX fuel. But too few of Japan’s reactors are able to accept MOX, there is no processing facility for spent MOX fuel, and no obvious alternative storage for spent MOX fuel. Incidentally, Japan’s MOX fuel contracts are with France’s Areva, weakening the case that the nuclear fuel cycle will bring Japan energy independence.
- **No long-term nuclear waste storage site** selected or even proposed.



# Nuclear Power Outlook for 2030

- **Nuclear power's ratio likely to drop** in the revised 2030 energy mix due next year. We see it falling to around 15% from the current 20—22%. Even that will require around 20 reactors to be restarted – double the current number.
- Japan may move towards **some form of consolidation in domestic nuclear industry**. In part, this will be to phase out the TEPCO brand from the nuclear business.

A new entity may be more palatable for the restart of the Kashiwazaki Kariwa NPP and the completion of construction of Higashidori NPP.

