

Japan's nuclear crisis

Fukushima Daiichi Status report

GREENPEACE

February 2015

© Robert Knoth / Greenpeace

www.greenpeace.org

The Fukushima Daiichi nuclear crisis

Year Four

Status report

February 2015

Written by Shaun Burnie (Greenpeace Germany)

"(The) impact from accumulating radioactive water at the crippled Fukushima No. 1 nuclear plant has been "under control." Prime Minister Shinzo Abe, October 16th 2013.¹

"There is a mountain of issues, including contaminated water, decommissioning, compensation and contamination... When I think of the victims still living in difficult evacuation conditions I don't think we can use the word 'settled', " to describe the Fukushima plant," Prime Minister Shinzo Abe, January 30th 2015.²

Introduction

Four years after the start of the Fukushima Daiichi nuclear power plant disaster of March 11th 2011 the enormous scale of the nuclear crisis continues to unfold. In the face of the continuing disaster, even Japanese Prime Minister Abe appears to be revising his position of 2013 that the situation at Fukushima is under control. The INES 7 nuclear accident on the International Atomic Energy Agency (IAEA) nuclear event scale³, which led to the melt down of three General Electric Mark 1 Boiling Water Reactors (BWRs) at Fukushima Daiichi has created a nuclear disaster unique in the history of nuclear power. Plant owner, Tokyo Electric Power Company (TEPCO), and sub-contracting companies have used tens of thousands of workers during the past four years,⁴ in an attempt to bring the site under some form of control, reduce the risks of further accidents and to lower radioactive releases into the environment, including the Pacific Ocean. Despite the enormous efforts of these workers significant contamination continues to be released from the site and the threats of further accident remain high. The scale of the challenges, including those yet to be identified, means that this work will continue for decades to come. As the people of Japan remember and pay their respects to the victims of the Great Tohoku earthquake, and amidst all the uncertainties about the Fukushima Daiichi nuclear disaster, one thing is certain, tragically there will be many more anniversaries in the years ahead when the crisis at the Fukushima site will still threaten the environment and people of Japan.

Water, water everywhere

The multiple problems facing TEPCO in relation to the management of contaminated water are unprecedented. For nearly four years since the start of the Fukushima Daiichi accident, TEPCO has been pumping hundreds of tons of water each day into the plant to cool the molten nuclear reactor fuel reactor units 1, 2 and 3.⁵ Without this cooling water the molten fuel (corium) temperature would rise leading to additional nuclear reactions. The precise locations of the molten cores⁶ remain unknown to TEPCO or anyone else, though it is accepted that a large proportion has melted through the steel pressure vessels into the lower containment.⁷ The coolant water with added neutron-absorbing

¹ "Abe claims Fukushima radioactive water woes are 'under control', Kyodo, October 16th 2013, <http://www.japantimes.co.jp/news/2013/10/16/national/politics-diplomacy/abe-claims-fukushima-radioactive-water-woes-are-under-control/#.VNk15yiaH6g>

² "Japan looks at 2030 energy targets in shadow of Fukushima cleanup, Osamu Tsukimori and Mari Saito, Reuters, January 30th 2015, <http://www.reuters.com/article/2015/01/30/us-japan-nuclear-idUSKBN0L314M20150130>, accessed January 30th 2015, accessed February 11th 2015.

³ In reality the radioactive releases in the first 12 days of the accident were the equivalent of at least 3 level seven INES (International Nuclear Event Scale), Fukushima Already Level 7 Chernobyl Accident Greenpeace analysis concludes https://www.greenpeace.de/sites/www.greenpeace.de/files/INES_7march_25th_0.pdf, accessed February 11th 2015.

⁴ "Special Report- Japan's homeless recruited for murky Fukushima clean-up", Reuters, December 30th, 2013, <http://uk.reuters.com/article/2013/12/30/fukushima-workers-special-report-pix-grf-idUKL3N0K51ZU20131230>, accessed February 11th 2015.

⁵ PCV Venting and Alternative Cooling Water Injection Preparation for Fukushima Daiichi Nuclear Power Station Unit 2 http://www.tepco.co.jp/en/nu/fukushima-np/interim/images/111202_12-e.pdf

⁶ TEPCO began new efforts to identify the location of the molten fuel in reactor unit 1 on February 9th 2015. Fukushima Daiichi NPS Prompt Report 2015 Fukushima Daiichi NPS Prompt Report (Feb 09,2015) Recent topics: Cosmic "MUON" Rays To Look Inside Fukushima Reactors As Tepco Begins Testing, TEPCO, http://www.tepco.co.jp/en/press/corp-com/release/2015/1248057_6844.html, accessed February 11th 2015.

⁷ Update on the Nuclear and Radiological Situation at Fukushima Daiichi, Large and Associates, Greenpeace Germany May 25th 2011; TEPCO:

boron is pumped and sprayed into the main vessels; it then leaks into the secondary containment through the holes and cracks at the bottom of the reactor vessels, into the basements of the reactor buildings and the connected turbine buildings. The molten fuel cooling operation will be required to continue for many years.

