13 years of Fukushima - Vienna Environmental Advocate and Cities for Nuclear Free Europe (CNFE)

11 March 2024 Vienna

Nuclear power in Japan

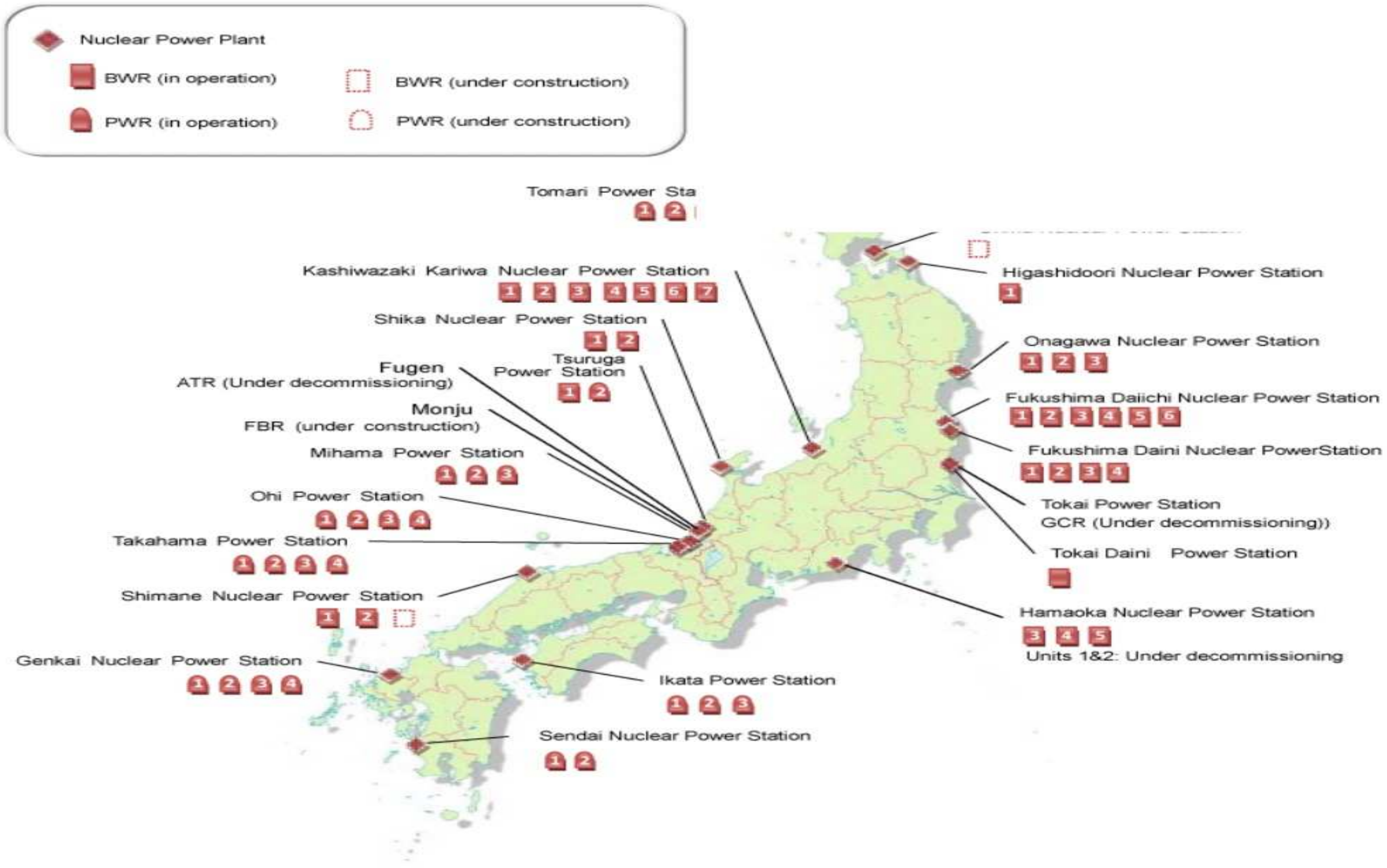
Shaun Burnie
Greenpeace East Asia

Nuclear power in Japan – current status

By the end of 2023, 12 nuclear reactors were operating in Japan, generating approximately 10% of the nation's electricity. This compares with 7.2 percent in 2021 and 6.1 percent in 2022. Japan's power companies have a total of 33 nuclear reactors (33.1 GW, gross) of which 25 reactors (24.8 GW, gross) have applied to the Nuclear Regulation Authority (NRA) for an operating license.

Twelve out of 17 reactors that have been granted licenses have been operating in recent years, while eight applications remain under review.

Twelve years after the Fukushima Daiichi nuclear disaster, the majority of Japan's nuclear reactors remain in long term outage or permanently shutdown.



The massive shock of Fukushima-daiichi – reactor closures

A total of 13GW of nuclear capacity shutdown permanently – that is close to 50% of Austria's total installed generating capacity

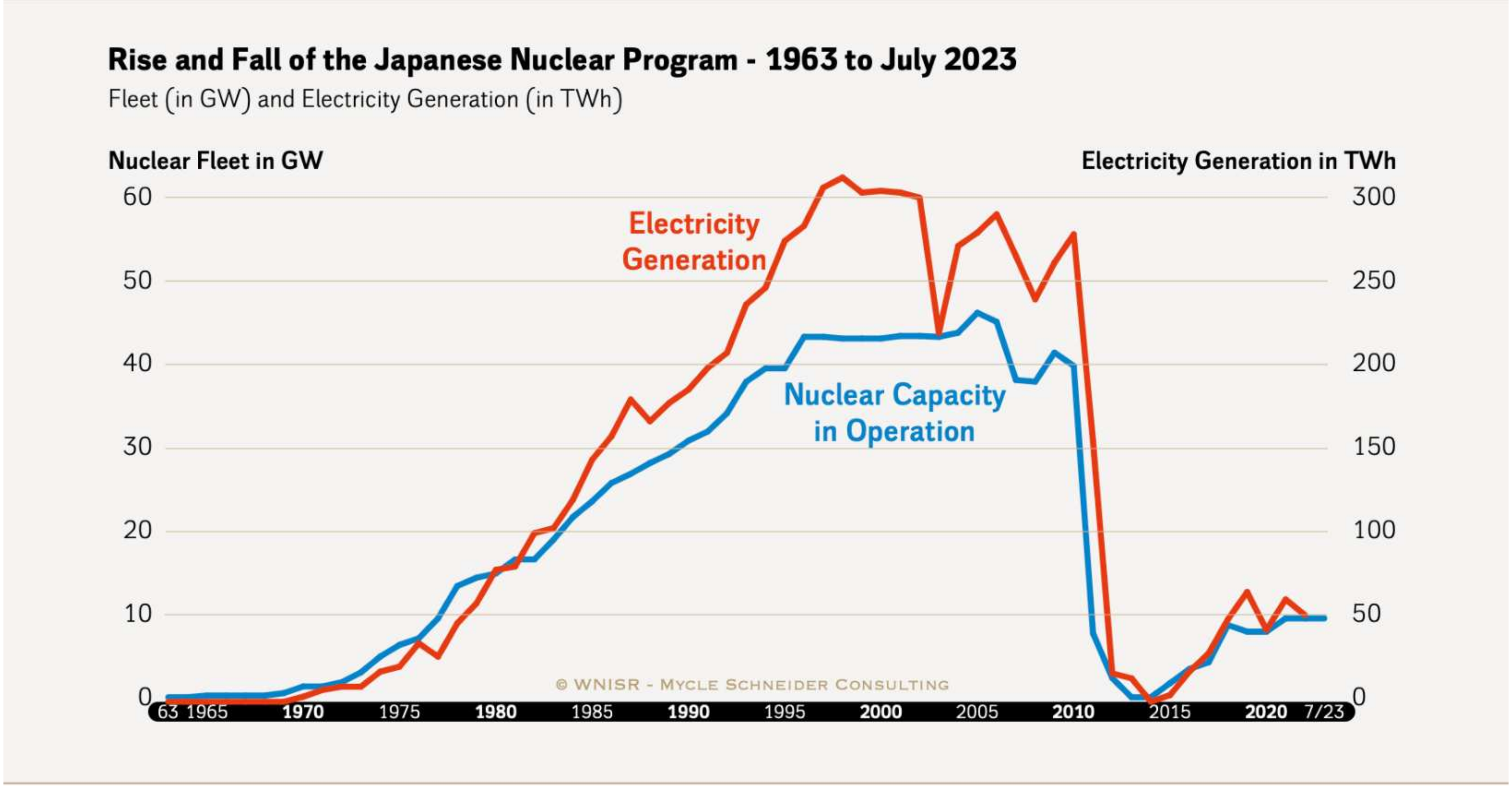
Operator	Reactor	Capacity MW	Startup Year	Closure Announcement[a] dd/mm/yy	Official Closure Date[b] dd/mm/yy	Last Production	Age[c]
TEPCO	Fukushima Daiichi-1 (BWR)	439	1970	-	19/04/12	2011	40
	Fukushima Daiichi-2 (BWR)	760	1973	-	19/04/12	2011	37
	Fukushima Daiichi-3 (BWR)	760	1974	-	19/04/12	2011	36
	Fukushima Daiichi-4 (BWR)	760	1978	-	19/04/12	2011	33
	Fukushima Daiichi-5 (BWR)	760	1977	19/12/13	31/01/14	2011	34
	Fukushima Daiichi-6 (BWR)	1 067	1979	19/12/13	31/01/14	2011	32
	Fukushima Daini-1 (BWR)	1 067	1981	31/07/19	30/09/19	2011	30
	Fukushima Daini-2 (BWR)	1 067	1983	31/07/19	30/09/19	2011	28
	Fukushima Daini-3 (BWR)	1 067	1984	31/07/19	30/09/19	2011	26
	Fukushima Daini-4 (BWR)	1 067	1986	31/07/19	30/09/19	2011	24
KEPCO	Mihama-1 (PWR)	320	1970	17/03/15	27/04/15	2010	40
	Mihama-2 (PWR)	470	1972	17/03/15	27/04/15	2011	40
	Ohi-1 (PWR)	1 120	1977	22/12/17	01/03/18	2011	34
	Ohi-2 (PWR)	1 120	1978	22/12/17	01/03/18	2011	33
KYUSHU	Genkai-1 (PWR)	529	1975	18/03/15	27/04/15	2011	37
	Genkai-2 (PWR)	529	1980	13/02/19	13/02/13	2011	31
SHIKOKU	Ikata-1 (PWR)	538	1977	25/03/16	10/05/16	2011	35
	Ikata- 2 (PWR)	538	1981	27/03/18[d]	27/03/18	2012	30
JAEA	Monju (FBR)	246	1995	12/2016[e]	05/12/17	LTS[f] since 1995	-
JAPC	Tsuruga -1 (BWR)	340	1969	17/03/15	27/04/15	2011	41
CHUGOKU	Shimane-1 (PWR)	439	1974	18/03/15	30/04/15	2010	37
TOHOKU	Onagawa-1 (BWR)	498	1983	25/10/18	21/12/18[g]	2011	27
TOTAL: 22 Reactors /15.5 Gwe							

