Master's Thesis

From Backbone to Minimalization :

Japan's Nuclear Trend in the Post-Fukushima Era

후쿠시마 이후 일본의 원자력 발전 경향 및 에너지믹스 분석

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Abstract

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This thesis aims to contribute to further discussions on the future direction of energy policy in Japan by presenting an analysis of Japan's energy mix in the post-Fukushima era from 2011 to 2016 and examining what changes have been made in national energy policies under the government led by three prime ministers; Kan Naoto (2010-2011), Noda Yoshihiko (2011-2012) and Shinzo Abe (2012-present). As the Fukushima accident came as a great shock to the whole nation, the Japanese government decided a radical shift from a nuclear-reliant society to a nuclear-free society. However the country soon faced with a huge cost of electricity shortfall with nuclear absence which resulted in a ballooning trade deficit due to a sharp increase in imported fuels. Experiencing the biggest trade deficits in the following years, Prime Minister Abe decided to use a nuclear card to revive the Japanese economy. Japan's trade performance after restarting nuclear reactors in 2015 proves that the use of nuclear power is inevitable for the country to ensure a stable supply of inexpensive electricity for the time being. However strong oppositions to a nuclear return from the majority of the Japanese public have

been contributing to a rather slow progress in restarting nuclear reactors for the past few years. Anti-nuclear sentiment will continue as long as painful memories of the catastrophic nuclear disaster at the Fukushima linger with the Japanese society. The Japanese government will continue to confront a long-term challenge to keep nuclear energy to a minimum, and at the same time, to meet electricity demands through enhanced energy security.

Keyword: Japan, Fukushima, nuclear power, energy mix, nuclear energy policy, electricity market reform, nuclear phase-out

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Ⅰ. Introduction

1. Research Background

Three Mile Island, Chernobyl and Fukushima. The worst nuclear accidents in the world history occurred in these three regions. The Three Mile Island Nuclear Plant Accident in March 1979 which involved a massive scale of evacuees at an estimated 200,000 in total was rated level 5 while Chernobyl was rated level 7, the highest level in the International Nuclear Events Scale (INES)[1], when a nuclear reactor was exploded in 1986. Chernobyl had been the worst nuclear disaster in the history in terms of radiation leakage and casualties until the Fukushima Daiichi Nuclear Plant experienced triple meltdowns in March 2011.[2] Four units of the plant were severely affected which caused the second largest amount of radiation leakage following the Chernobyl. In result, the Fukushima accident was rated level 7 and became the second to be categorized as the highest level of INES.

Until the Fukushima accident brought a huge shock to the whole nation in 2011, Japan had designated nuclear power as the most significant energy source since the mid-1950s. The significance of nuclear power generation was further highlighted as Japan's heavy reliance on imported fuels due to a lack of natural resources was recognized as a major setback of its economic growth when Japan experienced two oil crises in 1973 and 1979.

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1) IAEA, "INES - The International Nuclear and Radiological Event Scale,"accessed on April 15, 2018, https://www.iaea.org/sites/default/files/ines.pdf
2) "Fukushima compared to Chernobyl and Three Mile Island," nippon.com, May 20, 2011, accessed on April 15, 2018, https://www.nippon.com/opinion311/311-data/1016/

Accordingly, the Japanese government placed a top priority on enhanced energy independence for a stable supply of electricity, and more nuclear power was deemed the best solution to reach its ambitious energy goal. For more than five decades, Japan had promoted the expansion of nuclear power with its grand plan to construct more reactors and increase the share of nuclear to at least 40 percent of the total generation by 2019.[3] Its energy plan was based on a remarkable development in nuclear technology which created a firm belief in the safety of nuclear plants, so-called "the myth of nuclear safety". As overconfidence in the technology of nuclear power generation became prevalent, the Japanese nuclear safety regulators and utilities turned a blind eye to potential risks at the plants. When a tsunami of an unprecedented scale hit the Fukushima plant, Japan came to face enormous challenges in energy security, trade, electricity rates and environment as a consequence of willful negligence of major actors in the nuclear industry. The severity of the accident and widespread fear over the use of nuclear power prompted the Japanese government to quickly refrain from operating nuclear plants and carry out a comprehensive safety review of the plants. As all 54 nuclear reactors were shutdown for an indefinite period of time immediately after the accident, Japan lost what was believed to be the most affordable and environmental friendly energy source in such a short period of time which contributed a lot to a stable supply of electricity for the last few decades. Without nuclear power generation, the government led by then Prime Minister Kan Naoto was left with a fundamental task to plan for an optimal energy mix with minimal impact on electricity supply. In

3) The Institute of Energy Economics Japan, "Japan Energy Brief," May, 2010, accessed on April 16, 2018, https://eneken.ieej.or.jp/en/jeb/1005.pdf

order to fill the energy gap and prevent power shortage, Japan had no other alternative but to turn its eyes to the traditional and the easiest option: burning more fossil fuels. The utilization rate of thermal power plants was maximized, and even the aging thermal plants resumed operation. Kan declared a radical shift to nuclear-free policies whereas Noda Yoshihiko who replaced Kan in September 2011 pursued a gradual phase-out. During Noda's term in office, nuclear power generation was kept to a minimum which was a temporary remedy to avoid blackout during the periods of peak demand. Back then, Japan seemed to be on the right track with regard to its revised energy policies for zero nuclear. However the absence of nuclear power had catastrophic impacts on the Japanese economy. A significant drop in nuclear power triggered a sharp increase in a supply of fossil fuels such as coal, oil and liquefied natural gas (LNG). Japan imported more fuels from overseas than ever. Its heavy reliance on imported fuels seriously undermined Japan's energy security as well as trade balance. In fact, Japan's energy self-sufficiency rate began to drop since 2011, and in that same year Japan recorded the first trade deficit in 30 years.[4] Since then, Japan's trade balance continued to reach a record deficit year by year until 2014 in which the figure stood at 12.8 trillion yen, an increase of 293% from the pre-Fukushima level in 2010.[5]Concerned about devastating consequences from an energy gap, Prime Minister Shinzo Abe who assumed office again in

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4) The Telegraph, "Japan set to record first trade deficit in 31 years," January 24, 2012, accessed on March 12, 2018, https://www.telegraph.co.uk/finance/financialcrisis/9034465/Japan-set-to-record-first-trade-deficit-in-31-years.html

5) Ministry of Finance, "2014 Trade Statistics,"March 12, 2015, accessed on February 2, 2018, http://www.customs.go.jp/toukei/shinbun/trade-st_e/2014/2014_117e.pdf

December 2012 called for a revision of energy policies that pursue nuclear phase-out set by his predecessors, and expressed his initiative to bring back nuclear power. This paper aims to contribute to discussions on future energy policy in Japan through an analysis of electricity supply and demand in the post-Fukushima era and a shift in Japan's energy policies.

2 Literature Review

When Prime Minister Kan Naoto declared an ambitious target of nuclear phase-out soon after the Fukushima accident, the majority of the public and environmental organizations welcomed his decision.[6] According to a survey conducted in June 2011, 74 percent of respondents supported abandonment of the nuclear power.[7] Kan's major shift in energy policy seemed to be in accordance with public opinions. However literatures on Japan's plan for phase-out of nuclear energy presented negative views about its effectiveness.

Yoon (2012) in his journal investigates the background of 2010 Strategic Energy Plan and Options for Energy and the Environment proposed by the Japanese energy authority in 2012.[8] While examining major causes that

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6) "Greenpeace reaction to Japanese Prime Minister Kan's call for a "nuclear-free society"," Greenpeace International,July 13, 2011, accessed on April 6, 2018, http://www.greenpeace.org/archive-international/en/press/releases/2012/Greenpeace-reaction-to-Japanese-Prime-Minister-Kans-call-for-a-nuclear-free-society/ Justin McCurry, "Naoto Kan resigns as Japan's prime minister," The Guardian, August 26, 2011, accessed on April 6, 2018, https://www.theguardian.com/world/2011/aug/26/naoto-kan-resigns-japan-pm

7) Nobuo Fukuda, "Japan at nuclear crossroads,"March 12, 2012, accessed on April 3, 2018, https://www.wilsoncenter.org/article/japan-nuclear-crossroads

8) K.J.Yoon, "Energy Policy Changes of Japan after Fukushima Nuclear Accidents: Implications on Energy Policy of South Korea(후쿠시마 원전사고 이후 일본의 에너지정책변동: 한국 에너지정책에 대한 시사점을 중심으로)," Current Society and Administration(현대사회와행정), 2012

triggered the Japanese government to make drastic changes in their energy plan, Yoon recognizes that a number of significant factors that could hinder the process of nuclear phase-out. He points out a lack of will and initiative of the Japanese government in realizing a phase-out of nuclear power as there has been conflicting ideas within the government. For example, after the strategic plan was released, Minister of Economy, Trade and Industry (METI) Edano Yukio expressed his hope to resume constructions of nuclear power plants which had been suspended since the Fukushima accident. He also said that a decision on whether to grant operations of new nuclear plants even after 2030 would be made in the future, leaving doubts on determination of the government on its own plan. Yoon also raises the issue of potential policy changes by a shift in external and internal political environment such as an approval rating of the Democratic Party of Japan (DPJ). Controversy over consistency of the revised energy policy claimed in his paper was proven to be reasonable as Japan proposed for a transition to pro-nuclear policies under the Abe administration.

Similarly, Vivoda (2012) demonstrates why Japan's anti-nuclear strategy is not a future-oriented direction for its energy industry by examining possible consequences of less share of nuclear power in energy production.[9]He argues that eliminating nuclear power which accounts for 30 percent of Japan's total electricity generating capacity from energy supply will inevitably involve further damage to the Japanese economy. Nuclear phase-out also indicates that Japan would be placed in a more difficult situation to fulfill its

9) V. Vivoda, "Japan's energy security predicament post-Fukushima," Energy Policy, 2012

commitment to greenhouse gas reduction. Vivoda points out that Japan's energy security is seriously undermined as the electricity cost for the Japanese consumers has increased while the supply has become less stable and secure compared to the pre-Fukushima energy policy which pursued increased share of nuclear power. Vivoda's analysis supports the argument of why the Japanese government under Abe's leadership has returned back to its traditional pro-nuclear plan adopted back in the pre-Fukushima era

Hayashi and Hughes (2013) also presents negative views on the shift in energy policies. The paper explains what changes has been made to nuclear policies and regulations during the period from March 2011 to May 2012 by comparing Japan's energy plan before and right after the Fukushima accident.[10] The impact of the nuclear accident in March 2011 is analyzed using three indicators (availability, affordability, and acceptability) of several different energy sources. Based on their analysis, Hayashi and Hughes claim that considering the rising electricity cost and Japan's commitment to reduction of greenhouse gas emissions, a radical shift from pro-nuclear to anti-nuclear is rather unrealistic. Furthermore, two scholars argue that nuclear technology is expected to maintain its position as an important contributor to Japanese electricity and exports. Their argument coincides with the rationale of the recent Japanese government's shift away from expensive fossil fuels imported from overseas to affordable nuclear power under Abe.

10) Hayashi and Hughes, "The policy responses to the Fukushima nuclear accident and their effect on Japanese energy security," Energy Policy, 2013

Ⅱ. Japan's Long-Term Energy Plan : Pre-Fukushima (2007-2011)

1 2007 Basic Energy Plan

The 2007 Basic Energy Plan was developed and released in March 2007 under the government led by the Liberal Democratic Party (LDP) during Shinzo Abe's first term as prime minister. The 2007 Plan was developed on the following key points. First, it should present guidelines for Japan to materialize the structure of energy supply and demand without having adverse effect on the environment, and to aggressively promote electricity generation from nuclear power while expanding the use of renewables. Second, Japan's resources diplomacy for a stable supply of fossil fuels such as oil should be strengthened. The plan also placed an emphasis on reinforcing strategic and comprehensive measures to raise competitiveness of utility companies. Third, Japan should strive for further improvement in energy conservation policies as a frontrunner in the global community, and take a lead in development of effective solutions to the global warming issue. Lastly, a strategic development and use of technology are required to eliminate technological restrictions on energy and environment both domestic and overseas.

What was highlighted in the 2007 Plan was that Japan in the next decade would promote nuclear power as the backbone of its energy industry and a balanced development of the power supply system including fossil fuel, LNG and hydroelectric power in pursuit of diversification of energy sources. Considering that Japan is one of the most resource-poor countries in the world, its heavy reliance on imported fuels such as coal, natural gas and

uranium has been a great disadvantage.[11] The 2007 Plan reflected concerns on any potential changes in import situation that could cause disruption in energy supply, and thus greatly emphasized the need to enhance the energy diversity. Accordingly, the plan suggested that Japan should develop, introduce and utilize various energy sources in order to successfully implement "Basic Guidelines for Policies on Energy Supply"[12] specified in the first chapter as the fundamental principle of the 2007 plan.[13] Based on the grounds that most of Japan's energy resources were relied on overseas imports with oil being accounted for half of the primary energy supply in Japan, and that the country was faced with a tough challenge of addressing the climate change issue, it was vital for Japan to perform assessments of stability, environmental compatibility and economic feasibility of each energy source and formulate the best mix for more effective use of diversified energy sources.

The future direction of Japan's national energy policy was set to promote nuclear power as the major source of electricity with its safety ensured. While acknowledging the significance of a rigorous safety management, the increased use of nuclear power was considered as a solution to tackle energy issues as it contributes to a stable supply of electricity and leaves less carbon footprint, serving as a highly effective countermeasure to global warming. The policy also called for enhanced safety of nuclear power plants, requiring operators to strengthen the safety assurance system, and government agencies

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11), "Solving Japan's Energy Crisis," Berkeley Political Review, November 11, 2014, accessed on February 2, 2018, https://bpr.berkeley.edu/2014/11/11/solving-japans-energy-crisis Manahil Shah

12) エネルギ"[の需給に関する施策についての基本的な方針

13) Agency for Natural Resources and Energy, "Basic Energy Plan (エネルギ"[基本計画)," March, 2007

to perform scientific and reasonable safety regulations in order to gain public trust which was seriously damaged by safety data fabrication scandal in 2002.[14)]

In regards to renewables, despite of unstable electricity output and high cost, it is one of few green energy sources that can mitigate the effects of climate change, and at the same time, places less restrictions on resources. Therefore the Japanese government initiated its plan to develop renewable energy technology in pursuit of reduction in cost and increase in its usage.

Fossil fuel which accounted for the majority of the total energy supply had long been one of the main contributors to Japan's heavy reliance on energy imports and also in adverse effects on the environment. In order to enhance energy independence and minimize damage to environment, Japan planned to develop a well-balanced energy mix which would ensure a stable supply of oil and gas while producing less carbon emissions from coal.

Recognizing the significance of diversification of energy sources, issues regarding countermeasures against global warming were also continuously raised in the plan. According to the plan, it was imperative for Japan to adopt alternative fuels which produce less carbon dioxide and also to exert its efforts to improve the efficiency in power generation through employment of highly efficient methods for generation. However the initiative to further promote renewable energy as part of its efforts for energy diversification and reduction in carbon emissions was not well represented in the figures. As the 2007 Plan clearly stipulated that it aimed to produce most of Japan's

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14) "Heavy fallout from Japan nuclear scandal," CNN, September 2, 2002, accessed on March 13, 2018, http://edition.cnn.com/2002/BUSINESS/asia/09/02/japan.tepco/

electricity from nuclear power generation as a major energy source, the energy mix for the next 10 years presented in the plan was heavily weighted in favour of the nuclear power compared to other energy sources. Only a minor increase of less than one percent was expected from hydro-electricity and renewable energy (Table 1). On the other hand, fossil fuel, despite of its share being gradually decreased over the next few years, would still account for almost half the total power generation as it was expected to generate 48.8 percent of the total power in 2016. An increase in the nuclear power generation was quite impressive as it was expected to produce 41.2 percent of the total electricity by 2016, a 10.6 percentage point up from the 2006 level.

According to the 2007 Plan, a total number of nuclear plants which were expected to start operation within the next 10 years was nine with an estimated power output of approximately 12.26 million kW.[15] There were four more nuclear plants of which constructions were planned after 2011 and expected to start operation from 2017. Those plants were to generate approximately 4.9 million kW. Out of 13 plants, 12 plants were scheduled to begin operation from 2011, and all 13 nuclear plants were supposed to be in normal operation by 2018. However following the Fukushima disaster, all construction projects of nuclear plants including Ohma Nuclear Plant of Japan Electric Power Development Corp (J-Power) and Higashidori No.1 and 2 of Tokyo Electric Power Corporation (TEPCO) in Aomori prefecture of which constructions already began were either delayed or suspended for an indefinite period of time.

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15) Ministry of Economy, Trade and Industry, "Overview of 2007 Energy Supply and Demand Plan (平成19年度電力需給計画の概要について)," March 30, 2007

Table 1. Power output by energy sources

	2006	2007	2011	2016
Hydro-electricity	9.3%	8.9%	9.2%	9.0%
Thermal power	60.1%	59.3%	53.3%	48.8%
- Coal	24.4%	24.0%	21.4%	20.0%
- LNG	25.8%	24.8%	24.8%	22.8%
- Oil and other	9.6%	10.2%	6.7%	5.7%
- Geothermal	0.3%	0.3%	0.3%	0.3%
Nuclear power	30.6%	31.7%	36.6%	41.2%
Renewables	0.6%	0.8%	1.0%	1.0%
Other	-0.6%	-0.7%	0.0%	0.0%

Source: Created based on 2007 Energy Supply and Demand Plan, Ministry of Economy, Trade and Industry (METI)

The Ohma plant which was more than 40 percent complete at the time of the disaster and initially planned to begin commercial operation in 2014 resumed construction in October 2012. J-Power considered that it would take longer than initially planned to complete construction of Unit 1 at the Ohma plant. Therefore the utility made an announcement in September 2016 that there would be a delay of two years in order to take additional safety measures. A similar situation was witnessed at Unit 3 of the Shimane nuclear plant of which Chugoku Electric Power Corporation began construction in 2005. Shortly before the completion of the plant, the Fukushima Daiichi

accident triggered a comprehensive review of the existing safety measures which led to a halt in construction. Plans for constructions of new nuclear plants starting from 2011 such as Unit 7 and 8 at the Fukushima Nuclear Plant were scrapped.

Electricity production from nuclear source decreased considerably in 2007 due to a 6.8 magnitude earthquake in July that struck Niigata prefecture where Kashiwazaki-Kariwa Nuclear Plant was located. It led to a temporary shutdown of the plant for 21 months which was considered as a major contributor to a drop in the share of the nuclear power in that year. However the earthquake did not stop Japan's ambitious energy policy to further develop nuclear technology and pursue a greater share of the nuclear power in electricity production. Accordingly, the 2007 Plan affirmed Japan's strong belief in nuclear power, aiming to increase electricity output from nuclear plants more than any other energy sources such as hydro-electricity, fossil fuel and renewable energy.

2. 2010 Basic Energy Plan

According to the Basic Act on Energy Policy, Japan's national energy plan was first established in 2003 and revised in 2007 and 2010 under Ministry of Economy, Trade and Industry (METI) as stipulated in the law to revise the plan every three years. During the period between 2007 and 2009, there had been grave concerns in the energy sector as Japan's solar cell business which used to account for the largest share in the world market handed over its top position to Germany and China. Moreover, Japan failed to win a contract of nuclear plant construction in UAE in 2009.[16] Inevitably, the 2010 Energy Plan reflected the Japanese government's firm initiative to overcome difficulties faced by the energy industry.

The 2010 Plan had set five goals to be accomplished by 2030 based on three principles: energy security, environment and efficient supply. First, Japan's energy self-reliance should increase from 38 percent to 70 percent by doubling both self-sufficiency and a supply rate of fossil fuels from independent resource development[17] which stood at 18 and 26 percent respectively (Table 2). Second, the use of energy which does not produce greenhouse gas should increase from 34 percent to 70 percent.

Third, carbon dioxide emissions from households should be reduced by half. Fourth, improvement in energy efficiency of the industry sector is required. Fifth, Japan's energy-related products and systems should capture the largest share in the world market. Japan made a commitment to its five ambitious goals to reduce greenhouse gas by 30 percent below 1990 level by 2030.

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16) Yoon (2012)
17) 자주개발 화석연료 공급비율

Table 2. Target for Energy Independence

	2010	2030
Energy self-reliance	38%	70%
Energy self-sufficiency	18%	(double the 2010 level)
Supply rate of fossil fuels from independent resource development	26%	(double the 2010 level)

Source: 2010 Basic Energy Plan, Ministry of Economy, Trade and Industry (METI)

As a country with no natural resource which was also emphasized in the previous 2007 Plan, Japan continued to aim for fundamentally strengthening energy security. The figures in the plan demonstrated Japan's commitment to rely less on imported energy and to head towards energy independence.

