

Six years after the Fukushima Daiichi accident and the lessons learnt

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Abstract: March 11, 2017, marks the sixth anniversary of the Great East Japan Earthquake Disaster which triggered the Fukushima Daiichi accident. It was the most severe nuclear accident in Japan on the international nuclear event scale (INES), caused by the largest earthquake and tsunami in Japanese historical records. This article, discusses the interim reports on what had happened, and reviews the lessons learnt from the accident by Japanese society and internationally. However, some points require further study, because the Fukushima Daiichi accident has not yet completely ended, and there are implications for the real meaning of nuclear governance and best practice. In particular the road map toward full decommissioning will require another thirty to forty years to eventuate.

Keyword: Great East Japan Earthquake; Fukushima Daiichi accident; lessons learned from Fukushima Daiichi accident; road map toward full decommissioning

1 Introduction

March 11, 2017, marks the sixth anniversary of the Great East Japan Earthquake Disaster which triggered the Fukushima Daiichi accident. It was the most severe nuclear accident in Japan on the international nuclear event scale (INES), caused by the largest earthquake and tsunami in Japanese historical records.

The progress in the accident, its reporting and subsequent analysis have followed a variable progression in official, academic and media sources.

Japanese Prime Minister (at the time), Naoto Kan, declared a state of nuclear emergency and established a joint headquarters with Tokyo Electric Power Company (TEPCO) to deal with the exceptionally urgent issues, including road map plans, assistance of those exposed or affected by nuclear radiation, evacuation area designation, radioactive decontamination process, and investigation/verification of the Fukushima Daiichi accident.

TEPCO disclosed for the first time, in mid-May 2011, that most of the fuel rods in the No.1, No.2 and No.3 reactors at the Fukushima Daiichi had melted.

On December 2011, cooling and cold shutdown of the reactors of stricken Fukushima Daiichi was declared.

Up to March 11, 2012, the International Journal of Nuclear Safety and Simulation (IJNS) presented four cyclical reports regarding the aftermath of the Fukushima Daiichi accident. This article complements those reports.

The content of those four reports updated the meltdown, cold shutdown, mid-and-long-term roadmap of decommissioning, the various social and economic issues of radioactive contamination and subsequent decontamination on-site and off-site of the Fukushima Daiichi plant, and several investigation committees' reports on the Fukushima Daiichi accident. In addition, some effects of the Fukushima Daiichi accident on international collaboration were also summarized in each article.

As a consequence of the Fukushima Daiichi accident, Japan's nuclear policy underwent a paradigm shift, in the face of tremendous opposition against nuclear energy. The governing Democratic Party of Japan (DPJ), which assumed nuclear emergency crisis control, put forward the "energy best mix policy" including more use of renewable energy, with substantial reduction of nuclear energy reliance.

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On December 2012, the Liberal Democratic Party (LDP) had a clear victory in the Diet election, with Shinzo Abe as the new (and present) Prime Minister (PM). The new government pushed for a gear change towards restarting nuclear plants. In his election campaign PM Abe criticized supporters of zero nuclear power as "irresponsible" and urged that the nuclear crisis was over. PM Abe's commitment to nuclear energy policy, in particular to restarting idled and halted nuclear plants, has been a priority agenda in his government.

In this article, the author attempts to summarize the status to date, as well as some points to be further studied, because the Fukushima Daiichi accident has not completely ended. In particular, the road map toward the full decommissioning, which will require another thirty to forty years to take place, is still in progress.

Regarding the structure of the article, firstly, the author examines the revised mid-and-long-term roadmap of decommissioning, the various socio-economic issues of radioactive contamination and subsequent decontamination of areas surrounding Fukushima Daiichi.

Secondly, the author analyzes the issues relating to restarting nuclear plants with 54 plants offline, and energy mix policy and options.

Thirdly, the author analyzes the public opinion poll results regarding restarting nuclear plants which are offline. The results indicate that only 17% people of poll voters support restarting, while 44% of voters oppose it, with the remaining 39% undecided.

Fourthly, the author overviews variable aspects of long-term nuclear policy settings in Japan amid various uncertainties. The author's overview examines the prospect of difficulty in maintaining the traditional nuclear fuel cycle policy in Japan together with news of the Toshiba crisis. In early February 2017 it was made known that a leading company of Toshiba suffered a huge financial loss owing to the failure of its nuclear construction business in the U.S. Although still in the process of emerging from this turmoil, the author will elaborate on the Toshiba

crisis.

Lastly in this article, the author will introduce some of the key international partners' comments and advice from the aspect of the numerous lessons learned from the Fukushima Daiichi accident. These include messages from International Atomic Energy Agency (IAEA), Organization for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA) and other competent persons and organizations, including the Nuclear Reform Monitoring Committee (NRMC), and the international advisory body for TEPCO. The author concludes this paper by giving his personal observations about the future.

2 Revised mid and long-term roadmap

2.1 Reactor "cold shutdown" in 2011

In mid-May in 2011, TEPCO disclosed that most of the fuel rods in the No.1, No.2 and No.3 reactors at the Fukushima Daiichi had melted. On 16 December 2011, the Government-TEPCO Integrated Response Office announced that the conditions for a 'cold shutdown state' had been achieved in Units 1–3.

2.2 Revised decommissioning roadmap

In December 2011, a comprehensive, high level strategic plan for stabilizing and decommissioning the damaged nuclear power plant was issued by the government and TEPCO. It was initially called the "30 year decommissioning plan". This was updated in 2016.

The original roadmap timetable from the government and TEPCO includes a plan to begin removing used fuel rods from spent fuel pools in all four reactor buildings of the Fukushima Daiichi Units No. 1 to 4, within 2 years. In practice, the removal of fuel from the Unit 4 spent fuel pool was completed in December 2014.

The work to remove the melted fuel inside Units No. 1 through No. 3 reactors should be completed in 25 years, and the work to scrap the Fukushima Daiichi NPS should be completed within 34 years, although the schedule has already been delayed due to various on-site factors. The work at No.3 reactor was initially

scheduled for fiscal 2015, but had been pushed back because of high radiation readings in and around the reactor building. This is shown in **Table 1** in the revised mid-and-long-term roadmap as of May 2016.

Table 1 The revised mid-and-long-term roadmap as of May 2016

	Main target	Individual items
Phase 1 (Time span: Within 2 years, until November 2013)	- On December 2011, cool down declaration -Start of fuel removal from spent fuel pool -R&D necessary for the removal of fuel debris	-Reduce the radiation impact due to additional emissions from the site and from the radioactive waste -Maintain stable reactor cooling and accumulated water processing -Commence R&D on decontamination and on radioactive waste processing and disposal
Phase 2 (Time span: Within 10 years, until December 2021)	-R&D on the removal of fuel debris, and start of removing debris -Reinforcement of PCV	-Complete fuel removal from the spent fuel pools in all units -Complete preparations for the removal of fuel debris -Continue stable reactor cooling -Complete the processing of accumulated water -Continue R&D on radioactive waste processing and disposal, and commence R&D on decommissioning of reactor facilities
Phase 3 (Time span: Within 34 years)	-Implementation of tasks of fuel debris removal to fulfill until the end of decommissioning	-Complete the fuel debris removal -Complete the decommissioning (in 34 years) -Implement radioactive waste processing and disposal

(Source: METI's "White Paper on Energy 2016 edition", and TEPCO's "Mid-and-long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Units 1-4"(December 21, 2011, Digest Version))

2.3 Current status of Fukushima Daiichi reactors

On 9 February, 2017 TEPCO announced that radiation levels inside the reactor No.2 were estimated at up to 650 sieverts per hour - much higher than the record 530 sieverts per hour marked by the previous survey. A robot camera called "Sasori (scorpion)" made its way inside the reactor's containment vessel for the first time. (See **Fig.1**)

With the environment inside too treacherous for a key component in the process, TEPCO's

decommissioning project may take longer than originally expected.