It is the massive volume of cooling water that accounts for the majority of the radioactively contaminated water stored in approximately 1000 steel tanks assembled on the site since 2011. As of December 2014, a total of 320,000 tons of this highly contaminated water was stored in the tanks.⁸ TEPCO is operating several technologies to remove up to 62 radionuclides from this water, not including the radioactive isotope tritium.⁹ Multiple delays and technical breakdowns have occurred during the past years.¹⁰ However, TEPCO have scaled up their program and during the month to December 17th 2014, the volume of highly contaminated water was reduced by 20,000 tons. The principle technologies being used, including for the removal of strontium-90, a bone-seeking carcinogenic isotope – are ALPS¹¹ and Kurion¹². In the week to February 12th, 2015, TEPCO expect to process 16,000 tons of highly contaminated water,¹³ with a predicted maximum processing of 60,000 tons of water each month according to the company.¹⁴ At the same time, treated water with high levels of tritium amounted to 297,000 tons as of February 8th 2015, which will continue to increase until they reach the point if and when they are able remove tritium.¹⁵

TEPCO's schedule was to have completed processing of all highly contaminated water by the end of March 2015 but was revised in January 2015 when the company announced that it had completed processing of "approximately 50 percent".¹⁶ A new schedule is to be announced in March, with TEPCO predicting that it will complete processing of water in May. At the same time, around 300 tons of water each day is required to cool the remaining core and molten fuel in the three reactors.¹⁷

Underground water – The official estimate is that 800 tons of water flows onto the site each day, of which TEPCO estimate 300-400 tons becomes contaminated. TEPCO state that the contamination of groundwater entering the site is due to surface contamination permeating the soil and reaching the ground water, and that 'theoretically' the

-
- Nearly all nuclear fuel melted at Fukushima No. 3 reactor, Asahi Shimbun, August 7th 2014, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201408070055>, accessed February 11th 2015.
- ⁸ Situation of Storage and Treatment of Accumulated Water including Highly Concentrated Radioactive Materials at Fukushima Daiichi Nuclear Power Station (181th Release) December 17, 2014 Tokyo Electric Power Company. http://www.tepco.co.jp/en/press/corp-com/release/betu14_e/images/141217e0101.pdf, accessed February 1st 2015.
- ⁹ Multi-nuclide Removal Equipment (ALPS) Confirmatory Testing, Installation and Characteristics of Radioactive Waste June 25, 2012 Tokyo Electric Power Company, TEPCO, http://www.tepco.co.jp/en/nu/fukushima-np/roadmap/images/m120625_01-e.pdf, accessed February 11th 2015.
- ¹⁰ "Tepco Set to Miss Target for Fukushima Radioactive Water Cleanup", Jacob Adelman, Bloomberg, August 4th 2014, <http://www.bloomberg.com/news/articles/2014-08-04/tepco-set-to-miss-target-for-fukushima-radioactive-water-cleanup>, accessed February 11th 2015; Fukushima Daiichi NPS Prompt Report 2014 Fukushima Daiichi NPS Prompt Report (Jun 26,2014) Tepco's 'ALPS' Restart Part Of Major Upgrade To Water Treatment, http://www.tepco.co.jp/en/press/corp-com/release/2014/1238403_5892.html, accessed February 11th 2015.
- ¹¹ Overview of the Multi-nuclide Removal Equipment (ALPS) at Fukushima Daiichi Nuclear Power Station, March 29th, 2013 Tokyo Electric Power Company, http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2013/images/handouts_130329_01-e.pdf, accessed January 30th 2015.
- ¹² Wastewater Treatment at Fukushima Daiichi Nuclear Plant, <http://www.kurion.com/applications/separation/fukushima> and <http://www.environmentalleader.com/2014/12/12/kurion-mobile-processing-system-exceeds-fukushima-decontamination-targets/> accessed January 30th 2015.
- ¹³ Situation of Storage and Treatment of Accumulated Water including Highly Concentrated Radioactive Materials at Fukushima Daiichi Nuclear Power Station (187th Release) February 6, 2015 Tokyo Electric Power Company http://www.tepco.co.jp/en/press/corp-com/release/betu15_e/images/150206e0201.pdf, accessed February 11th 2015.
- ¹⁴ Fukushima Daiichi NPS Prompt Report - TEPCO Reports Major Progress In Water Treatment, But Completion Target Date Extended Due To Implementation Of New Technologies And To Ensure Worker Safety – January 23rd, 2015. http://www.tepco.co.jp/en/press/corp-com/release/2015/1247689_6844.html, accessed January 31st 2015.
- ¹⁵ Three companies were selected in September 2014 to demonstrate the potential use of technology for tritium removal at the Fukushima-daiichi site. The three companies are RosRAO, a subsidiary of Russia's state nuclear corporation Rosatom, GE Hitachi Nuclear Energy Canada and US-based Kurion. The technology must be shown to be capable of achieving a separation factor higher than 100 and of being able to process up to 400 cubic metres of water a day with a tritium concentration between 0.6 and 4.2 million becquerel per litre (Bq/l). The deadline for the demonstration is 31 March 2016., 08.09.2014_No282 / News in Brief Companies Chosen For Fukushima-Daiichi Tritium Demonstration Project, <http://www.nucnet.org/all-the-news/2014/09/08/companies-chosen-for-fukushima-daiichi-tritium-demonstration-project>, accessed February 11th 2015.
- ¹⁶ Fukushima Daiichi NPS Prompt Report - TEPCO Reports Major Progress In Water Treatment, But Completion Target Date Extended Due To Implementation Of New Technologies And To Ensure Worker Safety – January 23rd, 2015. http://www.tepco.co.jp/en/press/corp-com/release/2015/1247689_6844.html, accessed January 31st 2015.
- ¹⁷ Situation of Storage and Treatment of Accumulated Water including Highly Concentrated Radioactive Materials at Fukushima Daiichi Nuclear Power Station (175th Release) November 5, 2014 Tokyo Electric Power Company, http://www.tepco.co.jp/en/press/corp-com/release/betu14_e/images/141105e0201.pdf, accessed January 31st 2015.

groundwater does not come into contact with water inside the reactor buildings;¹⁸ as such it's a theory not yet proven. Efforts to reduce the flow on to the site have included pumping ground water from wells on the land side of the plant.