Table 3. Target for emissions reductions

	2030
Total emissions	30% ↓ from 1990 level
Carbon emissions from households	50% ↓ from 2007 level
Use of non-carbon emitting energy sources	70% (34% in 2010)

Source: 2010 Basic Energy Plan, Ministry of Economy, Trade and Industry (METI)

While improving energy security, the Japanese government at the same time placed an emphasis on environmental effect of energy sources. The plan

indicated that Japan would increase the share of zero-emission energy sources such as nuclear and renewable energy to over 50 percent by 2020 and 70 percent by 2030 from the current level of 34 percent (Table 3).[18)]

To achieve these objectives, Japan planned to construct 12 additional nuclear plants, and thus a total of 14 plants were to begin operation by 2021. A target was set to increase the share of renewable energy in total electricity production as well as reaching 85 percent and 90 percent of the overall plant capacity utilization by 2020 and 2030 respectively which stood at 60 percent in 2008. It implied that Japan would make a long-term commitment to CO^2 reduction with a shift away from energy sources that produce greenhouse gas to environmental friendly energy sources as a responsible member of the global community in addressing global warming. By pursuing clean energy, Japan ultimately aimed to develop an effective energy mix which could realize reduction of CO^2 produced from the residential sector by 50 percent to the 2007 level. In regards to the industrial sector, the government called for not only maintaining its position as one of the top performers in energy efficiency in the world, but further enhancing the efficiency to the highest level. Concerning competitiveness of Japanese companies in the global energy sector, the 2010 Plan also set out Japan's objectives to lead the global markets in energy-related products and systems.

A major feature of the 2010 Plan was that the portion of fossil fuel including oil, coal and gas was expected to be significantly reduced from 84 percent in 2007 to 72 percent in 2030 (Table 4).

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18) Ministry of Economy, Trade and Industry, "Basic Energy Plan (エネルギ"[基本計画)," June, 2010

Table 4. Energy mix by 2030

	2007	2030
Fossil fuel	84%	72%
Nuclear	10%	24%
Renewables	6%	13%

Source: 2010 Basic Energy Plan, Ministry of Economy, Trade and Industry (METI)

The Japanese government planned to cut the use of coal and oil,and increase the share of gas. Nuclear power and renewable energy sources were to fill a considerable fossil fuel void. Nuclear was set to account for 24 percent in the total primary energy source by 2030 which is an enormous increase from 10 percent in 2007. In other words, while the use of fossil fuel drops by 12 percentage point, the share of nuclear power increases by 14 percentage point. In order to produce electricity from more nuclear power, the 2010 Plan included the construction of more than 14 extra nuclear plants while continuing operation of the existing 54 plants. The renewable energy sector was also set to grow more than double in the domestic energy market from 6 percent in 2007 to 13 percent in 2030. However the figure was considered insignificant compared to advanced countries such as Germany which had set a target of increasing the use of renewable energy to 30 percent by 2030 and 60 percent by 2050.[19)]

Compared to the 2007 Supply and Demand Plan, the figures in the 2010 Plan placed less significance on hydroelectric generation as the estimated

19) Yoon (2012)

power output from hydroelectric power plants which were expected to begin operation within 10 years dropped by 29 percent from the figure in the 2007 Plan.[20] Although the revised plan suggested less electricity from hydroelectric power and an increase of about 5 percent in generation from fossil fuels in the next ten years, it did not imply that Japan had made a shift in its future direction for energy policies from promoting environmental friendly energy sources to increasing the use of fossil fuels. As Japan in 2010 continued to promote nuclear power to serve as a major energy source, nuclear plants which were scheduled to begin operation by 2020 were expected to generate 5.5 percent more power than what was planned back in 2007. An increase of 11 percent in the estimated power output from renewable energy was also included in the plan.

20) In the 2007 Plan, the planned power output from hydroelectric power plants which would start operation in the next decade was 2.1 million kW whereas the 2010 Plan expected a total of 1.5 million kW.

3. Nuclear Safety Governance

In 2009, the Democratic Party of Japan (DPJ) came to power as the party won more than 300 seats out of 480 in the lower house.[21] DPJ took over the initiative of Japan's national energy strategy which had been promoted by its predecessor, the Liberal Democratic Party (LDP). The strategy aimed for industrial structure reform in response to ever-increasing threat of global climate change, pursuing a stable supply of energy, particularly green energy, and promoting Japan's energy business as a new economic growth engine.[22] Japan's energy industry had been largely focused on the use of environmental friendly energy, and among various green energy sources such as solar, hydrogen and wind power, Japan considered nuclear power as the one that would play a decisive role in reducing energy dependence through the use of safe and efficient energy source that produces no greenhouse gas at an affordable price.

Triggered by the U.S. President Eisenhower's "Atoms for Peace" speech in 1953[23], Japan began to develop nuclear technology and enacted the Atomic Energy Law in 1955.[24] The law was built upon three principles that pursue a democratic decision-making process, independent management and

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21) "民主３０８議席を獲得、鳩山政権誕生へ," The Asahi Shimbun, August 30, 2009, accessed on January 18, 2018, http://www.asahi.com/senkyo2009/news/TKY200908300212.html

22) J.H. Kyung,"Changes in Japan's energy policy and domestic politics after the Fukushima(후쿠시마 원전사태 이후 일본 에너지 정책과 국내 정치의 변화)," Jpi 정책포럼 127 (2013): 1-11

23) IAEA, "Atoms for Peace Speech," December 8, 1953, accessed on 23 May, 2018, https://www.iaea.org/about/history/atoms-for-peace-speech

24) Tatsujiro Suzuki, "Energy security and the role of nuclear power in Japan," Nautilus Institute, 2000, accessed on February 2, 2018, http://www.nautilus.org/wp-content/uploads/2015/04/Reg_Japan_final1.pdf

transparency in the use of nuclear energy being limited to peaceful purposes.[25] Following the enactment of the legislation, several key energy organizations were established which include the Atomic Energy Commission (JAEC, 原子力委員会), Science and Technology Agency (JST, 科学技術振興機構), Japan Atomic Energy Research Institute (JAERI, 日本原子力研究所) and the Atomic Fuel Corporation.[26]

Japan's nuclear industry in the post war era showed a robust growth for several decades with multiple actors involved. The Japanese government was the greatest contributor to such growth as the whole nuclear industry including the administration system, safety and regulations were established and stimulated as a national project under private management (國策民營).[27] Before a government reshuffle took place in 2000, Japan's nuclear policies were designed by nuclear interest groups under the dual system[28] led by JST and Ministry of International Trade and Industry (MITI). After the reshuffle, JST was merged to Japanese Atomic Energy Agency (JAEA) and Ministry of Economy, Trade and Industry (METI), the successor of MITI, took control of Japan's nuclear industry and monopolized nuclear policies. Under the dual system, the so-called Nuclear Village (原子カムラ) was established comprising nuclear interest groups which showed strong solidarity against external criticisms of the nuclear use.

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25) Vlado Vivoda, Energy security in Japan: challenges after Fukushima, Routledge, 2016

26) Kiyonobu Yamashita, "History of nuclear technology development in Japan," AIP Conference Proceedings, Vol. 1659. No. 1. AIP Publishing, 2015

27) Jinho Jeon, "Japan's nuclear and Korea after 3.11(3.11 이후의 일본의 원자력과 한국)," 2012

28) 이원체제적 이익연합 Ibid.

There had been numerous discussions and reports published by many investigation bodies and scholars on what led the Fukushima incident to become one of the worst nuclear incidents in the world history. Major conclusions found that the incident was a multi-faceted problem involving mismanagement of the electricity company, lax supervision over nuclear power plant operation by government agencies and ineffective crisis management of the prime minister's office. A defective working mechanism of the nuclear industry was not created in a single night; it was the result of accumulated complacency in letting the Nuclear Village which had been the most influential actor in the decision-making process orchestrate nuclear safety and development policies based on the "safety myth" over several decades since the beginning of the nuclear technology development in Japan.[29)]
This chapter investigates how the nuclear safety governance had been mishandled between 2007 and 2011.

29) Ibid.

3.1 Institutional Flaws of Nuclear Industry

Japan's nuclear policies were developed by METI in 2006 based on three objectives in pursuit of 3Es, namely economic growth, energy security and environment protection.[30] Japan aimed to improve (1) economic security by procuring cost-effective energy source, (2) energy security by less relying on imported energy and increasing energy self-sufficiency; and (3) environmental security by promoting green energy sources which contribute to reduction of greenhouse gas emissions.[31] Since the Fukushima incident, the need for a shift in the direction of national energy policy was highlighted, and a greater emphasis was placed on safety governance of nuclear plants. Moreover, as various controversial issues rooted in inadequate institutional system were revealed, a strong imperative to carry out a fundamental administrative reform in the nuclear sector such as ensuring independence and autonomy of nuclear safety regulation organizations was nationally recognized as one of the most important lessons from the disaster.

A report on nuclear safety submitted by the Japanese government to IAEA in June 2011 outlined three critical issues as the major causes for the meltdown of the Fukushima Daiichi.[32] First, the Fukushima Daiichi experienced a loss of off-site power supply which led to a failure in procuring emergency power supply. Second, reactors failed to release the heat from reactor core to the

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30) International Energy Agency (IEA), "Energy Policies of IEA Countries – Japan: 2008 Review," 2008

31) Ministry of Economy, Trade and Industry, "New National Energy Strategy (Digest)," May, 2006

32) Ministry of Economy, Trade and Industry,"原子力安全に関するIAEA閣僚会議に対する日本国政府の報告書について," last modified on October 11, 2011, accessed on February 17, 2018, http://www.meti.go.jp/earthquake/nuclear/backdrop/20110607001.html

ocean due to a loss of cooling system. Thirdly, malfunction of the cooling systems for storage pools for spent fuels caused a cut off of cooling water to pools which stored more than 8,800 nuclear fuel rods. It indicated that the loss of all AC power even including emergency power which was fundamental in nuclear plant safety was what exacerbated the situation. Japan had been overly confident with their nuclear technology and safety of nuclear plants which in large part was contributed by the "safety myth". No safety manual was prepared for a situation of a magnitude 9.0 earthquake which brought massive waves over 15 meters because the scale of natural disasters which was supposed to be most significant factor when constructing nuclear plants was largely underestimated by nuclear safety regulation bodies. In the same context, potential problems that could occur when an unprecedented scale of a natural disaster strikes nuclear plants such as destruction of roads, electricity blackout and flooding of generators were deemed insignificant. As a result, safety procedures or manuals which specify appropriate measures to be taken in the case of emergencies were absent when it was needed the most. The pervading culture of complacency over safety which caused the Fukushima incident to develop into one of the worst atomic disasters in history was contributed by five major actors responsible for enhancing nuclear safety which include the Japanese government, Nuclear and Industrial Safety Agency (NISA), Nuclear Safety Commission (NSC), Nuclear Village and Tokyo Electric Power Company (TEPCO).

3.2 Japanese Government

After severe situation at the Fukushima Plant was reported to the central government, Nuclear Emergency Response Headquarters (原子力災害警戒本部)

established under the prime minister's office was aware of the fact that it was just a matter of time before the reactor core and pressure vessels completely lose functions. The Japanese government in accordance with the crisis management manual should have announced the result of the System for Prediction of Environmental Emergency Dose Information (SPEEDI) to the public and the related bodies such as JAEC to swiftly evacuate local residents. However the government failed to provide the public with sufficient information about the situation quickly enough which caused misleading communications and uncertainty in regards to safety measures including which direction residents should head for evacuation. While the Japanese government provided SPEEDI predictions to the U.S. armed forces and IAEA during the early stages of the accident, the public was given insufficient and inaccurate information.[33] As a result, some local residents near the Fukushima Daiichi plant ended up evacuating to the area with a high level of radiation.[34] According to The Fukushima Nuclear Accident Independent Investigation Committee (福島原発事故独立検証委員会), the top leadership figures of the government including Prime Minister Kan Naoto and Chief Cabinet Secretary Edano Yukio did not even know the existence of SPEEDI. Kaieda Banri who was the head of METI, the government body that oversees Japan's nuclear industry, was in no better situation. Kaieda learned about the system from the media report released on 15 March.[35] The Japanese government's crisis

33) "U.S. forces given SPEEDI data early," The Japan Times, January 18, 2012, accessed on February 5, 2018, https://www.japantimes.co.jp/news/2012/01/18/national/u-s-forces-given-speedi-data-early/#.Wu0q9oiFNPY

34) "Fukushima report: Key points in nuclear disaster report," BBC, July 5, 2012, accessed on January 30, 2018, http://www.bbc.com/news/world-asia-18718486

35) The Independent Investigation on the Fukushima Nuclear Accident, The Fukushima Daiichi Nuclear Power Station Disaster: Investigating the Myth and

management did not work effectively at all in the process of implementing appropriate countermeasures. Irresponsible conduct in the management process by the government and the related bodies was translated as that the interests of the Nuclear Village had been given a greater priority than protecting the lives of the Japanese public from risks of nuclear plant.

The 3.11 Fukushima incident proved that the time had finally come for Japan which enjoyed nuclear renaissance in the 2000s with a firm belief in the "safety myth" to realize that the nuclear power does not guarantee safety, and the government was completely incompetent in dealing with nuclear accidents. At the same time, Japan's energy policies which had been heavily focused on the nuclear power became subject to a comprehensive review.

3.3 Nuclear and Industrial Safety Agency (NISA)

Another issue raised regarding Japan's nuclear safety governance was that there had been a lack of coordination between the prime minister's office, METI and the related nuclear safety organizations.[36] Incompetence in crisis management of the government and safety regulation bodies as well as electricity companies in national contingency was the subject of an intense controversy. In particular, Nuclear and Industrial Safety Agency (NISA) came under severe criticisms for failing to perform its role to properly regulate safety measures and prevent any harm produced by the meltdown of nuclear reactors. However it is difficult to put the blame to NISA alone. Rather, a fundamental flaw in administrative system was pointed out since NISA was

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Reality, Routledge, 2014

36) Kenji E.Kushida, "The Fukushima nuclear disaster and the democratic party of Japan: Leadership, structures, and information challenges during the crisis," The Japanese Political Economy, 40.1 (2014): 29-68

established under the Agency for Natural Resources and Energy (資源エネルギ"-庁) which was a branch of METI that promoted development of nuclear power. Its association with METI undermined NISA's independence in overseeing safety practices. Accordingly, a question of whether it was appropriate to attach a nuclear safety regulation body to a nuclear development body was raised, and the majority argued that for the former body to function effectively, they should be distinguished from each other.[37] Accordingly, the Cabinet announced a basic policy on the organizational reform of nuclear safety regulations to separate nuclear regulation and nuclear promotion in August 2011.[38]

3.4 Nuclear Safety Commission (NSC)

At the site of the Fukushima nuclear plant, there was no backup plan for a long-term power loss. It was not prepared in advance because utility companies believed that the situation in which the power being lost for more than 8 hours was highly unlikely to occur. Based on the basic guidelines, the Regulatory Guide for Reviewing Safety Design of Light Water Nuclear Power Reactor Facilities (安全設計審査指針) last revised by Nuclear Safety Commission in 1990, it was concluded that a long term power loss was unnecessary to take into consideration. Due to Nuclear Safety Commission's negligent attitude toward safety, the Commission came to face severe criticisms that the safety regulation body which should have taken the full

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37) Hideaki Shiroyama, "Nuclear safety regulation in japan and impacts of the Fukushima Daiichi accident," Reflections on the Fukushima Daiichi Nuclear Accident, Springer, Cham, 2015. 283-296.

38) Cabinet Secretariat, "原子力安全規制に関する組織の見直しについて," August 2013, accessed on February 1, 2018, http://www.cas.go.jp/jp/genpatsujiko/info/kakugi_110815.html

responsibility to oversee the safety of nuclear plant operation assigned higher priority not on safety but on interests of utility companies.[39)]

3.5 The Nuclear Village

The Nuclear Village which had orchestrated Japan's nuclear policies is comprised of political, business and academic circles that have close ties with the energy industry and METI. Power companies extended their influence by having bureaucrats appointed to top positions of their companies, making a contribution in the name of political funds, research fund and advertisement.[40)] Pro-nuclear groups continued to expand their relationship, and as the nuclear safety regulatory bodies came under the influence, it was the beginning of mismanagement of safety measures for nuclear power plants which was found to be one of the most critical causes for the Fukushima incident. Since a corrupt nuclear energy regime was revealed, one question arose: considering that the Nuclear Village contributed to the growth of the industry and created complacency about nuclear safety by claiming the "safety myth", would this powerful lobbying group be dissolved in the post-Fukushima era? Samuels (2013) expressed skepticism about the collapse of the Nuclear Village. He claimed based on a history of nuclear power in Japan that this particular ‘cash cow’industry which had been hugely contributing to the economic growth and national revenues was "too big to fail,"[41)] that the cooperative relationship between METI, the business circle and the Nuclear Village is expected to remain strong.[42)]

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39) Jeon (2012)

40) Wilcox, Nadesan Boys McKillo, Fukushima: Dispossession or Denuclearization?, Lulu Press, Inc, 2014

41) Richard J. Samuels, 3.11: Disaster and change in Japan, Cornell University Press, 2013

3.6 Tokyo Electric Power Company (TEPCO)

3.6.1 Poor Safety Management at Site

Absence of effective manual for crisis greatly contributed to a failure of taking timely measures which aggravated the situation. It was repeatedly pointed out as a significant problem during the early stages of the management in the official report presented by The Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) to the national diet of Japan.[43] The report found that decisions and directives were made on the spot, completely relying on intuitive judgment by site workers because manuals and tools were not available at the plant. The Fukushima incident revealed serious organizational problems of Tokyo Electric Power Company (TEPCO), the operator of the Fukushima Daiichi Plant, since a limited expertise of TEPCO employees and poor preparations such as lack of training and inspection in case of emergency at the plant hindered the process of responses to the accident back then. Another contributing factor was the absence of manuals and procedures which specify appropriate measures to be taken in contingencies. Site workers were not equipped with valid tools to effectively perform their role to prevent the chaotic situation from deteriorating further. TEPCO's organizational problems inevitably led to operational flaws at site during the accident. The Fukushima incident itself served as evidence that on-site workers without crisis management manuals, have extremely limited choices when the plant is suffering a total loss of

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42) Jeon (2012)

43) The Fukushima Nuclear Accident Independent Investigation Commission, "The official report of Executive summary, "July 5, 2012, accessed on March 4, 2018, https://www.nirs.org/wp-content/uploads/fukushima/naiic_report.pdf

electrical power known as Station Blackout. In the report, the Commission pointed out that a delayed recovery process including confirmation of isolation condenser (IC) in Unit 1 was due to TEPCO's negligence in preparing countermeasures and performing training for IC operation. While the adequacy of the manual is of great significance as site workers cannot handle the situation effectively with ineffective manuals, management of the plant disaster became more difficult for workers because instruction manuals at the site were inaccurate with missing diagrams. Without effective manual at site, not many alternatives were left to the plant workers. They were situated to take any possible responses while being pressured to work within limited time in the dark, relying only on their flashlights. Consequently, TEPCO's reputation was largely discredited for substantial delays in emergency responses. The report outlined that organizational problems were evident from outdated contingency manuals that did not provide clear instructions in the event of plant crisis. Negligence in safety measures was also observed in personnel training as emergency drills were deemed insignificant which caused unprepared workers to face the worst nuclear plant disasters.

3.6.2 Negligence in Anti-seismic and Anti-tsunami Safety Assessment

The earthquake which brought a huge tsunami on 11 March was of the scale far beyond expectation and was overwhelmingly destructive for the Fukushima Daiichi Nuclear Plant to withstand. The structure of the plant was vulnerable to the unprecedented scale of severe accident. In this regard, few questions arose; why was the Fukushima Daiichi plant so easily damaged while it was supposed to be constructed to survive from any possible natural disasters? Was it simply due to unpredictability of natural phenomenon? Was the

tsunami really unavoidable? Why TEPCO and nuclear safety organizations failed to take earthquake and tsunami of a massive scale into consideration when planning the plant? A report from the NAIIC criticized that the accident was preventable, had there been a more careful deliberation on safety issues and preventive measures for emergency.[44)]

The specification of the Fukushima Daiichi Unit 1 was found in the report to be inadequate in terms of anti-quake and anti-tsunami yield strengths. It was largely because of the following two factors. First, when three nuclear plant units were permitted to be constructed in Fukushima Prefecture back in late 1960s, guidelines for nuclear plant construction lacked sufficiency, largely due to limited nuclear technology at the time. Second, there had been no earthquake damage in the area around the plant with only a minor seismic activity expected.