Fig. 1 The Sasori (Scorpion) robot is stuck inside the containment vessel of No. 2 reactor of Fukushima Daiichi nuclear power plant.

3 Decontamination efforts

3.1 On-site and around Fukushima Daiichi

Following the Fukushima Daiichi accident, there were difficulties in establishing locations to store the large amounts of contaminated material arising from off-site remediation activities. The management of such material — with its varying physical, chemical and radiological properties — is complex and requires significant efforts.

National strategies and measures for post-accident recovery need to include the development of a generic strategy for managing contaminated liquid and solid material and radioactive waste, supported by generic safety assessments for discharge, storage and disposal.

3.2 "Ice wall" challenge

A frozen soil wall has been proposed, with the aim to block the flow of groundwater into the reactor buildings to prevent it from becoming contaminated with radioactive substances.

To build the frozen soil wall, TEPCO has inserted 1,568 pipes to a depth of 30 meters in the ground around the No. 1 to No. 4 reactor buildings up to December 2016. Before the frozen wall project, TEPCO had to pump up about 300 tons of contaminated water a day. The daily volume dropped to about 130 tons in recent weeks, but it was still well beyond the target of 70 tons with limited success despite its efforts, according to NRA's appraisal

(December 27, 2016, The Asahi Shimbun).

3.3 Evacuation zone reduction

As of February 2016, two categories of contaminated areas were defined on the basis of annual doses estimated in the autumn of 2011. First, the ‘Intensive Contamination Survey Area’ within 30 km of Fukushima Daiichi, as shown on the map of local cities and towns surrounding the Fukushima Daiichi plant (see **Fig.2**), is where the additional annual doses were projected to exceed 1 mSv but to remain below 20 mSv. Second, the “Specific Area”, within 20km, where dose reduction goals were set, including a long term goal of achieving an additional annual dose of 1 mSv or less.

In early 2017, it was revealed that the concentration of radioactive cesium in all the fish and shellfish collected during tests in 2016 fell below the national standard value of 100Bq/kg. It was the first time since the nuclear accident that all such seafood from Fukushima fell below the standard value in a single calendar year.

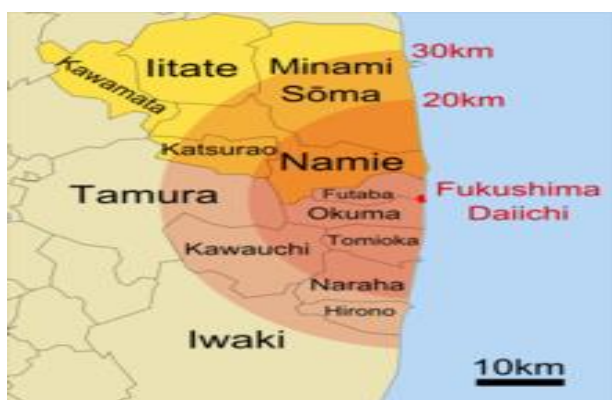


Fig. 2 Contaminated cities and towns surrounding Fukushima Daiichi nuclear power station.

3.4 75,000 affected people compensated

Japan's tsunami victims have received minimal compensation and most want to return home, but cannot because their homes are gone. Meanwhile, many of the Fukushima evacuees can return home but choose to stay away and prosper from huge government-mandated personal and property compensation which amounted to over \$42 billion by August 2014 for about 75,000 evacuees.

These payments are promised to continue until 2021, but cease a year after residents return to their homes.

Of the approx. 300,000 tsunami victims however, one-third have moved to other parts of Japan and the rest have received less than half the total sum awarded to the nuclear accident evacuees, though most do not need to remain away from their homes, according to The World Nuclear Organization (Updated April 2016).

Notably, after the Fukushima Daiichi accident, the Convention on Supplementary Compensation for Nuclear Damage (CSC) with the IAEA came into force on April 15, 2015.

3.5 Looming clean-up expenditures

Japan's government estimates the cost of cleaning up radioactive contamination and compensating victims of the 2011 Fukushima nuclear disaster has more than doubled. The latest estimate from the trade ministry put the expected cost at 21.5 trillion yen.

The decommissioning of the reactors forms the largest slice of 8 trillion yen with the next largest being for compensation of 7.9 trillion Japanese yen. Storing the contaminated soil (1.6 trillion Japanese yen) and decontamination (4 trillion Japanese yen) are the two next greatest costs. The compensation cost has been increased by about 50% and decontamination estimates have been almost doubled, according to media reports (on 28 November 2016).

The increase in decontamination costs was mainly led by the rise in prices of bags to hold contaminated materials and the larger-than-expected personnel costs of decontamination workers.

The compensation costs will be temporarily covered by the government. But TEPCO will eventually shoulder most of the burden, in principle, spending many years paying it off.

4 Restarting nuclear plants amid crucial debates

4.1 Only three reactors operating

After the Fukushima accident, all 54 of Japan's reactors were shut down. The state of all nuclear power stations in Japan is shown in **Table 2** as of August 2016. Twelve reactors totaling 7.2 gigawatts (GW) were permanently closed, that is, waiting for

decommissioning. Restart applications for 20 previously operating reactors (totaling 19.5 GW) and 1 new reactor under construction (the 1.4 GW Oma Nuclear Power Station) have been filed with the NRA. The remaining 17 reactors (16 GW) have yet to submit restart applications. There is still uncertainty about whether some of these reactors can meet the new NRA safety regulations, particularly regulations regarding the ability to withstand severe earthquakes.

Table 2 Current status of nuclear capacity in Japan (as of August 2016)

2.5 GW	Operating	3 reactors
1.7 GW	Approved for restart, awaiting court decision	2 reactors
20.9 GW	Application under review	21 reactors
16.0 GW	Yet to file restart application	17 reactors
7.2 GW	Shutdown after Fukushima	12 reactors
48.3 GW	Total 55 reactors including Oma	

(Source: U.S. Energy Information Administration, based on Institute of Energy Economics, Japan, and IAEA Power Reactor Information System)

In addition to NRA approval, the restart of Japan's nuclear reactors requires the approval of the central government and the consent of local governments or prefectures where the power plants are located. Opposition to reactor restarts has been primarily related to public concerns about seismic risks, the adequacy of NRA regulations, and evacuation plans in the event of an accident.

The continued uncertainty related to the length of the NRA review process, the difficulty in getting local consent, and the potential for protracted court proceedings can all affect both the actual level and timing of nuclear capacity restoration.

As of the end of August 2016, the five reactors approved by the NRA to restart total nearly 4.2 GW. Three reactors are operating, while two remain idle pending the outcome of legal challenges:

Kyushu Electric Power company's Sendai Units 1 and 2 (1.7 GW combined) in the Kagoshima prefecture, that were the first reactors restarted in August and October 2015.

Shikoku Electric Power company's Ikata Unit 3 (0.8 GW) in Ehime prefecture began generating electricity in August 2016. However, although Kansai Electric Power Company (KEPCO)'s Takahama Units 3 and 4 (1.7 GW combined) in Fukui prefecture briefly restarted in early 2016, a district court in neighboring Shiga prefecture issued an injunction to shut down the two reactors.