TEPCO also launched efforts during the last year to pump up contaminated water in the drainage system immediately around the plant (both land side and ocean side), as well as at the groundwater drain in close proximity to the ocean. It was confirmed that this water was contaminated.¹⁹ TEPCO plans to process this water to remove radionuclides, with the exception of tritium²⁰, and then release it into the Pacific Ocean – but not before 'understanding' is reached with local commercial fishing associations.²¹

TEPCO is also installing what is described as an 'impermeable' wall on the ocean-side of the plant, the aim of which is to prevent contaminated water continuing to flow into the Pacific. After admitting in 2013 that up to 400 tons of contaminated water has been flowing into the ocean since the beginning of the nuclear crisis,²² attempts to prevent this contamination have focussed on the construction of the 770 metre underground steel pipe and sheet wall. As of January 2015, the structure has been nearly completed.²³ How effective this will be in preventing contaminated groundwater from entering the Pacific remains to be seen. The steel structure is located to a depth of 30 metres, which TEPCO asserts is below the permeable soil layer. This assumption is highly questionable due to geological surveys of the site, which show permeable sandstone and pumice layers from the surface to a depth of nearly 200 metres.²⁴ Based upon this potentially deeply flawed geological assessment, TEPCO has estimated that there will be a reduction of 97.5% of cesium and strontium released into the ocean once this wall is in place, and contaminated groundwater is pumped to storage tanks. Tritium discharges are predicted to be reduced by 93%.²⁵

Ice wall - TEPCO plans to reduce the volume of groundwater entering the site by constructing what has become known as a frozen ice wall – with a circumference of 1.5km around Fukushima Daiichi.²⁶ The technology to be used involves drilling holes and inserting 1571 steel pipes 30 metres into the ground, which will then be cooled to minus 30 centigrade. TEPCO's aim is that this will then gradually freeze soil to create what they hope will be an ice wall that will significantly reduce to one third the present rate of groundwater entering the site and contaminated water on site from leaking out. TEPCO plans to begin the freezing operation in March 2015, with the objective to maintain it for six years – the time they say that will be required to seal the reactors from the environment. In addition to looking like an unrealistic schedule, there are significant doubts about the effectiveness of the ice wall plan. The uncertainties include the actual rate of ground water migration, the effect this diversion of water will have on the site, the geology of the site, soil movement (including seismic risks) and surface temperature. For good reason, even one of TEPCO's own senior international advisors and a Commissioner at the Nuclear Regulatory Authority (NRA) have questioned the prospects for the ice wall barrier's effectiveness and its consequences.²⁷

¹⁸ Efforts to ensure ocean protection Tokyo Electric Power Company August 11th, 2014, http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_03-e.pdf, accessed February 12th 2015.

¹⁹ Fukushima ice wall plan delayed by 2 weeks, NHK, August 2014, <http://www3.nhk.or.jp/nhkworld/english/news/nuclear.html>, accessed February 11th 2015.

²⁰ "The hazards of tritium – revisited". *Medicine, Conflict and Survival*. Vol 24:4, October 2008. pp 306 -319, http://www.ccnr.org/tritium_Fairlie.pdf, accessed February 10th 2015.

²¹ "Tepco Faces Decision to Dump Radioactive Water in Pacific", Tsuyoshi Inajima, Bloomberg, April 12th 2013, <http://www.bloomberg.com/news/2013-04-11/tepco-faces-decision-to-dump-radioactive-water-in-pacific-ocean.html>, accessed February 9th 2015.

²² "New Leaks Into Pacific at Japan Nuclear Plant", Martin Fackler, New York Times, August 6th 2013, http://www.nytimes.com/2013/08/07/world/asia/leaks-into-pacific-persist-at-japan-nuclear-plant.html?pagewanted=all&_r=1&, accessed January 31st 2015.

²³ Overview of Impermeable Wall Construction on the Sea Side, Tokyo Electric Power Company, April 2nd, 2013, http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2013/images/handouts_130402_01-e.pdf, accessed February 2nd 2015.

²⁴ Stratigraphic geology of the site of Fukushima Daiichi, August 2011, <http://ddata.over-blog.com/4/37/62/00/The-Geology-of-Fukushima.pdf>, accessed January 31st 2015.

²⁵ Efforts to ensure ocean protection, Tokyo Electric Power Company August 11, 2014, http://www.tepco.co.jp/en/nu/fukushima-np/handouts/2014/images/handouts_140811_03-e.pdf, accessed January 30th 2015.

²⁶ The Oak Ridge National Laboratory in the United States demonstration project is cited as the example on why the ice wall should work, but there are significant differences and therefore uncertainties with the Fukushima plan, not least the scale of the project in Japan, see, Frozen Soil Barrier Technology, SEG Facilities Oak Ridge, TN in cooperation with U.S. Department of Energy Oak Ridge Operations U.S. Department of Energy Office of Environmental Management Office of Technology Development April 1995.

²⁷ "Experts Criticize Ice Wall Plan At Japan's Fukushima Nuclear Plant", Mari Yamaguchi, February 5th 2014, Associated Press, http://www.huffingtonpost.com/2014/05/02/fukushima-ice-wall_n_5252868.html, accessed January 29th 2015.

Another operation that aimed to prevent 11,000 tons of highly contaminated water located in underground trenches at the Fukushima Daiichi plant from leaking into the Pacific Ocean also involved efforts to freeze the water – this failed during 2014.²⁸ TEPCO have denied²⁹ that this delay will have any effect on the much larger ice wall construction and operation around the site, but it has raised further questions as to the effectiveness of their plan. The failure of this project would have a major impact on decommissioning plans, radiation dose to workers, and environmental impacts at the site over the coming decades.³⁰

Spent fuel removal - In a positive development, by November 5th 2014, workers completed the removal of all spent fuel assemblies in the Fukushima Daiichi reactor Unit 4 storage pool to the common pool storage building on the site.³¹ According to its decommissioning plan, TEPCO plans to transfer 566 fuel assemblies, including 514 spent fuel assemblies, now at the Unit 3 reactor to either the common pool or the Fukushima-Daiichi Unit 6 pool during 2015. However, unlike the Unit 4 fuel transfer, the work at reactor Units 1-3 will be done by remote control due to higher radiation dose levels in the building, which makes it impossible for human beings to work in the heavily contaminated environment. Complicating further the fuel removal is the presence of debris from the damaged containment buildings and structures, particularly in spent fuel pools in unit 1 and 3. A range of plans have been developed for each reactor with major uncertainties on when they can be implemented.³² On October 30th 2014, TEPCO announced that it would review its plan to begin removing spent nuclear fuel from the Unit 1 pool in the first half of fiscal 2017 at the earliest.³³ The utility said it will postpone this work for two years, to sometime during 2019.