The Fukushima plants, according to data of the US Nuclear Energy Institute, were constructed to withstand peak ground acceleration of 0.18 g[45)]. The Tohoku earthquake recorded a peak ground acceleration of 0.35 g.[46)] The reason for the Fukushima Daiichi being incapable of enduring massive earthquake can be found from inaccurate anti-seismic measures by TEPCO throughout the regular process of assessment over the past years.

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44) Ibid.

45) A unit in gravity acceleration

46) Marianne Lavelle, "Japan Battles to Avert Nuclear Power Plant Disaster," National Geographic, March 14, 2011, accessed on March 9, 2018, https://news.nationalgeographic.com/news/energy/2011/03/110314-japan-nuclear-power-plant-disaster/

Japan's seismic guidelines which had been adopted by NSC in 1981 was partly revised and upgraded in 2001 due to a magnitude 7.3 earthquake in 2000 which hit the Chugoku region in western Japan. Later, the new revised version of the Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities was released in September 2006.[47] The revised guidelines required utilities to perform an assessment of anti-seismic safety of their nuclear plants. Accordingly, reports on seismic evaluation of Units 1 through 6 of Fukushima Daiichi regarding the safety of anti-seismic measures were submitted by TEPCO in 2008 and 2009. However the investigative commission pointed out that anti-seismic assessment lacked sufficiency in its contents as the scope of the assessment in the reports was restricted to only a few of significant safety facilities. Despite of the limited scope of the reports, NISA accepted TEPCO's interim reports. Moreover, TEPCO realized that critical flaws existed in safety equipment during the assessment of anti-seismic safety measures, and that improvements must be made for the Fukushima units to satisfy safety standards of the revised guidelines. However TEPCO did not perform any reinforcements to Units 1, 2 and 3 until the Fukushima incident occurred. Besides, any major assessments on nuclear plant's anti-seismic safety were not carried out since the last interim report was submitted in June 2009, and thus no report was presented by TEPCO since then. The deadline for the latest report was initially scheduled to June 2009. However TEPCO postponed the date to January 2016 on its own unilateral decision. NISA also cannot escape from the responsibility for

47) Tokyo Electric Power Company, Inc., "Fukushima Nuclear Accident Analysis Report," June 20, 2012, accessed on March 9 2018, http://www.tepco.co.jp/en/press/corp-com/release/betu12_e/images/120620e0104.pdf

failing to maintain anti-seismic safety of the plant up to the latest standards as it did not make its full commitment to overseeing TEPCO's performance in reinforcements despite of having recognized the vulnerability of the plant to serious seismic activities.

TEPCO claimed that the accident which involved critical damage and failure of safety equipment was caused by 15-meter waves of powerful tsunami rather than earthquake itself "to the extent that has been confirmed" in their reports submitted to the government and the IAEA.[48] However it remains doubtful whether TEPCO can be exempted from responsibilities for the unexpected tsunami in the situation where even sufficient preventive measures for seismic activities were not in place at the site due to their negligence.

Contrary to what TEPCO argued, since it was not the earthquake alone that triggered the disaster but also the subsequent tsunami, anti-seismic measures as well as tsunami countermeasures were proven to be essential parts of crisis management. According to the report from NAIIC, research on seismicity and its potential aftereffect had been continuously conducted for several decades since 1967 in which the Fukushima Daiichi began its construction. The findings by researchers repeatedly indicated that there was a high risk of the plant being stricken by a tsunami of a massive scale which exceeds the level assumed back in 1967 that could lead to a core damage. However TEPCO did not pay attention to such indications and was reluctant to take any measures. In 2002, after a report on the possibility of a large-scale earthquake and tsunami in the region was released by the

48) The Fukushima Nuclear Accident Independent Investigation Commission (2012)

government's Headquarters for Earthquake Research Promotion (地震調査研究推進本部), TEPCO was requested by NISA to come up with a calculation of possible effects from a major earthquake and tsunami off the coast from Fukushima to Ibaraki prefectures. TEPCO argued that the government report lacked reliable scientific basis, and thus the calculation which is time-consuming and costly was not needed. Therefore it was postponed without clear deadline with agreement from NISA. In 2006, NISA again called for the estimation of the potential impact of earthquakes and tsunami of a massive unprecedented scale on the Fukushima plant. It was two years later in 2008 when TEPCO finally presented a report which included a statement specifying that there was a possibility of a 15.7-meter tsunami strike the plant. The calculation was close to the actual scale of the waves that hit the plant in March 2011 which was up to 14 meters high. However despite of their close estimate, TEPCO did not take any follow-up measures.[49)]

It was 2006 when TEPCO started to share information about the possibility of station blackout and potential reactor core damage at the Fukushima plant in case of the tsunami of the level beyond the assessment performed by the Japan Society of Civil Engineers (公益社団法人土木学会). The investigation body argued that there were three critical factors in negligence of both TEPCO and NISA. First, information about evaluations or recommendations regarding the need to recalculate the assumptions used at the time of constructing the Fukushima plant and to update safety system against earthquake and tsunami

49) "TEPCO refused in 2002 to calculate possible tsunami hitting Fukushima: ex-gov't official," The Mainichi, January 30, 2018, accessed on March 22, 2018, https://mainichi.jp/english/articles/20180130/p2a/00m/0na/017000c

was neither recorded nor publicized. Therefore not only the public was deprived of an opportunity to be provided with sufficient information on the plant's safety status, but it also caused great difficulties to discover the truth of the situation back then after the accident occurred. Second, NISA tolerated the methodology developed by the Japan Society of Civil Engineers in 2002 of which the process and validity were not evaluated and unclear. The same methodology was favored only by the Japanese utilities including TEPCO when reviewing tsunami safety, but not adopted by NISA's technical support agency, the Japan Nuclear Energy Safety Organization (原子力安全基盤機構).[50] While its own safety organization did not employ the methodology, NISA recognized it as a standard for estimating one of the most significant figures in prevention of catastrophic consequences from potential natural disasters. Third, TEPCO's selective evaluation of safety issues concerning the scale and possibility of a tsunami contributed to poor control of safety management. In order to avoid the need for countermeasures, TEPCO arbitrarily interpreted safety assessments, using a biased calculation that indicated a low probability of tsunami. At the same time, the company justified their decision of shelving consideration of tsunami countermeasures because, according to their argument, implementation of safety measures should not be based on technical uncertainties. Such lax attitude to risk management of TEPCO was overlooked by NISA which resulted in the absence of appropriate preventive

50) James M. Acton and Mark Hibbs, "Why Fukushima was Preventable," Carnegie Endowment for International Peace, March 6, 2012, accessed on March 29, 2018, http://carnegieendowment.org/2012/03/06/why-fukushima-was-preventable-pub-47361

guidelines and system, making the plant and also the site-workers extremely vulnerable to a serious crisis.

4. Energy Supply and Demand (2010 - 2011)

Japan's energy supply and demand marked a turning point in 2011. Since then, significant changes in the structure of an electricity supply have been observed. It was between 2010 and 2011 in particular that showed a dramatic shift in the energy mix of Japan.

4.1 Energy Independence (2010)

A report released in April 2012 by METI found that in 2010 Japan improved in energy self-sufficiency which increased by one percentage point to 19 percent compared to the 1990 level.[51] At the same time, the level of dependency on oil decreased by 1.5 percentage point from 45.2 percent in the past year to 43.7 percent, reaching the lowest level in the last decade. Back in 1990, Japan's oil dependence was 57.1 percent. Dependence on imported fossil fuels also decreased but only slightly by 0.3 percentage point from 82.9 to 82.6 percent. As Japan continued its pro-nuclear policies, the share of the nuclear power accounted for 11.3 percent in the domestic supply of total primary energy source in 2010, showing a significant increase of 32.2 percent from 1990.

4.2 Environmental Effect (2010)

In regards to greenhouse gas produced by power plant operations, as economic performances improved in 2010, more industrial production led to an increase in energy consumption. Furthermore, the household sector consumed more energy than the past year due to extreme weather, causing a

51) The rate of energy self-sufficiency varied depending on whether the nuclear power was considered quasi-domestic energy or imported energy. In 2010, it stood at 19 percent when nuclear power was considered as quasi-domestic energy. When nuclear was considered as imports, the rate was 7.7 percent.

rise in CO^2 emissions by 4.5 percent from 2009 to 1.1 billion tonnes. The figure showed an increase of 6.1 percent compared with the 1990 level.[52)]

4.3 Electricity Generation and Supply (2011)

In 2011, a drastic drop in the share of nuclear power in the primary energy source was witnessed. The figure did not change dramatically between 2007 and 2010 as the nuclear share accounted for 9.7 percent in 2007 of the total supply of primary energy source and increased to 11.1 percent in 2009 and then decreased to 10.8 percent in 2010. Although there had been up and downs, the fluctuation range of the nuclear share never exceeded 20 percent in the last two decades. However in 2011 the figure significantly dropped by 64.5 percent. A drastic decline of nuclear power represented that the supply of non-fossil fuels in overall recorded the lowest level in 20 years. While the nuclear energy was losing its share, electricity generation from fossil fuels increased by 16.4 percent and 3.3 percent in LNG and oil respectively. It coincided with more import of the primary energy sources in 2011 as the import increased by 2.2 percent compared with 2010.

4.4 Energy Independence (2011)

As Japan's dependence on oil and fossil fuel which are in large part imported from overseas increased by 5.5 percent and 7.5 percent from 2010, its energy self-sufficiency rate declined by 35 percent.[53)]

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52) Agency for Natural Resources and Energy, "2010 Energy Supply and Demand Performance (平成22年度におけるエネルギ"[需給実績),"April, 2012

53) The self-sufficiency rate declined by 35 percent when nuclear was considered as quasi-domestic, and increased by 7.8 percent when considered as import.

Table 5. Impact of Fukushima in 2011 (compared to 2010)

Category	Increase/Decrease (rate of change)
Nuclear Supply	64.5% ↓
LNG Supply	16.4% ↑
Oil Supply	3.3% ↑
Total Import	12.2 ↑
Primary Energy Source Import	2.2% ↑
Oil Dependence	5.5% ↑
Fossil Fuel Dependence	7.5% ↑
Energy Self-sufficiency	35% ↓
Carbon Dioxide Emissions	3.9% ↑

Source: Agency for Natural Resource and Energy, Ministry of Finance, and Ministry of the Environment[54)]

4.5 Environmental Effect (2011)

Total greenhouse gas emissions in financial year (FY) 2011 increased by 3.9 percent from FY2010 to which increased carbon dioxide emissions produced from power generation contributed the most. The Fukushima disaster triggered shutdowns of nuclear plants in a very short period of time and therefore more fossil fuels were required to operate additional thermal power plants to meet national electricity demand which had been a major cause for greater emissions. Carbon dioxide produced from energy increased by 4.4 percent compared to FY2010 and 1.8 percent from 1990. Since 2008, less emissions were produced from energy related activities for two consecutive years. However after Japan's CO^2 emissions from energy dropped to its lowest level

54) When nuclear is considered as quasi-domestic energy

in 15 years in 2009, it rose for the second year in a row in 2011.[55] Emissions from the Commercial sector recorded the highest increase of 14.3 percent among five sectors which include Industries, Transport, Residential and Energy Industries. The second highest increase was from Residential sector at 9.8 percent, followed by Energy Industries at 7.7 percent. All three sectors which showed increases in greenhouse gas emission were adversely affected by worsened emissions intensity. The remaining two sectors, Industries and Transport, produced less greenhouse gases in FY2011 by 0.5 and 1.0 percent respectively. Industries sector which include factories showed a decrease in emissions since manufacturing industry was seriously disrupted by the Fukushima accident which led to a decline in production.[56]

4.6 Energy Imports (2011)

According to 2011 Trade Statistics released by Ministry of Finance in March 2012, Japan's exports value had been exceeding its imports value which led to continued trade surplus over the past years until 2010. However in 2011, Japan imported more than it exported as exports value decreased by 2.7 percent at 65.54 trillion yen while imports recorded 68.1 trillion yen, up 12.2 percent from the previous year. In consequence, Japan saw the first trade deficit in 31 years which hit a 2.5 trillion yen.[57] The greatest contributor to a sharp increase in imports value was mineral fuels. Among nine principal

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55) Agency for Natural Resources and Energy, "2011 Energy Supply and Demand Performance (平成23年度におけるエネルギ"[需給実績),"April, 2013.

56) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2011(2011 年度(平成 23 年度)の温室効果ガス排出量(確定値)について)," April 12, 2013, accessed on January 13, 2018, https://www.env.go.jp/press/16547.html

57) "31年ぶり貿易赤字、11年2.4兆円 震災で輸出減," Nihon Keizai Shimbun,January 25, 2012, accessed on January 18, 2018, https://www.nikkei.com/article/DGXNNSE2IFN01_U2A120C1000000/

commodity categories which included foodstuff, raw materials, chemicals, manufactured goods, machinery, electrical machinery, transport equipment and others, the largest percentage increase was observed in the import value of mineral fuels by 25.4 percent. Mineral fuels captured the largest share in total principal commodity imports at 32 percent. More reliance on imported mineral fuels in order to increase electricity generation from thermal power plants to fill the nuclear gap in the aftermath of the Fukushima disaster severely undermined the Japanese economy.

Ⅲ. Fukushima and New Energy Mix (2011-2013)

1. Options for Energy and the Environment (2012)

In June 2012, a report on Options for Energy and the Environment (エネルギ″-環境に関する選択肢, the Options) was presented by Energy and Environment Council (エネルギ-環境会議) which was established within the National Policy Unit of the Cabinet.[58] The report provided a direction of Japan's future energy policies by suggesting three scenarios of alternative energy mix plans in the post-Fukushima era developed based on the following three basic principles. First, Japan's future energy plan should pursue green energy and green growth. While expanding the use of renewable energy and reducing total energy consumption, Japan should promote green innovation and invest in an advanced energy network as basic fundamentals for energy industry. Second, the reform of energy system in which the demand side takes the lead should be introduced based on a new distributed energy system to guarantee consumers' freedom to choose from variable types of energy sources. Third, Japan should make a strong commitment to the global energy sector and environment in a diversified manner which includes development of clean energy technology and energy efficiency innovation. In light of the Fukushima nuclear accident, Japan was responsible for making a positive contribution to the international community by promoting the use of nuclear power for peaceful purposes and enhancing safety management.

58) Energy and Environmental Council, "エネルギ"["E環境に関する選択肢," Ministry of the Environment, June 29, 2012, accessed on January 5, 2018, https://www.env.go.jp/council/06earth/y060-110/mat01_2.pdf

The Options set out four objectives to be pursued by all three scenarios in common. First, the scenarios must be designed to strengthen nuclear safety and minimize any potential risk of nuclear power. It implied that the future energy plan should place more emphasis on safety, and reduce Japan's reliance on nuclear power. Less reliance on nuclear power became the most significant feature in Japan's energy plan since the Fukushima accident. Second, the options must pursue energy security improvement which had long been a major international issue. Its significance came under the spotlight since the Fukushima incident delivered a clear message to the international community that the global energy demand and supply system as well as prospects on alternative energy should be re-examined carefully. Third, Japan's revised energy plan must contribute to addressing global warming. It emphasized that there should be every effort to be exerted in cutting carbon dioxide emissions. In early discussion on energy policies after the Fukushima accident, a majority opinion was to cut down on nuclear power and adjust Japan’s original emissions target set in 2010 downwards. The target in the 2010 Plan was to reduce greenhouse gas emissions by 30 percent from the 1990 level by 2030. In the 2012 report, the target was maintained in overall without significant changes, implying that the majority was seeking for green energy which contribute to minimal negative impact on environment. Fourth, alternative options should be cost-effective and prevent adverse impact on related industries. It implied that the basic principles on which the options for Japan’s future energy mix were based demonstrate that Japan’s revised energy policies should not hinder industrial performance or employment in the related sector.

Three scenarios presented in the Options were designed to contribute to less reliance on nuclear power and fossil fuel while increasing renewable energy and curbing carbon dioxide emissions. Each of the scenarios was developed based on the Japanese government's initiative to reduce nuclear power, proposing prospects of Japan's energy mix with nuclear power at 0 percent, 15 percent and 20-25 percent of electricity generation.

Although scenarios vary in the extent of potential implications of reducing the use of nuclear power, Yoon (2012) argued that the figures presented in the Options suggested a number of key findings which served as counter-arguments against what the Nuclear Village claimed in support of nuclear power generation for the past few decades.[59)]

First, Japan can reduce greenhouse gas emissions while cutting its reliance on nuclear energy in large scale. The target set in the 2010 Plan to reduce 30 percent of emissions from the 1990 level by 2030 may not be achievable. However even if Japan turns into a complete nuclear-free country, CO^2 emissions can decrease by 23 percent from the 1990 level (Table 6).

Figures in scenarios raise questions on the credibility of arguments from pro-nuclear groups that the use of nuclear energy is essential in addressing the climate change issue. Nuclear power is certainly the leading green energy source which can reduce carbon dioxide emissions more swiftly and would greatly contribute to solving major global environment issues such as global warming, climate change, pollution and environmental degradation. However recognizing substantial risks of nuclear plants and knowing that greenhouse gas emissions can be cut without relying on nuclear energy, three scenarios

59) Yoon (2012)

of less or even no nuclear use cast a doubt on the adequacy of the rationale for the continued use of nuclear energy.

Table 6. Three scenarios for 2030

	2010	Zero nuclear power scenario	15% nuclear power scenario	20-25% nuclear power scenario
Nuclear energy share	26 %	0%	15%	20-25%
Renewables	10%	35%	30%	25-30%
Fossil fuel	63%	65%	55%	50%
Non-fossil fuel	37%	35%	45%	50%
CO2 emissions (from 1990 level)	0.3% ↓	23%↓	23%↓	23%↓
Electricity generation (from 2010)	1.1 trillion kWh	approx. 1 trillion kWh (10%↓)	approx. 1 trillion kWh (10%↓)	approx. 1 trillion kWh (10%↓)

Source: Options for Energy and Environment, Energy and Environment Council (2012)

Second, Japan's demand for electricity can be met with less production of electricity. The 2010 Plan was developed based on an estimate of approximately 1.1 trillion kWh of electricity production required by 2030 which added weight to the supporting argument for more nuclear development. However in the 2012 Options, total electricity generation was

estimated for 1 trillion kWh, down 10 percent from the 2010 figure. According to Yoon, the reason to propose an estimate of power generation that was significantly reduced from previous years was because the reduced volume of electricity would be able to meet Japan's energy demand in 2030, implying that the demand had been overestimated in previous energy plans. Back in 2010, nuclear power generation accounted for 26% of the total electricity production. However when every nuclear plant in Japan was shutdown temporarily in May 2012, Japan did not experience power shortages. Although Ohi Nuclear Plant resumed operation two months later in early July due to serious concerns over insufficient supply of electricity and potential blackout during the peak period of power demand in summer, utility companies managed to maintain a reasonable reserve capacity, representing that Japan's reliance on nuclear power can be reduced through effective power supply management.

Third, nuclear power is not a cost-effective source of energy when compared with that of renewable energy, and the potential impact of less nuclear power on Japan's trade balance is not negative in the long term. Until the outbreak of the Fukushima incident, the long-time rationale for nuclear power development claimed by the Nuclear Village was that nuclear power costs less than any other energy sources such as renewables and fossil fuel. The triple meltdown of the Fukushima Daiichi was a trigger for taking a multi-faceted approach to the fundamental issue of nuclear power, and cost was one of the main focus of a comprehensive review of this particular energy source of which the advantages had been more emphasized than its potential risks. A report released by the Cost Estimation and Review

Committee（コスト等検証委員会）found that the cost of nuclear electricity generation is not low enough to compete with that of electricity generation from renewables which is projected to decrease gradually over the years. In the short term, nuclear plants shutdown would definitely raise import payments for fossil fuels because renewable energy cannot replace nuclear power in a short period of time at the same rate as previously offered by the most affordable energy source at the time. Increase in fuel import had been undoubtedly a major contributor to trade deficit since April 2011 to March 2014. The figures showed that Japan's negative trade balance in FY2012 was 6.9 trillion yen while it was 13.75 trillion yen in FY2013, indicating that the deficit almost doubled in a single year.[60] However considering that electricity production from nuclear power decreased rather rapidly within the first three years after the incident, it was inevitable for Japan to face a short-term loss to their economy. Besides, despite of insignificant changes in import volumes for the past recent few years, import prices significantly dropped after it reached its peak in 2014 at a total amount of 27 trillion yen which was made to fill the gap caused by the closure of all nuclear plants in that year.[61]Import prices decreased to 18 trillion yen in 2015 and 12 trillion yen in 2016. It is contrary to import volume as Japan imported more coal than ever in 2015, showing an increase of 4.8 percent for 114.145 million tonnes.[62] The volume of imported fossil

60) Ministry of Finance, "2013 Trade Statistics,"March 13, 2014, accessed on February 27, 2018, http://www.customs.go.jp/toukei/shinbun/trade-st_e/2013/2013_117e.pdf

61) "Energy and Environment Opportunities in Japan," Business Sweden Tokyo, February, 2018.

