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Nuclear Energy Policy after the Fukushima Nuclear Accident: An Analysis of “Polarized Debate” in Japan

Tatsujiro Suzuki

Abstract

The Tokyo Electric Power's Fukushima Daiichi nuclear accident in 2011 was a turning point for Japan's nuclear energy and overall energy policy. In reality, Japan has reduced its dependence on nuclear energy drastically despite the government's policy to maintain nuclear energy as a major power source. Even with sharp drop in production from nuclear energy, Japan could achieve carbon reduction of around 60–70% by 2050 even without nuclear power. But the biggest impact of the Fukushima accident is the loss of public trust. The policy debate on nuclear energy is now divided between “pro” and “anti” of nuclear power. The aim of this study is to analyze why such “polarized debate” has not been resolved and find a way to restore public trust. This study analyzes three important nuclear energy policy issues, i.e., decommissioning of Fukushima Daiichi nuclear plant, spent nuclear fuel and waste management, and plutonium stockpile management. The analysis of these three cases suggest that lack of independent oversight organizations is a common cause of impasse of nuclear energy policy debate. The author argues that Japan needs to establish independent oversight organizations in order to gain public trust and solve important policy issues regardless of the future of nuclear energy.

Keywords: Fukushima accident, polarized debate, public trust, independent oversight, nuclear waste, plutonium

1. Introduction

The Tokyo Electric Power Fukushima Daiichi nuclear accident was a turning point for Japan's nuclear energy and overall energy policy.

The biggest impact is the huge drop in the number of reactors operating and its share in electricity supply in Japan. Before the Fukushima accident in 2010, the share of nuclear energy was about 25%, and it went down to zero in 2012 and still only 1.7% in 2016 [1]. It is surprising that despite such sharp reduction in nuclear power generation, no serious power shortage has happened in Japan. One of the main reasons is sharp reduction in electricity consumption and peak demand. In FY 2011, power consumption dropped about 3.8% from FY 2010, and consumption continued to decline until FY 2016 and is now about 10% below the level of FY 2010. Peak demand also declined sharply. Its peak demand in FY 2010 was 178 GWe

in August 23, 2010 but declined to 153 GW in FY 2015 on August 7, 2015, which is about 14% reduction [1].

Another major impact of the Fukushima accident is loss of public trust and dramatic shift in public opinion on nuclear power. Before the Fukushima accident, majority of the public was in favor of either maintaining or expansion of nuclear power, but now majority of the public was in favor of either immediate shutdown of all reactors or gradual phaseout of nuclear power. Based on such shift in public opinion, the government under the Democratic Party of Japan in 2012 issued a new energy policy to phase out nuclear power by the end of 2030 [2]. But the new government under the Liberal Democratic Party reversed its policy and still maintains nuclear power as an important power source [3]. But loss of public trust has not been restored, and majority of the public still believes that severe nuclear accident could happen despite the new and much tougher nuclear safety regulation standards and establishment by the newly established, independent Nuclear Regulation Authority (NRA) in 2013.

As a result, whenever a reactor is ready for restart up, public debate occurs and legal cases follow although the pronuclear government and utility industry insist that restart-up of nuclear power is necessary for economy and energy security. In short, the country is now divided into “pro” and “anti” nuclear energy, and policy debate is often polarized and has led to unproductive discussion, and major policy issues remain unsolved. It is important to clarify the issues that need to be addressed regardless of the future of nuclear energy. By focusing on these issues and through more productive policy discussion, consensus may emerge among the public on what to do to solve those important issues.

Meanwhile, new energy policy of Japan should reflect new developments in renewable energy and energy efficiency in which the public has strong support. Given structural change in energy demand and rapid development of renewable energy, Japan could reduce its carbon emission by 60–70% by 2050, based on the recent analysis [4, 5].

The aim of this study is to analyze why “polarized debate” has not been resolved and find a way to restore public trust by focusing on issues that need to be resolved regardless of the future of nuclear energy.