Reactor cores and decommissioning schedule – Proceeding to decommissioning of the reactors, including accessing the molten cores is dependent upon gaining control over the water crisis at the plant. The current plan of TEPCO for the removal of 450 tons of molten/damaged fuel is to be based on the flooding of the containment and torus with the aim of reducing radiation levels for workers. The effectiveness and safety implications of this plan remain considerable.³⁴ However, due to the scale of damage to the reactor buildings, high radiation levels as well as the unrealistic timeframe for removal of spent fuel and debris, there are enormous uncertainties in the actual schedule for when TEPCO will reach the point when actual detailed inspection and removal of the molten fuel can begin.

TEPCO announced in October 2014 that it would reschedule its plan to begin removing the molten nuclear fuel in reactor Unit 1 from the first half of 2020 to 2025.³⁵ Clearly given the complexity of the challenges at the Fukushima Daiichi site the prospects for this schedule slipping further are obvious. While TEPCO have published a medium to long term decommissioning schedule,³⁶ in reality a final path to decommissioning of the nuclear reactors has yet to materialise. Given the scale of the nuclear disaster at Fukushima and the amount of unknowns this is perhaps not surprising.

Finally on the overall timescale for decommissioning, TEPCO is on record as indicating 30-40 years.³⁷ However this is based on completing stage 2 of the schedule by 2021 (debris removal, sealing of the plant against leaks, and flooding of containments). That is already unrealistic. Nuclear power plant decommissioning of commercial reactors worldwide – and depending on the strategy adopted – is in the range of 40-80 years.³⁸ This timeframe is based upon reactors

²⁸ “TEPCO faces hurdles in construction of ice walls to block flow of contaminated water”, Akira Hatano and Shunsuke Kimura, Asahi Shimbun, July 9th 2014, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201407090052>, accessed January 28th 2015.

²⁹ Status of and measures for removing highly contaminated water in trench, TEPCO, June 20th 2014, http://www.tepco.co.jp/en/decommision/planaction/images/140620_01.pdf, accessed January 29th 2015.

³⁰ “Ice wall failure sends Tepco back to drawing board”, Nikkei Asian Review, November 21st 2014, <http://asia.nikkei.com/Business/Companies/Ice-wall-failure-sends-Tepco-back-to-drawing-board>, accessed January 28th 2015.

³¹ “Tepco removes all spent fuel from unit 4 at Fukushima I”, Shota Ushio, Tokyo, Nuclear Fuel, January 5th 2015.

³² Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO’s Fukushima Daiichi Nuclear Power Station Units 1-4 June 27, 2013 Nuclear Emergency Response Headquarters Council for the Decommissioning of TEPCO’s Fukushima Daiichi Nuclear Power Station, http://www.meti.go.jp/english/press/2013/pdf/0627_01.pdf, accessed February 3rd 2015.

³³ http://www.tepco.co.jp/nu/fukushima-np/roadmap/images/d141030_10-i.pdf#page=10 (in Japanese), accessed February 1st 2015.

³⁴ Tepco Plan To Flood The Primary Containment Of Unit 1, Fukushima Dai-Ichi, Large and Associates, Greenpeace Germany, May 2011, https://www.greenpeace.de/sites/www.greenpeace.de/files/Large_Report_engl_0.pdf, accessed February 11th 2015.

³⁵ http://www.tepco.co.jp/nu/fukushima-np/roadmap/images/d141030_10-i.pdf#page=10 (in Japanese), accessed February 1st 2015.

³⁶ Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO’s Fukushima Daiichi Nuclear Power Station Units 1-4 June 27, 2013 Nuclear Emergency Response Headquarters Council for the Decommissioning of TEPCO’s Fukushima Daiichi Nuclear Power Station, http://www.meti.go.jp/english/press/2013/pdf/0627_01.pdf, accessed February 3rd 2015.

³⁷ Mid-and-long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Units 1-4, TEPCO (Digest Version) December 21 2011, http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/111221e10.pdf, accessed February 1st 2015.

³⁸ Deloitte (2006). Nuclear Decommissioning and Waste: A Global Overview of Strategies and the Implications for the Future. Deloitte Energy and Resources, May. <http://deloitte-ftp.fr/Lot-B-Energie-ressources/doc/NuclearDecommissioning.Mai06.pdf>, as cited in Closing and Decommissioning Nuclear Power Reactors Another look following the Fukushima accident, UNEP Yearbook 2012,

that did not experience the kind of catastrophic accident, multiple reactor core meltdowns and exploded containment buildings, and continuing uncontrolled radiation releases to the environment as is the reality at Fukushima Daiichi. Deferred decommissioning is the closest comparison with Fukushima: this is where a period of years are allowed to pass to reduce radiation levels. The average period estimated for this deferred process is around fifty years. The timeframe within TEPCO's decommissioning schedule is simply not credible.

Fukushima prefecture contamination, decontamination and evacuees

Greenpeace has conducted 23 radiation surveys in the Fukushima prefecture since March 2011.³⁹ We have found radiation at levels high enough to raise health concerns for the people who continue to live daily with this contamination and those who may be forced to return to places in which the evacuation order has been lifted.

We have also shown that the authorities have consistently underestimated both the risks and extent of radioactive contamination. Based on our results in March 2011, we called for a significant extension to the evacuation area,⁴⁰ which was later implemented.⁴¹ We advised that until decontamination was completed, children should be held back from their schools to avoid high radiation levels. We have also found that official monitoring stations systematically underestimate the radiation risks for the population.⁴²

Our analysis of the threats to public health have given residents an alternative to the often contradictory information released by Japan's authorities since the Fukushima disaster began.⁴³

The teams are made up of Greenpeace radiation experts who have been trained in radiation monitoring and the use of sophisticated measuring devices.