62) Osamu Tsukimori and Aaron Sheldrick, "As Japan's oil, gas, power use stalls, coal imports hit new record," Reuters, January 25, 2016, accessed on March 3, 2018,

fuel in 2016 was similar to that in 2014 but there was a significant difference in import value. A sharp decrease in Japan's spending on energy imports was largely contributed by favorable exchange rates and falling global fuel prices. Decreased import values in 2015 and 2016 rather contradicts arguments that nuclear power is the cheapest source of energy. Although the figures may vary, the estimated import values proposed in all three scenarios also indicated that a significant reduction in reliance on nuclear power from the 2010 level would involve less spending on imported fossil fuels by 2030.[63)]

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https://uk.reuters.com/article/uk-japan-energy-demand/as-japans-oil-gas-power-use-stalls-coal-imports-hit-new-record-idUKKCN0V30N6

63) Yoon (2012); "Nuclear Power in Japan," World Nuclear Association, last modified in March, 2018, accessed on February 21, 2018, http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/japan-nuclear-power.aspx

2. DPJ's Management of Nuclear Crisis

Since the Fukushima nuclear incident developed into one of the worst catastrophes in the Japanese history due to a flawed working mechanism of nuclear safety regulation and plant operations, the Japanese government and major actors within the nuclear industry could not escape from huge criticisms. Both DPJ and Prime Minister Kan were condemned for mismanagement of the disaster which led to Kan's resignation and a decline of the party. However is Kan or DPJ the sole actor to be blamed for the disaster? Considering that the intertwined relationships between pro-nuclear groups and political circles created by the Nuclear Village in the era of the Liberal Democratic Party (LDP), a question arose as to whether such severe criticisms were fair and whether DPJ was simply in the wrong place at the wrong time. Regarding Kan's responses to the nuclear crisis, Kushida (2014) argued that when DPJ came to power, it also inherited a long-time defective structure of the nuclear industry which already had established a strong relationship with LDP. Kushida insisted that contrary to widespread criticisms, Kan managed the crisis in a balanced manner and overcame several critical issues deeply rooted in the nuclear circle.

2.1 Criticisms of Responses to Nuclear Crisis

Investigative reports released by the government and independent bodies pointed out five major issues in the DPJ's crisis management. First, the Kan Cabinet failed to give a timely announcement of a nuclear emergency and evacuation around the Fukushima nuclear plant.[64] Severe criticisms against

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64) World Nuclear News, "Fukushima evacuees failed by information flow," June 12, 2012, accessed on April 12, 2018,

Kan and DPJ were focused on delays in notifying the public and for failing to make an announcement of the plant situation quickly enough. The Fukushima Daiichi plant manager Yoshida came into contact with TEPCO headquarters and NISA at 3:42 pm on 11 March to inform that there is a very high chance of nuclear emergency.[65] At 4:30 pm, a declaration of nuclear emergency in progress was made based on Yoshida's judgment that cooling of the reactors and checking the water levels of reactors were almost impossible which automatically issued an evacuation order. At the time when Kan released a statement on the situation at 4:54 pm, he was not informed of the Yoshida's declaration of nuclear emergency. Because of that, Kan provided the Japanese public with misleading information about the situation that the shutdown of the plant was in progress and there was no radiation leakage. He later was heavily criticized for downplaying the severity of the situation.[66]

Second, press conference did not deliver accurate information and communication with the public was ineffective. Press conferences held in the early stage of the incident failed to calm public sentiment. It rather created grave concerns about the situation. Top officials of the government and utility companies were unable to answer questions and explain the situation with

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http://www.world-nuclear-news.org/RS-Fukushima_evacuees_failed_by_information_flow-1206127.html

65) Investigation Committee on the Accident at Fukushima Nuclear Power Stations of Tokyo Electric Power Company, "Interim Report,"December 25, 2011, accessed on April 8, 2018, https://www.cas.go.jp/jp/seisaku/icanps/eng/120224Honbun04Eng.pdf

66) Ulrike Mast-Kirschning, "Japanese government criticized for downplaying nuclear disaster," Deutsche Welle, April 18, 2012, accessed on April 8, 2018, http://www.dw.com/en/japanese-government-criticized-for-downplaying-nuclear-disaster/a-15890837

accurate information which left an impression that those who were supposed to know the full development of the nuclear disaster in fact did not know exactly what was going on. It only deepened public fears and distrust of the government.[67)]

Thirdly, Kan personally involved in the management which aggravated the situation.[68)] Kan made a personal visit to the Fukushima plant early on the day on 12 March. As his personal involvement was interpreted as an inconsiderate action which only disrupted recovery work, Kan was depicted as "an unnecessarily meddling figure".[69)]

Fourthly, the government did not take appropriate measures swiftly enough for hydrogen explosions.[70)] Due to its slow responses to explosions which took place in the afternoon on 12 March, the public were thrown into greater panic and brought discredit on the top leadership as it was proven that the statements made by Yukio Edano, the head of METI, were contradictory to what was being broadcasted on televisions.[71)] While Edano was avoiding the acknowledgement of the reactor meltdown, the Japanese public at the same

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67) Elaine M. Grossman, "Japanese Panel finds Fukushima Accident was "Manmade" and "Preventable"," Nuclear Threat Initiative, July 6, 2012, accessed on April 11, 2018, http://www.nti.org/gsn/article/japanese-panel-finds-fukushima-accident-was-manmade-and-preventable/

68) "Fukushima: former Japanese government admits policy to blame," The Telegraph, May 28, 2012, accessed on March 17, 2018,https://www.telegraph.co.uk/news/worldnews/asia/japan/9294946/Fukushima-former-Japanese-government-admits-policy-to-blame.html

69) Kushida (2014)

70) Clifton B. Parker, "Japan's political leadership helped save country from worst-case Fukushima disaster, Stanford researcher says," Stanford Report, June 25, 2014, accessed on April 4, 2018, https://news.stanford.edu/news/2014/june/fukushima-crisis-kan-062514.html

71) "東日本大震災"E"ュ生6カ月ドキュメント," nippon.com, October 3, 2011, accessed on February 26, 2018, https://www.nippon.com/ja/in-depth/a00105/

time were watching the footage of explosion at the Fukushima plant on TV channels.

Lastly, the system for radiation diffusion prediction known as SPEEDI (System for Prediction of Environment Emergency Dose Information) was not fully utilized in the evacuation system.[72] Although the government simulated radiation diffusion for at least 45 times between 11 and 16 March, it did not release simulation results to the public which caused confusion to local residents.[73]

2.2 Inherent Structural Problem

Kushida (2014), on the other hand, claimed in his paper that in order to have a theory that DPJ's incompetence in crisis management aggravated the Fukushima incident to be validated, one condition must be met: the pre-existing nuclear governance was well prepared for the disaster, but DPJ was negligent in following the given procedures and failed to make proper responses. The theory needs some evidence which can prove that (1) the existing safety manual was effective but not followed by DPJ; (2) the previous safety system developed under the earlier LDP leadership became scrapped or short of fund during the DPJ era; (3) political flaws hindered rescue process; or (4) expert advice was not taken into consideration and disregarded by the political leaders of DPJ in the decision making process. However if the cause of mismanagement was not DPJ's inadequacies but rather structural issues long-existed in the nuclear governance system since

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72) Gakkai, Nihon Genshiryoku, ed. The Fukushima Daiichi Nuclear Accident: Final Report of the AESJ Investigation Committee, Springer, 2014

73) "Fukushima report: Key points in nuclear disaster report," 2012

the LDP era, the situation would have involved; (1) the absence of nuclear plant emergency response procedures; (2) a lack of smooth communication between the cabinet, the related bodies and the power plant site which would lead to a failure in delivering accurate and real-time information about the situation; and (3) DPJ's measures which were productive in alleviating the crisis. The author asserted that the latter was evident in the Fukushima case, and thus it was inherent structural problems that were subject to blame. What created fundamental flaws in the nuclear safety governance was a combination of an interest group (the Nuclear Village) and a powerful belief that had long been deeply rooted in the industry, the "nuclear safety myth".

While Japan's energy industry achieved development with a priority on a stable supply of energy, the regional power companies monopolized the energy market. The industry became more friendly for those monopoly companies as electricity prices were set at cost-plus basis as stipulated by Electricity Operators Law which guaranteed sufficient revenues for capital investments.[74] Utility companies were rich in financial resources and provided with support from major industries.[75] As the whole energy sector experienced a strong growth, the nuclear industry came to form a pro-nuclear alliance within the industry and academia using its abundant financial resources. The Nuclear Village was created as the result of the expansion of pro-nuclear groups. The majority joined the powerful Nuclear Village whereas only a handful of independent scholars who could express opposition to the nuclear

74) Jun Saito, "Deregulation of the Energy Sector Its Achievements and the Remaining Agenda," Japan Center for Economic Research, April 6, 2017, accessed on April 4, 2018, https://www.jcer.or.jp/eng/research/pdf/saito20170406e.pdf

75) Kushida (2014)

power development remained.

What played a significant role in strengthening the influence of the Nuclear Village was "the myth of nuclear safety".[76] It was what the pro-nuclear groups strongly supported and propagated successfully in order to assure local residents that nuclear power generation was absolutely safe. They aggressively argued that there is a slim chance of catastrophic nuclear plant accidents which did not even worth consideration. It continued for decades, and power companies came to ignore the need to prepare an emergency plan for severe accidents. For "the myth of nuclear safety" to remain perfectly true to the public, nuclear plant operators purposely took a reluctant stance toward safety inspections or upgrades since such measures would prove that there in fact exists possible danger of the nuclear plants which was contrary to what they claimed.[77] Operators eventually had a firm belief themselves in "the safety myth"and became negligent in performing risk assessments and planning for severe emergency.

Since "the safety myth" had been the very root of the flawed nuclear safety governance in Japan, it explained the mismanagement of the government during the disaster, and also the reason why Prime Minister Kan and DPJ were not the only ones to take full responsibility for the Fukushima incident but their predecessors, LDP too contributed to the development of the accident.[78]

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76) Kyoko Sato, "Japan's nuclear imaginaries before and after Fukushima: visions of science, technology, and society," Resilience: A New Paradigm of Nuclear Safety, Springer, Cham, 2017, 195-206

77) Charles D. Ferguson and Mark Jansson, "Regulating Japanese Nuclear Power in the Wake of the Fukushima Daiichi Accident," FAS Issue Brief, May,2013, accessed on April 14, 2018, https://fas.org/wp-content/uploads/2013/05/Regulating_Japanese_Nuclear_13May131.pdf

2.3 Ineffective Communication

Ineffective communication during the Fukushima incident cannot be attributed to a single person's mismanagement, but rather a critical structural problem in communication within the related organizations. The problem existed in the nuclear governance for decades to which the majority considered not worth paying much attention until the triple meltdown of the Fukushima Daiichi occurred. It was finally revealed to the public, clearly demonstrating how unprepared the government and the nuclear industry were toward safety measures for emergency.

When a tsunami of a massive scale hit the plant, the means of communication were limited due to severe damages to plant facilities.[79] The fundamental cause of a vulnerability of important safety facilities was negligence in safety by the pre-existing government bodies and utility companies. It resulted in creating poor communication system between the nuclear industry and the government which exacerbated the situation. LDP or any other party would not have been better in dealing with the disaster.

There were two critical issues in the communication structure. First is that information was not delivered timely to the top officials in the government; and second was that the management of the related organizations were completely incompetent in managing the nuclear accident.[80]

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78) Kushida (2014)

79) Motoki Kazama and Toshihiro Noda, "Damage statistics (Summary of the 2011 off the Pacific Coast of Tohoku Earthquake damage)," Soils and Foundations 52.5 (2012): 780-792

80) Atsuyuki Suzuki, "Managing the Fukushima challenge," Risk Analysis,34.7 (2014): 1240-1256

2.3.1 Communication problem at site and government

The Great East Earthquake of magnitude 9.0 scale followed by a 15-meter tsunami literally destroyed most of the operations centers at Fukushima Daiichi Plant. Backup power generators were severely damaged, leaving the operations centers including control panel indicators in the complete dark.[81] Cellular communication tower were also damaged thus cell phones were of no use. Seismically reinforced emergency operations center which was built just eight months before the earthquake was the only onsite command center that survived the earthquake. While most of the facilities at the plant were in critical condition, TEPCO headquarters were able to communicate with those at site only through a video conference facility and a satellite telephone.[82] For workers at the plant, there was no other communication method to contact nuclear plant authorities outside the plant. The government had no direct communication whatsoever. Kan and his aides at the prime minister's office had to rely on information from TEPCO due to insufficient infrastructure for communication at the office.

The Emergency Operations Center in the Prime Minister's Office basement provided only emergency fax and telephone lines with no cellular reception. When Kan realized that those in top positions at nuclear organizations and bureaucrats having cooperative relationships with the nuclear industry were not reliable, Kan became so distrusted that he needed his trusted political

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81) Tokyo Electric Power Company, "Effects of the Earthquake and Tsunami on the Fukushima Daiichi and Daini Nuclear Power Stations,"May 24, 2011, accessed on April 16, 2018, http://www.tepco.co.jp/en/nu/fukushima-np/images/handouts_110525_01-e.pdf

82) Acton and Hibbs (2012)

associates. However Kan faced a problem of contacting them via cell phone since the cellular signals were not received. Although the Emergency Operations Center in the basement was where official emergency communications were available, Kan moved to his office in the fifth floor where cell phones can be used. The results of SPEEDI which were received at the basement center were not delivered to Kan on the fifth floor. It was later found that there was not a single government body which stepped in and informed the top officials of simulation results because they wanted to avoid any responsibility for reporting SPEEDI data.[83] Kan administration would have ordered to pass on live data, but that would have been possible only when they were aware of SPEEDI. Back then, top bureaucrats did not even know that such system was in place.

2.3.2 Incompetence of the management at nuclear organizations

Incompetence of those at the top management level of nuclear organizations was another critical factor that hindered information sharing between the government, related organizations and the Fukushima plant site.

In the event of a nuclear accident at the plant, the utility company, the government bodies related to nuclear safety and plant operations are responsible for reporting the situation to the prime minister as well as playing a role of an advisor on how to settle the situation with minimal damage. In the Fukushima case, such role should have been taken by three organizations, namely Nuclear and Industrial Safety Agency (NISA), METI

83) Norimitsu Onishi and Martin Fackler, "In Nuclear Crisis, Crippling Mistrust," The New York Times, June 12, 2011, accessed on March 19, 2018, https://www.nytimes.com/2011/06/13/world/asia/13japan.html

and TEPCO. However these three major actors of the accident failed to fulfill their duties due to a lack of competence.

METI, the government body that oversees Japan's nuclear plant operations, was composed of elites who had studied economics or law at top universities.[84] A METI-affiliated body, NISA was also a group of officials who never specialized in nuclear plant operation. When the head of NISA and former TEPCO vice president gathered at the Prime Minister's Office soon after the emergency declaration was made at the Fukushima Daiichi, Kan asked them about what caused the emergency situation. Neither of them could answer properly which made Kan so irritated that he wanted to see someone else who can provide him with accurate information with nuclear expertise. Consequently, METI had to invite a nuclear specialist from outside. Kan was disillusioned with competence of NISA and disappointed that the nuclear safety regulatory agency did not know any better than the prime minister himself as NISA had no direct means of communication with the site either. The agency was merely being informed of the situation through TEPCO. What also contributed to undermining the agency's credibility was NISA officials' irresponsible behavior of leaving the site without performing their duties once the situation at the plant worsened.

The top management of the responsible organizations who were supposed to be equipped with nuclear expertise or at least capable of grasping the situation with accurate information proved that they were completely unprepared for nuclear emergency. In other words, Japan's nuclear emergency management was carried out with no adequate procedures, no effective

84) Kushida (2014)

communication system and no "right person" to advise on the disaster. The Fukushima disaster revealed fundamental flaws within the organizational structures of the nuclear industry and the government.

3. Energy Reform

3.1 Institutional Reform

Recognizing the need for a fundamental reform of the organizational system, the cabinet adopted the Basic Policy on the Reform of an Organization in Charge of Nuclear Safety Regulation (原子力安全規制に関する組織等の改革の基本方針) on 15 August 2011.[85] The policy presented the government's initiative to create a new nuclear regulatory agency under the jurisdiction of Ministry of the Environment for the purpose of separating nuclear regulation and promotion.

In order to conduct a regulatory structural reform and create an independent regulation authority, the next step taken by the Japanese government was reinforcement of related laws. In June and September 2012, the Atomic Energy Basic Act[86] and the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors were amended.[87] Each law was enacted "for the purpose of protecting the life, health, and property of citizens and contributing to environmental conservation and the security of our country" and "for providing necessary regulations assuming the occurrence

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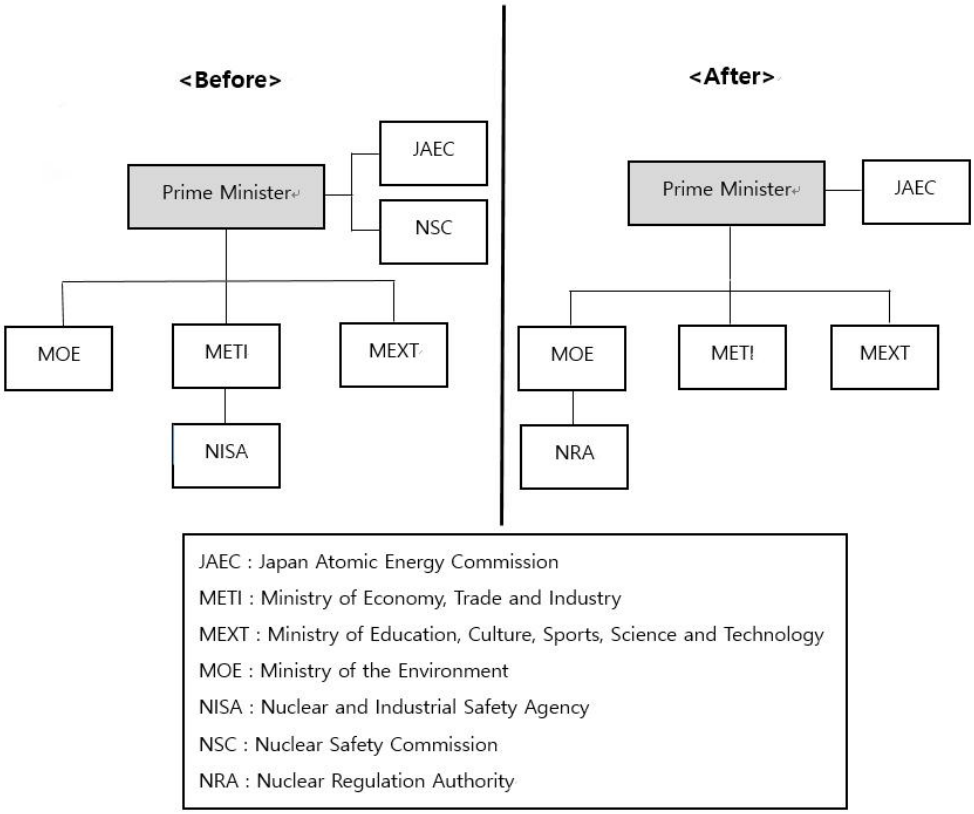
85) Cabinet Secretariat, "原子力安全規制に関する組織等の改革の基本方針," August 15, 2011, accessed on April 5, 2018, https://www.cas.go.jp/jp/genpatsujiko/pdf/kakugi_110815.pdf

86) Research Organization for Information Science and Technology, "原子力基本法," November 2012, accessed on April 6, 2018, http://www.rist.or.jp/atomica/dic/dic_detail.php?Dic_Key=906