Only three of those reactors are currently operating at present. Applications for the restart of 21 other reactors, including 1 under construction, are under review to be approved by the NRA.

4.2 Different stances on Kashiwazaki-Kariwa's restart

The governor of Niigata Prefecture, Ryuichi Yoneyama, who took office in October 2016, has taken a cautious stance on restarting the Kashiwazaki-Kariwa plant of TEPCO, the world's largest nuclear generation plants. Governor Yoneyama has insisted that the plant should not be put back online until after an investigation into the cause of an accident in Fukushima and its effects on human health. The governor said he's not sure how long the verification process will take, but assumes it will probably be several years. (NHK, January 5, 2017)

On 20 November 2016, Masahiro Sakurai, the mayor-elect of Kashiwazaki, Niigata Prefecture, called for a conditional restart of Kashiwazaki-Kariwa plant, but this new mayor's position has somewhat changed since TEPCO's repetitive apologies for their mistakes in handling the anti-seismic design of the emergency response facility at Kashiwazaki-Kariwa. (See why the mayor changed his mind in Note 1 in the part of APPENDIX.)

5 Mixed public opinion poll results

5.1 Changing support for nuclear facilities

The Broadcast Research of Nihon Hoso Kyokai (NHK), the public broadcaster of Japan, announced the survey results of a public poll on "whether or not to keep nuclear facilities" in August 2016, with the outcomes as presented in **Tables 3 and 4**. Of all respondents, the group "support" rose gradually by

6% in 2016 since 2013, while “opposed” and “undecided” fell by 4% and 2% respectively. Regarding the opinions of the group “support”, 65% support the “as is” policy, while only 10% advocate new construction of nuclear plants as well as mothballing.

Table 3 Whether or not to keep nuclear power (1)

	Support	Opposed	Undecided
2016	17%	40%	42%
2013	11%	44%	44%
(2016)*	(29%)	(57%)	(13%)

(Source; The NHK Monthly Report on Broadcast Research, August 2016) Notes; (2016)* is the survey result published by THE ASAHI SHIMBUN on October 18, 2016, which shows the results of the telephone survey conducted on October 15 and 16, 2016.

Table 4 Whether or not to keep nuclear power (2)

For or Against	Increase	As Is	Decrease	Abolish
Support	13%	65%	20%	1%
Opposed	3%	47%	50%	0%
Undecided	2%	32%	63%	3%

Notes: those respondents in support; 435, opposed; 1,021, undecided; 1,079 persons, respectively

(Source; The NHK Monthly Report on Broadcast Research, August 2016)

According to NHK research staff, the following is observed:

- (i) The proportion of those who support nuclear restart has decreased in both the “opposed” and “undecided” groups
- (ii) Males were more affirmative than females in terms of nuclear restart.
- (iii) Those who put emphasis on low electricity expenses and stable supply are more affirmative to restart than those who put emphasis on safe operation, when they choose electricity generation.
- (iv) Those who consider the energy mix target in FY2030 “appropriate” are more affirmative to restart than those who are “unresolved”.
- (v) In the case where electricity consumption should be reduced, even if living standards were to be lowered, those who don’t agree are more affirmative to restart than those who are “unresolved”.
- (vi) With regards to the difference of news source, those who use often internet and SNS are more affirmative to restart than those who don’t use at all.
- (v) Municipalities that expressed caution said they cannot be sure whether the nuclear power plants are really safe, and cited the difficulty of persuading

residents.

However, the result of another social survey in 2016 by Asahi Shinbun is somewhat different as indicated in Table 3. According to this, the results show that half of the respondents were opposed to nuclear power.

5.2 Restart of Sendai NPS in Kagoshima Prefecture

On August 11, 2015, Kyushu Electric Power Company activated Sendai Nuclear Power Station Unit 1 (PWR, 890 MW, located in Satsuma-Sendai City, Kagoshima Prefecture).

This marked the first restart of a nuclear power reactor in Japan that had been approved under the new government regulation standards established after the Fukushima accident.

Regarding this, NHK also conducted a social survey, and the results are shown in **Table 5**. Respondents were from Satsuma-Sendai city (804), Urban areas (1,083) and Nation-wide (1,001) persons, respectively.

Table 5 Whether or not to accept the restart of Sendai NPS

	Support	Slightly Support	Slightly Opposed	Opposed	Unresolved
Sendai City	25%	25%	18%	26%	7%
Urban	14%	24%	24%	34%	8%
Nation	11%	26%	26%	31%	12%

(Source; The NHK Monthly Report on Broadcast Research, August 2016)

The opinion of the “support” group, including “slightly support”, accounts for 50%, while the “opposed” group accounts for 44% in the city that hosts the Sendai NPS. The percent of “support” group in Sendai City (25%) far exceeds that of other urban (14%) and nation -wide (11%). (See the meanings of different respondent groups in Note 2 in the APPENDIX.)

The “support” group may favor economic incentives

as a revenue earner from nuclear plant operation, in priority to nuclear safety assurance.

It may also yield a moral hazard, as people could demand more benefits for relief or compensation, which would potentially lead to social, financial and political predicaments.

The urban population response may be in line with the concept of “Not in My Backyard” (NIMBY) with regard to nuclear facilities.

6 Long-term nuclear policy amid uncertainties

6.1 Nuclear accounts for 20-22% of generation mix in 2030

Before the Fukushima Daiichi accident, nuclear energy accounted for 29% of the total electricity generation mix. (See The Nuclear White Paper 2014 compiled by METI.)

Soon after the Fukushima Daiichi accident, the Japanese government ordered a halt to all nuclear generation operation. The almost total loss of nuclear energy was compensated for with fossil fuels, including LNG, coal and oil, of which a total share of 88% were imported in 2014.

In April 2014, the Strategic Energy Plan (SEP) approved by the Cabinet, launched the official target generation mix for 2030, in which nuclear accounts for 20-22%, while renewables, LNG and coal account for 22-24%, 27%, and 26%, respectively, as illustrated in **Table 6**. (Also see The Nuclear White Paper 2014 compiled by METI.)

Table 6 Percentage electricity generation mix in Japan (2010, 2014, and 2030)

Year	2010	2014	2030
Oil	6	10	3
Coal	25	31	26
LNG	30	46	27
Renewable	10	12	22
Nuclear	29	1	22

(Source; White Paper, METI/ANRE 2014)

The government’s energy strategy aims to first and foremost ensure stable, low-cost energy supply and environmental sustainability on the premise of

“safety”, as described here in the later part, and as elaborated in the “White Paper”.

6.2 Severe public comments criticizing nuclear governance

The Japanese public has lost faith in its nuclear industry and in its government’s ability to manage plants safely. In 2013, METI/ANRE collected public comments regarding the new strategic energy plan and released its results, including the following examples:

- (i) Words are meaningless as long as a structure remains that allows arbitrary manipulation by METI/ANRE, all of which are responsible for this nuclear accident,
- (ii) Public relations activities concerning energy seem no more than propaganda unless information transparency and the existence of a fair third-party organization are ensured,
- (iii) After experiencing an accident that had been considered impossible and witnessing the bungled handling of the aftermath, it will be impossible to obtain the understanding of the relevant local residents regardless of the national government’s promotion activities concerning nuclear power plants.

