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DECISION-MAKING FACTORS TO ABOLISH OR MAINTAIN NUCLEAR ENERGY

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International Relations and European-Asian Studies

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ABSTRACT

Nuclear energy is a way to generate electric power that does not rely on fossil fuels. Because electricity consumption in most countries has been increasing and will be increasing, 31 countries now depend on nuclear power, and 4 countries have been trying to develop nuclear power plants while other 3 countries have given up nuclear energy. Although all countries need energy, each country has a different energy policy. This research elucidates the decision-making factors that impact on a country's nuclear energy policy.

This research selects three countries as case study research: Japan, Germany, and the United States of America (US). Even after the Fukushima nuclear plant accident, Japan still maintained the policy of nuclear energy while Germany decided to abandon all nuclear power plants. The policy of US is stable to maintain commercial use of nuclear energy. So, this research reveals what respective factors and institutions affect decision-making in the respective countries.

The research concludes that pro-nuclear actors in Japan have an unique and exclusive policy framework to maintain Japan's political stability, that Germany's geopolitical situation can let Germany abolish nuclear energy and let Germany depend on renewable energy, and that US still needs to maintain the world order of non-proliferation of nuclear weapons by its civilian nuclear energy. The reasons of the difference between the three cases are affected by their geopolitical situation and electoral systems.

Keywords: decision-making process, nuclear energy, Fukushima Daiichi Accident, case study

INTRODUCTION

In 2011, the Fukushima Daiichi Accident in Japan showed the undesirable aspect of nuclear energy. The level of the disaster was rated as 7 on the International Nuclear and Radiological Event Scale (INES), which was the same as the Chernobyl Accident, so many countries in the world re-considered whether they should abolish or maintain their nuclear energy policy. Germany has decided to abolish all nuclear power plants by 2022 while Japan, according to the 5th Strategic Energy Plan, decided to maintain a nuclear energy policy. Meanwhile, the United States of America (US) also had a major accident in 1979 and now is more than self-sufficient in energy resources because of the Shale Oil Revolution, but it does not seem to decide to limit or abolish civilian use of nuclear energy. It is not easy to explain Germany's decision to abolish its nuclear plants because it did not directly suffer from the Fukushima accident. It is difficult to explain Japan's decision to maintain its nuclear energy policy although it directly suffered terrible damage from the Fukushima accident. The decisions of both countries seem to be the reverse. Furthermore, although the US also had a major nuclear accident, its decision to maintain civilian nuclear energy seems to be stable. Theses puzzling decisions motivate this research. The first research question of this paper is which factors affects decision-making more in the respective countries, and the second question is why the decisions of the three countries are different.

Causing factors this research uses are national security factors, energy security factors, economic factors, and environmental factors because these factors are expected to relate to decision-making of nuclear energy in respective countries. In addition, institutions are also argued to play a role because political decision is made by mixed interests of various institutions. This research employs the case study method. As case study method, this study selects Japan, Germany, and the United States of America. Then, the three cases are compared in order to explain the difference of the three countries.

This paper consists of five chapters. The first chapter has a literature review and sets out the methodology of this research. The reasons of the different decisions of the three countries are related to their different interests and institutions of each country. To understand the difference,

case study method is introduced so that the different political situations are compared. The second chapter is about three countries' decisions as dependent variables. Before talking about the factors for those decision-making processes, this chapter describes the decisions of the three countries. Chapter three, four and five discuss how each factor influences the decision-making in Japan, Germany, and US whether to abolish or maintain nuclear energy.

1. RESEARCH FRAMEWORK

To answer the first research question that was proposed in the introduction, this study analyses cases of three countries: Japan, Germany, and the United States of America (US). Respective cases are argued in Chapter 3, 4, and 5. In each case, four factors and institutional influence are discussed to understand which factor affects the decision-making of respective countries. The reason that this research selects four factors and institutional influence is mentioned in the sub-chapter 1.1. Literature review part and 1.2. Research approach part. After arguing the three cases, the second research question is discussed (Table 1).

Table 1. Framework of This Research

Cases	Japan (Chapter 3)	Germany (Chapter 4)	US (Chapter 5)
Decision (Effect)	Maintain Nuclear Energy	Abolish Nuclear Energy	Maintain Nuclear Energy
Cause & Effect	↑	↑	↑
Factors (Cause)	National Security influences?	National Security influences?	National Security influences?
	Energy Security influences?	Energy Security influences?	Energy Security influences?
	Economic influences?	Economic influences?	Economic influences?
	Environment influences?	Environment influences?	Environment influences?
	How do institutions influence?	How do institutions influence?	How do institutions influence?
Research Question	Q1: Which factor affects more?	Q1: Which factor affects more?	Q1: Which factor affects more?
	Q2: Why the decisions of the three are different?		