Sources: JAIF, Japan Nuclear Safety Institute, compiled by WNISR, 2011–2022

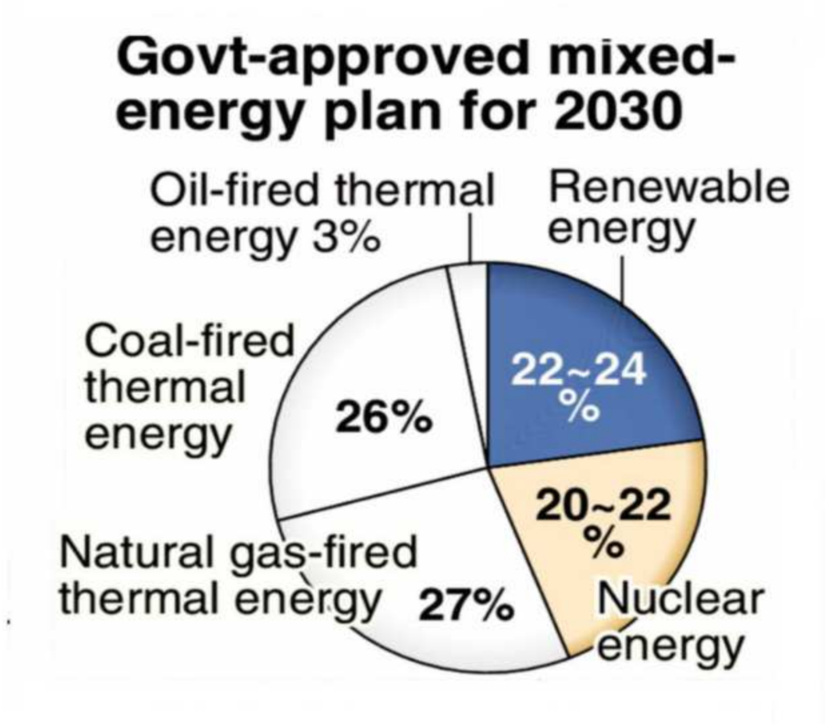
Notes

BWR: Boiling Water Reactor; **PWR**: Pressurized Water Reactor; **FBR**: Fast Breeder Reactor; **LTS**: Long-Term Shutdown.
JAEA: Japan Atomic Energy Commission; **JAPC**: Japan Atomic Power Company

Source: World Nuclear Industry Status Report | 2022



Sources: WNISR with IAEA-PRIS, 2023



For the sixth Basic Energy Plan in 2021, METI estimated that electricity demand in 2030 would be 860-870 TWh, with total electrical power generation at 930-940 TWh. If Japanese nuclear reactors were to generate 20-22 percent it would be between 186-204TWh. The principal factors that will determine whether this is possible are the total number of reactors operating in 2030, their installed generating capacity (MW) and their capacity factors.

To attain the 2030 20% target share METI calculated in 2021 that 27 reactors would be in operation, and with a capacity factor of 80%, which would generate 186TWh of electricity. To attain the 22% target would require 204.6TWh – this would require between 2-4 additional reactors (depending on generating capacity of the specific reactor and an 80% capacity factor). It is likely the seventh Basic Energy Plan in 2024 will be based on similar projections.

METI, Outline of Strategic Energy Plan October, 2021 Agency for Natural Resources and Energy, see www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/6th_outline.pdf

- To attain 27 reactors operation would mean 17 reactors restarting within the next six years in addition to the twelve reactors operating in 2023.
- Undoubtedly some reactors will restart operation – but how many? It is credible to envisage 5 additional reactors operating by 2027.
- Greenpeace analysis concludes that the most likely to restart during the next two-three years are – Shimane-2, Onagawa-2, and Kashiwazaki-Kariwa 6&7, followed by the new reactor Shimane-3.
- If these reactors were to operate at 80% capacity then the additional generation would be in the range of 38TWh, which added to the generation of the current 12 reactors operating in 2023 would be 126.5TWh – or 13.4 percent of the projected total generation of 940TWh in 2030.
- Beyond these reactors it becomes highly speculative - so enormous uncertainties in significant percentage – without a more ambitious RES program the gap will be filled with fossil fuels.

Photo credit: Greenpeace/Aslund, November 2018

Japan's electric power companies - too big to fail

- In 2020/21 - A decade after the start of the Fukushima Daiichi disaster, Japan's nuclear reactor operators largely remained in crisis. Most reactors not operating, massive investments needed to back-fit to meet post Fukushima regulatory requirements (710 billion yen / US$5 billion for Onagawa 2 – more than double construction cost), organized and destabilizing opposition, including lawsuits, and growing availability of lower cost renewable energy.
- As a consequence of Russia war on Ukraine and the resultant impact on global energy prices, Japan's utilities were pushed further into debt - high fuel import costs and a weak yen.
- In 2023 for example, some of Japan's largest banks, Sumitomo Mitsui Banking Corp. and Mizuho Bank extended emergency loans totaling 400 billion yen ($3.01 billion) to Tokyo Electric Power Co. Holdings .
- Not alone - Japan's top 10 utilities booked a combined 1.42 trillion yen net loss in April-December 2022.
- Total demand for financing among the 10 utilities could reach trillions of yen by the summer 2023.
- **Fundamentally nuclear energy in Japan is framed as indispensable to energy security, attaining net zero is only the latest banner to justify nuclear power and therefore Government interventions is essential.**

GX (Green Transformation) Implementation Council at the Prime Minister’s Office –

Based on two principles: climate change and overcoming issues in the energy supply-demand structure, the Sixth Strategic Energy Plan was formulated in October 2021.

The Plan consists of a long-term outlook towards achieving carbon neutrality by 2050 and policy measures for 2030.

It outlines the path for future energy policies.

Discussions and considerations by experts at the "GX Implementation Council" at the Prime Minister's Office

Compiled the "The Basic Policies for Realization of GX -A roadmap for the next 10 years-" (December 22)

- Based on the achievements of previous discussions at the GX Implementation Council, a roadmap outlining the direction of future initiatives over the next 10 years was compiled, with the secure supply of energy as a fundamental premise for realizing GX.

2023

Cabinet Decision made on the "The Basic Policies for Realization of GX" (February 10) and "GX Promotion Act" (May 12) and "GX Decarbonized Power Source Act" (May 31) was approved

- Formulation and implementation of GX promotion strategies, issuance of GX Economy Transition Bonds, introduction of the Growth-oriented Carbon Pricing, establishment of the "GX Promotion Organization" and progress evaluation and necessary revisions
- Maximum introduction of renewable energy with regional coexistence and utilization of nuclear power with the utmost priority on ensuring safety

Cabinet Decision made on the "GX Promotion Strategy" (July 28)

- Based on the GX Promotion Act, the Government of Japan compiles efforts to address climate change through NDC (the 46% reduction in GHG emission in FY2030 and continuously strenuous efforts in its challenge to meet their aspirational goal of cutting emission by 50% and Net-Zero achievement by 2050) and initiatives to enhance the competitiveness of Japanese industry and lead to future economic growth

Green category: Low carbon and decarbonized energy

No.3.1 Utilization of nuclear power

Developing and constructing next-generation innovative reactors that incorporate new safety mechanisms, with the utmost priority on ensuring safety.

< Related key policy roadmaps, technology roadmaps >

Policy roadmaps: Next-generation innovative reactors

Technology roadmaps: Power sector

< Examples of initiatives (overview, etc.) >

- Project for the development of fast reactor demonstration

  Based on the revised "Strategic Roadmap" for fast reactor development, which was updated on December 23rd 2022, the specifications for the reactor concept and the core companies to be selected for the conceptual design from FY 2024 onwards

- Project for the development of high-temperature gas reactor demonstration

  Feasibility study of carbon free hydrogen production method using high temperature above 800°C. Establishment of connection technologies and evaluation methods to achieve high safety using decarbonized high-temperature heat source above 800°C and hydrogen production technology through commercialized methane steam reforming method

  Criteria example:

  With the aim of supplying a large amount of hydrogen stably at approximately 12 yen/Nm3 by 2050 using decarbonized high-temperature heat above 800°C and carbon-free hydrogen production methods, efforts will be made for industrial applications such as iron and steel production and chemical industries

The government's Green Transformation Basic Policy announced in February 2023, called for Japan to maximize the utilization of nuclear power, which replaced the policy adopted after the Fukushima Daiichi disaster of aiming to reduce dependence on nuclear energy as much as possible

Overall public and private investment over the next decade

150 trillion yen

60 trillion yen~	• Massive introduction of renewables • Nuclear energy (R&D of innovative reactors, etc.) • Hydrogen and ammonia etc.

- To reach the 2030 government target of 20-22% target nuclear generation will require eleven reactors restarting operation in the next six years. Given the current government policy measures to support nuclear power, and the pressure being put on the NRA to approve reactor operations, this is not an impossible target, but is also highly uncertain. Compared to the last ten years where nuclear generation has been less than 10%, attaining a percentage of 17% would undoubtedly be seen as a success for current government nuclear energy policies. But it has come at a price – both in economic terms and in terms of reducing nuclear safety. In seeking to achieve significant nuclear reactor operations there have been major policy changes, which run counter to Japan achieving a rapid decarbonized, sustainable and safe energy system.
- One of the clear messages from this analysis of Japan's nuclear energy policy is that it remains highly uncertain the number of reactors restarts by 2030. Projections by utilities of early restarts over the past decade have largely proved wholly unreliable, but clearly more reactors are going to restart in the coming years. Attaining a target of more than 10 percent of electricity by 2030 looks assured; up to 15 percent looks possible, while 17 percent is the highest share theoretically possible.
- On the basis of this analysis, the national target of 20-22 percent is not attainable. Therefore, the shortfall in electricity supply in 2030 will likely range between 5 and 7 percent. As with most issues of nuclear power generation there are also major disruptive factors that could destabilize the current trajectory. The impact from the Noto earthquake will take time to fully be clear, with the potential to delay further restarts and existing reactor operation. Citizen-led lawsuits will almost certainly have further evidence on the risks of earthquakes to submit against operating and yet to be restarted reactors.

Photo credit: Greenpeace/Burnie, Aug 2019

Major obstacles to nuclear restarts / long term operation

- Physical reality of Japan – earthquakes, tsunamis and nuclear regulation
- Local opposition and lawsuits
- Aging of reactor fleet and costs of retrofits/post Fukushima regulatory requirements
- Fukushima Daiichii decommissioning disaster