In October 2014, Greenpeace monitoring results from Iitate (40km from Fukushima Daiichi), Fukushima city (60km), Miyakoji of Tamura city (20km) and Kawauchi village (20km) showed that efforts at decontamination were still failing to reduce contamination in many areas to meet the Japanese government's long-term decontamination target level of 0.23micro Sv/h. In Kawauchi, part of which had its evacuation order lifted in October 2014,⁴⁴ Greenpeace monitoring found 59% of our radiation measurements were over the target level and, again, with higher levels found away from the roads.⁴⁵ The decontamination efforts also do not "get rid" of the contamination – they simply move it. The process is generating vast amounts of radioactive waste, which is being piled up at temporary sites throughout the prefecture. Currently 120,000 residents of the prefecture remain displaced in temporary housing or elsewhere in Japan.⁴⁶

http://www.unep.org/yearbook/2012/pdfs/UYB_2012_CH_3.pdf, accessed February 11th 2015.

³⁹ Radiation surveys - Fukushima October 30th, 2014, <http://www.greenpeace.org/international/en/campaigns/nuclear/safety/accidents/Fukushima-nuclear-disaster/Radiation-field-team/>, accessed February 11th 2015.

⁴⁰ "Greenpeace radiation team pinpoints need to extend Fukushima evacuation zone: Need to protect pregnant women and children", March 27th 2011, <http://www.greenpeace.org/international/en/press/releases/Greenpeace-radiation-team-pinpoints-need-to-extend-Fukushima-evacuation-zone-especially-to-protect-pregnant-women-and-children-/>, accessed February 9th 2015.

⁴¹ "Japan Nuclear Disaster Put on Par With Chernobyl", Hiroko Tabuchi And Keith Bradsher, April 11th 2011, <http://www.nytimes.com/2011/04/12/world/asia/12japan.html?pagewanted=all&r=0>, accessed February 9th 2015.

⁴² Radiation surveys – Fukushima, Greenpeace, October 30th 2014, <http://www.greenpeace.org/international/en/campaigns/nuclear/safety/accidents/Fukushima-nuclear-disaster/Radiation-field-team/>, accessed February 12th 2015.

⁴³ Greenpeace measuring data as well as sample analyses can be found in spreadsheets at the [link http://www.greenpeace.org/international/en/campaigns/nuclear/safety/accidents/Fukushima-nuclear-disaster/Radiation-field-team/](http://www.greenpeace.org/international/en/campaigns/nuclear/safety/accidents/Fukushima-nuclear-disaster/Radiation-field-team/), accessed on February 2nd 2015.

⁴⁴ "Evacuation advisory lifted for part of Fukushima village of Kawauchi", JJI, October 1st 2014, <http://www.japantimes.co.jp/news/2014/10/01/national/radiation-evacuation-advisory-lifted-part-fukushima-village-kawauchi/#.VNtkWSiaH6g>, accessed February 11th 2015.

⁴⁵ Learning the tragic lesson of Fukushima: No nuclear restart at Sendai, Jan Vande Putte, October 31st 2014, <http://m.greenpeace.org/international/en/mid/news/Blogs/nuclear-reaction/No-nuclear-restart-at-Sendai/blog/51158/>, accessed February 11th 2015.

⁴⁶ "Fukushima nuclear disaster: three years on 120,000 evacuees remain uprooted" Justin McCurry, The Guardian, September 10th 2013, <http://www.theguardian.com/world/2014/sep/10/fukushima-nuclear-disaster-japan-three-years-families-uprooted>

The problems with the compensation process for evacuees are manifold: the processing of claims is delayed, and the monthly payments are not enough to ensure people a living, let alone enough to set up a new life. Not everyone is eligible for compensation, and the lucky ones only get a fraction of the value of their lost homes. According to many polls, most have abandoned hope of picking up their old lives and want enough money to set up new ones.⁴⁷ However, in November 2013, a Liberal Democratic Party (LDP) panel called on the government to state that for some residents they will never be able to return home - "At some point in time, someone will have to say that this region is uninhabitable, but we will make up for it," LDP's secretary general, Shigeru Ishiba.⁴⁸

In some parts of Fukushima's 20km evacuation zone, the government has partially lifted the evacuation order. A survey by Namie town office in 2013 found that 37.5% of residents had given up on reclaiming their old lives, and the same percent remained "unsure".⁴⁹ The evacuation order was lifted in April 2014.⁵⁰ Only about 19% were confident they would return, but even that figure is viewed with scepticism. "Why would people come back here permanently to live?" asks Masami Yoshizawa, a farmer who refused to leave his cattle herd in Namie. "There is no infrastructure any more; no schools, shops or transport."

Japan's central government refined its policy in December 2011, defining evacuation zones as "areas where cumulative dose levels might reach 20 millisieverts per year". This is 20 times higher than the limit recommended by the International Commission on Radiological Protection for non-accidental situations. The 2014 UNSCEAR report⁵¹ on radiation health consequences from Fukushima has been criticized as not scientific, including by the former head of the radiation-protection program at the World Health Organization's Regional Office for Europe.⁵²

Local governments are spending millions of dollars to persuade refugees to come back, dividing the nuclear clean-up costs with the central government, which handles the most toxic areas. One estimated price tag for decontaminating a heavily mountainous and wooded area is \$50 billion U.S. dollars.⁵³ That figure is widely considered an underestimate. Fighting radiation is now one of the few growth industries in Minamisoma, about 20km north of the Fukushima Daiichi plant. Most of the city's 71,000 people fled in March and April 2011. One third had yet to return as of March 2014. Decontamination employs about 1,000 people – a large percentage of the town's remaining able-bodied workforce. Minamisoma budgeted US\$230m in 2014 alone to clean local homes and businesses of radioactivity.⁵⁴

In spite of the massive effort and expenses incurred, decontamination is likely to be a never ending process. The hills, mountains, and forests of Fukushima prefecture are heavily contaminated. As a result, radioactive material washes down into reservoirs and lower river basins,⁵⁵ as well as to formerly decontaminated areas. To put this in some

⁴⁷ "70% of Fukushima evacuees: won't return home", NHK, December 6th 2013, as cited in <http://recoveringtohoku.wordpress.com/2013/12/06/70-of-fukushima-evacuees-wont-return-home-nhk-12613/>, accessed February 9th 2015.