1.1. Literature review

To select factors that influence decision-makers, characteristics of nuclear energy need to be clear. Basu & Miroshnik (2019) mention some aspects of nuclear energy: geopolitical aspect, economic advantage, and environmental advantage. In the geopolitical aspect of nuclear energy, the authors mention that possessing nuclear energy forms national nuclear geopolitics and that the possibility

of nuclear weapons is viewed by politicians as a "political weapon" that can significantly influence the geopolitics of the surrounding states. When talking about geopolitical aspect of nuclear energy, the authors call some countries "threshold" countries. The "threshold" countries are on the verge of creating nuclear weapons, and threshold countries that can create their nuclear charges are Argentina, Brazil, South Korea, Japan and more than ten other countries (Basu & Miroshnik 2019, 28). One of the interests that decision makers of public policy aim is to protect a country, so in this research, this aim is regarded as a national security issue that includes the idea of geopolitics. Basu & Miroshnik also point economic aspect of nuclear energy that has the supply of massive amount of energy at a low cost. Especially, they mention that nuclear power has low operating costs and fuel costs. Comparing to coal or oil, nuclear power needs little energy sources as the result of the small amount of nuclear fuel used, and it needs the low cost of transportation because of the low volumes; for example, enriching 1 kg of uranium emits energy equivalent to burning about 100 tons of high-quality hard coal or 60 tons of oil (Basu & Miroshnik 2019, 18). The authors also describe the good and bad environmental aspect of nuclear energy. Nuclear energy does not contribute to the greenhouse effect. However, nuclear energy has environmental demerits, such as the risk of accident and radioactive waste. The authors insist that the main environmental hazard of nuclear power plants is attributed to the possibility of accidents, and it is impossible to eliminate the possibility although the probability of such accidents at modern nuclear power plants is low. When we talk about nuclear energy, energy security is also important factor for sustainable economic growth. Cherp, Vinichenko, Jewell, Suzuki and Antal (2017) compare electricity resources in Germany and Japan, especially by the point of energy security. They show how states' quest for secure supply-demand balance shaped both countries' strategies in the 1970s and the 1980s and affected their different commitment to nuclear power in the 1990s.

The reason that this study introduces factors is that the factors show the different priority of the three countries and the different decision-making process. Müller & Thurner (2017) emphasizes that factors drive actors into political decision on nuclear energy and that factors are the reasons to have the decisions of upheld or reversed. Moreover, investigating factors on nuclear energy issue highlights the different political system.

Besides of the four factors, this research also needs to analyse institutions that relate to decision-making process of the factors so that this research demonstrates the reason of the three countries' decisions. Aoki and Rothwell (2012) introduce a comparative institutional analysis and argue the

Japan's institutional framework that is one of causing factors relating to decision-making process in Japan. Kraft and Furlong (2018) also mention that institutional theory emphasizes the formal and legal aspect of government structure. The definition of "institution" includes both organizations and rules of the organizations. The authors say, "… in addition to a focus on organizations such as legislatures, courts, or bureaucracies, the term encompasses how people within organizations relate to one another and to those in other organizations --- that is, the rules that govern their behaviour." Therefore, in order to know which factor relates to a decision of public policy, the role of institutions is also considered.

1.2. Research approach

This research analyses three countries, Japan, Germany, and US. In this research, cause or independent variable is a factor or factors and effect or dependent variable is the decision on public policy of nuclear energy, and the aim of this study is to reveal which independent variable affects the decision-making in respective cases. So, before starting the argument, Chapter 2 describes the decisions of three countries as the dependent variables of this research in more detail. They are as follows: Japan's decision to maintain nuclear energy even after the Fukushima Daiichi accident, Germany's decision to phase-out nuclear energy after the Fukushima accident, and US's stable decision to maintain nuclear energy even after the Three Mile Island accident and other major nuclear accidents in the world.

Then, in each case, four factors, that are selected by the articles summarised in the literature review, are used. Basically, having various energy resources improves energy security, so maintaining nuclear energy is regarded as the better political choice to increase energy security. The reason to select national security factor is that, as Basu and Miroshnik say, having nuclear energy can be regarded as political weapons, and that some Japanese media, especially conservative media like Sankei Shimbun and Seiron, describes the national security merit of nuclear energy. In fact, the relationship between civilian nuclear energy and military nuclear weapons is sometimes argued, so the national security must be related to decision-making. Economic factor is also discussed by both pro-nuclear and anti-nuclear policy actors. Some say that nuclear energy is better for a country's economy while others say it is not. Nuclear energy is regarded as non-green house gas emitting energy and eco-friendly energy source, but at the same time, nuclear energy is regarded as a threat to the environment because of its radioactive wastes and the risks of accidents.