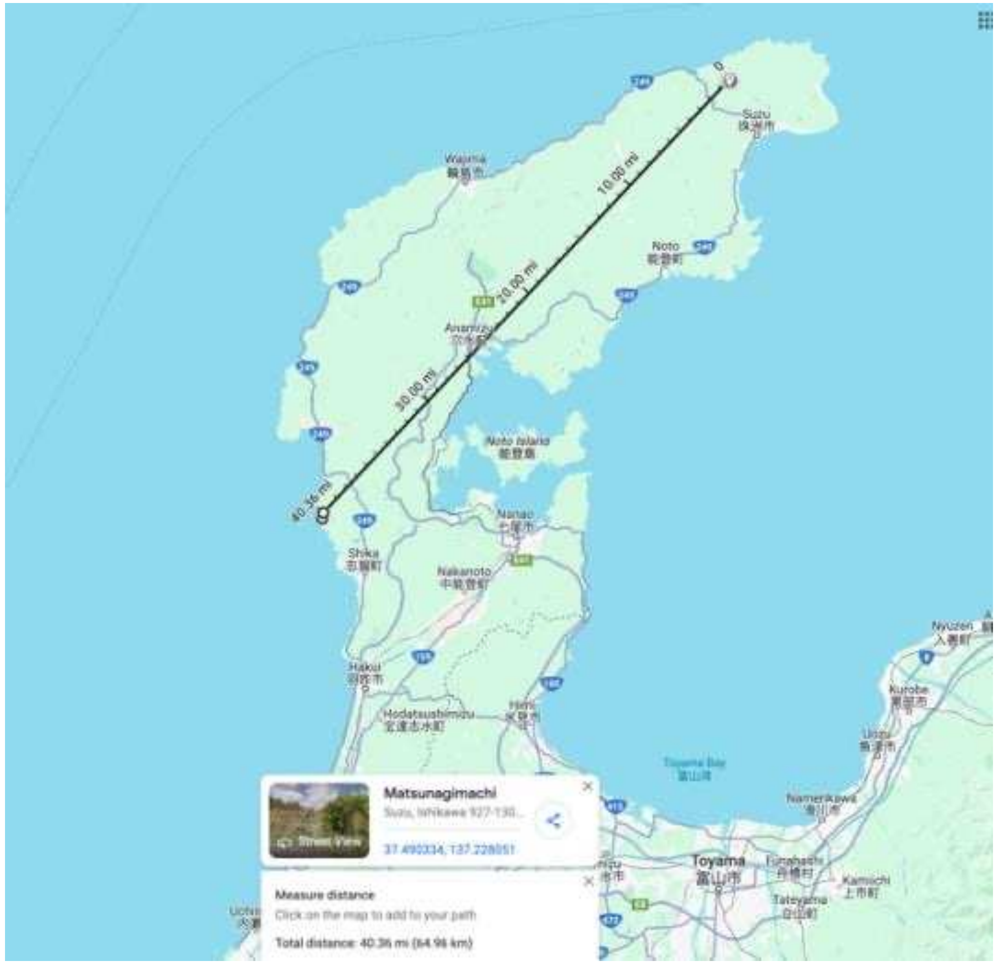
Noto Earthquake, 1 January 2024

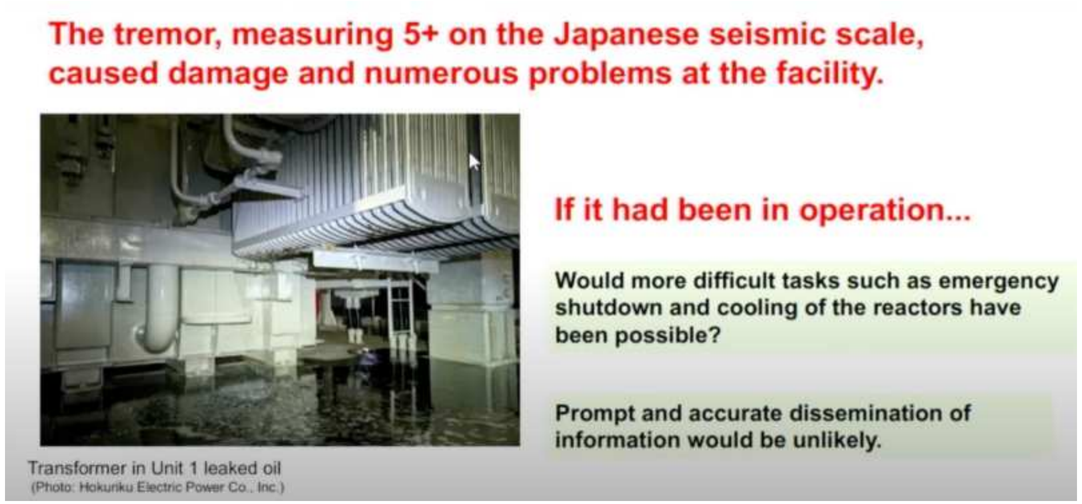
Photo credit: Asahi Shimbun


NBC NEWS

Shika nuclear plant - two reactors BWR and ABWR – not operating since 2011. The site is approximately 45km from epicenter of earthquake on Noto peninsula.

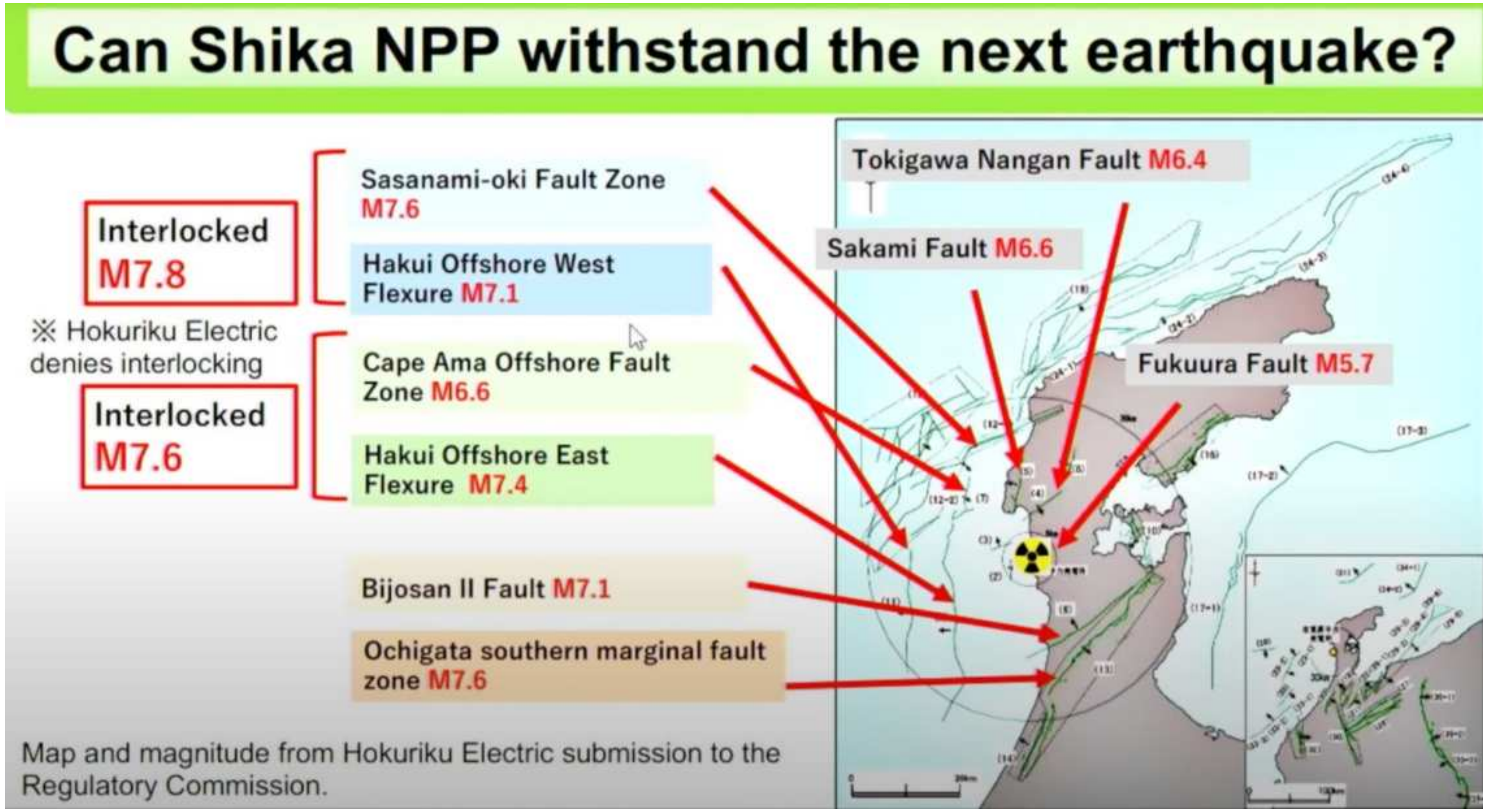
No reactor fuel in the RPV/cores. Spent fuel volumes - 672 assemblies in Unit 1 and 200 assemblies in Unit 2 for a total of 150 tons of fuel –the second smallest volume of any commercial plant in Japan. This is due to the limited operation of unit 2 ABWR which was connected to the grid in 2006.





2006 court victory - On March 24 2006, the Kanazawa District Court ordered the Hokuriku Electric Power Company (Rikuden) to shut down operations of the ABWR Shika 2 reactor due to safety concerns over its ability to withstand powerful earthquakes. The court ruled that there was a real possibility that the plaintiffs might be exposed to radiation if there was an accident at the plant. Prior to the rulings issued by courts after the Fukushima 2011 disaster, this was one of the most important court rulings on nuclear safety during the last 50 years.

The evidence presented to the court included a study commissioned by the Earthquake Research Committee of the Government of Japan. This concluded there was a two percent chance that an earthquake with a magnitude of 7.6 or higher could occur along the 44- kilometer long Ochigata fault, which runs near the NPP. The unit was built to withstand a magnitude 6.5 earthquake. The plaintiffs claimed that unit 2 was built to seismic specifications established more than two decades earlier and therefore posed a direct threat to their safety.



Nearly twenty years after citizen court victory there remain major seismic issues at the plant.

The implications extend across Japan to all nuclear plants, including those reactors still under review by the NRA, such as Tomari in Hokkaido, those that have been granted a license but not resumed operation, and all operating reactors.

CNIC, Shika-2 Verdict Demands Suspension of Operations, May/June 2006, see https://cnic.jp/english/newsletter/nit112/nit112articles/nit112shika2.html

Nuclear Power Plant Disaster due to Earthquake

Earthquake disaster makes self-evacuation difficult

Nuclear disaster makes outside earthquake disaster assistance difficult

Residents are trapped and exposed to radiation

Isolation of contaminated areas prolonged, without relief

Evacuation plans not viable

The nuclear disaster that did not happen – Suzu Nuclear Power Plant, 1 January 2024

The joy of the citizens of Suzu on hearing that the Suzu Nuclear Power Plant plan had been cancelled

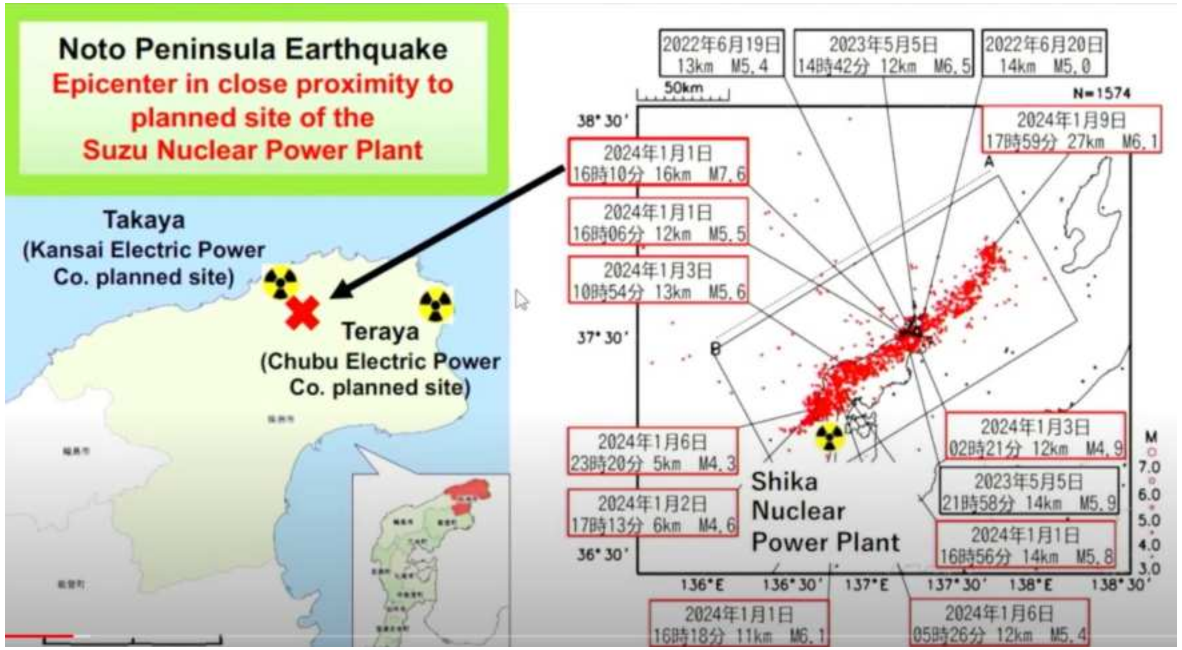
https://cnic.jp/english/newsletter/nit98/nit98articles/nit98suzumaki.html