87) Tadahiro Katsuta and Tatsujiro Suzuki (2017), "Policy Brief 34 - Japan's Nuclear Safety Governance after Fukushima," Asia Pacific Leadership Network for Nuclear Non-proliferation and Disarmament, February 27, 2017, accessed on April 10, 2018,http://a-pln.org/briefings/briefings_view/Policy_Brief_34_-_Japan%E2%80%99s_Nuclear_Safety_Governance_after_Fukushima

of large-scale natural disasters, terrorism, and other criminal acts."[88] The Nuclear Reactor Regulation Law was also tightened up in regards to measures for serious accidents with adoption of the back-fit system which involves compliance of nuclear facilities with the appropriate regulatory standards, and the operation period of the nuclear plant.[89]

Figure 1. Institutional Reform of Japan's Nuclear Safety Regulation



Source: Nuclear Regulation Authority (2013); IAEA (2016)

88) Nuclear Regulation Authority, "Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors," https://www.nsr.go.jp/data/000067232.pdf
89) Katsuta and Suzuki (2017)

Along with revisions, the government at the same time enacted a new law called the Act for Establishment of the Nuclear Regulation Authority in June 2012 in pursuit of creating an independent body that regulates safety of nuclear power plants. Accordingly, the Nuclear Regulation Authority (NRA) was established as an external entity of the Ministry of the Environment on 19 June 2013 (Figure 1). During the process of establishment of this regulatory agency, independence was given the top priority. Thus the agency was created not based on a provision applied to other external branches but on a different provision to recognize its full independence.[90] With the emergence of a new safety regulation agency, Nuclear Safety Commission (NSC) and NISA which had been severely discredited due to unpreparedness for disaster and failures in their functions were abolished. What distinguished NRA from its predecessors was reinforcement of the following three factors; independence, regulation and transparency. The new safety regulation organization was designed to exercise its authority without being overseen by any other entities of a higher tier as the National Government Organization Act recognizes its independence.[91]Moreover, in order to eliminate any factor that undermines the agency's independence, employees who had been engaged in nuclear businesses in the past three years were banned from holding a position in NRA. Likewise, NRA employees were prohibited from returning to a government body that promotes the use of nuclear power. Independence

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90) The Law Library of Congress, "Japan: Legal Responses to the Great East Japan Earthquake of 2011," September 2013, accessed on April 2, 2018, https://www.loc.gov/law/help/japan-earthquake/index.php#miscellaneous

91) Nuclear Regulation Authority, "Act for Establishment of the Nuclear Regulation Authority Act No. 47 of June 27,2012," last modified on November 22, 2013, accessed on March 18, 2018, http://www.nsr.go.jp/data/000067231.pdf

of the agency is ensured even from the prime minister by clearly specifying the scope of the prime minister's rights in case of severe nuclear plant accident to prevent any excessive or direct intervention.[92)]

Before the reform, the responsibility of tasks related to safety regulations were divided to multiple players in the nuclear industry which include NSC and NISA. After NSC and NISA were disbanded, the regulatory system was integrated in the way that all safety-related regulatory tasks including a review of nuclear plants based on new safety standards were transferred to a single organization, NRA, which replaced two former regulatory bodies.[93)] Transparency of the agency was enhanced as information including decision making processes is provided to the public without the need to make a request for the release of information.[94)]

Less than a year after NRA was created, the agency developed and adopted the new safety regulatory standards on nuclear power plants in June 2013.[95)] According to its independence and transparency principles, external experts as well as members of the public participated in the process of establishing the new standards which was proceeded openly and publicly. Public participation was considered as of great significance in the process and thus the procedure of surveying public opinion was conducted twice before finalizing the new safety standards.[96)] The new standards came in effect on 8 July 2013. With

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92) Ibid.
93) Vivoda (2016)
94) Katsuta and Suzuki (2017)
95) "New nuclear safety standards," The Japan Times, June 28, 2013, accessed on March 28, 2018, https://www.japantimes.co.jp/opinion/2013/06/28/editorials/new-nuclear-safety-standards-2/
96) Nuclear Regulation Authority, "Enforcement of the new regulatory requirements for commercial nuclear power reactors," July 8, 2013, accessed

the new standards, nuclear operators are obliged to apply enhanced hazard assumptions for any potential seismic and tsunami activities in the region where their nuclear plants were built. In accordance with the 2006 Anti-seismic Guidelines for Nuclear Power Plants (発電用原子炉施設に関する耐震設計審査指針), construction of nuclear reactors above active fault lines since the late Pleistocene age (120,000-130,000 years before present) was prohibited.[97] The new standards required more rigorous assumptions by adding a provision which specifies that if an active fault is not clear during the prescribed age of 120,000 to 130,000 years, the period to be taken into consideration is up to 400,000 years ago which would be as far back as the middle Pleistocene. Moreover it became compulsory for nuclear plant operators to implement additional preventive measures against severe accident at the plant. In order to prevent a loss of function of the system or facilities incontingency, the regulation requires countermeasures such as building second control rooms as a backup in case of severe damage to primary control room and installations of filtered vent systems on boiling water reactors which would release radioactive steam and stop diffusion of radioactive materials. A number of crucial regulatory requirements adopted in the new standards was absent in the previous safety guidelines or standards. The Fukushima disaster revealed willful negligence of safety regulations by the Japanese nuclear industry which triggered a radical reform of both institutional system and nuclear safety policies.

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on April 10, 2018, http://www.nsr.go.jp/data/000067212.pdf

97) Ibid.

3.2 Electricity Market Reform

As public distrust in the nuclear power expanded to utility companies and the existing electricity market, the process of the electricity market reform gained momentum. In April 2013, the Cabinet approved the "Policy on Electricity System Reform", and about seven months later in November 2013, a new bill for electricity reform was passed in Japan's lower and upper house.[98] The Cabinet's approval followed by the enactment of the bill was the beginning of the most drastic reform of the Japan's electricity market since 1951 in which nine regional electricity companies were established as part of reconstruction of the electric power industry and democratization of the economy in postwar Japan.[99] Those nine companies were namely Tokyo, Tohoku, Kansai, Hokkaido, Chubu, Hokuriku, Chugoku, Shikoku and Kyushu Electric Companies. Okinawa Electric Company joined the industry after Okinawa Prefecture was returned to Japan in 1972 which completed ten-member regional monopolies.

Recognizing abnormalities in the high-cost structure and the monopoly system, attempts for liberalization of the energy sector had been made since 1990s.[100] However regional electricity companies which had maintained strong cooperative relationships with politicians by funding their campaigns

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98) Ministry of Trade, Economy and Industry, "Cabinet Decision on the Bill for the Act for Partial Revision of the Electricity Business Act," February 28, 2014, accessed on April 11, 2018, http://www.meti.go.jp/english/press/2014/0228_02.html

99) The Federation of Electric Power Companies of Japan, "History of Japan's Electric Power Industry," accessed on April 11, 2018, http://www.fepc.or.jp/english/energy_electricity/history/

100) Tokyo Electric Power Company, "Liberalization of the Electric Power Market," last modified July 11, 2014, accessed on March 15, 2018, http://www.tepco.co.jp/en/corpinfo/ir/kojin/jiyuka-e.html

and often appointing them as executives of the company had been able to exercise great influence over the issue.[101] The Electricity Utilities Industry Law was amended in 1995, 1999 and 2003, but the extent of liberalization was limited in large part.[102] Since the companies strongly opposed the reform plan, electricity industry liberalization was slow in progress as the market was only partially liberalized to the extent that interests of electric companies were safeguarded. Enactment of the legislation in November 2013 implied that electric companies greatly lost their influence along with seriously damaged reputation from the Fukushima accident.

The need for a reform was highlighted as three major issues were pointed out as critical problems in regional monopoly system of the Japanese electricity industry. First, electricity cannot be transmitted beyond regions under the existing system. Second, since electricity in each region was supplied by a single electric utility company in the form of monopoly, there was little competition which caused the price being solely controlled by utilities. Third, the monopoly system hardly allowed changes or improvement in energy mix, making it difficult to increase the share of renewable energy in the total energy supply.[103]

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101) Aaron Sheldrick and Osamu Tsukimori, "Japan passes law to launch reform of electricity sector,"November 13, 2013, accessed on March 16, 2018, https://www.reuters.com/article/us-japan-power-deregulation/japan-passes-law-to-launch-reform-of-electricity-sector-idUSBRE9AC08N20131113

102) Tokyo Electric Power Company, "Electricity Market in Japan," July, 2004, accessed on March 16, 2018, http://www.tepco.co.jp/en/news/presen/pdf-1/0406-e.pdf

103) Agency for Natural Resources and Energy, "Japan's Electricity Market Reform and Beyond," July 7, 2015, accessed on April 12, 2018, https://www.iea.org/media/workshops/2015/esapplenaryjuly2015/Yamazaki.pdf

In pursuit of eliminating critical flaws in the existing electricity market, the reform as a whole was planned to be carried out in three stages. First, establishment of a national grid company. Second, full liberalization of the retail market. Third, legal unbundling of power transmission and distribution sectors from electric companies.

The reform was designed to fulfill three objectives. First, to ensure a stable supply of electricity through power interchange between regions. Second, to curb Japan's high electricity rates. Third, to provide more choices for household and business consumers.[104)]

A reliable electricity system and less reliance on planned outages of power plants are critical in a stable supply of electricity. Therefore the first stage of the reform was designed to enable cross-regional transmission of electricity and allow consumers to choose from various options of generation sources such as renewables and in-house power generations so that electricity can be used in a more effective way.[105)] Objectives of the reform also included promoting electricity conservation measures such as demand response and a reduction in electricity rates by stimulating competition in the market to enhance creativity and management efforts of the companies. The second stage which involves market liberalization provided companies from non-electricity sectors such as oil and gas companies with an opportunity to enter the market and launch a new business as a power producer.[106)]

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104) Agency for Natural Resources and Energy, "Electricity market reform in Japan," October, 2014, accessed on April 10, 2018, http://www.meti.go.jp/english/policy/energy_environment/electricity_system_reform/pdf/201410EMR_in_Japan.pdf

105) Agency for Natural Resources and Energy, "Energy Market Reform in Japan," accessed on April 2, 2018, http://www.enecho.meti.go.jp/en/category/electricity_and_gas/energy_system_reform/

Therefore, all electricity consumers including both households and companies can enjoy a full range of pricing plans and services offered by various electricity suppliers.

The bill passed in November 2013 with an overwhelming majority of members in favor called on the government to establish a national grid in 2015.[107] Accordingly, an independent body that coordinates national electricity operations called the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) was created under the authority of METI in April 2015.[108] The organization is in charge of facilitation of nation-wide grid operation through electricity interconnection between nine regions in mainland Japan. For a stable national power grid, OCCTO reviews electric power companies' plans on supply and demand. It also monitors a nation-wide transmission network to adjust power supply by advising utilities to either increase or decrease power generation according to the supply and demand situation. The significance of power interchange between regions was strongly emphasized by the Fukushima accident as the nation was faced with the imminent crisis of power shortage when nuclear power plants were rapidly shutdown leaving the nation with the existing thermal plants to fill the electricity gap. Establishment of a national grid was to prevent power shortages due to incapability to transmit electricity to the region where necessary.

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106) Agency for Natural Resources and Energy, "Electricity Market reform in Japan," November, 2013, accessed on March 29, 2018, http://www.meti.go.jp/english/policy/energy_environment/electricity_system_reform/pdf/201311EMR_in_Japan.pdf

107) Sheldrick and Tsukimori (2013)

108) "Japan's Electricity Market Reform and Beyond," July, 2015

The legislation for full retail deregulation was passed in June 2014 and amendments to the Electricity Business Act came into effect on 1 April 2016.[109] On the same date, full liberalization, which was the second stage of the whole reform, was implemented and opened a new chapter in the Japanese electricity market. While retail competition was expanded to small factories and buildings which consume more than 50kW in 2005 following partial liberalization in 2000 and 2004 for large factories and middle-sized factories respectively, small consumers with the usage of less than 50kW such as residential customers had no choice in electricity providers other than ten major utilities which monopolized supply in their own regions.[110]However with the market open to new entrants, consumers now have a greater range of choices of electricity suppliers. Regulated electricity rates for household and small consumers will be removed in 2020 when retail tariff is abolished at the same time as or after the final stage of the reform.

Despite that much liberalization of the market was achieved at the second stage, ten utility companies still have the greater share of control in the energy sector as transmission lines are managed by them, indicating that those major utilities can block power supply from new market participants.[111] Therefore the third stage is designed to complete full liberalization by separating generation and transmission functions as well as eliminating regulations on electricity prices. Accordingly, a transmission unbundling law was passed on 17 June 2015.[112] The final stage of the reform involves (1)

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109) Kae Takase, "Japanese energy policies after Fukushima," NAPSNet Special Reports, June 23, 2017, accessed on April 8, 2018, https://nautilus.org/napsnet/napsnet-special-reports/japanese-energy-policies-after-fukushima/

110) "Japan's Electricity Market Reform and Beyond," July, 2015

111) Sheldrick and Tsukimori (2013)

legal unbundling of the transmission and distribution sectors starting on 1 April 2020 in pursuit of enhanced neutrality in those two sectors; (2) deregulation of retail electricity tariffs; and (3) a new independent regulatory authority equipped with an extensive expertise to perform functions which are currently handled by the existing administration body that regulates electricity businesses.[113)]

From April 2020, electricity companies will not be allowed to perform retail and generation businesses while running transmission business. Operating electricity retail and generation business as well as transmission requires a permission from METI.[114)] It implies that ten regional utilities except for Okinawa Electric Power Company must separate their power transmission and distribution operations to transfer the functions in either holding company style or affiliated company style by 2020. By doing so, the final stage aims to create a level-playing field in the energy industry for ten major utility companies and new entrants. Therefore general transmission companies are required to maintain impartiality in businesses with retail companies.[115)] With

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112) "Japan passes major reforms for power, gas sectors," Reuters, June 17, 2015, accessed on April 9,2018, https://www.reuters.com/article/japan-power-regulations/japan-passes-major-reforms-for-power-gas-sectors-idUSL3N0Z31GL20150617

113) Ministry of Economy, Trade and Industry, "Cabinet Decision on the Bill for the Act for Partial Revision of the Electricity Business Act and Other Related Acts," March 3, 2015, accessed on April 9, 2018,
http://www.meti.go.jp/english/press/2015/0303_02.html

114) Agency for Natural Resources and Energy, "Japan's Electricity Market Deregulation," June, 2015, accessed on April 11, 2018, http://www.meti.go.jp/english/policy/energy_environment/electricity_system_reform/pdf/201506EMR_in_Japan.pdf

115) Reiji Takahashi et al., "The Energy Regulation and Markets Review- Edition 6 : Japan,"July 13, 2017, accessed on April 11, 2018, https://thelawreviews.co.uk/chapter/1144345/japan

the introduction of licensing unbundling since April 2016, TEPCO became the first company to legally unbundle its transmission business by transferring transmission function to a subsidiary company.[116] In result, three operating companies were founded under TEPCO Holdings, namely TEPCO Fuel & Power, TEPCO Power Grid and TEPCO Energy Partner. Each company is responsible for operation of fuel and thermal power generation, general power transmission and distribution, and electricity retail business while TEPCO Holdings manages administration as a stockholding company.[117]

116) Ministry of Economy, Trade and Industry, "Electricity System and Market in Japan,"January 22, 2018, accessed on March 13, 2018, http://www.emsc.meti.go.jp/english/info/public/pdf/180122.pdf

117) Tokyo Electric Power Company, "Annual Report 2016," July 13, 2016, accessed on March 23, 2018, http://www.tepco.co.jp/en/corpinfo/ir/tool/annual/pdf/ar2016-e.pdf

4. Energy Supply and Demand (2012) : Toward nuclear phase-out

After taking over the office in early September 2011, Prime Minister Yoshihiko Noda affirmed the government initiative to phase out nuclear power by 2040 and made a statement that he envisioned a Japanese society with zero dependence on nuclear power. In his first press conference, Noda confirmed that the future direction of energy policies Japan should pursue was a shift away from nuclear energy and further develop new alternative energy sources.[118] He also claimed that the existing nuclear power plants which would hit the end of their lifespan in the near future should be decommissioned and no additional nuclear plant should be constructed. But at the same time, Noda recognized the significance of a stable supply of energy and declared that the reactors of which safety was ensured by rigorous safety assessments would be restarted. His position on the use of nuclear energy was clear: Japan should promote nuclear phase-out, but it should be carried out gradually over the next few decades with a minimum impact on energy supply and economy. Despite of opposition from 46 percent of the Japanese public[119], Noda did not change his position while he was serving as a prime minister. During the Diet sessions, Noda repeatedly emphasized the future direction of Japan's energy sector to pursue less dependence on nuclear power but at the same time to refrain from immediate elimination of nuclear plants which could bring adverse effects on the Japanese economic performance.[120]

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118)l "Press Conference by Prime Minister Yoshihiko Noda," September 2, 2011, accessed on March 2, 2018, https://japan.kantei.go.jp/noda/statement/201109/02kaiken_e.htm

119) Mariko Oi, "Japan PM Noda orders nuclear reactors back online," June 16, 2012, accessed on March 1, 2018, http://www.bbc.com/news/world-asia-18468685

120)

Based on Noda's gradual nuclear phase-out strategy, Japan maintained the number of nuclear plant in operation at the lowest level throughout the year in 2012 with only two Ohi Units 3 and 4 in operation for most of the year.

4.1 Energy Consumption and Imports

As most of the nuclear plants in Japan stopped operation, the government strongly urged national energy conservation from both households and businesses with a target of up to 15 percent saving in order to prevent power shortage. In the aftermath of the accident which encouraged national efforts in energy saving campaign, final energy consumption in overall declined by 1.3 percent compared to 2011. Less energy consumption was contributed by a decrease in production and improvement in energy consumption efficiency as well as relatively mild weather throughout the year with cool summer and warm winter. However despite of decreased consumption, imports of the primary energy source increased by 2.9 percent from 2011.[121] The import volume of the primary energy sources had been on the rise since 2010 which coincided with three consecutive years of increase in the share of mineral fuels in total principal commodity imports.[122] According to the World Bank, Japan's fuel imports in 2012 was

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"Policy Speech by Prime Minister Yoshihiko Noda to the 181st Session of the Diet," October 29, 2012, https://japan.kantei.go.jp/noda/statement/201210/29syosin_e.html "Policy Speech by Prime Minister Yoshihiko Noda to the 180th Session of the Diet," January 24, 2012, accessed on March 2 2018, https://japan.kantei.go.jp/noda/statement/201201/24siseihousin_e.html

121) Agency for Natural Resources and Energy, "2012 Energy Supply and Demand Performance (平成24年度におけるエネルギ"[需給実績),"April 15, 2013, accessed on March 3, 2018, http://www.meti.go.jp/press/2014/04/20140415004/20140415004.pdf

122) Ministry of Finance, "2012 Trade Statistics," March 13, 2013, accessed on

the second highest in the share of total merchandise imports following the figure in 2008 in the past 23 years since 1985 in which fuel imports recorded 43.75 percent (Figure 2).[123]

Figure 2. Fuel imports of Japan (% of merchandise imports)

Source: The World Bank

4.2 Energy Independence

Increased imports of energy from overseas had a direct influence on Japan's dependence on oil and fossil fuel as the dependency ratio increased from 46

March 4, 2018, http://www.customs.go.jp/toukei/shinbun/trade-st_e/2012/2012_117e.pdf

123) World Bank, "Fuel Imports,"accessed on February 18, 2018, https://data.worldbank.org/indicator/TM.VAL.FUEL.ZS.UN?end=2016&locations=JP&start=2004&view=chart

percent to 47.3 percent for oil, and from 88.8 percent to 92.5 percent for fossil fuel. At the same time, it led to a sharp decrease in energy self-sufficiency from 12.4 percent to 8.7 percent in both cases where nuclear power was considered as either quasi-domestic or imported energy. A continued fall in the share of nuclear power in the total energy source contributed to a drop in self-sufficiency rate.

4.3 Energy Supply

The share of fossil fuel in domestic supply of primary energy source was inversely proportional to that of non-fossil fuel. Domestic supply of fossil fuel indicated a steady rise for two consecutive years from 2011. Fossil fuel which includes oil, coal and natural gas accounted for 81.9 percent in 2010, 88.4 percent in 2011 and 92.1 percent in 2012, showing an increase by 8 percent and 4.2 percent respectively. On the contrary, the share of non-fossil fuel had been dropping sharply since 2011 from 18.1 percent in 2010 to 11.6 percent in 2011 and further decreased to 7.9 percent in 2012.