Public policy, such as abolition of nuclear energy, is decided by inter-relation of various institutions, such as ministers, parliament members, interest groups, electricity power companies, citizens, media, and so on. Thus, after investigating each factor of decision-making processes, interests of institutions need to be argued so that the difference of the three cases is cleared to answer the research question 2. Most important institutions in decision-making are congress, bureaucracy, and interest group; the relations of the three is sometimes called “iron triangle”. Because the policy of nuclear energy is a national issue, this research starts investigating formal institutions that are the organizations of the government that create, enforce, and apply laws, and they often mediate conflict, make governmental policy on the economy and social systems, and otherwise provide representation for the population (Boddy-Evans 2020). Informal policy actors, such as interest groups and citizens, also play an important role in decision-making process. Public opinion has to be considered as a major actor in decision-making process in democracies. Public opinion influences what elected officials try to do, especially on issues that are highly salient, or of great importance to voters, or on those that elicit strong opinions (Kraft & Furlong 2018, 62). In this research, the results of poll data are considered so that the role of public opinion or citizens is explained. Interest groups also influence public policy by their lobbying and spending money. Most groups are involved in direct lobbying of policymakers, indirect or grassroots lobbying aimed at mobilizing the public or the group’s supporters, and public education campaigns (Kraft & Furlong 2018, 65). In the public policy of nuclear energy, interest groups of nuclear industry need to be analysed because their activity affects not only politicians and political parties but also ordinary citizens.

The materials this research uses are official documents of governments, scholarly articles and books, and data and reports of other institutions. Official documents or reports of governments are primary research materials because they show official reasons for the decisions of a country. However, the information of official documents are not the only reasons for the decision. This research also uses various kinds of secondary sources from related institutions and researches to understand the backgrounds of decision-making process about nuclear energy in respective countries. Thus, unofficial documents and articles are also used.

2. DEPENDENT VARIABLE: DECISIONS OF THE THREE COUNTRIES

2.1. Japan's decision to maintain nuclear energy

A huge earthquake hit the north-eastern region of Japan on 11 March 2011, and a tsunami generated by the earthquake hit and broke the Fukushima Daiichi Nuclear Power Plant. Although the accident did not directly kill any person, the disaster emitted huge amount of radioactivity into the surrounding water, air, and soil. After the accident, about 140,000 people needed to be evacuated from the region. This incident had Japan re-consider its nuclear energy policy. The level of the disaster was 7, the worst accident on the International Nuclear and Radiological Event Scale (INES). Just after the accident, many citizens and media started insisting on abolishing nuclear energy. The Government of Japan immediately decided the suspension of all nuclear power plants. However, the disaster did not change the direction of Japan's nuclear policy, and Japan did not decide to abolish nuclear power plants. In July 2013, two years after the Fukushima accident, the New Regulatory Requirements for Commercial Nuclear Power Reactors, written by the Nuclear Regulation Authority (NEA), were introduced to apply more rigid requirement to nuclear power plants. This means that Japan maintains nuclear power plants after taking the test of the new standard. In August 2015, the Sendai Nuclear Power Plant, operated by Kyushu Electric Power, restarted nuclear power generation after passing the test of the New Regulatory Requirements. Restarting nuclear power plants is the decision of the government. In fact, Prime Minister Abe, who was inaugurated in 2012, had lobbied for a restart of nuclear power plants because the shutdown had hurt the economy, forcing Japan to import expensive fossil fuels to make up the power shortfall (BBC 2014).

In 2014, three years after the accident, the Cabinet of Japan announced the 4th Strategic Energy Plan that insisted on the importance of nuclear energy for Japan. The plan points to Japan's vulnerable supply-demand structure and insists on a bold reform. The plan described the four points: 'Safety' as the premise, 'Energy Security', 'Economic Efficiency', and 'Environment'. This is Japan's current energy policy called "3E+S" (Agency for Natural Resources and Energy