⁴⁸ "Fukushima residents may never go home, say Japanese officials", Justin McCurry, The Guardian, November 12th 2013, <http://www.theguardian.com/environment/2013/nov/12/fukushima-daiichi-residents-radiation-japan-nuclear-power>, accessed February 9th 2015.

⁴⁹ As cited in "Three Years On: Lives in Limbo" Dr David McNeill, Greenpeace International, February 2014, http://www.town.namie.fukushima.jp/uploaded/life/5229_11523_misc.pdf and <http://www.greenpeace.org/international/Global/international/briefings/nuclear/2014/Fukushima-3rd/Three%20Years%20On.pdf>, accessed February 9th 2015.

⁵⁰ "Fukushima's Namie sees no-go zone designation lifted", JJI, April 1st 2015, <http://www.japantimes.co.jp/news/2013/04/01/national/fukushimas-namie-sees-no-go-zone-designation-lifted/#.VNtlfiiaH6g>, accessed February 11th 2015.

⁵¹ "Sources, Effects And Risks Of Ionizing Radiation" UNSCEAR 2013 Report Volume I Report To The General Assembly Scientific Annex A: Levels And Effects Of Radiation Exposure Due To The Nuclear Accident After The 2011 Great East-Japan Earthquake And Tsunami, United Nations Scientific Committee on the Effects of Atomic Radiation, http://www.unscear.org/docs/reports/2013/14-06336_Report_2013_Annex_A_Ebook_website.pdf, accessed January 30th 2015.

⁵² 'British researcher blasts U.N. report on Fukushima cancer risk as unscientific', citing Keith Baverstock, December 1st 2014, Asahi Shimbun, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201412010036>, accessed January 30th 2015.

⁵³ With Fukushima nuclear plant still leaking, Japan clean-up bill soars to \$50bn, David McNeill, The Independent, July 24th 2013, <http://www.independent.co.uk/news/world/asia/with-fukushima-nuclear-plant-still-leaking-japan-cleanup-bill-soars-to-50bn-8730832.html>, accessed February 10th 2015.

⁵⁴ "Three Years On: Lives in Limbo", Dr David McNeill, February 2014, Greenpeace International, [http://www.greenpeace.org/international/global/international/briefings/nuclear/2014/fukushima-3rd/three Years on.pdf](http://www.greenpeace.org/international/global/international/briefings/nuclear/2014/fukushima-3rd/three%20Years%20On.pdf), accessed January 30th 2015.

⁵⁵ "Evolution of radioactive dose rates in fresh sediment deposits along coastal rivers draining Fukushima contamination plume", Olivier Evrand, Caroline Chartin, Yuichi Onda, Jeremy Patin, Hugo Lepage, Irène Lefèvre, Sophie Ayrault, Catherine Ottlé & Philippe Bonté, Scientific Reports 3, October 29th 2013 <http://www.nature.com/srep/2013/131029/srep03079/full/srep03079.html>, accessed February 11th 2015.

perspective the half life of one of the most prevalent radionuclides released from the Fukushima accident, cesium 137, at 30 years, means that it will remain a hazard for around ten half lives – or 300 years.

Nuclear waste crisis - As a result of the decontamination program in Fukushima prefecture, temporary storage areas are already near capacity and radioactive debris is being stored at about 54,000 locations in the prefecture, including the backyards of homes, parking lots, and parks.⁵⁶ Official estimates of the storage volume required are between 15 and 28 million cubic meters of waste, enough to fill 12 to 23 Tokyo Domes, generated from the cleanup process. This is based on decontamination being restricted to towns and farmland. The estimated area of Fukushima prefecture contaminated above the 1mSv level is 2000 square kilometers, which if it was to be decontaminated would generate in the range of 100 million tons of radioactive waste.⁵⁷ In reality this is not possible, and therefore recontamination will continue from the forested mountains and rivers for the foreseeable future.

In August 2011, then Prime Minister Naoto Kan, announced that intermediate storage facilities would be needed to take in the waste from decontamination in the countermeasure areas in Fukushima prefecture. The Abe Government announced in December 2013 that in exchange for hosting the interim storage facilities, the central government plans to provide a tax grant to the host municipality and compensation to individuals whose land will be used in the project.⁵⁸ In spite of the incentives offered, plans for buying land in Fukushima were largely abandoned in June 2014, due to public opposition. A total of 16 square kilometers is planned to be used for hosting the storage facilities, but as of February 2015, only 2 percent of this had been secured by the Ministry of Environment, all of it in former industrial parks owned by private companies.⁵⁹ The most likely option is that most of the land will be acquired through a leasing arrangement – but it remains unclear how much of the land will be secured and it “It will take a very long time,” according to a senior Environment ministry official.⁶⁰

In January 2015, the Environment Ministry reached agreement with Fukushima prefecture for the storage of waste at Okuma and Futaba towns, near the Fukushima Daiichi plant.⁶¹ Former residents and community members have a legitimate fear that the 16 square kilometres site will end up being the permanent and final nuclear waste disposal site, despite a condition that commits the government to remove the waste no later than 2045.⁶²

The plan was originally to have operation of the interim storage sites by the end of March 2015. Due to the significant delays, this will not be possible, with no timescale for securing sufficient capacity to store the existing nuclear waste at tens of thousands of sites around Fukushima, and certainly not the estimated 30 million tons predicted to accumulate over the coming years. The first waste transfer as part of a year long trial will begin in March 2015 with a total of 43,000 tons planned to be transported during the next year.⁶³ This waste will be stored temporarily, prior to depositing in the actual interim storage facilities, construction of which is only now about to begin.