While all three major types of fossil fuel increased in a total supply of primary energy sources in 2012, non-fossil fuel which is largely composed of nuclear, hydro-electricity and renewable energy was reduced substantially for the past few years. In particular, the share of nuclear power in total primary energy supply finally reached a single-digit figure in 2011 at 4 percent and almost zero percent at 0.6 percent in 2012. It indicates that the share of the nuclear power generation was significantly cut by 64.5 percent in 2011 compared to the 2010 level and again by 84.3 percent in 2012 compared to the previous year. In substitution for nuclear, more electricity was produced

from thermal power generation which caused a rise in supply of coal, natural gas and oil.

Table 7. Impact of Fukushima in 2012 (compared to 2011)

Category	Increase/Decrease (rate of change)
Nuclear Supply	84.3% ↓
Energy Consumption	1.3% ↓
Primary Energy Import	2.9% ↑
Oil Dependence	1.3%p ↑
Fossil Fuel Dependence	3.7%p ↑
Energy Self-sufficiency	3.7%p ↓
Fossil Fuel Supply	4.2% ↑
Non-fossil fuel Supply	32% ↓
Carbon Dioxide Emissions	2.9% ↑

Source: Agency for Natural Resource and Energy, Ministry of Finance and Ministry of the Environment[124)]

4.4 Environmental Effect

Carbon dioxide emissions in 2012 coincided with the increased share of fossil fuel in supply as more greenhouse gases were produced year by year since 2009. After gradual increases for third straight year, the figure in 2012 increased by 70 million tonnes, up 2.9 percent from 2011 since increased emissions from fossil fuel was not offset by national efforts in enhancing

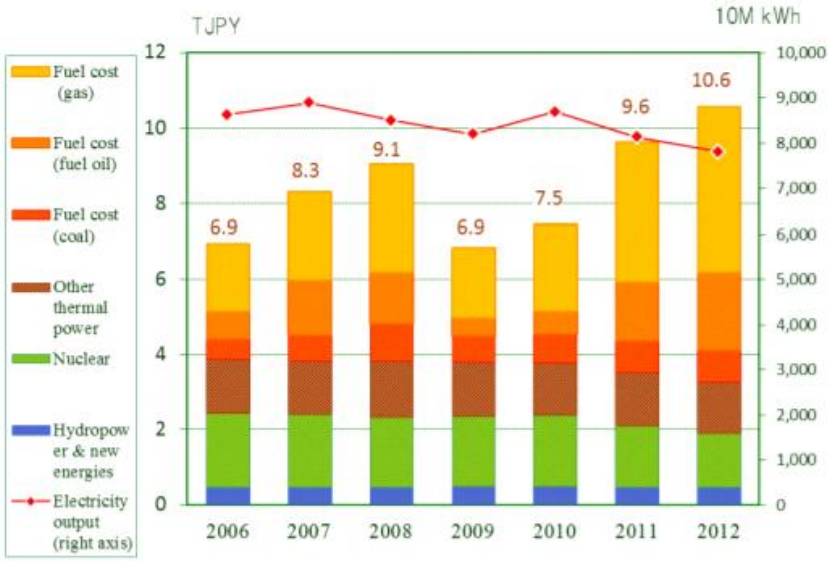
124) When nuclear is considered as quasi-domestic energy

energy efficiency. When compared with emissions in the pre-Fukushima level in 2010, Japan's CO^2 emissions rose by 7.5 percent.

4.5 Energy Cost and Electricity Rates

Drastic changes in the share of energy sources in supply directly affected import costs of fuels and electricity rates. Regarding the cost, Japan had to suffer from higher power generation cost and higher electricity bills. According to the report released by the Institute of Energy Economics Japan (IEEJ) there had been increases in the total cost of power generation for three straight years from 2010 to 2012 (Figure 3).[125)]

Figure 3. Power Generation Cost from 2006 to 2012



Source: The Institute of Energy Economics, Japan (2013)

125) Yuhji Matsuo and Yuhji Yamaguchi, "The rise in cost of power generation in Japan after the Fukushima Daiichi accident and its impact on the finances of the electric power utilities," The Institute of Energy Economics, Japan, November, 2013, accessed on April 1, 2018, https://eneken.ieej.or.jp/data/5252.pdf

The cost rose significantly from 7.5 trillion yen in 2010 to 9.6 trillion yen in 2011 and further to 10.6 trillion yen in 2012. Accordingly, the unit cost of power generation also rose substantially from 8.6 yen/kWh in 2010 to 11.8 yen/kWh in 2011, and again to 13.5 yen/kWh in 2012. Similar situation was witnessed two decades ago when the unit cost soared to 10.7 yen/kWh in 2008 from around 8 yen/kWh in the 1990s after the oil crises (Figure 4). Among various energy sources included in the total cost, fossil fuel soared the most from 3.7 trillion yen in 2010 to 6.1 trillion yen in 2011 and 7.3 trillion yen in 2012. The hike in the fuel cost was attributed by the increased cost of purchasing natural gas and oil.

Figure 4. Trend of Average Unit Cost of Power Generation

Source: The Institute of Energy Economics, Japan (2013)

Japan experienced a net increase of 1.2 trillion yen in the cost of power generation, down by 0.2 trillion yen from the estimated cost which would have incurred if no offset by the currency exchange rate was made. Matsuo (2013) insisted that had the Japanese imports of fossil fuel not compensated by favorable exchange rates, the cost of imports of primary energy sources from 2010 to 2012 would have amounted to an additional 1.4 trillion yen due to a rise in prices of primary energy sources such as crude oil, LNG and coal.[126] Similarly, despite of more power generated from thermal power plants in 2012 compared to 2010, electricity consumption decreased as a result of energy saving campaign that swept the nation. Less demand and less consumption prevented the cost of power generation from further rising as it reduced the required volume of fossil fuels by 1.2 trillion yen from the estimated volume which would have been required if the demand was unchanged.

Higher cost of power generation was by far the most crucial factor that contributed to significant revenue losses for electric utilities over a three-year period since 2010. TEPCO, the operator of the Fukushima Daiichi Plant, was the only company that suffered from a net deficit of 1.3 trillion yen in the FY2010 while other eight utilities recorded net profits. However in the following financial years 2011 and 2012, all eight companies experienced huge deficits which amounted to a total of 800 billion yen. Their retained earnings were adversely affected with a total loss of 2 trillion yen from 2010 to 2012. Although TEPCO improved to some extent in its earnings during the same period, it still had a long way to reach the pre-Fukushima level.

126) Ibid.

Since increases in both fuel imports and cost of power generation threatened the finances of the electric companies, they inevitably began to raise electricity rates (Table 8).

Table 8. Increases in household electricity rates by utility companies

	Rate increase by	Date
Tokyo Electric Co.	8.46%	1 Sep 2012
Kansai Electric Co.	9.75%	1 May 2013
Kyushu Electric Co.	6.23%	1 May 2013
Tohoku Electric Co.	8.94%	1 Sep 2013
Shikoku Electric Co.	7.80%	1 Sep 2013
Hokkaido Electric Co.	7.73%	1 Sep 2013
Chubu Electric Co.	3.77%	1 May 2014
Hokkaido Electric Co.	15.33%	1 Nov 2014
Kansai Electric Co.	8.36%	1 Jun 2015

Source: Consumer Affairs Agency, Government of Japan[127)]

In July 2012, TEPCO received an approval from METI to increase household electricity rates by 8.5 percent to cover the cost of increased fossil fuel imports for thermal power generation of which operation was unavoidable to fill the nuclear gap.[128)] The average household electricity rates of TEPCO

127) "2015 Consumer White Paper (平成27年版消費者白書)," Consumer Affairs Agency, Government of Japan, accessed on April 2, 2018, http://www.caa.go.jp/information/hakusyo/2015/honbun_1_2_1_1.html

increased by 8.46 percent in September 2012.[129] Earlier in April, TEPCO raised rates for its industrial consumers by up to 18 percent. The company explained that the rate increase was due to higher cost of power generation from energy sources other than nuclear power.[130] More burning of natural gas and coal was witnessed in 2012 because all but two reactors at Fukui Prefecture were shutdown and the electricity gap was filled with the existing alternative sources which could easily substitute nuclear energy in a short period of time.

4.6 Environmental Effects

As more thermal power generation was observed in FY2012, it inevitably produced more carbon dioxide than the previous year. According to the report from Ministry of Environment, total greenhouse gas emissions in FY2012 reached 1,343 million tonnes which was an increase by 2.8 percent from FY2011.[131] The rise in emissions was largely due to the increased fossil fuel consumption as a consequence of a drastic reduction in the share of nuclear power in supply. A decline in Japan's manufacturing production and

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128) "Fossil costs drive Kansai rate hike," World Nuclear News, November 26, 2012, accessed on March 19, 2018, http://www.world-nuclear-news.org/C-Fossil_costs_drive_Kansai_rate_hike_261112a.html

129) Toru Hatano,"Japan household power rates up 15% since '11 quake," Nikkei Asian Review, February 3, 2014, accessed on February 27, 2018, https://asia.nikkei.com/Business/Household-electricity-rate-rises-15-after-2011-earthquake

130) "Press Release Regarding Electricity Rate Increase," Tokyo Electric Power Company, May 11, 2012, accessed on March 29, 2018, http://www.tepco.co.jp/en/press/corp-com/release/2012/1204304_1870.html

131) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2012 (2012 年度（平成 24 年度）の温室効果ガス排出量（確定値）について)," April 15, 2014, accessed on January 13, 2018, http://www.env.go.jp/press/files/jp/24375.pdf

electricity savings driven by a popular movement in the residential sector to improve energy efficiency failed to prevent the country from producing less emissions.

Carbon dioxide produced from the energy sector increased by 2.9 percent from FY2011, and the Commercial sector produced 8.9 percent more emissions, the highest increase among five sectors including Industries, Transport, Residential and Energy Industries. Greenhouse gas emissions also increased from Industries, Residential and Energy Industries sectors by 0.1 percent, 7.8 percent and 0.2 percent respectively, indicating that four out of five sectors contributed to increased CO^2 emissions in FY2012. The only sector that showed improvement in emissions was Transport. The report pointed out a worsened CO^2 emissions intensity as a major factor that caused more production of greenhouse gases from Commercial and Residential sectors. In Industries sector, a decrease in emissions from manufacturing failed to offset increased emissions from non-manufacturing which in result led to 0.4 million tonnes of more carbon dioxide.

5. Energy Supply and Demand (2013) : Less nuclear plant

5.1 Electricity Rates

Ten regional utilities monopolized the energy market in Japan before the government carried out deregulation and energy market liberalization in March 2016 as part of the energy reform which in result invited more competitors in the market. Among 10 utilities, TEPCO was the first to increase the household electricity rate in September 2012. In 2013, seven out of ten power companies, namely Kansai, Kyushu, Chugoku, Hokurkiku, Tohoku, Shikoku and Hokkaido followed the same path as TEPCO (Table 8). The biggest increase in 2013 was from Kansai which raised the rate by 9.75 percent in May. On the same date, Kyushu also raised it by 6.23 percent. Chugoku and Hokuriku showed only a slight increase of 0.06 and 0.04 yen. Four months later on 1 September, three companies, Tohoku, Shikoku and Hokkaido simultaneously increased the rate by 8.94 percent, 7.8 percent and 7.73 percent respectively. Tohoku's move was followed after it applied to the government for approval to raise the prices by 11.4 percent early in the year. Since no nuclear reactors had been in operation in the region during 2012, Tohoku utility faced a burden of increased cost for fossil fuel while bearing the responsibility to meet electricity demand. The increase in September was the first increase by Tohoku utility in more than three decades.

In the fourth quarter of 2013, prices of crude oil, LNG and coal increased by 1.5 percent, 3.5 percent and 0.5 percent respectively which coincided with the period during which three power companies increased their household electricity.

5.2 Economic Impact

Japan recorded the highest trade deficit of 6.9 trillion yen in 2012 for first time since 1980 when the Japanese economy was devastated by the second oil crisis.[132] One of the major contributors to such deficit was a significant rise in imports of energy sources which caused an outflow of an enormous national wealth to overseas. In 2013, the figure broke the record as it reached 11.5 trillion yen, an increase of 65 percent from the 2012 level according to the Ministry of Finance. Japan's total imports value in 2013 was 81.2 trillion yen, and mineral fuels including crude petroleum and partially refined petroleum accounted for 33.8 percent of the total import value of primary commodity which was the largest share among all other import categories.[133] Not only the trade deficit reached a record high, but also the volume of coal imports set new records in 2013 with a total value of 109 million tonnes.

Keidanren, the Japan Business Federation (日本経済団体連合会) claimed that it was estimated for Japan to spend national wealth of 3.6 trillion yen for increased imports of fuels in FY2013 as a price for more thermal power generation while almost all nuclear power plants were remained idle.[134] The group expressed concerns that a continued trade deficit was deteriorating Japan's industrial competitiveness and economic growth. Emphasizing the

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132) Ministry of Finance (2014)

133) Statistics Bureau, Ministry of Internal Affairs and Communications, "2014 Statistical Handbook of Japan," 2014, accessed on March 4, 2018, http://www.stat.go.jp/english/data/handbook/pdf/2014all.pdf

134) "A Proposal for Future Energy Policy," Keidanren, October 15, 2013, accessed on February 14, 2018, http://www.keidanren.or.jp/en/policy/2013/089.html

significance of affordable and sufficient supply of energy in the economic growth, Keidanren called for a swift process of restarting nuclear reactors.

5.3 Energy Consumption and Domestic Supply

The last remaining nuclear plant in operation was shutdown in September 2013 which was the beginning of a zero nuclear society that lasted for almost two years. Japan's shift away from the traditional pro-nuclear stance and toward nuclear phase-out, though it was only a temporary measure, triggered by the Fukushima incident was finally realized with Kansai Electric Power Corporation's shutdown of Reactor No.4 at Ohi Nuclear Plant in Fukui prefecture. Therefore the figures of the energy sector in 2013 demonstrated how Japan managed its energy supply just before the zero nuclear plan was launched.

According to the report on 2013 Energy Supply and Demand Performance released by the Agency for Natural Resources and Energy[135)], the final energy consumption in 2013 was reduced by 1 percent compared to 2012, down 4.9 percent from the pre-Fukushima 2010 level which represented a continued decline for a third straight year. On the other hand, a domestic supply of primary energy sources increased slightly by 0.8 percent to which the major contributor would be coal as it increased by 8.5 percent and also more hydro-electricity by 3.6 percent as well as renewable energy by 1.8 percent. Consumption decreased by 5.2 percent compared to 2010 which is relatively minor considering a sharp decrease by 96.8 percent of nuclear

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135) Agency for Natural Resources and Energy, "2013 Energy Supply and Demand Performance (平成25年度におけるエネルギ"[需給実績)," April 14, 2015, accessed on March 3, 2018, http://www.meti.go.jp/press/2015/04/20150414004/20150414004.html

power in supply during the same period. Despite increases in supply of hydro-electricity and renewable energy, a non-fossil fuel supply in overall were kept at low level. Since 2011, the share of non-fossil fuel in total supply of primary energy sources began to decrease and reached a single-digit figure at 7.6 percent in 2013, falling to the lowest level in decades. A more severe cut was seen in the nuclear sector. In 2011, the share of nuclear power in total primary energy supply accounted for 4 percent which was hugely reduced by 64.5 percent from 10.6 percent in 2010, and dropped further in 2012 by 84.4 percent to 0.6 percent, recording the largest reduction in overall energy sources. The decline did not stop there as in 2013 the figure became closer to zero at 0.4 percent which was a decrease of 41.6 percent from the previous year. Among six energy sources of both fossil and non-fossil fuel, no other energy source experienced dramatic changes in supply as much as nuclear power did for the last few decades. Hydro-electricity and renewable energy showed relatively minor changes in their supply since 2011. Nuclear was the only energy source that showed more than 60 percent of change in a single year compared to the previous year.[136)]

136) The second largest change of supply in a single year was 54.1 percent of renewable energy in 2010.

5.4 Fuel Imports

Less nuclear power led to more imports of primary energy sources and more power generation from fossil fuel power plants. Electricity produced from imported energy source started to increase since 2010 and reached its highest level in 2013. Fossil fuel also showed a constant rise in supply since 2011. Increases by similar percentage were observed as the import in 2013 increased by 1.4 percent and the fossil fuel supply by 1.3 percent compared to the previous year. In 2013, imports of both LNG and thermal coal hit record with an increase of 0.2 percent to 87.49 million tonnes for LNG and of 1.3 percent to 109.03 million tonnes for coal. The reason for such rise was due to increased capacity of coal-fired power plants as a result of continued shutdown of nuclear plants. At the same time, the total supply of non-fossil fuel decreased by 1.1 percent.

Table 9. Impact of Fukushima in 2013 (compared to 2012)

Category	Increase/Decrease (rate of change)
Nuclear Supply	41.6% ↓
Trade Deficit	65% ↑
Fossil Fuel Supply	1.3% ↑
Non-fossil Fuel Supply	1.1% ↓
Primary Energy Import	1.4% ↑
Oil Dependence	3.2% ↓
Fossil Fuel Dependence	1.1% ↑
Energy Self-sufficiency	3.4% ↓

Source: Agency for Natural Resource and Energy, Ministry of Finance and Ministry of the Environment[137)]

Moreover, the last two remaining nuclear reactors in operation which finally came to a halt in September left no alternative for Japan but to import more energy sources from overseas. As the import volume increased, LNG cost more than ever with a record 7.06 trillion yen, breaking the 2012 record. Crude oil imports dropped by 0.6 percent to 3.65 million barrels a day, maintaining at a low level for two consecutive years.[138)]

5.5 Energy Independence

Three indicators, namely energy self-sufficiency rate, dependency rate of fossil fuel and oil clearly indicate that Japan's energy policies for energy independence were going backwards to some extent after the Fukushima incident. The dependency rate of fossil fuel consistently increased since 2011 for three consecutive years. The figure for Japan's dependence on oil also rose by 5.5 percent and 2.8 percent respectively in 2011 and 2012, but returned to the 2011 level in 2013 after a decrease of 3.2 percent from 2012. Despite of less dependence on oil in 2013, the energy self-sufficiency rate continued to drop since 2010 with a decrease of 3.4 percent in 2013.[139)]

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137) When nuclear is considered as quasi-domestic energy

138) "UPDATE 2-Japan's 2013 LNG imports hit record high on nuclear woes," Reuters, January 27, 2014, accessed on April 14, 2018, https://www.reuters.com/article/energy-japan-mof/update-2-japans-2013-lng-imports-hit-record-high-on-nuclear-woes-idUSL3N0L103N20140127

139) Energy self-sufficiency decreased for four consecutive years since 2010 when nuclear power was considered as quasi-domestic energy while the rate improved slightly in 2013 when it was considered as imports.

5.6 Environmental Effect

As more fossil fuel was consumed in the last four years from 2010, greenhouse gases produced from energy sources increased during the same period.

According to the report released by Ministry of the Environment, Japan's total greenhouse gas emissions in FY2013 increased by 1.2 percent from FY2012.[140] Compared to the pre-Fukushima level in 2005, the figure rose by 0.8 percent. Although a year-by-year increase was insignificant, considering that Japan produced 10.8 percent more greenhouse gases in FY2013 than it did in FY1990, a constant rise in total emissions for the past 23 years raises a question of whether Japan was on the right track on reducing greenhouse gases.

Increased carbon dioxide from power generation, particularly from burning coal, was pointed out in the report as one of the major causes for a rise in emissions. Despite of continued efforts by the whole nation in the energy-saving campaign, total CO^2 emissions from power generation increased by 1.1 percent (Table 10).

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140) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2013 (2013 年度（平成 25 年度）の温室効果ガス排出量（確定値）について)," April 14, 2015, accessed on January 14, 2018, http://www.env.go.jp/press/100862.html

Table 10. Energy-origin CO^2 emissions by sector

	FY1990 [Share]	FY2005 [Share]	FY2012 [Share]	Changes from FY2012	FY2013 (compared to FY2005) [Share]
Total	100%	100%	100%	+1.1%	(+1.3%) [100%]
Industries (factories etc.)	47.2%	37.5%	35.4%	-0.7%	(-6.0%) [34.8%]
Transport (cars etc.)	19.3%	19.7%	18.5%	-0.7%	(-6.3%) [18.2%]
Commercial and other (commerce, service, office etc.)	12.5%	19.6%	20.8%	+9.9%	(+16.7%) [22.6%]
Residential	12.3%	14.8%	16.7%	-1.3%	(+11.9) [16.3%]
Energy Industries (power plants etc.)	8.7%	8.5%	8.6%	-3.8%	(-2.9) [8.2%]

Source: Japan's National Greenhouse Gas Emissions in Fiscal Year 2013, Ministry of the Environment

The largest contributor to the increase was Commercial sector. Among five sectors which include Industries, Transport, Commercial, Residential and Energy Industries, increases in emissions from the Commercial sector had been largest for three consecutive years from 2011. On the contrary, emissions from Energy Industries showed the biggest drop of 3.8 percent between FY2012 and FY2013. In fact, all sectors but Commercial generated less emissions compared to the previous year due to decreases in emissions from economic activities such as manufacturing and passenger transport.