2014, 17). The plan says that the Government and nuclear power industry must learn from the Fukushima accident and must shed the so-called "safety myth" that severe accidents cannot happen in Japan (Agency for Natural Resources and Energy 2014, 49). In 2018, the Cabinet of Japan announced the 5th Strategic Energy Plan. Again, the plan emphasizes safety, energy security, environment, and economic efficiency (3E+S). To achieve the goal of 3E+S, the plan describes that nuclear power is needed because it is regarded as "base-load power source" that can be operated stably and by low cost regardless of day and night. The plan explains three perspective: superiority in stability of energy supply and efficiency, low and stable operational cost, and free from Green House Gases emissions during operation. In sum, the plan explains that the reasons for maintaining nuclear energy are related to energy security, economic aspect, and environmental aspect. Although the plan argued for the importance of safety, it did not have any words related to the possibility for abolishment of nuclear energy. It explains that Japan will give the highest priority to safety and will lower reliance on nuclear power as much as possible while attempting to expand economically self-sustaining and decarbonized renewable energy.

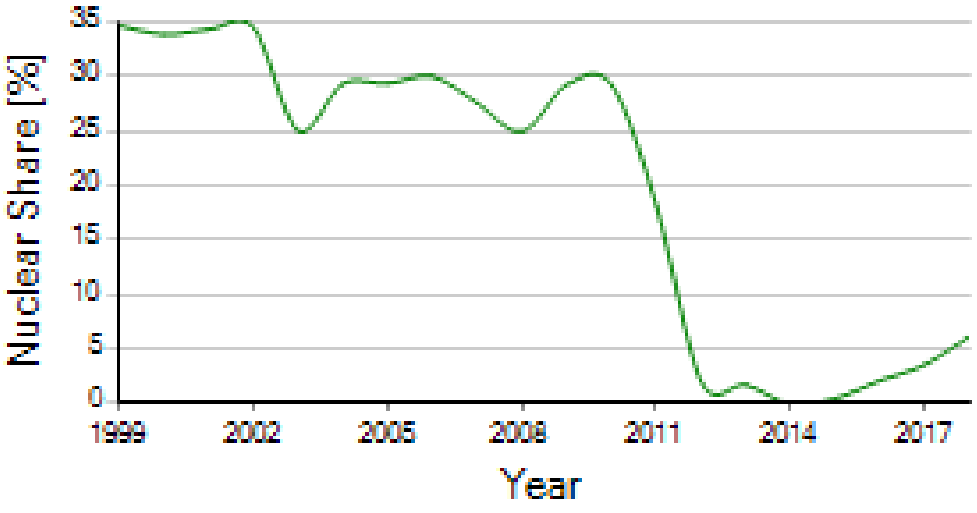

Figure 1. Japan's Change of Nuclear Share of Electricity Production
Source: IAEA

After the suspension of all nuclear power plants, some nuclear plants had been evaluated by the test of the New Safety Regulation. While some nuclear plants have not passed the test yet and it was decided to decommission fifteen plants, nine nuclear reactors have been restarted by 2020 (Japan Nuclear Safety Institute). Consequently, the nuclear share of electricity production after 2014 has been gradually increasing (Figure 1). The government now does not show its intent to build other new nuclear power plants because many citizens now suspect the safety of the plants

and dislike the decision to maintain nuclear power, but according to its Strategic Energy Plan, the current coalition government probably has the intention of building new nuclear power plants in the near future.

2.2. Germany's decision to abolish nuclear energy

In Germany, nuclear energy has always been a controversial issue not only for the government, but also for the citizens. Although the former coalition government, formed in 1998 between the Center-left Social Democrats (SPD) and the Green Party, decided in 2000 to decommission nuclear plants by 2021, Chancellor Angela Merkel's coalition government decided in September 2010 to extend the operation years of nuclear power plants. At this time, the government believed that Germany needed nuclear energy although the government promoted renewable energy at the same time. On 30 March 2011, nineteen days after the Fukushima Accident, Germany announced that it would shut down all nuclear power plants by 2022. The feasibility of her pledge is criticised by some people who say it was too ambitious to switch to renewable energy and phase out nuclear power at the same time because renewables are unable to make up the shortfall and Germany has been forced to turn to coal (Huggler 2019). They insist that the phase-out plans should be postponed in order to protect the environment. Although some scholars and media criticize the decision of the government, the government does not have any intention to change the decommission plan.

2.3. US's decision to maintain nuclear energy

US's policy to maintain civilian nuclear power has been adamant. Although the Three Mile Island Accident in 1979 changed the federal requirements for safety controls and emergency response planning to be more stringent (History.com Editors 2020), and although the change was one of the reasons to prevent nuclear industry from building new nuclear plants, US's decision was not abolition or a decrease in the reliance on nuclear energy. Just after the accident, the US government temporally suspended seven nuclear reactors, that were of the same type as the Three Mile reactor, but US soon restarted the policy of nuclear energy. In fact, the nuclear share of electricity generation started increasing in 1981 (Figure 2).