⁵⁶ “Fukushima governor sets 5 conditions for storing radioactive waste”, Asahi Shimbun, December 2nd 2015, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201409020061>, accessed February 8th, 2015.

⁵⁷ “Fukushima clean-up may require removal of 100 million cubic meters of soil”, September 15th 2011, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ2011091510556>, accessed February 9th 2015.

⁵⁸ “Government asks Fukushima to accept intermediate storage facilities”, Asahi Shimbun, December 15th 2014, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201312150018>. Accessed February 9th 2015.

⁵⁹ Land secured in Fukushima opens door for 1st shipment of radioactive waste, Asahi Shimbun, February 4th 2015, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201502040078>, accessed February 12th 2015.

⁶⁰ Land secured in Fukushima opens door for 1st shipment of radioactive waste, Asahi Shimbun, February 4th 2015, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201502040078>, accessed February 12th 2015.

⁶¹ Gov't to start interim storage of nuclear waste in March, January 19th 2015, Japan News, <http://www.japantoday.com/category/national/view/govt-to-start-interim-storage-of-nuclear-waste-in-march>

⁶² Five conditions have been set by the Fukushima Governor as of September 2014: a law should be passed stipulating that the waste will be moved outside the prefecture within 30 years of the opening of waste sites; compiling a budget to provide 301 billion yen (\$2.89 billion) in grants to the local governments; detailed measures should be presented to maintain and manage the transportation routes and secure the safety of local communities along those routes; securing the safety of the interim storage facility and transportation of the waste; and, reaching a safety agreement between the central government and the governments of Fukushima Prefecture, Okuma and Futaba over the waste storage. An amendment to law regulating operations of the government-affiliated Japan Environmental Safety Corp. (JESCO) was passed in November requiring removal not later than 2045.

⁶³ Land secured in Fukushima opens door for 1st shipment of radioactive waste, Asahi Shimbun, February 4th 2015, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201502040078>, accessed February 12th 2015.

Cost of Fukushima accident

There have been a range of figures on the costs of the Fukushima accident. Note the figures below in dollars reflect the yen to dollar rate at that time, since when the yen has depreciated. In November 2013, a figure of US\$ 50 billion spent so far was published, which did not include the cost of decommissioning.⁶⁴

Estimates of the total cost of the Fukushima catastrophe, including compensation, fluctuate wildly. TEPCO was told by an advisory panel in October 2011 to prepare for claims of 4.5tn yen (\$59bn) in the two years following the disaster, until March 2013.⁶⁵ In December 2011, a Japanese government panel estimated the total costs of the accident at 20 trillion yen – at that time US\$257 billion.⁶⁶

The private research institute, Japan Centre for Economic Research (JCER), put the bill over the next 10 years at 5.7tn yen (\$74bn) to 20tn yen (\$261bn) or higher.⁶⁷ But, neither figure includes compensation to the fisheries and farming industries, though the latter does budget for the purchase of contaminated land inside the 20km evacuation zone. Some sources calculated the cost of buying up contaminated land alone at about 4.3tn yen (\$52bn).⁶⁸ The same JCER assessment gave a total range of estimated cost of the disaster, including compensation and decommissioning the Fukushima Daiichi plant's six reactors, at 40-50tn yen (\$520bn – \$650bn).

Conclusion

"Workers are forced to handle contaminated water in such grim working conditions, where any human being should not be put to work... They tend to make easy mistakes under the pressure, but it's not they who are at fault – it's the conditions that force them to do terrible tasks." Fukushima nuclear worker, March 2014.⁶⁹

Every day, thousands of workers struggle to make slow deliberate progress at the Fukushima Daiichi site – confronted as they are with high radiation levels, contaminated water, terrible working conditions and low pay.⁷⁰ In contrast to the government and TEPCO, it is the workers of Fukushima that are doing their best to reduce the risks from the devastated Fukushima Daiichi nuclear power plant. Many things remain unclear about the future, but what is obvious is that the threats from Fukushima will persist for many decades to come. Long after the present government, politicians and executives of Japan's electric companies are distant memories, future generations of workers will enter the Fukushima site each day with the aim of trying to reduce the threats to the people and environment of Japan.

The eleventh of March 2015 is a day for us to remember the devastation brought to the lives and communities of the people of Japan - but they do not need an anniversary to remember. They live with the consequences every day as they have for the past four years, and as they and their families will continue to do for generations to come. The principle lesson of the Fukushima Daiichi accident is clear to the people of Japan, if not the Abe government – never again should nuclear power threaten the very existence of the Japanese nation.⁷¹

⁶⁴ "Fukushima residents may never go home, say Japanese officials", Justin McCurry, The Guardian, November 12th 2013, <http://www.theguardian.com/environment/2013/nov/12/fukushima-daiichu-residents-radiation-japan-nuclear-power>, accessed January 30th 2015.

⁶⁵ "TEPCO seeks 690 billion yen more for Fukushima compensation", Asahi Shimbun, December 27th 2011, <http://ajw.asahi.com/article/0311disaster/fukushima/AJ201112270013>, accessed January 30th 2015.

⁶⁶ "Japan sees atomic power cost up by at least 50 pct by 2030 -Nikkei", Reuters, December 6th 2011, <http://www.reuters.com/article/2011/12/06/japan-nuclear-cost-idUSL3E7N60MR20111206>, accessed January 30th 2015.

⁶⁷ "Impact to last Decade or more if Existing Nuclear Plants Shut Down GDP Could Drop 2% on Power Shortages", JCER Economic Research Department, <http://www.jcer.or.jp/eng/research/pdf/pe%28iwata20110425%29e.pdf>, accessed January 31st 2015.