2. Loss of public trust

The loss of public trust is one of the biggest impacts of the Fukushima nuclear accident. Public opinion on nuclear power in Japan has changed dramatically since the Fukushima accident.

According to the public polling done by Japan Atomic Energy Relations Organization [6], the ratio of public who believe that nuclear power is necessary was 35.4% in 2010 but dropped to 23.5% in 2011 after the accident and further dropped to 17.9% in 2017. At the same time, the ratio of the public who do not trust nuclear power (community) jumped from 10.2% in 2010 to 24.3% in 2011 and now even increased to 30.2% in 2017.

The public has lost faith in nuclear safety regulation too. Faith has not been fully restored even after a new independent Nuclear Regulation Authority was established in 2012, and new, much tougher regulatory standards were introduced. According to the same JAERO study, the ratio of the public who trust the government and nuclear industry is 1.9 and 1.2%, respectively, and the ratio of the public who do not trust the government and nuclear industry is 20.5 and 22.0%, respectively. The reasons for “not trustworthy” cited by those are lack of information disclosure (nuclear industry 68.3%, government 62.5%), insufficient preparation

and management on safety (nuclear industry 60.4%, government 54.1%), and not speaking honestly (nuclear industry 59.8%, government 59.2%). As a result, the ratio of the public who think that nuclear power should be increased and/or maintained before the Fukushima accident continuously dropped to 10.1% in 2014 and only 6.9% in 2017. On the other hand, the ratio of the public who are in favor of phasing out and/or should be abolished now increased to 79.6% in 2017 from 56.2% in 2013.

In the latest polling undertaken by Mainichi Shimbun in March 2018 [7], the proportion of the public who oppose the restarting of existing reactors rose to 55%, an increase of 2% points from previous polling on this question. And the proportion of the public who support the restarting of existing reactors was down to 26%, a decline of 4% from the previous polling. As a result, its gap between the opposition and the support became bigger.

The previous government under the Democratic Party of Japan tried to restore public trust by introducing more open decision-making process. Prime Minister Naoto Kan announced that it would critically review nuclear energy policy “from scratch” and set up new policy-making process to encourage “national public debate” on nuclear energy. It set up a new cabinet-level Council on Energy and Environment and promoted public participation in policy-making process. As a result, a new “Innovative Energy and Environmental Strategy” was issued in September 2012, incorporating results of public opinion polls which showed that majority of the public was in favor of “phasing out nuclear power.” The new strategy aimed at phasing out nuclear power by the end of the 2030s and did not allow for new construction of nuclear power plants [2].

But newly elected Shinzo Abe’s government abolished the previous government’s “nuclear phaseout” policy and abolished the open policy-making process to reflect public opinions to the decision-making. On April 11, 2014, the new Strategic Energy Plan was adopted by the cabinet [3]. Although the new plan stated that Japan will reduce its dependence on nuclear energy as much as possible, it still maintains that nuclear power is an important “base-load power source” (i.e., essential power source which should be operated 24 hours/day without changing its output). As a result, its “dual policy goals” (the goal of “decreasing dependence on nuclear power as much as possible” and the goal of “using nuclear power as a base-load power source”) send confusing signals to the public and energy market. Later the METI published its future energy mix projection, suggesting that nuclear power’s share in 2030 should be around 20–22% [8]. In order to achieve that goal, not only existing reactors should be restarted, but Japan may need new reactors replacing old reactors. Since then, the debate over nuclear energy—especially the restart of existing reactors—has been polarized as the government pushed its pronuclear stance, while the public was still in favor of eventual phaseout of nuclear energy.

On July 3, 2018, the Japanese government adopted METI’s new “Strategic Energy Plan” as a cabinet decision [9]. The new Strategic Energy Plan has some new features compared with the previous 2014 plan, such as stronger emphasis on renewable energy and new statement on plutonium stockpile which will be discussed later in this paper. But in overall, the plan is not so different from the previous plan. The plan still defines nuclear power as an important base-load power, while it aims to reduce its dependency on nuclear power as much as possible as was the case in the previous strategic plan in 2014.