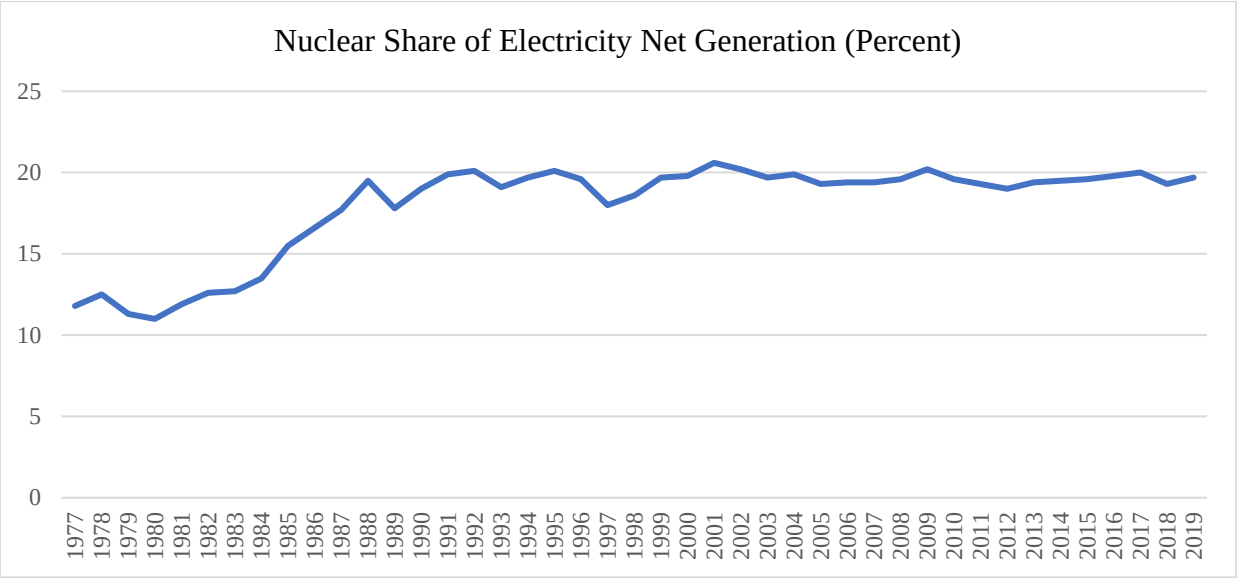

Figure 2. Nuclear Share of Electricity Generation
Source: U.S. Energy Information Administration (2020)

The Chernobyl Accident in 1986, that occurred in the former Soviet Union, influenced American public opinion, but it did not change the US's policy of commercial nuclear energy because the type of the nuclear reactor in Chernobyl was different from the type of American nuclear reactors. The reactor built at Chernobyl was a RBMK reactor, which was never built by any country outside the Soviet Union, and RBMK reactors used graphite for reducing its power while American nuclear reactors used water for it (Nuclear Energy Institute 2019). The Fukushima Daiichi Accident in 2011 had different meaning for US from the Chernobyl Accident because twenty-three nuclear plants in US used the Mark I containment that was the same base design as the Fukushima Daiichi Unit 1 design (Nuclear Energy Institute 2011, 3). After the Fukushima, US nuclear regulations were under review, as indicated by the Nuclear Regulatory Commission (NRC) (Spencer 2011). However, the US nuclear policy itself did not change although US government learned lessons from the Fukushima accident.

3. JAPAN: CAUSES FOR MAINTAINING NUCLEAR ENERGY

The first case study of this research is Japan. The Fukushima accident had a huge impact on Japanese citizens and the government of Japan, but Japan's decision has been the continuation of nuclear energy. This chapter examines how each factor influenced Japan's decision-making to maintain nuclear energy and how various institutions affect the decision-making.

3.1. Factors

The relevant actors in Japan are the prime minister; the Ministry of Economy, Trade and Industry (METI); the Liberal Democratic Party (LDP); the Democratic Party of Japan (DPJ); electric companies; local authorities that have nuclear plants; mass media; and citizens. In Japan, decision-making process is ambiguous and unclear because government's leadership is not strong; for example, characteristics of Japanese politics are the lack of the authority of the prime minister who is not directly elected by citizens, politicians' loyalty for their sect (Habatsu) inside a political party, and the politician who works for special interests or industries (Zoku-Giin). Thus, in each factor, these actors are considered.