⁶⁸ "Impact to last Decade or more if Existing Nuclear Plants Shut Down GDP Could Drop 2% on Power Shortages" p.11, Japan Center for Economic Research. (JCER), April 25th 2011, [http://www.jcer.or.jp/eng/research/pdf/pe\(iwata20110425\)e.pdf](http://www.jcer.or.jp/eng/research/pdf/pe(iwata20110425)e.pdf), as cited in "Lessons from Fukushima" February 2012, <https://www.greenpeace.de/sites/www.greenpeace.de/files/20120228-Lessons-from-Fukushima-Greenpeace.pdf>, accessed February 1st 2015.

⁶⁹ "Fukushima No. 1 workers rally against Tepco", AFP/Jiji, March 14th 2014, <http://www.japantimes.co.jp/news/2014/03/14/national/fukushima-no-1-workers-rally-against-tepco/>, accessed February 9th 2015.

⁷⁰ Nuclear workers kept in dark on Fukushima hazard pay Mari Saito And Antoni Slodkowski, Reuters, October 7th 2014, <http://www.reuters.com/article/2014/10/08/us-fukushima-workers-insight-idUSKCN0HW24120141008>, accessed February 9th 2015.

⁷¹ "Nuclear crisis turns Japan ex-PM Kan into energy apostle," Linda Sieg and Yoko Kubota, Reuters, February 7th 2012, <http://www.reuters.com/article/2012/02/17/us-japan-kan-idUSTRE81G08P20120217>, accessed February 9th 2015.

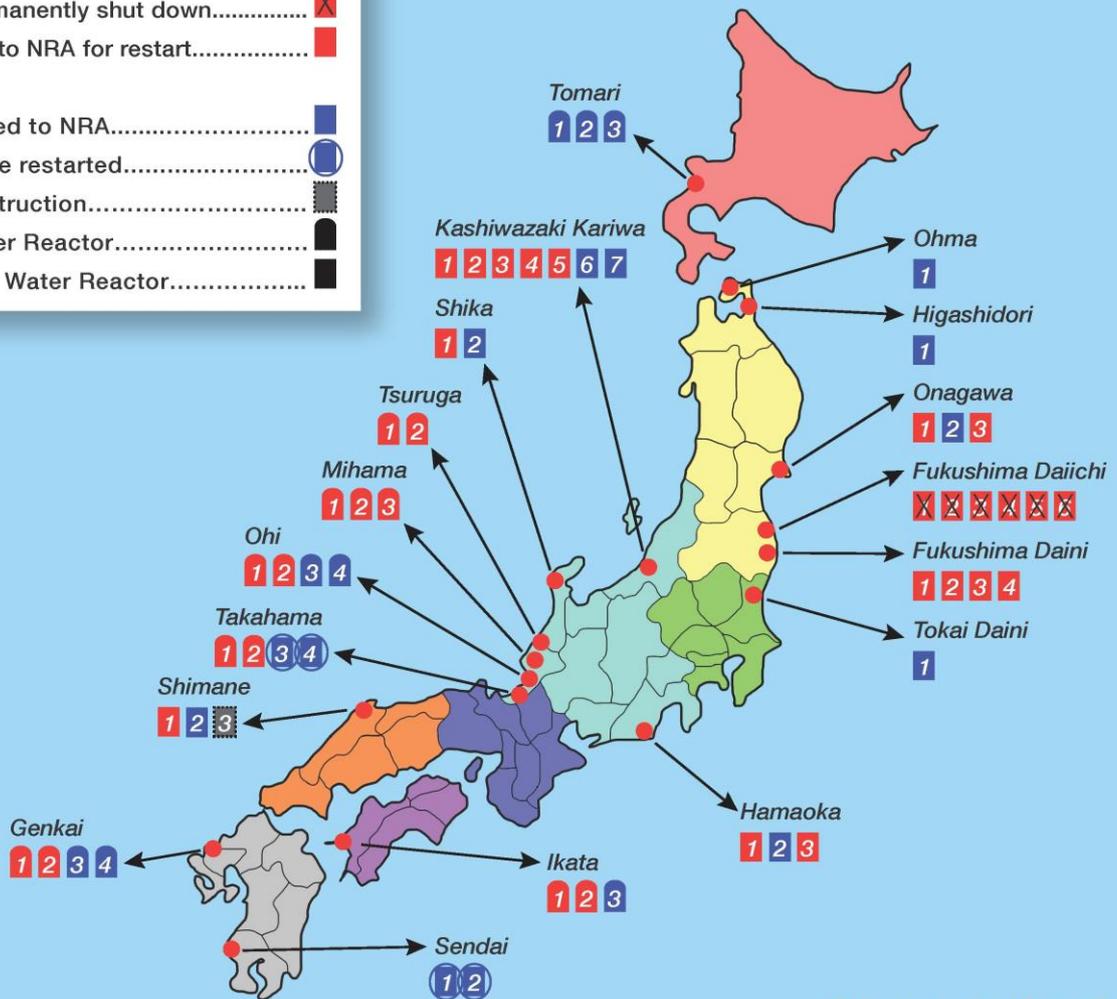
Japan's nuclear power crisis

Shutdown:

- Already permanently shut down..... X
- Not applied to NRA for restart.....

Re-start:

- Utility applied to NRA.....
- Priority to be restarted.....
- Under Construction.....
- Boiling Water Reactor.....
- Pressurized Water Reactor.....



GREENPEACE
Updated February 2015

For more information, contact:

Shaun Burnie – Senior nuclear campaigner – Greenpeace Germany – sburnie@greenpeace.org

Heinz Smittal – Senior nuclear campaigner – Greenpeace Germany – hsmittal@greenpeace.org

Kendra Ulrich – Senior nuclear campaigner – Greenpeace Japan – kulrich@greenpeace.org

Jan van de Putte – Senior nuclear campaigner – Greenpeace Belgium – jan.vande.putte@greenpeace.org