6.3 TEPCO’s failure on publicity

Immediately after the Fukushima Daiichi accident occurred, the then-president of TEPCO instructed employees not to use the term “meltdown”. In another instance, the true nature and extent of the accident was not fully disclosed in accordance with a top-down order.

These dishonest handling of public announcement by TEPCO means that the top management would not like to disclose the fact of meltdown or let people know the truth, and this attitude had lasted long in temptation to hide unfavorable facts to the public until the TEPCO’s press release of June 2016 that “TEPCO apologizes for previous leadership’s failure to acknowledge the occurrence of meltdown during the Fukushima accident”. “We deeply regret the shortcomings of the past,” President Hirose said.

6.4 Puzzled METI and nuclear governance

The government of the Democratic Party (DP) when the Fukushima Daiichi accident occurred in 2011,

adhered the nuclear zero option, while the Liberal Democratic Party (LDP) which took over the government in 2012 insisted to reduce the reliance on nuclear in 2030 in energy mix plan.

METI/ANRE stressed the necessity of nuclear energy, elaborating with a number of proofs and reasons in the “Energy White Paper 2014”.

6.4.1 Nuclear; the least cost option

The nuclear generation cost accounts for 10.1 Japanese Yen/kilowatt-hour (Y/kWh), which is the lowest and most economically competitive, in comparison with coal, LNG and mega-solar, according to the METI calculation in 2014 (See in **Table 7**).

The Nuclear generation cost jumped to 10.1 Japanese Yen per kilowatt-hour from 8.9 Yen in 2011, mainly reflecting increased disaster prevention measures, including expenses for decommissioning and compensation. With these latter costs increasing, this will inevitably entail further increasing costs and electricity rate hikes for final consumers, as illustrated above in the “huge clean up and compensation cost”.

Table 7 Comparison of electricity generation cost in 2011 and 2014 (Japanese Yen /KWh)

Year	Nuclear	Coal	LNG	Mega Solar
2011	8.9~	9.5	10.7	30.1~
2014	10.1~	12.3	13.7	24.2

(Source: Electricity Generation Cost Verification Working Group, METI, 2014)

6.4.2 Nuclear: energy strategy platform

The Strategic Energy Plan (SEP) was approved by the Cabinet in April 2014, and METI are enacting the long-term energy supply and demand plan toward 2030.

The point of the energy policy is to first and foremost ensure stable supply (“Energy Security”), and realize low-cost energy supply by enhancing its efficiency (“Economic Efficiency”) on the premise of “Safety.” It is also important to make maximum efforts to pursue environment sustainability (“Environment”).

The SEP notes that interest in energy issues has surged in Japan compared with that of before the Fukushima accident, and various people have expressed alternative opinions, such as:

- (i) Use of nuclear power should be stopped immediately,
- (ii) Nuclear power generation should be abandoned someday if possible,
- (iii) Large-scale, concentrated power sources like nuclear power plants are unnecessary for Japan,
- (iv) Even if nuclear power generation continues, its scale should be kept at a minimum, and
- (v) There will be continued need for nuclear power generation, and discussions are ongoing.

The Japanese government must take these various discussions seriously and address them squarely.

6.4.3 Nuclear as “key base-load”

The SEP stipulates that the actual scale of nuclear power will be determined from the viewpoints of stable energy supply, cost reduction, measures for combating global warming and maintenance of the technology and human resources required to secure safety. The SEP positions nuclear energy as a key base-load power source premised on safety assurance.

6.4.4 Nuclear option and climate change strategy

In 2014, as a result of the shutdown of nuclear power plants, greenhouse gas emissions from the power sector have increased by 112 million tons compared to FY2010, according to the “White Paper 2014”. This increase is equivalent to approximately 10% of Japan’s total greenhouse gas emissions. In the meantime, greenhouse gas emissions from other sectors have decreased by 27 million tons compared to FY2010, due to a business slump with longstanding slow growth of the national economy.

On 8 November 2016, Japan ratified the “2015 Paris Climate Change Agreement” to cut emissions and prevent climate change. PM Abe puts a priority in making maximum efforts to pursue nuclear and renewable energy policies, to slash greenhouse gas emissions by 26 percent by 2030 from 2013 levels.

6.5 Nuclear export policy under “ABENOMICS”

In late December, 2011, amid nuclear crisis, Japan’s

National Diet ratified bilateral agreements for cooperation in the peaceful use of nuclear energy with four countries: Russia, South Korea, Vietnam and Jordan, with whom the Japanese government had already signed agreements before the Fukushima Daiichi accident of March 11, 2011. However, the National Diet approval had been pending since the Fukushima Daiichi accident.

The Japanese government has also been negotiating similar bilateral agreements with five other countries: Brazil, Mexico, Turkey, India and South Africa.

The present Japanese government, led by the Liberal Democratic Party (LDP), has been promoting the export of nuclear reactor technology because it deems the export of infrastructure technologies as a pillar of its economic growth policy, called “ABENOMICS”.

Earlier in November 2016, PM Narendra Modi of India and PM Shinzo Abe of Japan signed a landmark civil nuclear energy agreement in Tokyo.

In November 2016, Vietnam’s National Assembly has voted to abandon plans to build two nuclear power plants with Russia and Japan, after officials cited lower demand forecasts, rising costs and safety concerns.

Toshiba had aimed to win orders for 45 or more nuclear reactors overseas including UK, India and China by fiscal 2030, before its current crisis, to be briefly discussed in Chapter 8.

6.6 Post-Fukushima nuclear power in Asian countries

6.6.1 Asian nuclear cooperation forum

The Forum for Nuclear Cooperation in Asia (FNCA), comprised of 17 members in Asia including Japan, China and Republic of Korea (ROK) at the ministerial level was held in Tokyo, on November 30, 2016.

The forum discussed cooperative issues including nuclear waste management, climate change and nuclear role, and also the political arena and the negative impact of the accident upon public opinion

In this meeting, policy discussions took place under the theme of stakeholder involvement related to "nuclear waste management" and "nuclear energy use in both power generation and non-power generation fields." At the meeting's conclusion, a joint communiqué was adopted that mentioned "themes and activities to be promoted," and "reform and improvement of the management of FNCA activities."

6.6.2 Taiwan’s nuclear phase-out

In October 2016, Taiwan took a step toward phasing out nuclear power generation in nine years` time. Currently, three nuclear power plants are in operation in Taiwan. This move represents Taiwan’s response to the lessons it has learned by thinking seriously about the Fukushima Daiichi. Taiwan lacks natural resources. It introduced nuclear power generation in the 1970s.

Like Japan, Taiwan is prone to earthquakes and other natural disasters. It has also seen a series of problems that plagued the island’s fourth nuclear reactor, which was under construction, intensifying public distrust of the safety of nuclear power, according to Asahi Shimbun dated on October 31, 2016.

7 Dim expectation for nuclear power in Japan

7.1 Narrow escape from winter power shortage

On October 28, 2016 the Japanese government announced that the national average reserve capacity in winter would increase to 10.8% for December and 8.0% for January, beyond the minimum guideline level of 3% for stable supply.

Six years on, under such a critical situation in which only three nuclear plants operate, the sensitivity among people towards the potential of power shortages has been eroded.

Reminiscent of the hardest days of February 2012, the first winter season after the Fukushima accident, national average reserve capacity fell critically to 2.2% nationwide. Electricity demand in Japan has decreased for 5 years in a row since 2011.