Although the majority of the public seems to be in favor of phasing out nuclear energy, the Japanese government continues to maintain its commitment to nuclear power. As of October 26, 2018, only 9 out of 39 existing reactors are operating, while 6 received operating licenses but have not yet started operation, and 16

reactors have been closed (to be decommissioned) since the accident. But still there are 14 reactors that have not applied for re-license, while 3 reactors are under construction [10]. It is not certain when and whether those reactors will receive operating licenses in the near future.

Political process to restart the nuclear reactors is complex and not straightforward in Japan. Technically, getting the approval from the NRA is sufficient to start up the reactor, but not politically sufficient. Utilities must get local governments' approval under the so-called Safety Agreement, which is a gentlemen agreement (not legally binding) between local governments and utilities. In particular, evacuation issue is the major hurdle for restart up, as evacuation plan is not a subject of NRA licensing process, and thus it is not clear how and who determines the appropriateness of evacuation plans.

Another challenge is legal lawsuits against utilities and/or government on nuclear safety. After the Fukushima accident, it is no longer automatic to assume that local residents and nuclear opponents lose the case. Uncertainties about legal decisions on nuclear safety issues are increasing due to different interpretation of "safety" by the courts. For example, on December 13, 2017, the high court in Hiroshima granted the injunction requested by the residents in Hiroshima and opponents for the operating Ikata #3 and #4 reactors. This was the first time that the high court granted the injunction against operating reactors [11]. However, on September 25, 2018, the same high court in Hiroshima now granted the objections from Shikoku Denryoku who is the operator of Ikata reactors and allowed the utility to restart the reactor. It turned out the judges who made the decision to grant the utilities are different from those who made decision to grant the injunction in 2017 [12].

3. Impact on energy policy of the Fukushima accident and long-term prospects on carbon emissions

As noted above, Japan's energy supply and demand picture has dramatically changed after the Fukushima nuclear accident. The sudden reduction of power production from nuclear power forced Japan to increase in fossil fuel consumption which led to increase in electricity rates, from 20 yen/kWh (the average of consumer electricity rate) in 2010 to more than 25 yen/kWh in 2014. But then, due to decrease in fossil fuel prices, it went down to about 20 yen/kWh in 2015 [1]. Increased consumption of fossil fuel resulted in increase of CO₂ emission of Japan, peaking its emission at 1.4 billion tons in 2013, but then declined to 1.3 billion tons in 2015 and 2016. The reasons for decline of CO₂ emission are increasing production of renewable energy and increased energy efficiency which led to reduction of energy consumption itself [13].

The energy efficiency improvement rate was almost equal to the one achieved after the first oil crisis in 1973. The average improvement rate of energy efficiency was 2.9% per from FY 1973 to 1985, while it was 3.2% per year from FY 2011 to 2014 [4].

According to a study done by a team at Japan Center for Economic Research (JCER) [4, 5], such trends will likely to continue based on the assumption that fossil fuel price will continue to increase and Japan's energy and economic structure will shift to more energy efficient nonmanufacturing industries. Furthermore, the study assumes expansion of renewable energy up to 60% of total electricity production through interviews of experts of renewable energy in Japan. The study also assumes that 15% of electricity production will come from nuclear power from 2030, which may require construction of new reactors to replace old reactors in Japan.

Based on such assumptions, Japan could reduce CO₂ emissions by 60% by 2030 or even 70% with introduction of environmental tax. Nuclear power, if it is too expensive, could be replaced by carbon capture storage (CCS) fossil power plants which are assumed to be commercially competitive by 2030. In fact, the study also analyzes the impact of the Fukushima accident on the economics of nuclear power. Due to increase in accident associate costs, nuclear power's commercial competitive advantage may disappear, and thus total cost of carbon reduction strategy without nuclear may not be so expensive compared with the one with nuclear power [4].