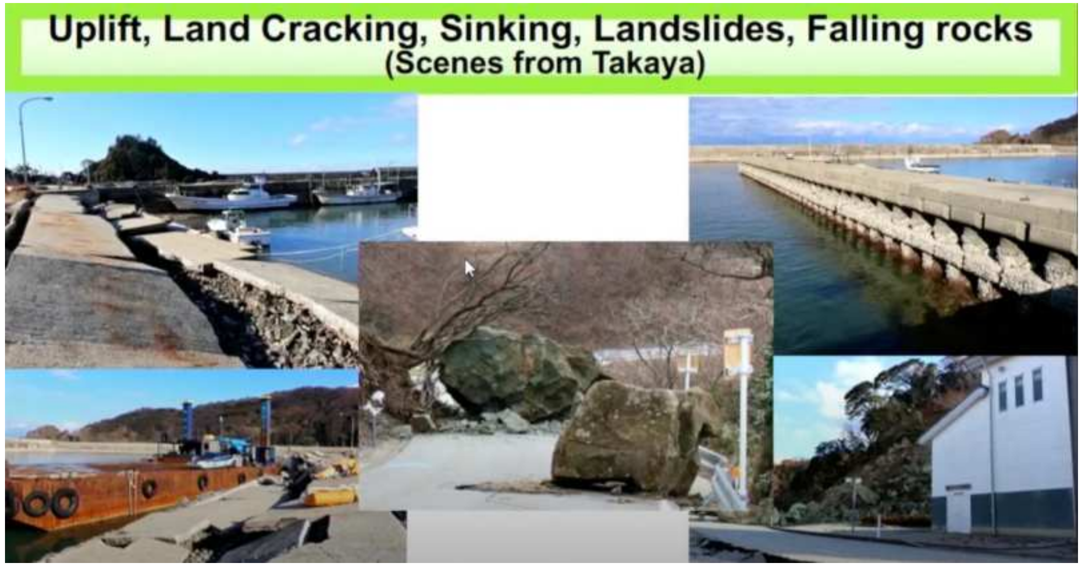
1975 – Local government requests central government for site consideration

1976 - Kansai, Chubu and Tohoku Electric Power Co .announce joint site proposal - local opposition begins

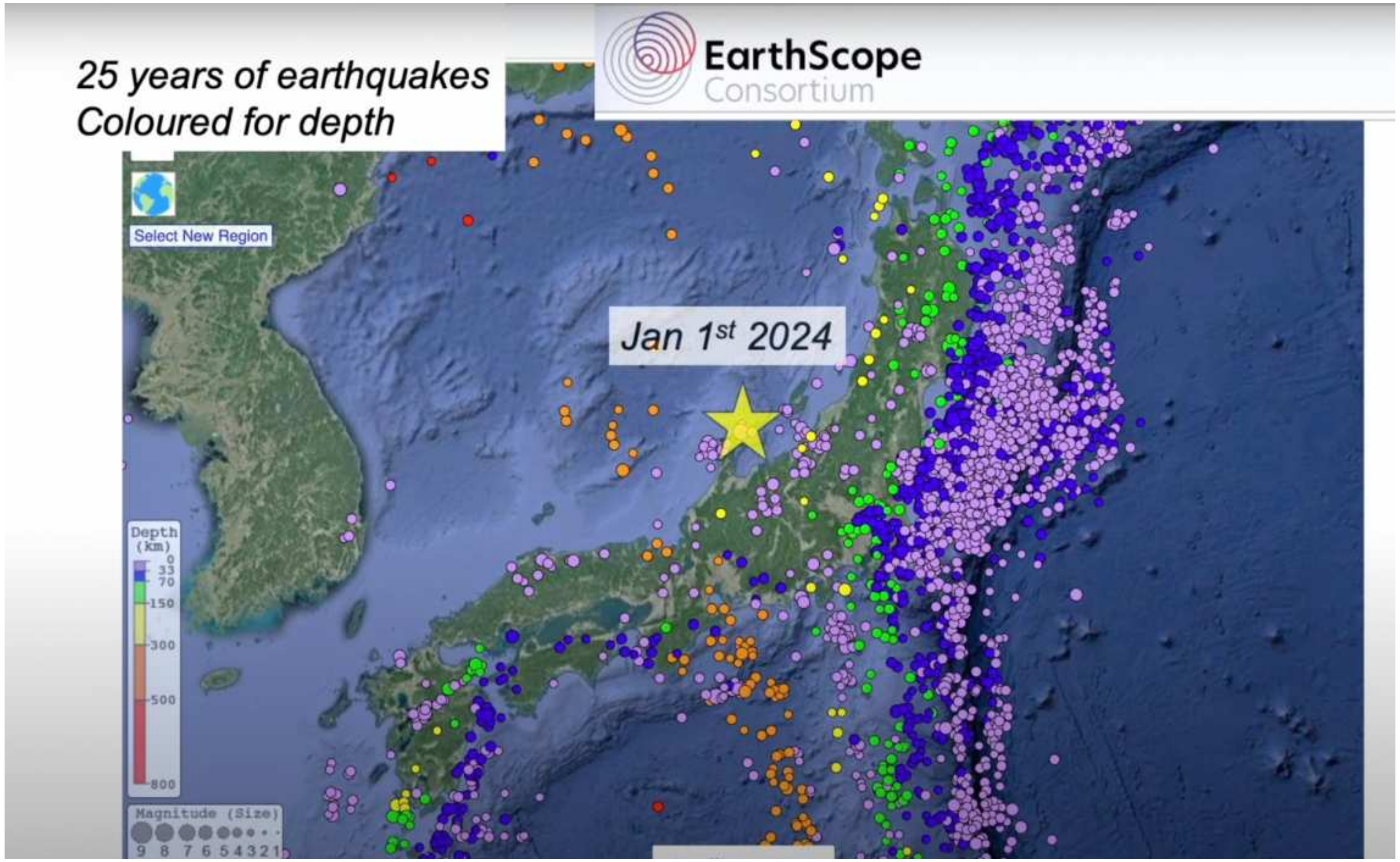
1989 - Citizens stage 3 week action to block City Hall in response to site inspection by KEPCO. Inspection stopped.

2003 - Nuclear power plant plan abandoned



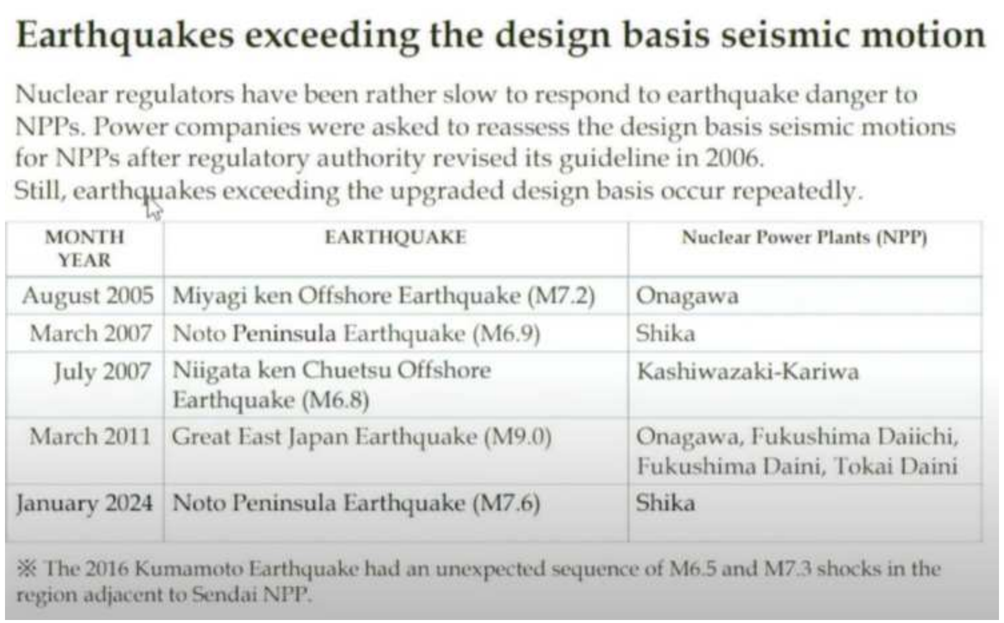


Slides and Photo credit: Susumu Kitano, Chief Plaintiff, Shika nuclear power plant, 29/01/24 - Japan's nuclear power policy and the Noto Peninsula FCCJ, https://www.youtube.com/watch?v=i5isCKb1U6k&t=667s



Source : Rob Butler, Professor of Tectonics at the University of Aberdeen. https://www.youtube.com/watch?v=7zX0loLKcsE

Regulatory capture, failure and returnng to pre-Fukushima



Earthquakes exceeding the design basis seismic motion

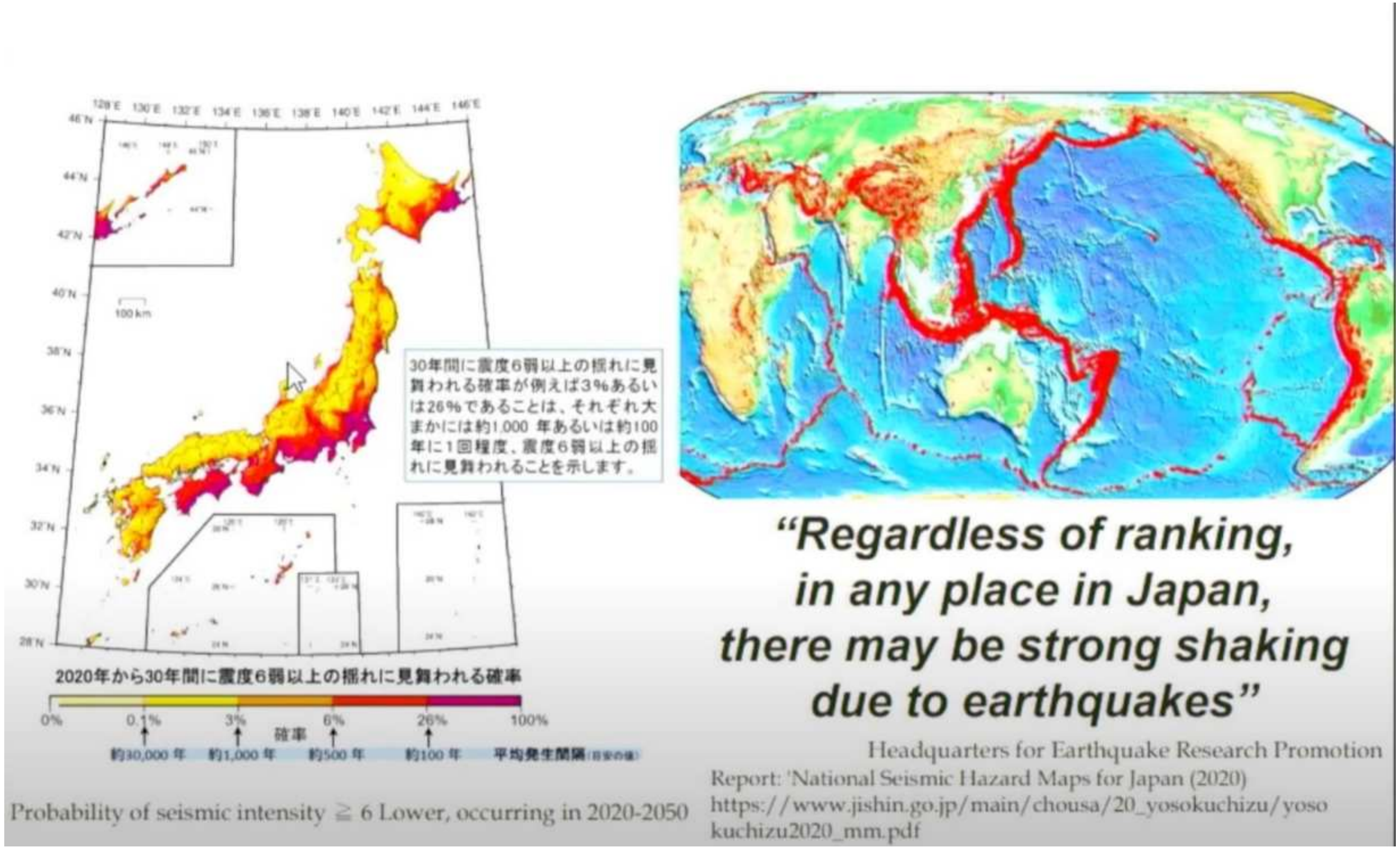
Nuclear regulators have been rather slow to respond to earthquake danger to NPPs. Power companies were asked to reassess the design basis seismic motions for NPPs after regulatory authority revised its guideline in 2006.
Still, earthquakes exceeding the upgraded design basis occur repeatedly.