Ⅳ. Abe's Return to Nuclear (2014-2016)

1 Abe's Energy Policy : Why restart nuclear plant?

As Prime Minister Shinzo Abe of the conservative LDP won a two-thirds majority in the Parliament, the new cabinet took office in late December 2012. From the very beginning of his term, Abe was very clear with his energy policy. Soon after inauguration, Abe announced that he would take bold measures to boost the economy and ensure that economic reform plans were not set back by high energy costs.[141] As revitalizing the Japanese economy was a top priority for Abe, more nuclear energy was a significant factor in narrowing the country's trade deficit by reducing fuel imports. At the time of Abe taking the office, only two reactors at Ohi nuclear plant in Fukui Prefecture were in operation. His initiative to aggressively pursue economic recovery and to revisit the energy mix plans developed by the previous governments were largely due to Japan's poor performance in trade for the past few years. Imports of fossil fuels consistently increased since 2011 and became a huge burden for big corporates consuming a substantial amount of electricity in their operation for the period during which almost all nuclear plants were shutdown.

According to a report on international trade trend released by METI in 2004, while the total value of exports in 2013 increased by 9.5 percent from 2012, the imports value increased by 14.9 percent due to a rise in fossil fuel

141) Sebastian Sarmiento-Saher, Shinzo Abe: Japan's Nuclear Salesman-In-Chief," The Diplomat, July 3, 2013, accessed on April 3, 2018, https://thediplomat.com/2013/07/shinzo-abe-japans-nuclear-salesman-in-chief/

imports for more thermal power generation to meet domestic demand.[142] The value of fossil fuel imports increased to 27 trillion yen in 2013 which was 10 trillion yen up from the pre-Fukushima level. The increase in imports continued for four consecutive years which largely contributed to Japan's trade deficit. Therefore in order to get Japan back on the right track, Abe promoted a return to nuclear by restarting reactors and constructing additional nuclear plants. Since his inauguration and throughout the year in 2013, Abe was constantly asked about Japan's future energy policy and his view on nuclear power plants during press conferences and policy speeches. His position was firm and determined as Abe replied that decisions on whether to restart nuclear reactors would be carefully made based on the revised safety standards by the Nuclear Regulation Authority (NRA). During the press conference, when a reporter asked for Abe's view on a gap between the opposition from half of the Japanese public and the government's plan, Abe answered that "The fundamental principle is 'safety first'. In terms of safety, operations at nuclear power plants will not be restarted unless the plants conform to the new regulatory standards, as determined through the decision of the experts at the Nuclear Regulation Authority."[143] In other words, if NRA finds no safety problem with the existing nuclear plants, there will be no reason to keep the plants idle and thus the cabinet would not hesitate to grant approval to restart operation.

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142) Ministry of Economy, Trade and Industry, "White Paper on International Economy and Trade 2014," accessed on March 19, 2018, http://www.meti.go.jp/english/report/data/gWT2014fe.html

143) Prime Minister of Japan and His Cabinet, "Press Conference by Prime Minister Shinzo Abe," June 26, 2013, accessed on February 14, 2018, https://japan.kantei.go.jp/96_abe/statement/201306/26kaiken_e.html

His pro-nuclear stance indicated that the revised energy policies would move in the opposite direction to the previous prime ministers, Kan (2010-2011) and Noda (2011-2012). Although two nuclear reactors were brought back to temporary operation in 2012 by the Noda cabinet in fear of power shortage in summer, both Noda and Kan shared the view that Japan should make full commitment to reach the ultimate goal of nuclear phase-out by 2040. However Abe's energy policies were interpreted as a shift away from a nuclear-free society.

Abe's stance on nuclear power generation was also evident in foreign diplomacy. Three nuclear power cooperation agreements were signed between Japan and Turkey when Abe visited Turkey in May 2013 which demonstrated his strong will to further promote and develop nuclear power, not being limited to the domestic energy market but further expand to overseas market. [144] Abe's primary goal is clear: to tackle trade deficit from increased fuel imports and bolster Japanese economy by exporting Japan's advanced nuclear technologies overseas, and to further strengthen national competitiveness.

144) Prime Minister of Japan and His Cabinet, "Press Conference by Prime Minister Shinzo Abe during His Visit to Turkey," May 3, 2013, accessed on April 6, 2018, https://japan.kantei.go.jp/96_abe/statement/201305/03turkey_naigai_e.html

2. 2014 Strategic Energy Plan

The Japanese cabinet approved the national energy plan on 11 April 2014 which presented the revised direction of Japan's future energy policies.[145)] The 2014 Plan defined five issues as major challenges in the Japanese energy sector in regard to the structure of energy supply and demand. First, Japan had been heavily reliant on overseas resources. Second, mid- and long-term changes were observed in the energy demand structure due to decreased population and technological development. Third, prices of energy resources had been unstable and volatile due to growing demand from emerging countries. Fourth, Japan had been producing more greenhouse gases. Fifth, continued efforts were required for recovery from the nuclear plant accident, and safety as well as stability of nuclear power needed to be ensured.

The new plan was developed based on a principle that the current government under LDP had set nuclear power as the base-load power. The government led by Abe expressed its willingness to restart nuclear power plant which satisfy new safety standards established by NRA, making a shift from the nuclear phase-out position taken by the previous DPJ government (Table 11). While Abe planned to bring nuclear power back over the coming years, it also recognized the significance of development in renewable energy and thus revised the target for renewable energy upward, implying that Japan would strive to achieve electricity generation from renewables beyond the level presented in the past plans. It indicated that the previous target of

145) Agency for Natural Resources and Energy, "Cabinet Decision on the New Strategic Energy Plan," Ministry of Economy, Trade and Industry, April 11, 2014, accessed on January 28, 2018, http://www.meti.go.jp/english/press/2014/0411_02.html

increasing the share of renewables including hydroelectric generation from 10 percent in 2014 to 13.5 percent by 2020 and 20 percent by 2030 would be revised with a view to ratcheting them up. According to the plan, Japan will focus on expanding the renewables market for the next three years, carrying out deregulation and technology development for cost reduction. While promoting the growth of renewable energy, the government took a stance to rely on thermal power generation due to continued shutdown of nuclear plants.

The share of fossil fuel exceeded 90 percent of the total power generation in Japan for the past few years since the Fukushima disaster which led to an increase of 3.6 trillion yen in import value of fossil fuel. Despite a huge damage to trade balance, Japan was in difficult situation to cut its reliance on fossil fuels. In case of coal, although it is the biggest contributor to greenhouse gas emissions, it has relatively lower geopolitical risk and involves lower costs. Therefore coal was reconsidered as a significant base-load power in the 2014 Plan and the revised policy pursued utilization of coal-fired generation at high efficiency rate while at the same time leaving less carbon footprint.

The plan for efficient use of coal would be carried out by renewing old coal-fired power plants and constructing new plants as well as fostering development of technology to reduce emissions. Lee (2014) pointed out that as the 2014 Plan reflects the Japanese government's stance on maintaining or even increasing its reliance on fossil fuel in a situation where uncertainty over operations of nuclear plants lingers, the revised policy under the LDP government contributes little to addressing global warming. Lee insisted that

the revised direction of Japan's energy policies would weaken its position in the international negotiations on post-Kyoto initiatives.[146)]

Table 11. Nuclear policy change (2003 - 2014)

LDP (2003-2007)	2003 Basic Energy Plan	To pursue nuclear as base-load power
	2007 Basic Energy Plan (2nd revision)	To pursue nuclear as base-load in the long term
DPJ (2010-2012)	2010 Basic Energy Plan (3rd revision)	To pursue nuclear as base-load power; To construct more than 14 nuclear plants by 2030
	2011 Fukushima Daiichi nuclear disaster	
	Innovative Energy and Environment Strategy (2012)	To phase out nuclear power by 2030; No additional nuclear plants to be constructed
LDP (2013-2014)	Experts'view on 2014 Basic Energy Plan (2013)	To consider nuclear as an important base-load power
	2014 Basic Energy Plan (4th revision)	To consider nuclear as an important base-load power; To restart nuclear plants if safety regulations are met

Source: Nihon Keizai Shimbun (2014); LG Economic Research Institute

For energy conservation, the Japanese government planned to exert more efforts in saving energy in order to address the existing issues including shutdowns of nuclear power plants which created a gap in energy supply,

146) Lee Ji Pyeong et al., "Japan Insight : 차세대 에너지 기술로 산업혁신에 나선 일본 기업," LG Economic Research Institute, May 2014, accessed on March 29, 2018, http://www.lgeri.com/report/view.do?idx=18554

high cost of renewable energy and heavy reliance on fossil fuels. Japan had been an exemplary country in energy efficiency as shown in their achievements since 1970s when oil crisis hit the nation and also after the Fukushima accident caused a significant decline in nuclear power generation.[147] However, since energy conservation campaign was considered to have already reached its maximum level, a greater emphasis was placed on development of new technology for saving energy in the 2014 Plan.

As Japan had been suffering from a major setback in promoting a low-carbon energy due to shutdown of all nuclear plants, the country was placed in an unfavorable situation that might lead to a failure of international commitments to addressing climate change. Thus in order to enhance effects of energy conservation and develop renewable energy as well as marine resource reserves which would help Japan refrain from being overly dependent on overseas resources, the revised plan reinforced a mid- and long-term strategy for development of energy technology.

The roadmap on domestic energy technology development proposed by the Japanese government covered every energy source available for Japan. For renewable energy such as wind and solar power, the plan pursued advanced technology for cost reduction and improved efficiency. Defining nuclear power as quasi-domestic energy, the focus of technology development was placed on various areas within the nuclear sector including safety of light

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Lecler, Yveline, and Bruno Faivre d'Arcier, "Smart cities experiments in France and Japan: Preparing the energy transition,"Association of Asian Studies Annual Conference, 2015. Willhemina Wahlin, "Powering up a nation: Energy security in Japan and Australia," Australian Review of Public Affairs, November 12, 2006, accessed on March 29, 2018, http://www.australianreview.net/digest/2006/11/wahlin.html

water reactor and final processing technology for radioactive waste. The need for high efficiency of advanced electricity, transmission and distribution grid was underlined particularly as Japan's energy reform has been underway since 2015 with an establishment of an organization that manages an integrated grid between regions.[148] Continued development of technology on low emission and efficiency improvement of coal and gas generation were also presented in the plan.[149]

Japan entered its third year of the post-Fukushima era in 2014. During that period, Japan had witnessed destructive impact on industries and households caused by critical flaws in their energy supply structure. Previous plans in the pre-Fukushima era had addressed the significance of diversified energy sources with a huge emphasis particularly on nuclear power for the reason that Japan was overwhelmingly dependent on imported fuels. Japan's commitment to further development of renewable energy had also been a major focus in the past years. However it was the accident at the Fukushima Daiichi that raised alarms not merely about grave risks of nuclear power plants but also the severity of fundamental problems lying in the existing utility companies and energy supply system. The accident delivered a message to the nation that Japan's energy reform and revision of the policies were of great urgency. The 2014 Plan demonstrated the Japanese government's initiative to review policies on each and every energy source to tackle critical issues revealed by the accident including instability of electricity supply due to a lack of energy independence. While accepting the situation, the Abe

148) Organization for Cross- regional Coordination of. Transmission Operators (OCCTO)
149) Lee et al. (2014)

cabinet set a new direction for energy policies in pursuit of alleviation of economic and environmental costs of fossil fuel dependence and utility companies' negligence.

3. Energy Supply and Demand (2014) : Nuclear Gap

3.1 Energy Supply

After shutting down the last nuclear plant in September 2013, Japan spent a full year without nuclear energy in 2014. The share of nuclear power in a domestic supply of primary energy sources decreased from 11.6 percent in 2005 to zero percent in 2014. Compared to the 2010 level before the Fukushima nuclear plant meltdown, the total domestic supply of the primary energy dropped by 9.5 percent. While oil and nuclear decreased by 5.8 percent and 100 percent respectively, natural gas and coal supply increased by 19.3 percent and 2.7 percent, indicating that the nuclear gap was filled mainly with those two fossil fuel sources since 2011.[150)]

Power generation from burning petroleum was constrained and less transportation was witnessed in 2014 due to stagnated freight movements. Accordingly, domestic demand decreased for second straight year by 8.1 percent, contributing to a decrease in oil supply for two consecutive years by 7.5 percent compared to 2013. Coal was less consumed in power generation for industrial purposes in 2014 which led to a decrease in domestic supply for the first time in three years by 3 percent. A supply of natural gas also continued to decrease for two years in 2014 but only by a minor 0.4 percent. Hydro-electricity was the only energy source which rose in supply for two consecutive years, and the figure increased by 2.9 percent from 2013. Its capacity utilization rate as well as generated electricity increased by 1.4

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150) Agency for Natural Resources and Energy, "2014 Energy Supply and Demand Performance (平成26年度におけるエネルギ"[需給実績)," April 15, 2016, accessed on March 4, 2018, http://www.meti.go.jp/press/2016/04/20160415005/20160415005.html

percent and 4.8 percent compared to a year before. Domestic supply of renewable energy, on the other hand, decreased by 3.7 percent which was the first decline in two years, indicating that Japan had been supplying less energy from two out of three non-fossil fuel energy sources (nuclear, hydro-electricity and renewables) domestically since 2013.

3.2 Energy Independence

In 2014, Japan's energy self-sufficiency rate was 8.5 percent, a 0.2 percentage point drop from last year when nuclear is considered as quasi-domestic energy, and a 0.2 percentage point increase when nuclear is considered as imported energy. Dependence on oil and fossil fuel showed a similar situation with only a minor change from the previous year. Back in 1990, Japan's dependence on oil was 56.9 percent. It gradually declined over the next 10 years, and since 2001 Japan maintained its oil dependency ratio below 50 percent. Although the Fukushima incident caused an increase in 2012, the figure dropped by 1.5 and 1.2 percentage point to 45.7 percent and 44.6 percent in 2013 and 2014. Fossil fuel reliance stayed between 80 - 85 percent since 1990. However it increased significantly after the Fukushima plant meltdown to more than 90 percent, and reached 92.5 percent in 2014 which was similar to the 1970 level.

3.3 Environmental Effect

Total greenhouse gas emissions in FY2014 dropped by 3.1 percent from FY2013. Such improvement in emissions was contributed by less electricity consumption and reduced carbon intensity. Despite of no nuclear plant in operation throughout the whole year, carbon dioxide emissions from power

generation was reduced by 3.7 percent from the previous year in which CO^2 emissions hit record high, returning back to the 2011 level. It was the first decline in three years since 2011.

Table 12. Impact of Fukushima in 2014 (compared to 2013)

Category	Increases/Decrease (rate of change)
Nuclear Supply	100% ↓
Trade Deficit	11.8% ↑
Mineral Fuel Import	0.9% ↑
Oil Dependence	2.4% ↓
Fossil Fuel Dependence	1.1% ↑
Energy Self-sufficiency	2.4% ↓
Total Carbon Dioxide Emission	3.1% ↓
Emission from Power Generation	3.7% ↓

Source: Agency for Natural Resource and Energy, Ministry of Finance, and Ministry of the Environment

Less demand in electricity and thus less generation from oil-fired power plants in 2014 contributed to decreased greenhouse gas emissions. Commercial sector generated 6.2 percent less emissions from FY2013, the biggest drop among five sectors. Considering that Commercial sector showed the biggest changes in emissions from year to year since 2011 which had always been corresponding with total greenhouse gas emissions, it is evident that CO^2 emissions depend on how well the Commercial sector performs. Energy Industries also produced less carbon dioxide by 5.3 percent, followed by

Residential, Transport and Industries with a decrease of 4.8 percent, 3.4 percent and 1.4 percent respectively.[151)]

3.4 Energy Import

Japan's trade deficit was recorded 12.82 trillion yen in 2014, up 11.8 percent from 11.47 trillion yen in 2013. It reached a record high for a third straight year as it continued to soar since 2012. The total trade deficit for three years from April 2011 to March 2014 amounted to 23.25 trillion yen.[152)] It was contrary to Japan's strong economic performance for the past two years in 2009 and 2010 during which the value of trade balance improved by 29.5 percent and 148.4 percent respectively.[153)] However considering that trade deficit increased by smaller percentages since 2013 by 65.2 percent and 11.8 percent in 2013 and 2014 respectively, Japan’s deficit had been slowing down.

Import value increased by 5.7 percent compared to the previous year, and mineral fuels accounted for 32.2 percent of which the share was the largest among nine principal commodity categories. Although the import value of petroleum dropped by 2.6 percent from 2013, Japan spent more on petroleum than any other fossil fuels as its share was still the largest at 16.1 percent which was almost half of the total mineral fuel imports. While the LNG imports value increased by 11.2 percent, a decrease of 9.6 percent was observed from coal. Considering shutdowns of all nuclear plants in 2014

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151) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2014 (2014 年度（平成 26年度）の温室効果ガス排出量（確定値）について)," April 15, 2016, accessed on January 14, 2018, http://www.env.go.jp/press/102377.html

152) World Nuclear Association (2018)

153) Ministry of Finance (2015)

which created a nuclear gap, an increase of 0.9 percent in import value of mineral fuels was deemed rather minor compared to the past two previous years as it recorded a rise of 10.4 in 2012 and 13.9 percent in 2013.

3.5 Electricity Rates

A continued loss due to suspension of nuclear reactors led utilities to raise electricity rates in order to avoid further financial setbacks. The new rates of Chubu Electric Power Company were increased by 3.77 percent in May while Hokkaido Electric Power Company which increased the household electricity rate in the previous year temporarily raised the rate again by 12.43 percent from 1 November 2014 to March 31 2015.[154] Compared to FY2010, electricity rates for households increased by 25 percent whereas industries paid 39 percent more for their electricity usage.[155]

154) "Screenings for restart of Tomari nuke plant likely to be prolonged," The Asahi Shimbun, December 11, 2017, accessed on April 3, 2018, http://www.asahi.com/ajw/articles/AJ201712110031.html

155) Agency for Natural Resources and Energy, "Japan's Energy," 2016, accessed on March 17, 2018, http://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2016.pdf

4. Energy Supply and Demand (2015) : Bringing back nuclear

4.1 Energy Supply

Japan restarted two nuclear reactors in August and October 2015 after almost two years of having zero nuclear power generation. Bringing back nuclear power definitely had a direct influence on various sectors including domestic supply, environment and economic performance.

According to the report released by Agency for Natural Resources and Energy[156)], the final energy consumption in 2015 was reduced by 1.4 percent compared to 2014 which was a fifth straight year of decline. Less consumption was due to a continued national movement for energy conservation and also mild weather throughout the year. A total domestic supply of the primary energy source also reduced by 1.4 percent from the previous year, marking two consecutive years of decline. Oil was 2.7 percent less supplied in 2015 due to decreased thermal power generation and improved fuel efficiency of automobiles. Natural gas also decreased in supply by 5.1 percent which was a continued decline for three consecutive years. Restarting nuclear plants and more supply from renewable energy caused less demand for natural gas. While both oil and natural gas fell in supply, coal and all three non-fossil fuels which include hydro-electricity, nuclear and renewable energy showed an increased supply in 2015. Coal and hydro-electricity supply rose by 1.2 percent and 3.3 percent respectively. Hydro-electricity in particular improved in all three indicators as domestic

156) Agency for Natural Resources and Energy, "2015 Energy Supply and Demand Performance (平成27年度におけるエネルギ"[需給実績),"April 13, 2017, accessed on March 4, 2018, http://www.meti.go.jp/press/2017/04/20170413003/20170413003.html

supply, capacity utilization and power generation each increased by 3.3 percent, 0.9 percent and 4.2 percent. Renewable energy had been supplied more since 2013 with an increase of 2.7 percent in 2015 compared to 2014. Major contributor of a consistent increase in renewable energy was an increase of natural energy by 5.6 percent largely due to a considerable rise in generation from solar photovoltaic energy.