The study results suggest that Japan's carbon reduction strategy may not need nuclear power as was expected before. In short, the most important factor in carbon reduction strategy is likely to be energy efficiency improvement and expansion of renewable energy, and thus dependence on nuclear power can be reduced as much as possible. In fact, public trust is essential in solving key policy issues regardless of the future of nuclear energy.

4. Analysis of three issues which need to be resolved regardless of the future of nuclear energy

Primarily due to loss of public trust, polarized debate has not led to constructive policy debate to solve important policy issues that need to be addressed regardless of the future of nuclear power. What would be necessary to avoid polarized debate and constructive discussion which could lead to solutions to important policy issues? This section deals with three important policy issues and examines the ways to overcome the current difficulties of polarized debate.

4.1 The decommissioning of the Fukushima Daiichi reactors

More than 7 years have passed since the earthquake, but the accident is not completely over. About 60,000 evacuated residents in Fukushima are still living in temporary housing and are still uncertain as to when and whether they can return to their original hometowns. Although conditions at the Fukushima power stations have improved, it will take more than at least 40 years to decommission the plant, but the removal of melted debris is the most challenging task with high risk. It is still not clear whether the debris can be removed safely and how to dispose all radioactive wastes from the decommissioning.

The task of decommissioning of the Fukushima Daiichi reactors is obviously the most challenging task that the global nuclear industry has faced. The Tokyo Electric Power Co (TEPCO) is still responsible for managing this important and challenging task, but the government has helped TEPCO by setting up the Inter-Ministerial Council for Contaminated Water and Decommissioning Issues which publish the “Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station”. The most recent one, published on September 26, 2017, again delayed the first phase (removing the spent fuel from storage pools of units 1–3) for more than 3 years [14].

There have been concerns about lack of transparency and independent oversight on the whole decommissioning process. The Japan Atomic Energy Commission, which is an advisory organ under the cabinet office, recommended that the government should establish an independent (third party) organization with overseas experts as members to assess and audit the entire measures in order to maximize transparency [15]. But such independent organization has not been established by the government.

After Prime Minister made a speech at the 125th Session of the International Olympic Committee (IOC) on September 7, 2013 [16], in which he stressed that the situation in Fukushima is “under control,” the government announced that it would take more responsibility in contaminated water problems. The government set up “Inter-Ministerial Council for Contaminated Water and Decommissioning Issues,” and “frozen wall method” was chosen by the Council as the best technology to deal with the contaminated water. However, it was not clear why this technology was chosen. Many underground water experts raise doubts about the effectiveness of the technology which is often used for a small-scale underground water treatment but has never been used for such a large-scale operation. Experts suggested that there are simpler and cheaper alternative technologies available, but selection was made in a closed meeting without full disclosure of its selection process [17]. The frozen wall was completed, but NRA gave a license to start operation of the wall on August 15, 2017, but its effectiveness is still unclear.

The second example of lack of transparency is the estimate of total cost of decommissioning. On December 20, 2016, the Committee for Reforming TEPCO and Overcoming 1F Challenges under the METI published new cost estimate for decommissioning of Fukushima Daiichi and compensation and decontamination of land. The total cost jumped from previous estimate of 11 trillion yen to 22 trillion yen [18]. But the foundations of such estimate are very weak. The analysis done by an independent economic think tank, Japan Center for Economic Research (JCER), did its own cost estimate, and it would be between 50 and 70 trillion yen [19]. JCER suggested that METI’s estimates do not include final disposal cost of the waste coming from the decommissioning and decontamination which METI admitted. But based on the TEPCO Committee’s estimate, METI made a decision that part of the total cost will be paid by other power producers and taxpayers.

According to the recent report published at the public hearing organized by the subcommittee on treatment of contaminated water on August 30, 2018, cumulative radioactivity in tank storage is now reaching to 1000 tera Becquerel (TBq), and the number of storage tank is now 860 units [20]. It is suggested by TEPCO that there will be no enough space to build additional storage tanks by 2020.