7.2 Scrapping of Monju fast breeder reactor

The Abe government decided on December 22, 2016, to decommission the Monju prototype fast breeder reactor in Fukui prefecture.

Monju was seen as a pillar of Japan's nuclear fuel recycling program because it is designed to burn plutonium which will be produced by reprocessing plants to retrieve plutonium 239 and uranium 235 from huge stockpiles of spent fuel at nuclear power plants. Fast breeder reactors are also supposed to produce more plutonium than they burn while generating power.

After scrapping Monju, the government will seek international cooperation with France for their alternative fast breeder reactor project. But France's Advanced Sodium Technological Reactor for Industrial Demonstration (ASTRID) program, which the Japanese government is counting on for its fast reactor project, is itself facing an unclear future. The French government is expected to decide in 2019 on whether to build the demonstration reactor. (The Asahi Shimbun, December 1, 2016)

7.3 After LWR, will IFR come?

A number of nuclear experts have referred to revolutionary improvement through a next generation nuclear concept.

This includes new types of reactors such as the Integral Fast Reactor (IFR) with high level waste reducing radioactivity in 300 years. This compares with LWR spent fuel that takes 100,000 years. IFR has features such as: being an inexhaustible energy supply, inherent passive safety, being a long-term waste management solution, and economic fuel cycle closure. (See Note 3 in APPENDIX on further details of IFR discussions)

8 Toshiba's financial fiasco

8.1 A surprising statement by Toshiba

The leading company Toshiba, with its pre-eminence in nuclear world, fell suddenly in a flurry. In early February 2017, the Japanese society was very much surprised to hear the company's announcement of a huge financial loss owing to the failure of its nuclear construction business in the U.S. The following briefing on the Toshiba crisis is inevitably related to

strengthened safety regulations for the U.S. nuclear industry in post-Fukushima days.

8.2 Toshiba-Westinghouse in critical mess

On 14 February, 2017 Toshiba, one of the biggest nuclear plant makers in the world, surprisingly announced a projected 712.5 billion Japanese yen (\$6.3 billion) loss for its nuclear business, stemming from Westinghouse's purchase of CB&I's Stone and Webster, one of the main construction companies building the AP1000 nuclear reactor design in Georgia and South Carolina in the United States. (Westinghouse is an 87% subsidiary of Toshiba at present.)

By early 2012, the U.S. NRC inspectors found steel in the foundation of one reactor had been installed improperly by the Shaw Group, the U.S. major nuclear contractor. Shaw held 20% share of Westinghouse with the remaining 80% owned by Toshiba at the initial M&A stage in 2006. In July 2012 Shaw agreed to sell itself for \$3.3 billion to Chicago Bridge & Iron Co (CB&I). The Shaw Group was acquired by CB&I in 2013. Three years later, CB&I decided to cut its losses, and sold the bulk of Shaw's assets to Toshiba for \$229 million, accepting the significantly lowered price in exchange for shedding liabilities related to the projects.

But in April 2016, four months after the deal closed, Toshiba concluded it had miscalculated and accused CB&I of inflating Shaw's assets by \$2.2 billion, and asked to renegotiate. CB&I balked and sued Toshiba for breach of contract in July 2016.

8.3 Shrinking global commitments

Toshiba as recently as last June 2016 had as its goal the construction of 45 nuclear reactors around the world, including two in the UK, six in India, and possibly two more in Georgia, all using Westinghouse's design, the AP-1000, according to Financial Times.

Toshiba is preparing to retreat from its involvement in NuGen of UK, the consortium building the 3.8 gigawatt plant at Moorside, West Cumbria of UK that is due to power 6m homes (BBC, 13, February, 2016). In China, all construction work of nuclear power

plants including Toshiba with four nuclear plants under construction according to Yomiuri Shimbun of Japan, stopped after Fukushima Daiichi accident occurred in 2011. China strengthened safety regulations at its operating nuclear facilities, and carried out safety assessments of all nuclear power plants in 2012. The results showed that all operating facilities are safe, and that the quality of nuclear facilities under construction satisfies the required safety standards.

8.4 Murky nuclear business in the U.S.

Behind the story of the financially troubled Toshiba-Westinghouse, it is noted that the nuclear plant industry in the U.S. has fallen into a dilemma, by the following two factors:

- (i) Sharp plunges of natural gas price led to downward pressure with the nuclear industry in terms of fuel economy, as gas fired combustion power had become more competitive than nuclear generation.
- (ii) Severe safety regulations on nuclear plants have required greater construction expenses, design changes and even schedule delays, reflecting the assessment of the Fukushima Daiichi accident.

8.5 Severe U.S. safety regulations in post-Fukushima

The U.S. Nuclear Regulatory Commission (NRC) determined after the Fukushima Daiichi accident, that additional facility improvements were needed to respond to an extended loss of electrical power and core cooling capability, (that was not inundated by a tsunami), and NRC ordered U.S. plants to have additional portable power supplies and pumps.

On March 2012, NRC directed 31 U.S. reactors to further improve their systems for safely venting pressure from their containment buildings during potential accidents, as a learning from the Fukushima Daiichi accident.

The agency's order dated June 6, 2013 supersedes a March 2012 order for the 31 reactors with "Mark I" and "Mark II" containments to install or improve their "hardened" venting systems.

The agency's order seems to show that the regulation of Japan before the Fukushima Daiichi accident was

not more severe than that of the U.S.

9 Perceived lessons learned from the Fukushima Daiichi accident in international arena

9.1 Key international partners' comments

In this section, the author would like to introduce key international partners' reports and advice on the lessons learned from the Fukushima Daiichi accident, including the IAEA, OECD/NEA Nuclear Energy Agency) and other competent persons and organizations, including NRMCC, the advisory body for TEPCO.

9.1.1 IAEA

Under the title of "Five years after the Fukushima Daiichi Accident-Nuclear Safety Improvement and Lessons Learnt", IAEA released the report on the progress in post-accident recovery up until March 2015, with a foreword by Yukiya Amano, Director General of IAEA.

(i) Initial response to the accident

Japan was not sufficiently prepared for a severe nuclear accident in March 2011. The Fukushima Daiichi accident exposed certain weaknesses in Japan's regulatory framework. Responsibilities were divided among a number of bodies, and it was not always clear where authority lay.

(ii) Transition from the emergency phase to the recovery phase

Specific policies, guidelines, criteria and arrangements for the transition from the emergency phase to the recovery phase were not developed until after the Fukushima Daiichi accident.

(iii) Management of contaminated material and radioactive waste

Stabilization of a damaged nuclear power plant and the on-site decontamination and remediation efforts in the surrounding areas resulted in large quantities of contaminated and radioactive waste.

(iv) Protecting the public

National emergency arrangements at the time of the accident envisaged that decisions on protective actions would be based on estimates of the projected dose to the public that would be calculated when a decision was necessary, using a dose projection model—the System for Prediction

of Environmental Emergency Dose Information (SPEEDI).

(v) Off-site remediation of areas affected by the accident

Policies and strategies for post-accident remediation were not in place in Japan.

(vi) Community revitalization

Evacuation and relocation measures and restrictions on food involved hardships for the people affected. The revitalization and reconstruction projects introduced in Fukushima Prefecture were developed from an understanding of the socioeconomic consequences of the accident.

(vii) Communication and trust building

Communication with the public on recovery activities is essential to build trust.

(viii) Socioeconomic consequences

Evacuation resulted in the loss of farms and businesses by which fishing, agricultural and other commercial activities have ceased.