3.1.1. Energy security policy factor

Japan does not have enough energy resources, so it needs to depend on importing from foreign countries. According to the Agency for Natural Resources and Energy (ANRE), self-sufficiency ratio of energy has been decreasing from 58.1% in 1960 to 9.5% in 2017 (Table 2) (ANRE 2019).

Table 2. The Change of Self-Sufficiency Ratio of Energy

Year	1960	1970	1980	1990	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
Self-sufficiency Ratio（%）	58.1	15.3	12.6	17.0	20.2	19.6	20.2	11.5	6.7	6.5	6.4	7.4	8.3	9.5

Source: Agency for Natural Resources and Energy (2019)

This is the difficult reality for Japan to maintain stability of energy supply. In 2017, Japan imported 90.5% of its energy resources, especially from Middle Eastern countries. About 39% of the

Japanese energy resource was imported petroleum, and the percentages of petroleum exporting countries of the Middle East to Japan were as follows: Saudi Arabia 38.6%, the United Arab Emirates (UAE) 25.4%, Qatar 7.9%, Kuwait 7.7%, Iran 4.3%, Iraq 1.8%, and Oman 1.7% (ANRE 2018). Thus, Japan imports 87.4% of crude oil from the Middle East. Meanwhile, about 23% of the Japanese energy resource was imported natural gas (LNG), and the percentage of LNG exporting countries of the Middle East to Japan were as follows: Qatar 12.0%, UAE 6.0%, and Oman 3.7% (ANRE 2018). Thus, Japan imports 21.7% of LNG from the Middle East. In sum, Japan imports 39% of its energy resource from the Middle East.

ANRE describes the current situation that, "Lower self-sufficiency ratio means that Japan has to depend on foreign countries for resources, that importing resources are more influenced by international affairs, and that energy supply is unstable." In fact, if something harms the importing from the Middle East, Japan might be losing 39% of its energy resources. The risk of importing from the Middle East concerns not only the region itself, but also the route of the importing. The route passes through the South China Sea where China nowadays tries to control. This is one of the main reasons that the pro-nuclear energy actors, especially ruling party LDP, encourage nuclear energy that its energy resource uranium is imported from lower political risk and various regional countries (Figure 3).

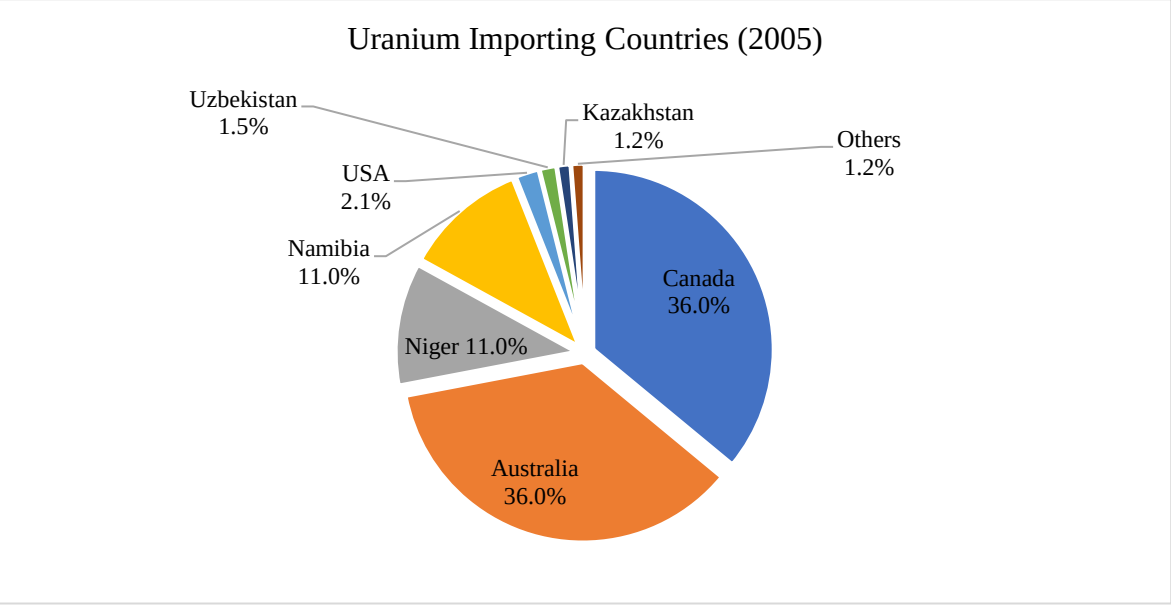

Figure 3. Uranium Exporting Countries to Japan
Source: Japan Energy Conference (2015)

The government and most of the business organizations believe that Japan must maintain nuclear energy for stable energy supply while many Japanese citizens believe that Japan can maintain enough energy supply with lowering or decommissioning nuclear power plants and with raising renewable energy (Table 3).