The subcommittee presented recommended that the water, which still contains tritium but no other radioactive materials which will be removed by the processing facilities (called “ALPS”), be released to the sea after confirming that the radioactive concentration is below the standard agreed beforehand, which is 1500 Bq/l. This standard is extremely low compared with drinking water standard of tritium water set by the World Health Organization (WHO) which is 10,000 Bq/l. But one of the conditions to release the tritium water is that all other radioactive substances are removed by the ALPS below detectable limit or regulatory standards. Unfortunately, it was reported that some radioactive materials such as strontium-90 (Sr-90) were not completely removed and its concentration was above the regulatory standards [21].

It would be fair to conclude that if there is an independent oversight organization, all above cases could have been avoided, or at least the public trust might have been better by presenting objective assessment of the situation.

4.2 Spent fuel and radioactive waste management

Even before the Fukushima accident, what to do with accumulating spent fuel on-site at nuclear power plants was a major policy issue for nuclear utilities and the government. The basic policy for spent fuel management in Japan has been (and still is) “reprocessing and recycling plutonium” for energy use. As a result, in Japan, spent fuel is considered as “resource (asset)” and not as a “waste.” Under the Japanese Law on Final Disposal of Specified Radioactive Waste (which is the law

for geological disposal of radioactive waste), the “specified waste” is defined as the waste coming out of reprocessing plant, i.e., vitrified waste and TRU waste, but spent fuel is not included. Like many other countries, Japan has not found a final repository site for high-level radioactive waste (HLW).

In Japan, the Law on Final Disposal of Specified Radioactive Waste was passed in 2000 which established Nuclear Waste Management Organization (NUMO) as the principal implementation institution for final disposal. But no single site has been found even for literature survey which is the first step of siting of disposal site. Since then, only one town (Toyo Town) volunteered to be a candidate for site survey but later canceled the request due to strong public opposition. In order to improve public acceptance, in 2010, JAEC issued a request to the Science Council of Japan for their advice on how to improve public communication on HLW. This was the first time that JAEC issued a request to an independent third party to review its program. The Science Council of Japan (SCJ) recommended “fundamental reform” of Japan’s HLW waste disposal policy. In particular, one important recommendation was to secure an open discussion forum where “independent, autonomous scientific groups can exchange their opinions” [22].

The JAEC responded with its own policy statement on December 18, 2012 [23]. JAEC agreed with SCJ on above point and recommended that the government “establish an independent and functionally effective third party organization to provide suitable advice to the government and related parties in time.”

Responding to SCJ and JAEC’s recommendation, METI set up two working groups, one of which is to look at the siting process including public participation. That working group also recommended that the government should “set up a scheme to conduct independent from a third party’s point of view” [24]. Based on its findings, the Japanese government published its new basic policy for HLW Disposal in May 2015 which specifies that JAEC is the organization to review the METI’s program as an independent organization [25]. But JAEC is not truly an independent organization as it is responsible for promoting nuclear energy under the basic Atomic Energy Act.

The following incident proved that current scheme is still lacking such independent review function. NUMO initiated public consultation process based on this map, but the NUMO again lost its public trust in this public consultation process. It was reported that NUMO’s contracted organization paid students and others to attend the public consultation meetings so that the meetings seemed successful in gathering general public [26].

Again, one fundamental issue is public trust. The Science Council of Japan recently published a report to follow up its own report published in 2013. In the new report, they re-emphasized the importance of a “consensus building process” for HLW disposal and proposed the creation of “national people’s conference on radioactive waste” [27].

4.3 Plutonium stockpile management

As noted above, Japan’s basic policy is to reprocess all spent fuel and recover plutonium and uranium to recycle them for energy use. However, in reality, the plutonium usage program (recycling as mixed-oxide (MOX) fuel into existing reactors and fast breeder reactors in the future) has been delayed significantly. As a result, as of the end of 2017, Japan possessed about 47.3 tons of separated plutonium (10.5 tons in Japan and 36.7 tons in France and the United Kingdom where Japan had commercial reprocessing contracts) (**Table 1**) [28]. This is the largest stockpile among nonnuclear weapon states and could increase further if the Rokkasho reprocessing plant starts operation in 2021 and its recycling program into 16–18 reactors as currently planned does not smoothly move ahead [29].