9.1.2 OECD/NEA

OECD/NEA report also puts importance on continuing enhancement of safety, risk insights, strengthening regulatory frameworks, the human elements, enhancing stakeholder involvement and public communication, among others.

9.1.3 G7 nuclear group

The G7 Summit is a meeting in which the heads of government of seven countries, *i.e.* Japan, the United States, the United Kingdom, France, Germany, Italy and Canada, along with the presidents of the European Council and the European Commission participate. The Nuclear Safety and Security Group within the G7 Summit framework published a report on 27 May 2016, highlighting the decommissioning of Fukushima Daiichi NPS. International Forum on the Decommissioning of the Fukushima Daiichi NPS was also held in April 2016 in Iwaki City in Fukushima Prefecture. The forum was jointly hosted by the Agency for Natural Resources and Energy (ANRE) of METI, and the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF).

9.1.4 UNSCER

The United Nations Scientific Committee on the

Effects of Radiation (UNSCER) published an assessment report with regard to levels and effects of radiation exposure due to the Fukushima Daiichi accident in November 2016.

9.1.5 FNCA

The Forum for Nuclear Cooperation in Asia (FNCA), comprising of 12 member countries in Asia at the ministerial level (Australia, Bangladesh, China, Indonesia, Japan, Kazakhstan, Korea, Malaysia, Mongolia, The Philippines, Thailand and Viet Nam) has been held 17 times up to 2016, and discussed cooperative issues including nuclear waste management, climate change and nuclear role, and also political arena with the negative impact of the accident upon public opinion.

9.1.6 JAIF

The Japan Atomic Industrial Forum (JAIF) held the East Asian Nuclear Energy Forum in 2013, and discussed several issues, including decontamination, storage of radioactive waste, and decommissioning of the Fukushima Daiichi.

9.1.7 Nuclear Reform Monitoring Committee (NRMC)

NRMC is an advisory body of the Board of Directors of TEPCO, with the objective of promoting reform of the corporate culture toward a safety-oriented atmosphere with TEPCO's self-assessment. The members of this NRMC are given in **Table 8**. In its first meeting held in July 25, 2012, NRMC reiterated its mission as follows:

- (i) Reform from top management to take the initiative to fully exercise leadership to improve safety,
- (ii) Reform to become a self-led organization to restructure emergency organization,
- (iii) Reform work processes by shifting from perfect countermeasures to quickly implemented measures, and
- (iv) Reform relationships with the regulator, siting community, and the public by enhancing risk communication and improving transparency.

Although they admitted that TEPCO is making progress in implementing its Nuclear Safety Reform Plan and has made significant improvement in nuclear safety leadership, culture, operations and emergency

preparedness, the 12th NRMCM Meeting held in January 30, 2017 has made recommendations to the chairman of TEPCO, including the following items:

- (i) Consistent efforts should be made to build a strong nuclear safety and instill the nuclear safety culture in an organizational culture, and
- (ii) Benchmarking for nuclear safety, risk management, radiation protection/or communications should be considered for Fukushima Daiichi, where the site is radiologically complex and very unique.

Table 8 Members of the Nuclear Reform Monitoring Committee Meeting (NMRC/TEPCO)

Dr. Dale Klein, Chairman Former Chairman of the U.S. Nuclear Regulatory Commission Lady Barbara Judge CBE, Deputy Chairman Former Chairman of the United Kingdom Atomic Energy Authority Mr. Masafumi Sakurai, Committee Member Former member of the National Diet of the Japan Fukushima Nuclear Accident Independent Investigation Commission; former Superintendent Public Prosecutor, Nagoya High Public Prosecutor's Office Mr. Fumio Sudo Chairman, Tokyo Electric Power Company Holdings, Inc.

9.1.8 Lady Judge, CBE

Lady Barbara Judge, CBE, the Deputy Chairman of the NMRC has remarked on nuclear reform and culture, in the twelve cyclical meetings held in Tokyo between October 2012 and January 2017.

- (i) The Japanese public has lost faith in its nuclear industry and in its government's ability to manage plants safely.
- (ii) With the objective of promoting reform of the corporate culture toward a safety-oriented atmosphere, and to make TEPCO the best in class with respect to Nuclear Safety and Security, TEPCO must inculcate lessons learned not only on paper but also in their heads of all employees.
- (iii) TEPCO would need to employ foreign and domestic decommissioning experts.
- (iv) TEPCO needs to change its culture even more, from one emphasizing efficiency to one emphasizing safety.
- (v) Increased specialization and management oversight would allow for a stronger safety culture in both operations and decommissioning.
- (vi) I recognize that TEPCO has been changing so that it puts safety ahead of efficiency. You must all

take the initiative and imbue a safety culture throughout the organization.

- (vii) TEPCO has appointed a woman as a head of its Social Communication Office. Under her leadership, TEPCO's communication has improved in terms of transparency, speed and context. Her challenge is the need to strengthen the level of communication, and them to more proactive and strategic, as well as to engage with local community at all times.

10 Concluding remarks

With the calming of power shortages in winter, the general public feeling of "there is no problem with us even without nuclear power" is prevailing gradually in the daily lives of Japanese people.

As illustrated earlier in this text, people still feel ambivalent with anxieties over nuclear operation, while they think it is needed, that it takes another thirty to forty years to decommission and decontaminate, which could take an unthinkable one hundred years and beyond in the case of the Fukushima Daiichi NPS.

Although sustained political protest is rare in Japanese society, it does not necessarily mean that the anti-nuclear movement is doomed to wither and it will not take more years to rollback in nuclear restart, as the New York Times wrote. The nuclear issue persistently would yield more deep ideological disputes between conservatives and liberals including political parties in Japan.

Junichiro Koizumi, former prime minister of Japan, although he supported nuclear power when he served as prime minister, is now set against it and calling for permanent shutdown. He argued that "there is nothing more costly than nuclear power" according to the New York Times on January 2, 2017.

None of us can deny that the "Nuclear Renaissance" will not be coming back again in the near future. The coming years will be crucial tests for Japan in terms of governance/governability, culture, compliance and public acceptance.

Nomenclature

AM	Accident Management
ANRE	Agency of Natural Resources and Energy
BWR	Boiling Water Reactor
CEO	Chief Executive Officer
CHUBU	Chubu Electric Power Company
DPJ	Democratic Party of Japan
EPZ	Emergency Planning Zone
FNCA	Forum for Nuclear Cooperation in Asia
G7	The Group of Eight industrial countries
GHG	Greenhouse Gas
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IFR	Integral Fast Reactor
JAIF	Japan Atomic Industrial Forum
JAEC	Japan Atomic Energy Commission
KEPCO	Kansai Electric Power Company
MAFF	Ministry of Agriculture, Forestry and Fisheries
LWR	Light Water Reactor
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHLW	Ministry of Health, Labor and Welfare
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOE	Ministry of the Environment
NERHQ	Nuclear Emergency Response Headquarters
NIMBY	Not in My Backyard
NAIIC	Nuclear Accident Independent Investigation Commission
NISA	Nuclear and Industrial Safety Agency
NHK	Nippon Hoso Kyokai (Japan Broadcasting Corporation)
NPS	Nuclear Power Station
NRA	Nuclear Regulatory Agency
NRC	Nuclear Regulatory Commission
NRMC	Nuclear Reform Monitoring Committee
NSC	Nuclear Safety Commission
OECA/NEA	Organization for Economic Co-operation and Development/ Nuclear Energy Agency
PCV	Pressure Containment Vessel
PM	Prime Minister
PWR	Pressurized Water Reactor
SPEEDI	Systems for Prediction of Environmental Emergency Dose Information
TEPCO	Tokyo Electric Power Company