4.2 Energy Independence

Energy self-sufficiency was recorded at 9.5 percent in 2015, up 0.8 percentage point from 2014 when nuclear power was considered as quasi-domestic energy. Two reactors in Kagoshima Prefecture that resumed operation contributed to improvement in energy self-sufficiency. When nuclear generation was regarded as imports, the figure was 9.1 percent which is 0.4 percentage point increase from the previous year contributed by increased supply of renewable energy and hydro-electricity.

Dependence on oil which stood at 56.9 percent in 1990 showed a downward tendency for nearly two decades until 2011. After the meltdown of the Fukushima Daiichi, it increased from 45.9 percent in 2011 to 47.2 percent in 2012. However the figure dropped in the following year in 2013 and remained the same at 44.7 percent in 2014 and 2015.

Since 1990 and up until 2011, Japan's reliance on fossil fuel stood at between 80 to 85 percent. However the figure had been over 90 percent since 2012. For the following four consecutive years, Japan relied on imported fossil fuel for more than 90 percent, returning to the 1970 levels. In 2015, the dependency rate decreased by 0.7 percentage point, falling between 90 and 91.6 percent.

Table 13. Impact of Fukushima in 2015 (compared to 2014)

Category	Increase/Decrease (rate of change)
Nuclear Supply	0.4% ↑
Trade Deficit	78.2% ↓
Mineral Fuel Import	34.2% ↑
Fossil Fuel Supply	1.6% ↓
Non-fossil Fuel Supply	7.8 % ↑
- Hydro-electricity	3.3% ↑
- Renewable	2.7% ↑
Oil Dependence	-
Fossil Fuel Dependence	0.75% ↓
Energy Self-sufficiency	8% ↑
Total Carbon Dioxide Emission	2.9% ↓
Emission from Energy	3.4% ↓

Source: Agency for Natural Resource and Energy, Ministry of Finance and Ministry of the Environment

4.3 Environmental Effect

Total greenhouse gas emissions in FY2015 decreased by 2.9 percent from FY2014, largely due to decreased electricity consumption and increased power generation from non-fossil fuels. During the course of a full financial year, two reactors at Sendai Nuclear Plant operated for eight months a year. It contributed to a reduction in the share of fossil fuel in primary energy sources. Moreover, Japan continued energy conservation movement while experiencing mild weather throughout the year with cool summer and warm winter. Thus both electricity demand and consumption dropped which led to a decrease in supply and power generation. Accordingly, energy-related carbon

dioxide emissions were 3.4 percent less produced in FY2015 compared to FY2014. Phenomena observed in Energy Industries such as a growth in supply of renewable energy, a return of nuclear power and less reliance on fossil fuel led to two consecutive years of a decline in greenhouse gas emissions from the energy sector. The largest decrease was from Energy Industries by 6.4 percent from FY2014, and the Residential sector came second with a decrease of 5.1 percent. The remaining three sectors, namely Industries, Transport and Commercial also showed improvement in reducing carbon emissions by 3.1 percent, 1.7 percent and 3.1 percent respectively.[157)]

4.4 Energy Import

Japan's trade deficit which had been observed since 2011 continued to 2015, recording a deficit of 2.8 trillion yen which was a fifth consecutive year of a decline in trade balance. However the figure in fact improved significantly by 78.2 percent when compared to a deficit of 13 trillion yen in the previous year. Such improvement in trade was contributed mostly by a sharp drop in total imports value by 8.7 percent which was the first decrease in the past five years. Imports value of mineral fuels coincided with a decline in overall imports of principal commodity. Although mineral fuels still accounted for the largest share of 23.2 percent in commodity imports, Japan spent 34.2 percent less on mineral fuels which was the biggest drop among nine categories, namely Foodstuff, Raw materials, Mineral fuels, Chemicals, Manufactured goods, Machinery, Electrical machinery, Transport equipment and Other.

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157) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2015 (2015 年度（平成 27年度）の温室効果ガス排出量（確定値）について)," April 13, 2017, accessed on January 16, 2018, https://www.nies.go.jp/whatsnew/executivesummary2015.pdf

Accordingly, all seven fuel and fuel related import products decreased in values by an average of 26 percent from 27.7 trillion yen in 2014 to 18.2 trillion yen in 2015. The largest decrease was observed in petroleum of 41 percent, followed by LPG of 40.1 percent.[158)]

4.5 Electricity Rates

In 2015, two utility companies, Hokkaido Electric Power Company (HEPCO) and Kansai Electric Power Company (KEPCO) imposed new rates for the third time in just three years. Following the first increase in September 2013, HEPCO raised rates by 12.43 percent in November 2014 which had been effective for five months until March 2015. Then in April, the rates were further raised by 15.33 percent. KEPCO which suffered from serious deficit more than other electric companies due to its heavy reliance on nuclear power, raised rates by 4.62 and 8.36 percent in June and October. After rate hikes for the third time in October 2015, KEPCO's standard rates for household became the highest among major utilities supplying electricity in the main island of Honshu.[159)]

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158) Ministry of Finance, "2015 Trade Statistics," March 10, 2016, accessed on March 6, 2018, http://www.customs.go.jp/toukei/shinbun/trade-st_e/2015/2015_117e.pdf

159) Agency for Natural Resources and Energy, "電気料金の水準,"November 18, 2015, accessed on March 29, 2018, http://www.meti.go.jp/committee/sougouenergy/denryoku_gas/kihonseisaku/pdf/002_04_02.pdf "Osaka utility cutting power prices for first time since Fukushima," Nikkei Asian Review, June 20, 2017, accessed on March 29, 2018, https://asia.nikkei.com/Business/Osaka-utility-cutting-power-prices-for-first-time-since-Fukushima

5. Energy Supply and Demand (2016) : More nuclear in operation

5.1 Energy Supply

A domestic supply of the primary energy dropped by 0.3 percent from the previous year.[160] While fossil fuel was supplied less for three consecutive years since 2014, a domestic supply of non-fossil fuel such as renewable energy increased for four consecutive years since 2013. Renewable energy has been on rise since 2005. Of non-fossil fuel energy sources, the share of renewable energy and nuclear power in primary energy supply increased by 0.6 and 0.4 percentage point respectively compared to 2015 which was largely due to development of renewable energy and restarting more nuclear reactors since 2015. The share of natural gas also rose by 0.8 percentage point. On the other hand, oil and coal decreased in its share in primary energy source by 1.2 and 0.5 percentage point.

There was a rise in total electricity produced in 2016 by 2.1 percent from the previous year. The share of renewable energy in power production was 15.3 percent which was an increase by 0.8 percentage point, and nuclear power rose from 0.9 percent in 2015 to 1.7 percent in 2016. Thermal power generation produced 83 percent of total electricity in 2016 which was a decrease of 1.6 percentage point from the previous year. Power generated by nuclear plants almost doubled since 2015 from 9.4 billion kW to 18.1 billion kW by 91.4 percent, the largest increase among nine energy sources followed by wind power (72.2 percent) and solar energy (46.4 percent). Although

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160) Agency for Natural Resources and Energy, "2016 Energy Supply and Demand Performance (平成28年度におけるエネルギ"[需給実績),"November 17, 2017, last modified on December 25, 2017, accessed on April 5, 2018, http://www.meti.go.jp/press/2017/11/20171117006/20171117006.html

natural gas and coal generated less power compared to the previous year by 1.5 and 0.7 percent, the share of those two fossil fuel energy sources accounted for over 70 percent in total electricity production in 2016.

Table 14. Impact of Fukushima in 2016 (compared to 2015)

Category	Increase/Decrease (rate of change)
Nuclear Domestic Supply	92% ↑
Trade Balance	243% ↑
Fossil Fuel Supply	1.3% ↓
Non-fossil Fuel Supply	9% ↑
- Nuclear share	0.4% ↑
- Renewable Share	0.6% ↑
Oil Dependence	3.2% ↓
Fossil Fuel Dependence	1% ↓
Energy Self-sufficiency	14% ↑
Total Carbon Dioxide Emission	0.2% ↓
Emission from Energy	0.5% ↓

Source: Agency for Natural Resources and Energy, Ministry of Finance and Ministry of the Environment

5.2 Energy Independence

Improvement in energy self-sufficiency was observed by 1 percentage point from the previous year at 7.4 percent to 8.4 percent in 2016. The figure

dropped significantly over 2 years in 2011 and 2012 due to the aftermath of the Fukushima incident, and it stayed between 6.2 and 6.3 percent for the following three years from 2012 to 2014. However Japan began to recover slowly since 2015, and more increase in self-sufficiency was witnessed in 2016. Improved energy self-sufficiency coincided with less dependence on imported fossil fuels. Dependence on both oil and fossil fuel energy rose by 2.5 and 4.2 percent in 2011, and then reached its peak in 2012 at 44.1 and 91.9 percent respectively. Since 2013, it gradually decreased for the fourth straight year to 39 and 88.8 percent in 2016.

5.3 Environmental Effect

The share of energy sources that produce no carbon dioxide accounted for 17 percent, an increase of 1.6 percentage point compared to 2015.[161] Although greenhouse gas emissions from the energy sector increased for four consecutive years since 2010, the figure began to drop since 2014 for three consecutive years. After carbon emissions reached its highest level in 12 years in 2013, it decreased from 2014 which continued to 2016.

Japan restarted one more reactor at Ikata Nuclear Power Plant in August 2016, totaling three reactors in operation by the end of 2016. In a situation where more reactors resumed and more electricity was supplied from renewable energy, total greenhouse gas emissions continued to drop in FY2016 with a decrease of 0.2 percent from the previous year. Compared to FY2013 in which emissions reached a record high in the past decade, the

161) Ministry of the Environment, "Japan's National Greenhouse Gas Emissions in Fiscal Year 2016 (2016 年度（平成 28年度）の温室効果ガス排出量（確定値）について)," December 11, 2017, accessed on January 28, 2018, https://www.env.go.jp/press/104900.html

figure in FY2016 decreased considerably by 6.2 percent. Improvements were made in energy-related sources as it had been in decline for three years since 2014. The largest decrease observed in the past three years was 3.7 percent in FY2014 in which no single nuclear reactor was online. After two reactors restarted in 2015, carbon dioxide emissions from the energy sector was down 3.4 percent, and again dropped by 0.5 percent in FY2016. A relatively low increase was mostly contributed by increased emissions from Energy Industries sector. It produced 7 percent more greenhouse gases compared to FY2015 along with the Industries sector from which emissions rose by 1.6 percent. At the same time, other three sectors namely Transport, Commercial and Residential showed decreases from the previous year, particularly the Commercial sector which recorded the largest drop of 5.2 percent among them in FY2016 which was at the same time the second biggest drop following 6.2 percent back in FY2014. Such decrease was largely due to less electricity consumption in those sectors.

5.4 Energy Imports

In 2016, Japan recorded the first surplus in six years since 2011. A total trade surplus was 4 trillion yen which was a significant increase from a deficit of 2.8 trillion yen in 2015 and 12.8 trillion yen in 2014. Both export and import values dropped but a decrease was larger in imports value than exports. Accordingly, the share of mineral fuels in imports of principal commodity was down 33.8 percent from 2015, the sharpest decline among nine commodity categories. Despite of a decrease, it still accounted for the largest share in total imports of commodity. Of seven import fossil fuels under the category of mineral fuels, the biggest drop in import value was

witnessed in petroleum products by 41 percent followed by LNG by 40.5 percent. A recovery of trade balance was contributed by declining energy prices which resulted in less spending on fuel imports. Along with cheaper oil, a number of factors such as a significant increase in the number of foreign tourists to Japan which led to a record travel surplus and substantial foreign income from Japan's direct and portfolio investments overseas also played an important role in leading Japan to trade surplus.[162)]

5.5 Electricity Rates

As part of Japan's electricity system reform of which Phase 1 began in 2015, full deregulation of electricity retail market was launched and moved into Phase 2 in April 2016. The market has turned into an expanded retail competition, and ten major utilities which monopolized electricity supply in their regions came to compete with new entrants to the market. In response to the expected intense competition, Kansai Electric Company planned to reduce electricity rates after bringing back the Takahama reactors online in early 2016. Takahama No.3 reactor restarted operation in January and No.4 reactor was supposed to be delayed "for about a month" due to technical problems. However as the Otsu District Court issued an injunction to stop operations of both No.3 and 4 reactors, the utility had to abandon their strategy which was initially designed to enhance its competitiveness by cutting electricity rates in a liberalized market.[163)]

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162) Ministry of Finance, "2016 Trade Statistics," March 13, 2017, accessed on April 6, 2018, http://www.customs.go.jp/toukei/shinbun/trade-st_e/2016/2016_117e.pdf Tetsushi Kajimoto, "Japan logs biggest current account surplus since 2007," Reuters, February 8, 2017, accessed on April 7, 2018, https://www.reuters.com/article/us-japan-economy-current/japan-logs-biggest-current-account-surplus-since-2007-idUSKBN15N0E1

Ⅴ. Conclusion

Since its declaration of the peaceful uses of nuclear energy with the enactment of the Atomic Energy Basic Law back in 1955, Japan achieved remarkable development in nuclear technology. Nuclear power was considered as the most promising source of energy that could address two major challenges: enhancing national energy security and reducing carbon dioxide emissions. As Japan had a firm belief that this particular energy source can produce inexpensive electricity safely and efficiently, nuclear power was given the top priority in national energy strategy and was promoted aggressively with a target of reaching 50 percent of share in total power generation by 2030. Eventually people began to use the term "nuclear renaissance" to describe the flourishing nuclear industry in the early 2000s.[164] According to its energy plan, nuclear power was supposed to provide Japan with affordable electricity and ensure a stable supply of energy for next generations. However Japan's advanced nuclear technology created overconfidence in safety regulations which prevailed the nuclear industry for a long time. It was none other than the arrogance and ignorance of the nuclear safety regulatory body under the Japanese government and utility companies that triggered the disastrous accident at the Fukushima Daiichi in March 2011.

The Fukushima accident revealed serious institutional flaws within the nuclear industry which had been abused by a powerful pro-nuclear group, the

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163) "Takahama reactor injunction torpedoes Kansai Electric's business strategy," The Mainichi, March 10, 2016, accessed on April 6, 2018, https://mainichi.jp/english/articles/20160310/p2a/00m/0na/007000c

164) Cutler J. Cleveland and Christopher G. Morris, "Handbook of energy: chronologies, top ten lists, and word clouds," 2013

so-called Nuclear Village, for the sake of its own interests. The Nuclear Village exercised its strong influence over Japan's nuclear energy policies by forming an alliance comprised of utility companies, bureaucrats, academia, media and financial sector.[165] The structural problem of the safety regulatory organization was also heavily criticized as NISA failed to fulfill its responsibility to regularly and thoroughly check the safety of nuclear plants due to a lack of independence. Being overseen by METI which promotes nuclear power, independence of NISA was severely damaged which led to willful negligence in safety regulations.[166] Since fundamental causes of the Fukushima accident were found in the nuclear regulatory regime involving government bodies and a private utility sector, Japan's energy reform which had been in a slow progress due to strong resistance from electric companies since 1990s was accelerated in pursuit of greater benefits and safety for the Japanese public.

While the Fukushima accident contributed to materializing reforms to reshape the Japanese power industry, it also served as a significant turning point in the structure of energy mix and energy policies. After the closure of all nuclear reactors soon after the accident, Japan which had been relying on the nuclear power for 30 percent of its total electricity generation came to face an immediate need to replace nuclear power. During the summer months in 2011, Japan had to keep its electricity supply stable with less than a third of

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165) Jeff Kingston, "Japan's Nuclear Village," The Asia Pacific Journal, September 9, 2012, accessed on April 16, 2018, https://apjjf.org/2012/10/37/Jeff-Kingston/3822/article.html

166) Justin McCurry, "Japanese cultural traits 'at heart of Fukushima disaster'," The Guardian, July 5, 2012, accessed on April 13, 2013, https://www.theguardian.com/world/2012/jul/05/japanese-cultural-traits-fukushima-disaster

nuclear reactors in operation, and only two out of 54 reactors generated power in the following year in 2012. To avoid power shortages, the government significantly increased capacity utilization of thermal power plants which led to a sharp increase in imports of fossil fuels. Due to a substantial outflow of national wealth and a rise in prices of primary energy sources, Japan recorded the first trade deficit in more than three decades in 2011.[167] The deficit continued for four years which made a fifth straight year of negative figures. As the Japanese economy was hit hard by a heavy burden of increased imports of fuels, it did not come as a surprise when Prime Minister Abe who placed the top priority on economic growth shifted a direction of Japan's future energy policies set by his anti-nuclear predecessors after taking the office. From the first day of inauguration, Abe clearly expressed his initiative to restart nuclear reactors which satisfy rigorous safety regulations developed by the newly established safety regulatory body. After two years of zero nuclear generation between 2013 and 2015, Japan began to restart nuclear reactors in 2015, declaring an official return to nuclear power. However contrary to Abe's bold statements about bringing back nuclear energy into Japan's energy mix, the process of restarting nuclear reactors is making rather slow progress since only five reactors resumed operation as of March 2018. In other words, less than one tenth of the total nuclear reactors in Japan were brought back online under the Abe cabinet in a five year period.

As scholars voiced concerns over ambitious and yet what was described as 'unrealistic' energy policies of the previous administrations which pursued a

167) Ken Koyama, "Japan's Post-Fukushima Energy Policy Challenges," Asian Economic Policy Review, 2013; Matsuo and Yamaguchi (2013)

nuclear phase-out, Abe also did not believe in Japan without nuclear power. Instead, he had a firm belief in nuclear power as a critical energy source that could ease burden in trade and save Japan from further economic collapse.

Japan definitely failed to make a perfect energy shift away from nuclear power as pro-nuclear Abe and his party came to power. However it does not necessarily mean that Japan is going back to the pre-Fukushima status quo. Rather, the restart of nuclear power plants is considered as a temporary remedy to revitalize the economy through improvement in trade balance. Although Abe might want to make a push for more nuclear share in total electricity production in pursuit of a strong economy, it does not seem to be realized any time soon as the majority of the Japanese public completely turned their back on nuclear power which was reaffirmed from the survey in 2017.[168] It indicates that the Japanese government would continue to face strong resilience and anti-nuclear sentiments from the public. An internal tug-of-war between the government and the public each placing greater value on the economic growth and safe energy source respectively will continue for some time in the future. Because of that, the role of nuclear power will be limited to a tool to relieve its trade deficit and stabilize electricity supply. Memories and experiences from the Fukushima accident which left Japan with a terrible shock on what used to be their proud technology will not allow the nuclear energy regime in the post-Fukushima Japan to return to the

168) "55% oppose restarting nuclear reactors, 26% in favor: Mainichi survey," The Mainichi,March 13, 2017, accessed on April 18, 2018, https://mainichi.jp/english/articles/20170313/p2a/00m/0na/006000c

previous era. It will take on a new aspect with a new energy mix in pursuit of enhanced energy security of Japan.

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Abstract (Korean)

후쿠시마 이후 일본의 원자력 발전 경향 및 에너지믹스 분석

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본 논문은 후쿠시마 사태 이후인 2011 년부터 2016 년까지의 일본 에너지믹스와 일본 정부가 발표한 국가 에너지 정책의 변화를 분석한다. 후쿠시마 사고는 국가 전체에 큰 충격으로 다가왔고, 이에 따라 일본 정부는 원전의존사회에서 탈원전사회 로의 급진적인 전환을 결정하게 된다. 그러나 머지않아 원자력 공백으로 인한 전력 부족이라는 큰 대가를 마주하게 되었고, 급격한 연료 수입 증가로 인해 무역 적자가 악화되었다. 후쿠시마 사태 이후 수년간 무역적자가 최대치를 기록함에 따라 아베 총리는 경제 활성화를 위해 원자력이라는 패를 들었다. 원전을 재가동한 2015 년부터 일본의 무역 실적이 향상됨에 따라 저렴하고 안정적인 전력 공급을 위해 현재로서는 원자력이 필수라는 것을 증명하고 있다. 하지만 국민들의 거센 반대로 인해 원전 재가동 계획은 다소 느리게 진행되고 있다.

후쿠시마 원전 사태의 기억이 남아있는 한, 일본 사회의 반원전 정서는 계속될 것이다. 일본 정부는 앞으로도 원자력 이용을 최소로 유지하고, 동시에 에너지 안보를 강화하여 전력 수요에 대응해야 하는 장기적 과제에 부딪힐 것이다.

키워드: 일본, 후쿠시마, 원자력, 에너지믹스, 원자력에너지정책, 전력시장개혁, 에너지전환