This plutonium stockpile issue has raised international concern. In 2016, a former US government official expressed his concern over Japan’s plutonium stockpile and its reprocessing policy. Jon Wolfsthal, Senior Director for Arms Control and Nonproliferation at the National Security Council said the following in a recent interview with Kyodo Press:

“There is no question that plutonium recycling in Japan has been expensive. That is a challenging future for Japan. If Japan were to change course, they would find the United States to be supportive.... The upcoming renewal in 2018 of a bilateral nuclear agreement with Japan has the potential to become a very controversial issue...If Japan keeps recycling plutonium, what is to stop other countries from thinking the exact same thing?” [30].

As noted above, under the 1988 US-Japan bilateral nuclear energy cooperation agreement, Japan has been given a 30-year “programmatic prior consent” on reprocessing, i.e., unlike a typical bilateral agreement, Japan does not need a case-by-case prior consent on reprocessing. This has been considered as a “special privilege” as only the European Atomic Energy Community (EURATOM) and Japan are given such special arrangements. The 1988 agreement was extended without any amendment in July 2018, but now the agreement could be canceled if either party notifies the other party 6 months in advance.

Concern over reprocessing programs are also spreading in Northeast Asia. The ROK government, during bilateral negotiation with the USA, strongly insisted that it has a sovereign right to reprocessing as Japan does. China is now planning to build a commercial reprocessing plant, imported from France, while criticizing Japan for holding a large plutonium stockpile. So, it has become a regional security issue and needs to be addressed with serious attention [31].

In order to reduce such international concern, the METI’s new Energy Strategic Plan [5] mentions for the first time that Japan aims to “reduce its plutonium stockpile”. In addition, on July 31, 2018, JAEC also published its new “Basic Principles on Japan’s Utilization of Plutonium,” which says the following:

	2016 (kg)	2017 (kg)
Stock in Japan (Pu total)		
Reprocessing plants	3913	3863
MOX fuel plant	3805	3854
Stored at reactors	2126	2829
Subtotal (Pu fissile)*	9844 (6605)	10,548 (7050)
Stocks in Europe (Pu total)		
The United Kingdom	20,839	21,232
France	16,217	15,486
Subtotal: Pu total (Pu fissile)	37,058 (24,510)	36,718 (24,265)
Total (Pu fissile)	46,902 (31,115)	47,266 (31,315)
*Fissile plutonium (Pu 239 and Pu 241) contents of plutonium which is typically about 60% of total plutonium which includes non-fissile isotope of plutonium (Pu 240 and Pu 242). Source: [23].		

Table 1.
Japan’s plutonium stockpile (as of the end of 2016 and 2017).

Japan will reduce the size of plutonium stockpile. Based upon realization of the following measures, the stockpile is not to increase from the current level. [32].

Although such new policy can be a positive step, that may not be enough. In 2017, strong policy recommendations were made by experts from the USA and Japan who participated in an International Conference on Plutonium Policy (PuPo 2017). They recommend to establish a “Joint Commission” between the US and Japanese governments to review the issue of nuclear fuel cycle policy and to analyze ways to deal with plutonium stockpile owned by both the Japanese and US governments [33]. In fact, experts from both inside and outside of Japan recently recommended to revise Japan’s nuclear fuel cycle policy and to find specific ways to reduce plutonium stockpile [34, 35].

While all recommendations would be helpful, the recommendation by the International Conference (PuPo 2017) is particularly interesting. The participants acknowledge the importance of “independent oversight” and recommend to establish “US-Japan bilateral joint commission” which can play such role.

5. Results and discussion: lack of independent oversight is the common problem

As can be seen from the above three cases, Japan’s policy debate is now polarized between “pro” and “anti” which led to unconstructive policy debate over important policy issues which need to be resolved regardless of the future of nuclear power. It is the lack of independent oversight that needs to be addressed.