UNSCER	The United Nation Scientific Committee on the Effects of Radiation
WTO	World Trade Organization

References

All of the news sources quoted in this article are cited from the press releases of the National Diet, the Cabinet Office, NRA, MOE, METI/ANRE, IAEA, TEPCO, JAIF, Asahi Shimbun, NHK and other relevant domestic and international sources. Major references are also obtained from the websites operated by various organizations as listed below:

Asahi Shimbun	http://www.asahi.com
Cabinet Office	http://www.cao.go.jp
IAEA	http://www.iaea.org
IJNS	http://www.ijnsweb.com/
JAIF	http://www.jaif.or.jp/
Japan Times	http://www.japantimes.co.jp
Keidanren	http://www.keidanren.or.jp
KEPCO	http://www.kepc.co.jp
MAFF	http://www.maff.go.jp
Mainichi Shimbun	http://www.mainichi.co.jp/
METI	http://www.meti.go.jp
MEXT	http://www.mext.go.jp
MHLW	http://www.mhlw.go.jp
MOE	http://www.env.go.jp
NRA	http://www.nsr.go.jp/
NRC	https://www.nrc.gov
NHK	http://www.nhk.or.jp
NISA	http://www.nisa.meti.go.jp
NSC	http://www.nsc.go.jp
PM Office	http://www.kantei.go.jp
TEPCO	http://www.tepco.co.jp

APPENDIX

Note 1:

TEPCO had initially explained to the NRA that the Kashiwazaki-Kariwa plant had been strengthened the anti-seismic design of the emergency response facility to meet with the NRA requirement, but in November 21, 2016 TEPCO announced that it is not fully met with the NRA requirement. According to TEPCO, this fault has occurred by mistaken communication between the seismic design section and the section in charge of official announcement to the public.

Note 2:

There are three groups of respondents of social survey in Table 4. Sendai city respondents living in the city where nuclear power station is located, Urban

represents respondents living in the neighboring cities and towns of Sendai city, and Nation represents respondents sampled randomly in whole Japan.

Note 3:

Nobuo Tanaka, Former Executive Director, IEA, is one of the advocates of IFR, in an international conference on Energy Security and Sustainable Nuclear Power, ICEF2, Tokyo, October 7, 2015. (See the URL: http://www.icef-forum.org/annual_2015/).

Updated calendar (April 1, 2012 ~ January 31, 2017)

Here below is the updated calendar (April 1, 2012 through January 31, 2017), cited from NHK, “Atoms in Japan Update” edited by JAIF and other relevant news sources. The archives of the past updated calendar of March 11, 2011 through March 30, 2012, can be used for comparison - of which coverage was included in the “*Nuclear Safety and Simulation, Vol. 3, Number 1, March 2012.*”

2012 April - June

April 1	PM Noda: Safety is top priority to restart reactors.
April 2	Prefectures preparing for tighter cesium standards.
April 2	Stricter food safety standards introduced.
April 6	No-return zone around Fukushima plant proposed. Govt. approves new nuclear plant safety standards.
April 7	Diet investigative panel visits Chernobyl.
April 9	Kansai area may face 20% power shortage this summer.
April 9	Govt. urged to set up new nuclear regulator.
April 13	Govt. acknowledges need to resume Ohi nuclear plant.
April 16	Osaka mayor criticized govt. on reactor restart.
April 18	Robot to inspect Fukushima Daiichi No.2 reactor.
April 19	Japan, Ukraine sign nuclear disaster agreement. TEPCO to draw up renewal plan under new chairman.
April 20	Kazuhiko Shimokobe, new TEPCO chairman to-be appointed.
April 22	Sale of Japanese rice resumed in China.
April 25	Japan's last online reactor in Hokkaido to shut down.
May 1	Kyoto criticism: Govt. explanation on Ohi is insufficient.
May 10	World Health Organization reported the radiation doses estimation.
May 15	UN Scientific Committee on the Effects of Atomic Radiation reported contamination of Fukushima accident.
June 18	Japan failed to use U.S. radiation data gathered.

2012 July - December

July 5	The Fukushima Nuclear Accident Independent Investigation Commission submitted the final report and criticized nuclear stake holders.
July 22	After Fukushima, nuclear power on collision course with Japanese public.
August 20	300 metric tons of heavily contaminated water had reportedly leaked from a storage tank in the Fukushima Daiichi.
October 12	The 1st Nuclear Reform Monitoring Committee Meeting of TEPCO was held.
October 26	TEPCO admitted that it could not stop radioactive material entering the ocean.
October 29	Supporters of zero nuclear power "irresponsible": PM Abe criticized.
Later October	a 16-member IAEA mission visited Fukushima.
December 16	The Liberal Democratic Party (LDP) had a clear victory at the Diet election, with Shinzō Abe as the new Prime Minister.

2013 January - June

January 10	Fukushima Daiichi: 400 tons per day of cooling water pumped into the reactors.
January 22	TEPCO; Financial support from the Nuclear Damage Liability Fund.
February 6	TEPCO; Strategy towards Introducing Annual 10 million tons of LNG.
February 7	Fukushima Daiichi; Revised Implementation Plan for revival was approved.
February 18	TEPCO; "Third Party Investigation Committee on TEPCO's Response established.
April 1	PM Abe directs Cabinet Members to design responsible Energy Policy.

May 20	Japan Atomic Industry Forum (JAIF) holds “East-Asian Nuclear Energy Forum” in Tokyo.
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2013 July - December

August 5	Japan and U.S. reaffirm commitment to Convention on Compensation Fund.
September 5	India and Japan sign MOU on nuclear energy cooperation.
October 9	Japan's fuel costs may rise to 7.5 Trillion Yen, METI estimates
October 23	Area around Fukushima may be a forbidden zone for decades to come.
October 29	Hydrogen recombiners at all 20 NPC plants to avoid Fukushima.
November 12	Japan starts up offshore wind farm near Fukushima.
November 25	TEPCO begins removing fuel from Unit 4 spent fuel pool.
December 16	Japan, China, Korea agreed to exchange nuclear regulatory information.

2014 January - June

February 3	PM Abe vows to accelerate reconstruction of Fukushima Daiichi.
February 13	TEPCO reported 37,000 becquerels of cesium-134 and 93,000 becquerels of cesium-137 were detected per liter of groundwater.
April 13	TEPCO implements new safety measures in bid to restart Kashiwazaki-Kariwa reactors.
April 21	Cabinet approved Strategic Energy Plan: nuclear energy as “base-load source”.
May 7	3% capacity margin could be secured this summer; METI.
May 19	The Diet passes the act of nuclear damage liability facilitation fund.
June 9	The Diet special committee witnessed criticism of regulatory administration.

2014 July - December

July 7	No nuclear power in Japan this summer, severe electricity situation continues.
July 22	NRA confirms compatibility of Sendai-1 and -2 units with new safety standard.
August 10	TEPCO reported the Unit 3 had melted through in the initial phase of the accident.
September 8	Cesium levels reduced significantly at Fukushima Daiichi.
September 16	KEIDANREN requests prompt restarts of NPSs with the reshuffled Abe government.
September 22	Japan had more than 47 tons of plutonium at the end of 2013.
September 29	PM Abe reaffirms policy of restarting NPSs.
November 4	Local assembly votes for restart of Sendai-1 and -2.
November 10	JNFL postpones completion of Rokkasho reprocessing plant again.
November 17	TEPCO announces removal of one more roof panel at Unit 1.
December 1	Work to seal trench at Fukushima Daiichi Unit 2 enters next phase.