Table 3. Public Opinion Poll about Nuclear Plants and Energy (March 2013)

	Which energy source should be increased more from now?	
1	Oil	1.6%
2	Coal	0.7%
3	Natural Gas	11.0%
4	Hydroelectric	6.3%
5	Nuclear Power	6.3%
6	Renewable Energy such as Solar and Wind Power	67.0%
7	Others	2.2%
8	Don't Know or N/A	4.8%

Source: NHK (2013)

Even the Democratic Party of Japan (DPJ), the opposition party of LDP, had promoted nuclear energy during the term from getting ruling party in 2009 to the Fukushima accident in 2011 although many politicians of DPJ now insists that Japan should abolish nuclear energy. The Democratic Party of Japan Policy Archive, a summery of the DPJ's agreements, that was written two months before the 2009's DPJ victory in the election, describes DPJ's energy policy that the party will stably manage the use of nuclear energy by obtaining citizens understanding and reliability (2009). Even the party advanced exporting nuclear technologies to foreign countries. Some politicians of DPJ are now members of liberal Constitutional Democratic Party and insist phase-out of nuclear energy, others still insist maintaining nuclear energy. Although politicians always care about their popularity and the next election, politicians of a ruling party need to care about the stability of energy resources. In fact, the prime minister and most of other politicians of ruling parties agree with nuclear energy.

3.1.2. National security policy factor

Basu & Miroshnik (2019) mention geopolitical aspect of nuclear energy, and they talk about "threshold" countries. This research uses "nuclear latency" countries instead of "threshold"

countries because nuclear latency is a more common term. Nuclear latency, not having nuclear weapons but having possibility for developing it in a short time period, is one of the reasons to have nuclear energy in Japan. In other words, the possibility to have nuclear weapons is considered as a national security issue. Japan is the most famous nuclear latency country. The idea is that some Japanese politicians want to keep capacity for developing nuclear weapons in case Japan loses US's nuclear umbrella. Politicians of LDP tend not to talk about nuclear latency although they understand the importance of nuclear energy as a national security issue because the talk about it must be unpopular and must be criticized by media and many citizens. Prime Minister Abe does not clearly talk about nuclear latency, but Shigeru Ishibashi, a competitor of the current prime minister Abe, sometimes talks his idea about nuclear latency. Ishiba says, "Maintaining nuclear power plants means that maintain nuclear latency although I do not think Japan should develop nuclear weapons." (NEWS Post Seven 2011). This is not his unique idea, but many politicians of LDP have had for more than fifty years. The LDP's senior Takeo Fukuda, then Minister of Finance in 1970, also honestly said, "Although Japan now follows a policy of not possessing nuclear weapons, it will be able to do so without undergoing hardships within a few years. I think that Japan should not have nuclear weapons but should maintain a capability to do so anytime" (Mainichi Shimbunsha as cited in Kurosaki 2017, 57).

Some politicians care about unstable geopolitical situation of Japan where is in the East Asia. Japan's large neighbour country China announced in 1964 that it had successfully carried out first nuclear test. Another neighbour North Korea also announced in 2006 that it had carried out an underground nuclear test. These threats let conservatives insist on the importance of nuclear energy as a source of nuclear latency.

The Cabinet Intelligence and Research Office (CIRO) or Naikaku Joho Chosa Shitsu, a Japanese intelligence agency, is unique institution which researches various political issues and reports its results to the prime minister. In 1968, CIRO's wrote a report which describes two key civilian nuclear technologies for plutonium production: nuclear reactors and spent fuel reprocessing (Kurosaki 2017, 53). Thus, getting plutonium from nuclear power plants means that Japan maintains the ability for developing nuclear weapons.

Although Japan has US as an alliance with the strongest military power in the world, and Japan and other countries believe that it is protected by the US's nuclear umbrella, some opinion leaders insist on the need of nuclear latency. For example, Kunihiko Takeda, a professor of Chubu

university wrote, “Other countries have been watching Japan, a country that has advanced technology and strong military power, that it will have nuclear missiles …” (Takeda 2015). The important thing here is not whether having nuclear weapons is possible or not, but the fact that some scholars believe the effect of nuclear latency and insist the preservation of nuclear power plants.