In the first case of decommissioning process of the Fukushima Daiichi reactor, lack of independent oversight resulted in wrong choice of technology dealing with contaminated water and inappropriate treatment of contaminated water. In the second case of disposal of radioactive waste, despite recommendations within the government, the METI has not established an independent oversight organization. Instead it still relies on JAEC which is not truly an independent organization. This led to lack of public trust and misconduct by NUMO. The third case dealing with plutonium stockpile also shows that independent oversight organization is recommended to solve complex technical/social and even international security issues involved.

In fact, right after the Fukushima accident, JAEC emphasized in its policy statements that having an independent oversight by the third party is essential to restore public trust and more constructive policy debate. The proposal to establish such an independent oversight organization was made in the context of (1) decommissioning process of the Fukushima Daiichi reactors, (2) decision-making process of final disposal of radioactive waste, and (3) assessment of nuclear fuel cycle and R&D programs. In all these cases, the assessment has been done only by the government agencies or the advisory council under the responsible government agencies.

What constitutes the key characteristics of “independent, third” party for the oversight process? The author argues that the following four conditions are essential:

First, independent funding and secretariat; it is essential that the organization must have independent funding and its own secretariat. In fact, JAEC was criticized in 2012 that its secretariat staff came from power companies and nuclear industry. Later, JAEC released those staff to be more independent. Still their staff come from other government agencies and it has no own staff.

Second, independent expertise; unless the organization has its own independent expertise, it has to rely on the outside organizations. Their analysis and judgment may not be independent if it does not have enough expertise in the organization.

Third, legal authority; independency must be institutionalized by legal status, and clear statute is needed. Ambiguous status of the organization can lose its influence and effectiveness.

Finally, complete transparency in its decision-making process. It is essential that transparency must be institutionalized backed by legal standard so that it can be verified later.

The establishment of independent oversight organization is also recommended by the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission in 2012. In its recommendation 7, it says the following:

“A system for appointing independent investigation committees, including experts largely from the private sector, must be developed to deal with unresolved issues, including, but not limited to, the decommissioning process of reactors, dealing with spent fuel issues, limiting accident effects and decontamination” [36].

In May 2017, the Diet finally established an advisory board, consisting of eight independent experts but has not established the independent investigating committees recommended above even 7 years after the accident. If the government cannot establish such independent oversight organization, the Diet can set up such independent organization to overcome Japan's polarized policy debate over nuclear power.

6. Conclusions

The Fukushima nuclear accident has not been over yet. The impacts of the Fukushima accident continue and have changed the nature of energy policy debate dramatically. The accident also triggered the changes of energy supply/demand structure significantly. The following are the main conclusions of this study:

1. Despite large reduction of nuclear energy production, Japan has managed to keep supply/demand in balance and reduced both electricity rate and carbon emissions primarily due to reduction in power consumption through improved energy efficiency.
2. Such trends are likely to continue if fossil fuel prices continue to rise and Japan could reduce its carbon emission more than 60% by 2050, with or without nuclear power.
3. The loss of public trust is one of the most important impacts of the Fukushima accident, and the majority of the public is now in favor of phasing out of nuclear power eventually. Still the Japanese government maintains that nuclear power is an important energy source and has not changed basic nuclear energy policy. As a result, nuclear policy debate in Japan has been polarized.
4. Based on three important policy case studies, it is found that lack of independent oversight can be a common cause for blocking the constructive debate leading to ways to solve important policy issues.
5. Establishment of such independent oversight organization has been recommended by both within and outside of the government, but it has not been realized. In order to overcome polarized policy debate, either the government or the Diet needs to establish such independent oversight organization.

Acknowledgements

The author acknowledges valuable financial assistance given by Japan Center for Economic Research and the Research Center for Nuclear Weapons Abolition, Nagasaki University (RECNA), and invaluable advice/comments from Prof. Tadahiro Katsuta and Mr. Tomoyoshi Hirata of Meiji University.

Conflict of interest

The author has no conflict of interest as no funding was given to the author by the nuclear industry or any other stakeholder organizations.

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