MONTH YEAR	EARTHQUAKE	Nuclear Power Plants (NPP)
August 2005	Miyagi ken Offshore Earthquake (M7.2)	Onagawa
March 2007	Noto Peninsula Earthquake (M6.9)	Shika
July 2007	Niigata ken Chuetsu Offshore Earthquake (M6.8)	Kashiwazaki-Kariwa
March 2011	Great East Japan Earthquake (M9.0)	Onagawa, Fukushima Daiichi, Fukushima Daini, Tokai Daini
January 2024	Noto Peninsula Earthquake (M7.6)	Shika

※ The 2016 Kumamoto Earthquake had an unexpected sequence of M6.5 and M7.3 shocks in the region adjacent to Sendai NPP.

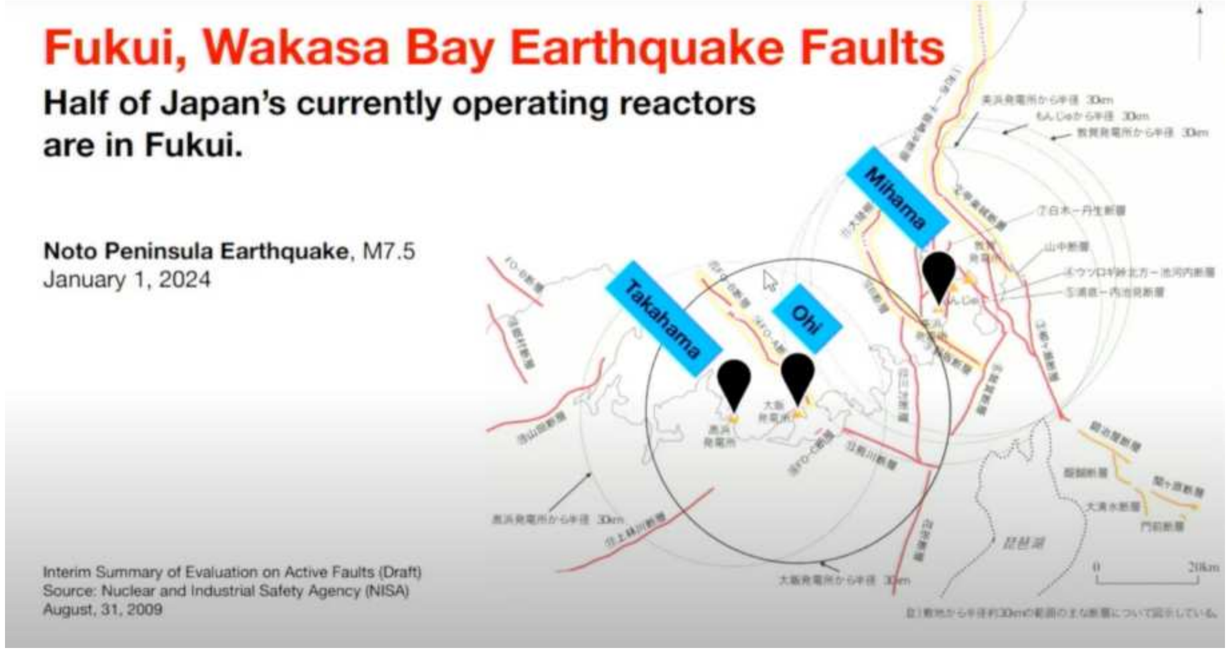
In March 2023, the NRA determined that Hokuriku Electric's claim that ``there are no active faults on the premises" was ``appropriate" during a compliance review of reactor Unit 2. Akira Ishiwatari, the NRA commissioner in charge of screenings, said that, "many pieces of evidence were gathered to determine (that the faults were not active) as a result of the re-evaluation using large amounts of data." The NRA was shortly to begin assessing if the fault lines adjacent to the plant including sub-seabed were active.

The fault that moved on the Noto Peninsula was 150 km, but the expected distance was 96 km, yet Hokuriku Electric Power has repeatedly underestimated the issue.
30 January 30, see https://www.tokyo-np.co.jp/article/306028
Jiji, Faults under Ishikawa nuclear plant inactive, regulator says, 3 March 2023, see https://www.japantimes.co.jp/news/2023/03/03/business/ishikawa-nuclear-plant-fault/



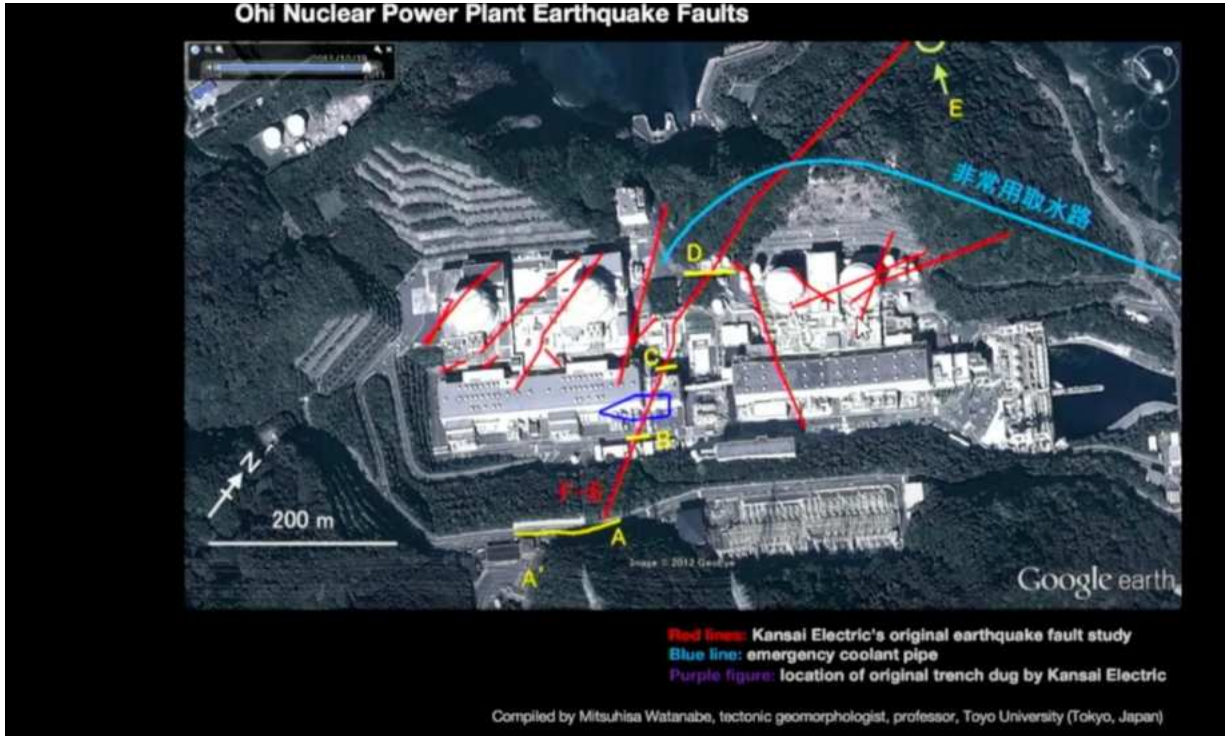
Slides and Photo credit: Susumu Kitano, Chief Plaintiff, Shika nuclear power plant, 29/01/24 - Japan's nuclear power policy and the Noto Peninsula FCCJ, https://www.youtube.com/watch?v=i5isCKb1U6k&t=667s

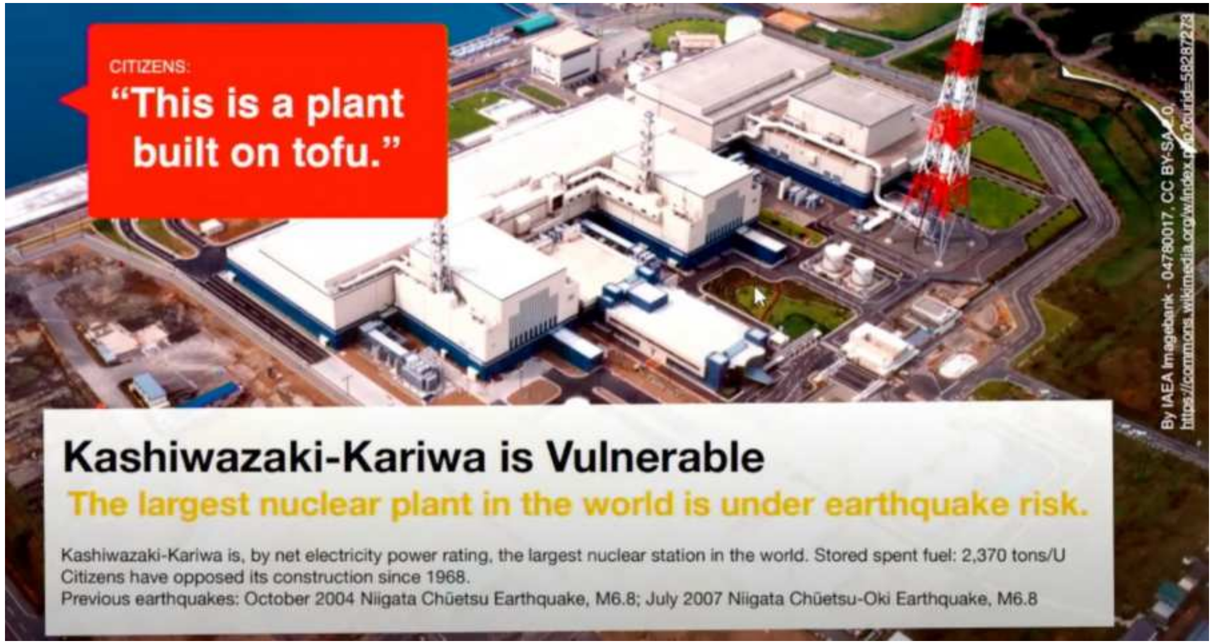
Independent seismologists in Japan have provided expert witness to multiple court proceedings that utilities seismic analysis was flawed and that the nuclear regulator was not considering the full potential impact of earthquakes including fault lines on nuclear power plant operations. This included the flawed distinction between active and inactive faults. The Noto earthquake is a tragic reminder that should not have been necessary - Japan is highly vulnerable to major seismic events including its nuclear plants. – see Yuichi Kaido, Judicial decisions on damages and criminal liability for the Fukushima nuclear accidents, World Nuclear Industry Status Report 2021, see www.worldnuclearreport.org/IMG/pdf/wnisr2021-hr.pdf



Slides and Photo credit: Aileen Mioko Smith, Green Action - Japan's nuclear power policy and the Noto Peninsula FCCJ,

https://www.youtube.com/watch?v=i5isCKb1U6k&t=667s





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Ageing and licensing of currently operating reactors as of 2023

Reactor	Grid connection	NRA life extension	2030	2050
Oi Unit 3 – PWR	1991		39 years	59 years
Oi Unit 4 – PWR	1993		37 years	57 years
Mihama Unit 3 PWR	1976	License to 2036.	54 years	74 years
Takahama Unit 1 PWR	1974	License to 2024, applied for license to 2034	56 years	76 years
Takahama Unit 2 PWR	1975		55 years	75 years
Takahama Unit 3 PWR	1984	Plans to apply for 20-year extension – 2044.	46 years	66 years
Takahama Unit 4 PWR	1984	Plans to apply for 20-year extension to 2044.	46 years	66 years
Genkai Unit 3 – PWR	1984		46 years	66 years
Genkai Unit 4 – PWR	1997		33 years	53 years
Sendai Unit 1 – PWR	1984	Yes until 2044	46 years	66 years
Sendai Unit 2 – PWR	1985	Yes until 2045	43 years	63 years
Ikata Unit 3 – PWR	1994		36 years	56 years

Source: Data compiled by Greenpeace Japan/East Asia

The nuclear policies of the Japanese government reflect an active rejection of the lessons of Fukushima

The NRA has come under severe pressure from Government and industry in recent years, frustrated that it has not approved more reactors for restart.