2015 January - June

January 19	TEPCO starts removing strontium from contaminated water at Fukushima Daiichi.
January 19	IAEA Director General Amano visits Japan.
January 23	NRA approves sub-drain facility at Fukushima Daiichi.
February 2	NRA starts discussing standards for burying decommissioning waste.
February 10	TEPCO started the "Muon scanning" process for Units 1, 2 and 3.
February 23	IAEA completes review at Fukushima Daiichi.
March 1	Fukushima Governor decides to accept transfer of radioactive waste.
March 6	TEPCO begins transfer of fuel to spent fuel pool at Fukushima Daiichi. Environment Ministry explains actions to monitor health of Fukushima residents.
March 9	Ohtsu District Court approved a motion for provisional disposition to suspend the operation of Takahama Units 3 and 4 of KEPCO.
March 14	KEPCO appealed of an objection to Ohtsu district court approval.
March 16	PM Abe stresses need to speed up “Return Home” plan in Fukushima. PM Abe asks German Chancellor to abolish EU import restrictions on Foods from Fukushima.
March 20	TEPCO to dismantle building cover at Fukushima Daiichi-1. DG Amano of IAEA released the report of the Fukushima Daiichi.
April 9	TEPCO to use robot to investigate containment vessel at Fukushima Daiichi.
May 15	Japan's Farm Minister slams Taiwan's limits on Japanese food imports.
May 18	Fukushima Daiichi frozen wall tests succeed in lowering underground temperatures.
May 25	Japan takes claim against South Korea to WTO about food import restrictions.
June 15	Fukushima evacuation orders to be lifted for 70 Percent of affected residents.
June 16	Government revises roadmap for medium and long-term decommissioning of Fukushima

	Daiichi.
June 19	NRA confirms additional dose reduction at Fukushima Daiichi.

2015 July - December

July 7	Evacuation order for Naraha town to be lifted.
August 28	Health Ministry Issues Guidelines Managing Safety and Health at Fukushima Daiichi.
September 16	TEPCO first releases of treated groundwater from Fukushima Daiichi into the Ocean.
September 30	WTO Panel on South Korean Restriction of Japanese Marine Product Imports.
October 6	TEPCO releases decontaminated groundwater five times into the sea from Fukushima Daiichi.
October 29	TEPCO completes shielding wall at Fukushima Daiichi, greatly reducing water leakage.
December 1	TEPCO to Dismantle Top of Unit 2 Reactor Building at Fukushima Daiichi.

2016 January - June

February 10	Fukushima's cleanup going; Not so well (Washington Post).
February 16	TEPCO: total debris from Fukushima Daiichi to reach 749,000 Cubic Meters.
March 2	FIVE YEARS AFTER: TEPCO admits to delay in reporting onset of Fukushima nuclear accident.
March 2	Of the original 470,000 evacuees, 174,000 evacuees remain.
March 4	FIVE YEARS AFTER: Recovery not in sight for 62% in Fukushima.
March 7	FIVE YEARS AFTER: Fukushima fishermen still struggle to prove catches are safe.
March 9	Court orders Takahama reactor shut down, 2nd offline. FIVE YEARS AFTER: Radioactive forests prevent logging revival in Fukushima.
March 10	FIVE YEARS AFTER: 1 in 3 Fukushima evacuees giving up hope of ever returning home.
March 12	Anti-nuclear rally in Tokyo marks 187th since the 2011 disaster.
March 13	FIVE YEARS AFTER: Government reluctant to specify Self-Defense Forces (SDF) role in nuclear crisis.
March 15	FIVE YEARS AFTER; OECD/NEA (Nuclear Energy Agency) Report released.
March 17	NRA criticizes Asahi story on radiation dose monitors.
March 18	Toshiba under U.S. probe into its accounting practices.
March 21	2 British ships in Japan to take plutonium to U.S. for storage.
March 25	Nuclear reactor in Ehime retired as cost of safety deemed too high. 30 years for Chernobyl clean-up effort.
March 26	Governor urges Washington to divert plutonium from Japan.
March 30	TEPCO given OK on freezing soil at Fukushima plant.
March 31	NRA approves start of freezing of wall at Fukushima Daiichi.
April 6	Court rejects appeal to halt operations of Sendai reactors.
April 11	Int'l Forum on the Decommissioning of Fukushima Daiichi was held in Fukushima Prefecture.
April 20	New regulatory requirements for Ikata Power Station Unit 3 is completed.
April 26	Japan to raise nuke safety check competency per IAEA review.
May 27	G7 Ise-Shima Summit Group called cooperation on nuclear R&D.
June 12	Evacuation lifted for Fukushima village; only 10% preparing return.
June 17	TEPCO head blamed for late mention of 'meltdown'.
June 20	NRA gives 1st OK to extend life of aging reactors of Takahama.
June 29	Utilities reject shareholders' call to abandon nuclear power.

2016 July - December

July 6	Ex-PM Koizumi appeals for help for U.S. vets who assisted in Fukushima.
July 7	Number of Fukushima evacuees falls below 90,000.
July 21	TEPCO ordered to pay for 'false rumors' from Fukushima crisis.
August 3	No marine products show radioactive concentrations above the value. Nuclear disaster evacuation plans worry many local authorities.
August 15	17% support for restarting nuclear; NHK public poll results.

August 19	TEPCO's 'ice wall' failing at Fukushima nuclear plant.
September 5	10% return to Fukushima town since evacuation order lifted.
September 6	Robot to probe nuke fuel debris in Fukushima No. 2 reactor.
September 12	External radiation exposure found to be unrelated to prevalence of thyroid cancer in aged 18 and younger.
September 21	Public to get new \$83-billion bill for Fukushima, reactor expenses. LDP policy chief urges scrapping of troubled "Monju" reactor.
October 2	Utilities may get caps on liability in time of serious nuke accidents.
October 7	Radioactive water leaks from storage tank at Fukushima plant.
October 29	Kagoshima governor accepts restart of reactor at Sendai plant.
October 31	Taiwan bows to public opinion in pulling plug on nuclear power.
November 2	Government to lift evacuation order for Kawamata.
November 10	United Nation Scientific Committee Report on the Effects of Radiation.
November 12	Japan, India sign agreement on civil nuclear power.
November 21	New mayor in Niigata willing to restart nuclear plant.
November 23	Vietnam abandons plan for first nuclear power plants.
December 6	State ownership of TEPCO likely to continue as costs keep rising.
December 9	Fukushima nuclear disaster bill to double to 21.5 trillion yen. Sendai-1 Restarted: Kagoshima governor accepts.
December 22	Ministers Decide to Decommission of "Monju".
December 23	Fuel removal at Fukushima reactor again faces delay.
December 27	NRA: Ice wall effects 'limited' at Fukushima nuclear plants.

2017 January 1- 31

January 2	Ex-PM Koizumi turns nuclear foe.
January 5	Niigata governor rejects restarts in 1st meet with TEPCO execs.
January 6	Fukushima seafood tested falls below cesium standard; JAIF.
January 14	EU eases restrictions on food imports from Japan.
January 31	Toshiba to Shrink Nuclear Business due to huge loss.