The revision of the nuclear regulation to allow for reactors to operate beyond 60 years is an example of this.

In the future a utility will submit a request to extend the life of a reactor to the Minister for Economy – this then is passed to the NRA for regulatory review.

The decision to make this change was passed by NRA Commissioners in early 2023, with a lone voice from the five commissioners voting against being seismologist Akira Ishiwatari, who warned that doing so "would drop the operation period (regulation) from the law, and cannot be said to be a modification to the safer side."

The NRA has already approved that reactors that are shutdown due to post Fukushima regulation, and lawsuits will have the period off line not included in their operational lifetime.

The trillion dollar elephant in the room - decommissioning Fukushima Daiichi

Reactor seismic stability

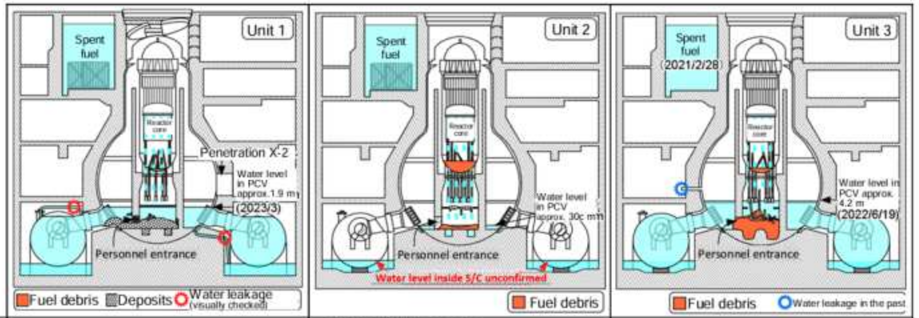
Fuel debris

Water management

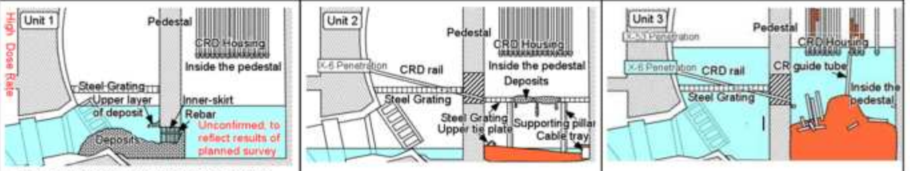
Nuclear waste storage

No credible solutions for any of it

Technical Strategic Plan 2023 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.



	Unit 1	Unit 2	Unit 3
Core region	· Little fuel debris remains.	· Little fuel debris remains. (Partially intact fuel might exist in the peripheral region)	· Little fuel debris remains.
At the RPV lower head	· A small amount of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.	· Large amount of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.	· Part of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.
At the PCV bottom (Inside the pedestal)	· Most of the fuel debris is present.	· A certain amount of fuel debris is present.	· Amount of fuel debris in Unit 3 is more than that in Unit 2.
At the PCV bottom (Outside the pedestal)	· Fuel debris may have spread outside the pedestal through the personal entrance(Deposits have been observed).	· The possibility of fuel debris spreading outside the pedestal through the personal entrance is low.	· Fuel debris may have spread outside the pedestal through the personal entrance.
On-site radiation dose *1	· Radiation dose around the penetration X-6 on the first floor of R/B is high (145 mSv/h).	· Radiation dose on the first floor of R/B had reduced to approx. 5 mSv/h as a whole.	· Radiation dose on the first floor of R/B reaches several to tens of mSv/h or higher than those, indicating a high dose level.



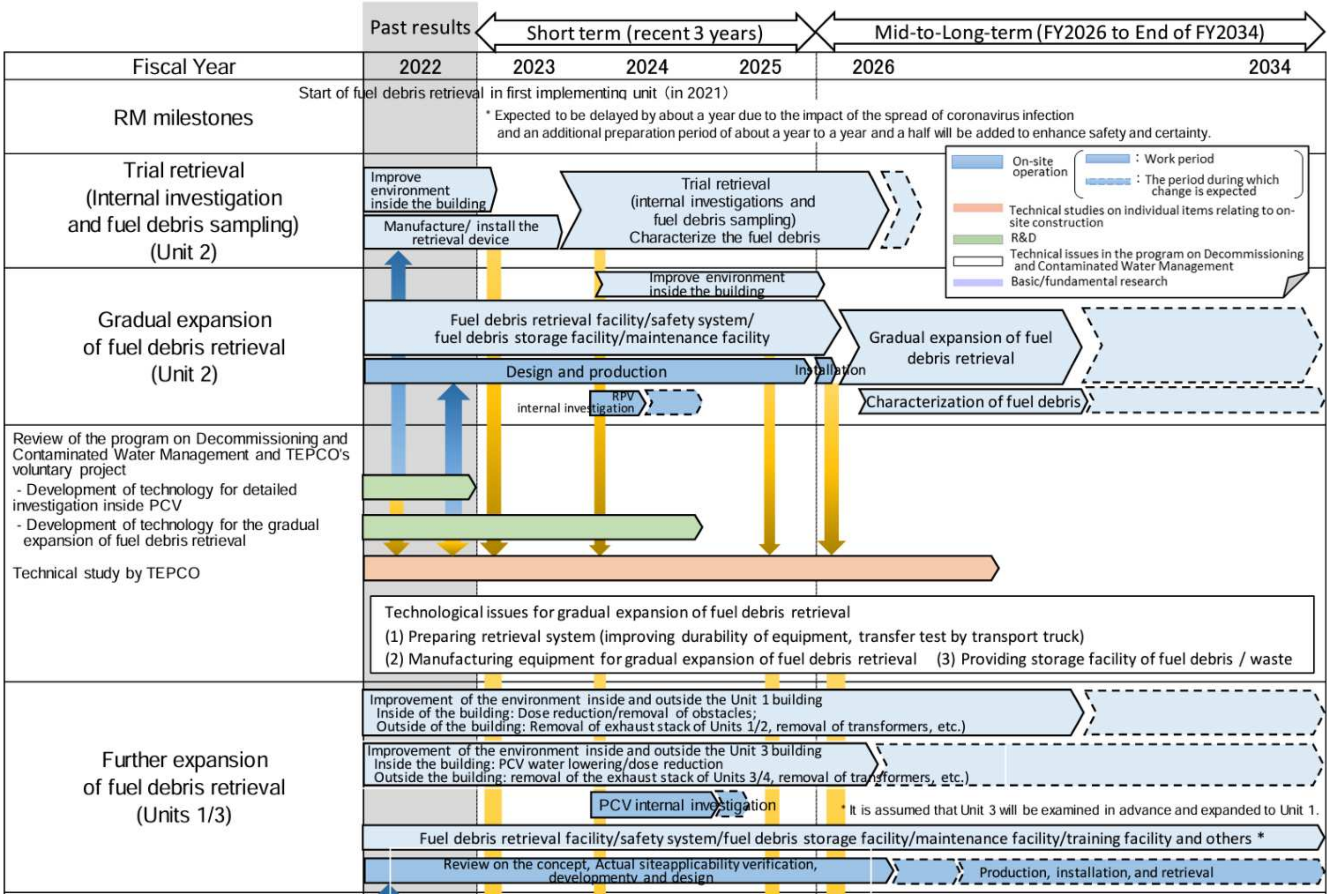
· Exposed rebars were observed around the personal entrance and inside surface of the pedestal.

	Unit 1	Unit 2	Unit 3
Information on the access route to fuel debris *2	· The D/W bottom outside the pedestal is accessible from the upper side of the steel grating. · Condition around the CRD rail connecting into the pedestal from the penetration X-6 has not been observed.	· No large obstacles have been observed on the CRD rail and around the pedestal entrance. · The bottom inside the pedestal is accessible through the pedestal entrance.	· The bottom inside the pedestal is accessible through the pedestal entrance.
Information on the condition of structures around the access route	· At personal entrance, the inner rebar and inner-skirt are exposed, and the PCW system piping is missing. · A deposit approx. 1.0 m thick has been observed around the personal entrance of outside the pedestal (condition, e.g. cavities, of the deposit inside could not be confirmed) · No significant damage has been observed on the wall surface outside the pedestal on the steel grating upper side. · Neutron and Eu-154 gamma rays were detected from the deposits outside the pedestal.	· While a part of fuel assemblies have fallen, no damage has been observed on the CRD housing support in the examined range . · No damage has been observed on the wall surface and the structures (CRD exchanger, etc.) inside the pedestal.	· Some damaged structures and fallen objects (which may include internal structures), and the fall and deformation of a part of the CRD housing support have been observed inside the pedestal. · No damage has been observed on the wall surface inside the pedestal.

*1 Data provided by TEPCO
*2 Results obtained through PCV internal investigation performed up to date were presented for judging whether any obstacles such as fallen objects may exist on the route to the inside of the pedestal from penetration X-6, which is considered as a dominant access route for fuel debris retrieval by the side access method.
Other access routes through the equipment hatch and others have been investigated under the Governmental-led R&D program on Decommissioning and Contaminated Water Management.
Due to high dose rate around penetration X-6 of Unit 1, an access route through the equipment hatch may be used in case that it is difficult to improve the environmental condition around penetration X-6.

(Prepared in reference to "Material 4-1: Progress of treatment of stagnant water in buildings", the 81st meeting of the Study group on monitoring and assessment of specified nuclear facilities)

Fig. 8 Estimated fuel debris distribution, access route and surrounding structures of Units 1 to 3



Past results
Short term (recent 3 years)
Mid-to-Long-term (FY2026 to End of FY2034)
Fiscal Year
2022
2023
2024
2025
2026
2034
RM milestones
Start of fuel debris retrieval in first implementing unit (in 2021)
* Expected to be delayed by about a year due to the impact of the spread of coronavirus infection and an additional preparation period of about a year to a year and a half will be added to enhance safety and certainty.
Trial retrieval (Internal investigation and fuel debris sampling) (Unit 2)
Improve environment inside the building
Manufacture/ install the retrieval device
Trial retrieval (internal investigations and fuel debris sampling) Characterize the fuel debris
On-site operation
: Work period
: The period during which change is expected
Technical studies on individual items relating to on-site construction
R&D
Technical issues in the program on Decommissioning and Contaminated Water Management
Basic/fundamental research
Gradual expansion of fuel debris retrieval (Unit 2)
Improve environment inside the building
Fuel debris retrieval facility/safety system/ fuel debris storage facility/maintenance facility
Gradual expansion of fuel debris retrieval
Design and production
Installation
RPV internal investigation
Characterization of fuel debris
Review of the program on Decommissioning and Contaminated Water Management and TEPCO's voluntary project
- Development of technology for detailed investigation inside PCV
- Development of technology for the gradual expansion of fuel debris retrieval
Technical study by TEPCO
Technological issues for gradual expansion of fuel debris retrieval
(1) Preparing retrieval system (improving durability of equipment, transfer test by transport truck)
(2) Manufacturing equipment for gradual expansion of fuel debris retrieval
(3) Providing storage facility of fuel debris / waste
Further expansion of fuel debris retrieval (Units 1/3)
Improvement of the environment inside and outside the Unit 1 building
Inside of the building: Dose reduction/removal of obstacles;
Outside of the building: Removal of exhaust stack of Units 1/2, removal of transformers, etc.)
Improvement of the environment inside and outside the Unit 3 building
Inside the building: PCV water lowering/dose reduction
Outside the building: removal of the exhaust stack of Units 3/4, removal of transformers, etc.)
PCV internal investigation
* It is assumed that Unit 3 will be examined in advance and expanded to Unit 1.
Fuel debris retrieval facility/safety system/fuel debris storage facility/maintenance facility/training facility and others *
Review on the concept, Actual siteapplicability verification, developmenty and design
Production, installation, and retrieval

Fuel removal mutiple scenarios - but decades away

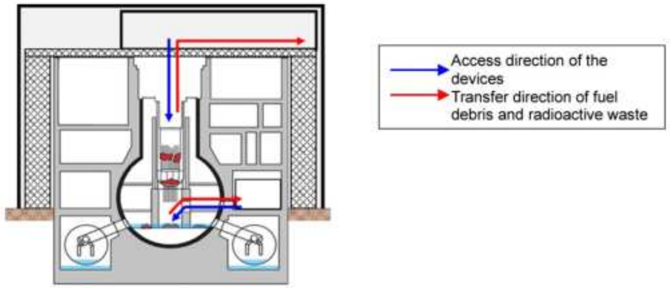


Fig. 15 Example of the proposed partial submersion method (water injection to RPV)
(Conceptual drawing o[illegible] and side access)

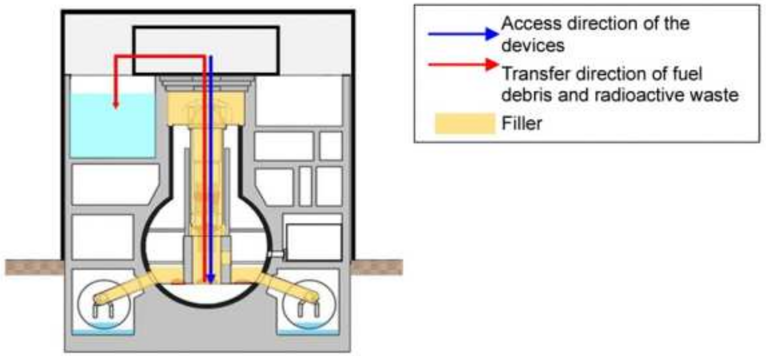


Fig. 16 Overview of the partial submersion method option (RPV filling and solidification)

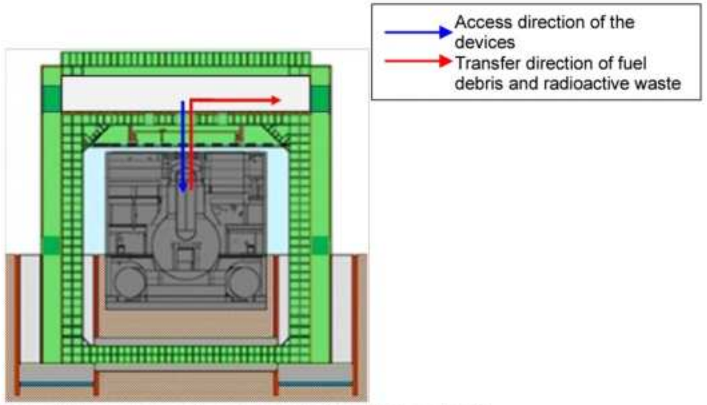
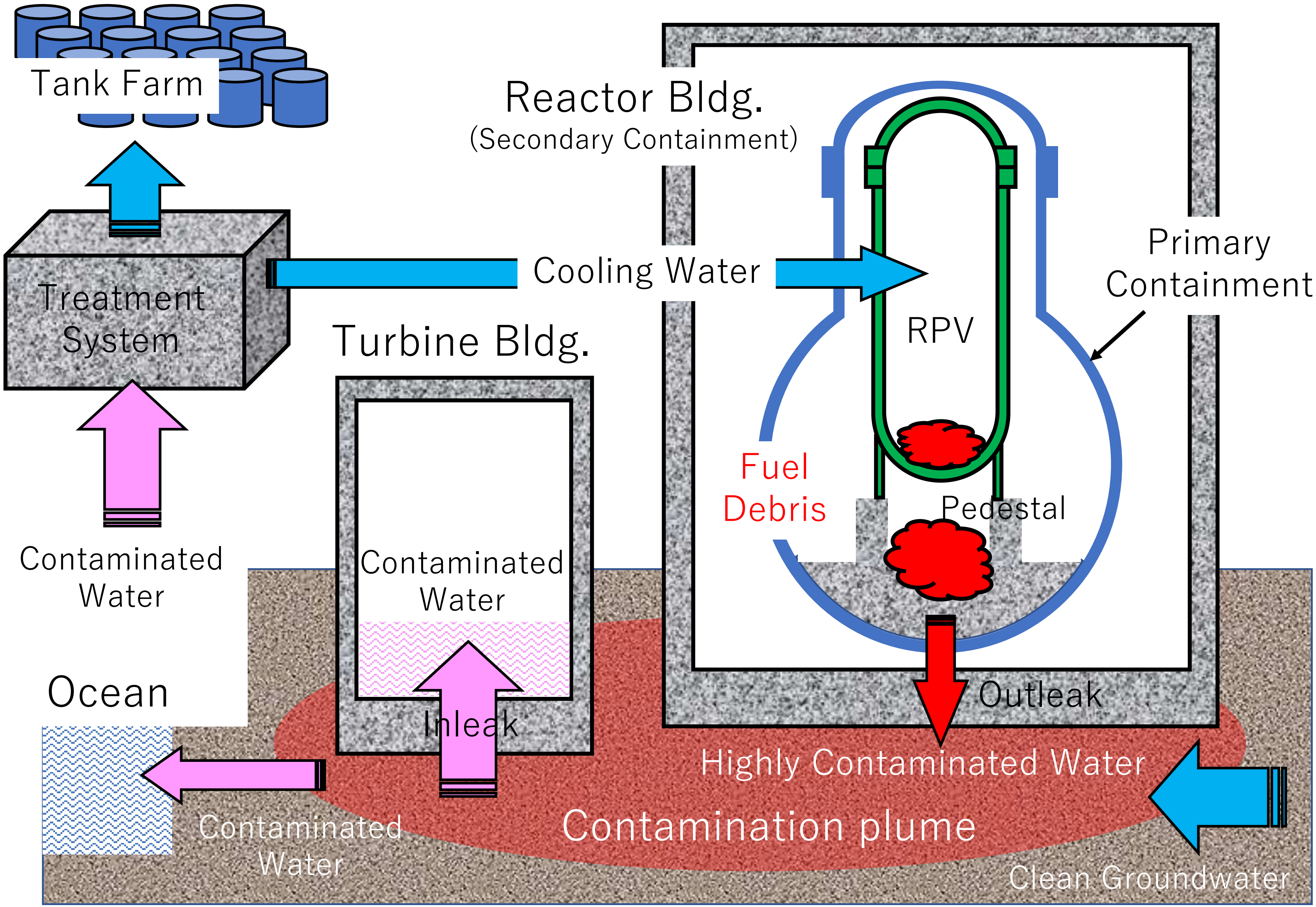


Fig. 17 Example of the submersion method (Shell structure)
(Conceptual drawing of the shell structure)



Tank Farm
Reactor Bldg.
(Secondary Containment)
Treatment System
Cooling Water
Primary Containment
RPV
Turbine Bldg.
Fuel Debris
Pedestal
Contaminated Water
Contaminated Water
Ocean
Inleak
Outleak
Highly Contaminated Water
Contamination plume
Contaminated Water
Clean Groundwater

Fuel burn through RPV Fukushima Daiichi

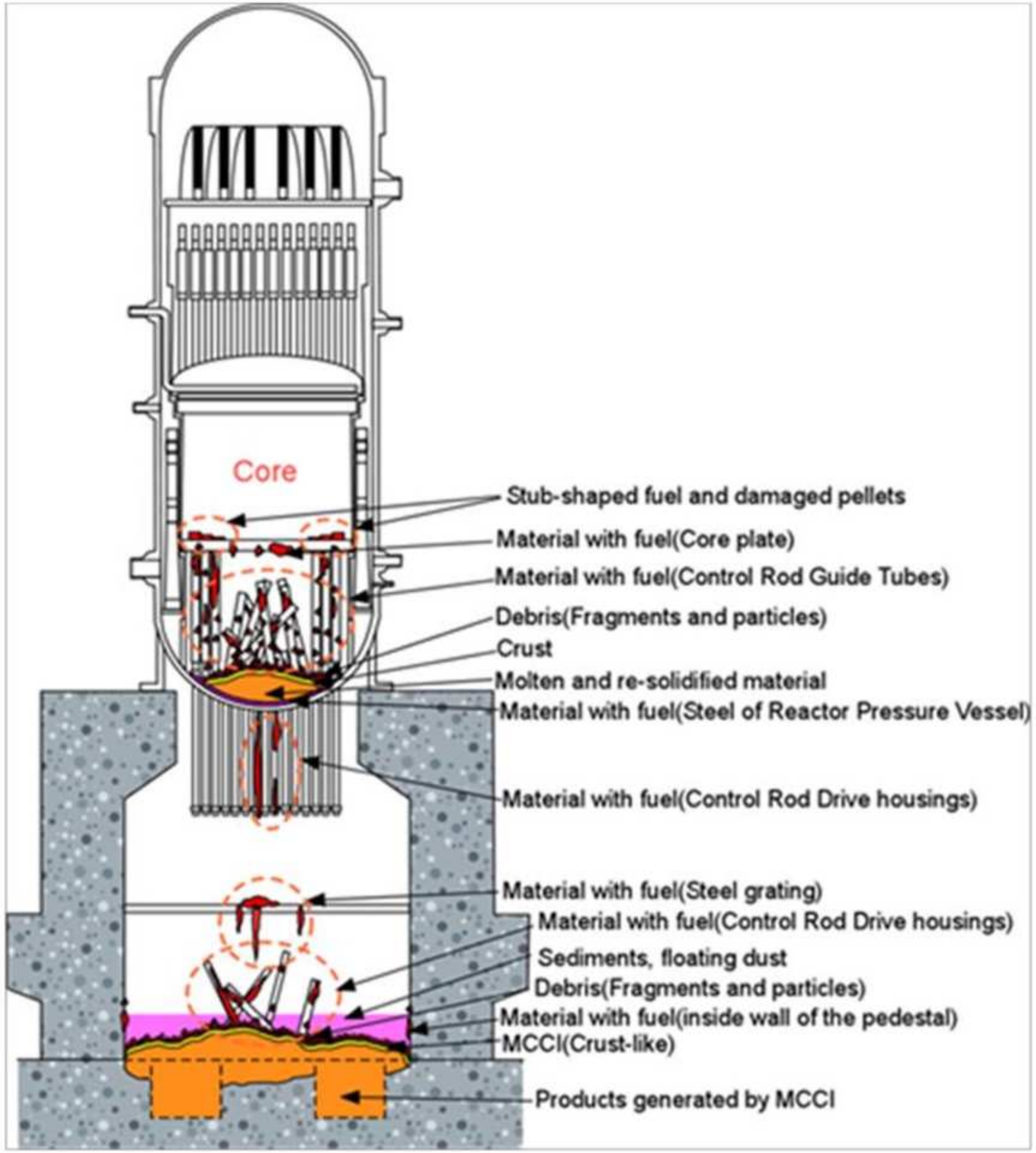
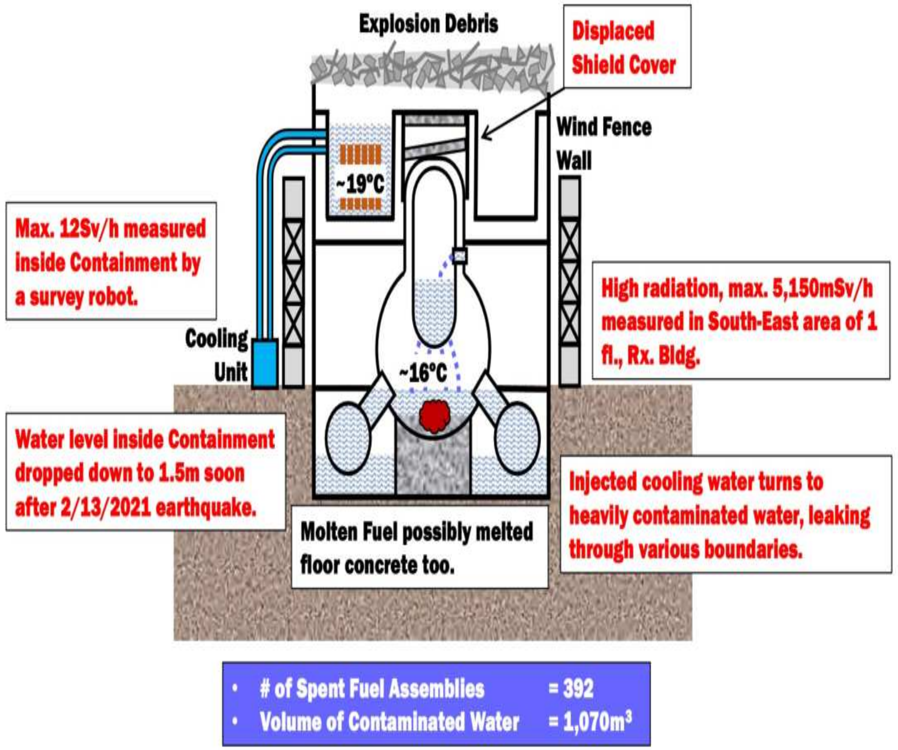


Fig. A6-1 Estimated inside of the PCV of the Fukushima Daiichi NPS

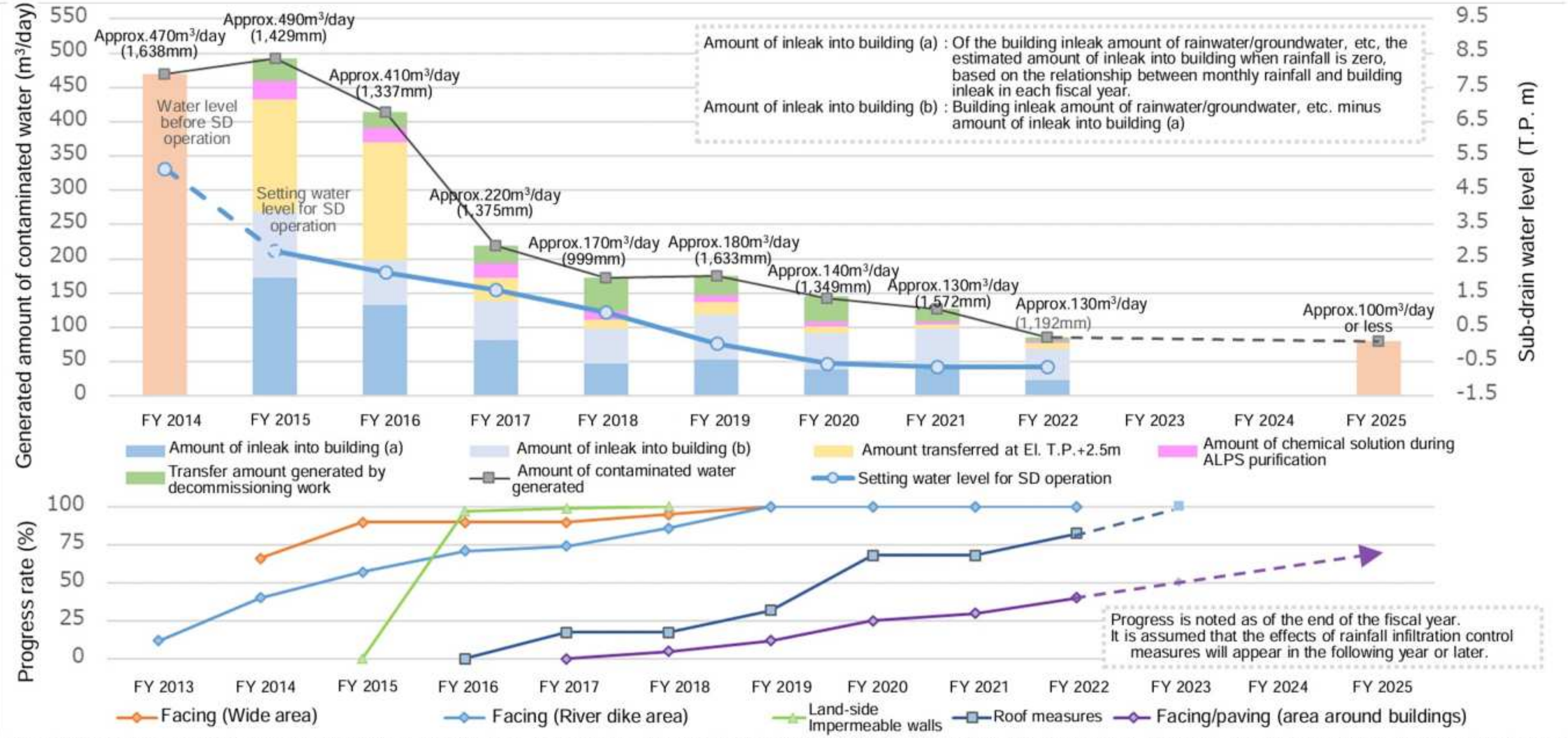
One example of the scale of the decommissioning challenge - Severe damage to Unit 1 pedestal – not predicted, not modelled – major implications – including seismic risks, spent fuel removal and potential collapse with radiological impacts and impact on debris removal

Photo 4 Exposed rebar at pedestal opening (left side)

Unit 1 Status as of 1/13-19/2022



No end to radioactive contaminated water



* In FY2014, the amount of contaminated water generated was not calculated by each breakdown, it was not accumulated by breakdown. (See Slide 28 for breakdown of contaminated water)

Major multilayered contaminated water management

May 2014
◆ Groundwater by-pass operation started

FY 2015
◆ Wide area facing established

September 2015
◆ Sub-drain operation started

October 2015
◆ Sea-side impermeable wall closed

November 2015
◆ Groundwater drain operation started

March 2016
◆ Freezing of land-side impermeable wall (Phase 1)

August 2017
◆ Land-side Impermeable walls

FY 2017
◆ Joint control of El. 2.5m facing

February 2018
◆ R/B cover for Unit 3 installed

FY 2016
◆ Freezing of seaward side of land-side impermeable wall

March 2018
◆ Enhancing processing capacity of SD system completed (1,000⇒2,000m³/day)

March 2020
◆ Roof measures for Rw in Unit 3 completed

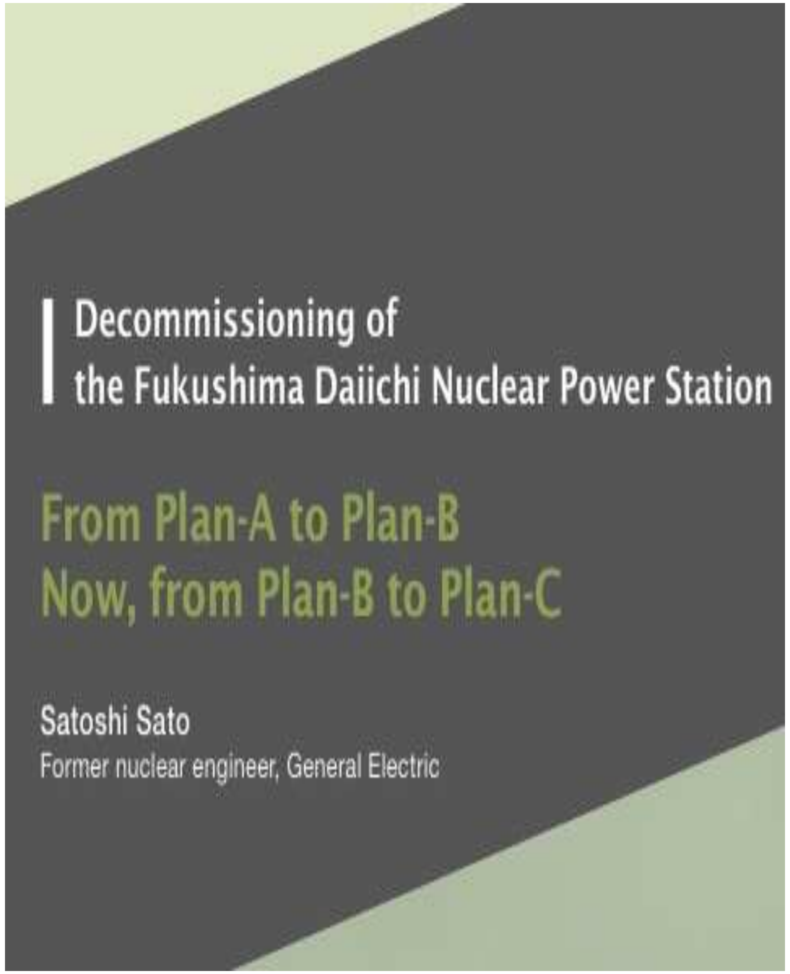
FY 2020
◆ Roof measures for T/B in Unit 3 completed
◆ Northeast roof for R/B in Unit 3

FY 2023
◇ Target of 50% completion for facing in frozen soil

Around FY 2023
◇ R/B cover of Unit 1 installed (Incl. rainwater measures for Rw/B of Unit 1)

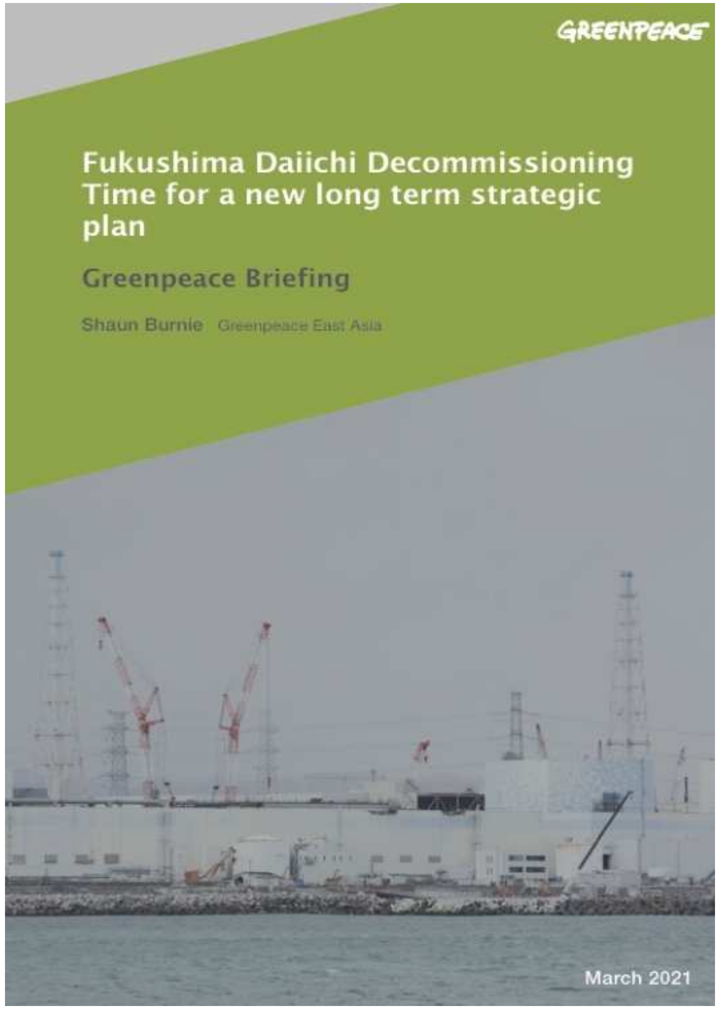
By the end of FY 2025
◇ Amount of contaminated water to 100 m³/day or less

◆ Measures taken
◇ Measures being planned


Decommissioning of
the Fukushima Daiichi Nuclear Power Station

From Plan-A to Plan-B
Now, from Plan-B to Plan-C

Satoshi Sato
Former nuclear engineer, General Electric


GREENPEACE

Fukushima Daiichi Decommissioning
Time for a new long term strategic plan

Greenpeace Briefing

Shaun Burnie Greenpeace East Asia

March 2021

Official decommissioning plan – 2041-2051 ?
Impossible