3.1.3. Economic factor

The question whether nuclear energy is cost effective or not is always controversial, but it is widely said that nuclear energy is cheaper in Japan in its running cost but is expensive in its initial capital cost. The Levelized Cost of Electricity (LCOE) is used to calculate nuclear power plant’s lifelong costs. LCOE is calculated by the total cost of building and operating divided by the total electricity output (LOCE = $\frac{\text{Total Cost of Building \& Operating}}{\text{Total Electricity Output (kWh)}}$).

Table 4. Normalized LCOEs for natural gas, coal, and nuclear in different countries

	Natural Gas		Coal		Nuclear
	LCOE	LCOE with Carbon Cost	LCOE	LCOE with Carbon Cost	LWR
US	0.67	0.85	0.88	1.21	1.0
South Korea	1.54 - 2.69	1.78 - 2.93	1.40	1.99	1.0
Japan	0.92 - 1.46	1.05 - 1.58	0.94	1.23	1.0
China	0.74 - 1.72	0.97 - 1.95	1.03	1.63	1.0
France	0.58 - 1.05	0.71 - 1.18	-	-	1.0

Source: MIT Energy Initiative (2018)

The MIT Energy Initiative calculated LCOE of five countries (Table 4). The MIT’s calculation; that calculated three resources of natural gas, coal, and nuclear but excluded oil; is little different from an ordinary LOCE calculation. In the MIT’s calculation, absolute cost values were normalized to a value of 1.0 for light water reactor (LWR) of nuclear power generation in respective countries, so all the numbers in the Nuclear columns are 1.0. If the normalized value is less than 1.0, nuclear is less competitive; and if it is greater than 1.0, nuclear is more competitive. Normalized values cannot be compared across countries (MIT Energy Initiative 2018, 36). Because of its normalization, we can compare costs of energy in each country but can not compare countries directly.

Carbon constraint or carbon cost means a cost that is imposed on energy related companies to decrease the amount of carbon emission. If the cost of carbon constraint is added to LCOE of fossil fuels, their LCOE will increase. The study of MIT Energy Initiative shows that nuclear energy in Japan is basically little cheaper than natural gas or coal. The reason is that fossil fuel in Japan is more expensive than other countries like US. For example, the price of natural gas in Japan is about $10.5 per million British Thermal Unit (BTU) in 2018 while the price of natural gas in US is about $3 per BTU in 2018 (BP p.l.c.).

The Agency for Natural Resources and Energy (ANRE) also insists on the cost effectiveness of nuclear energy. ANRE also calculated the Japan's costs of energy resources per 1 kilowatt per hour (LOCE $= \frac{\text{Total Cost of Building \& Operating (Yen)}}{\text{Total Electricity Output (kWh)}}$), and the results of costs are as follows: nuclear energy is ¥10.1, coal is ¥12.3, Natural Gas is ¥13.7, oil is from ¥30.6 to ¥43.4, wind is ¥21.6, and solar is ¥24.2 (2017). Although some people and institutions criticized it that the calculation does not include various related costs, advocate actors for nuclear energy often use the official numeric data calculated by ANRE.

3.1.4. Environmental factor

Environmental merit is one of the reasons for maintaining nuclear energy. As the 2019's Annual Report on Energy describes, 87.4 % of energy resources is from fossil fuels. Unless Japan lowers the dependency on fossil fuels, greenhouse gas emission can not be decreased. The 2018's Strategic Energy Plan, which was affirmed by the cabinet, describes that

> The zero-emission ratio in FY2013 was about 12%, including renewable energy of 11% and nuclear power of 1%, and this is expected to reach about 44% in FY2030 through the promotion of the introduction of renewable energy and the restarting of nuclear power plants that are recognized by the Nuclear Regulation Authority to conform with regulatory requirements which are at the most stringent level in the world. This is equivalent to a rise of about two percentage points per year. (Agency for Natural Resources and Energy 2018, 8).

Even after the Fukushima accident, the current coalition government still promote the same public policy of nuclear energy.

However, most people who are interested in environment, such as members of the No Nukes Plaza, disagree with maintaining nuclear energy because of its environmental demerits, such as wastes of nuclear power generation, risks of accident, and so on. Most of Japanese citizens do not ask the government for decreasing greenhouse gas emission, so the environmental merit of nuclear energy is not seriously considered by politicians. If politicians do not talk about their opinion of nuclear energy when they run in an election, many Japanese citizens will not care about environmental issue. Thus, environmental factor is not a main reason for continuing nuclear policy, but it is a subordinate reason from the actors who insist the need of nuclear energy.

3.2. Institutions

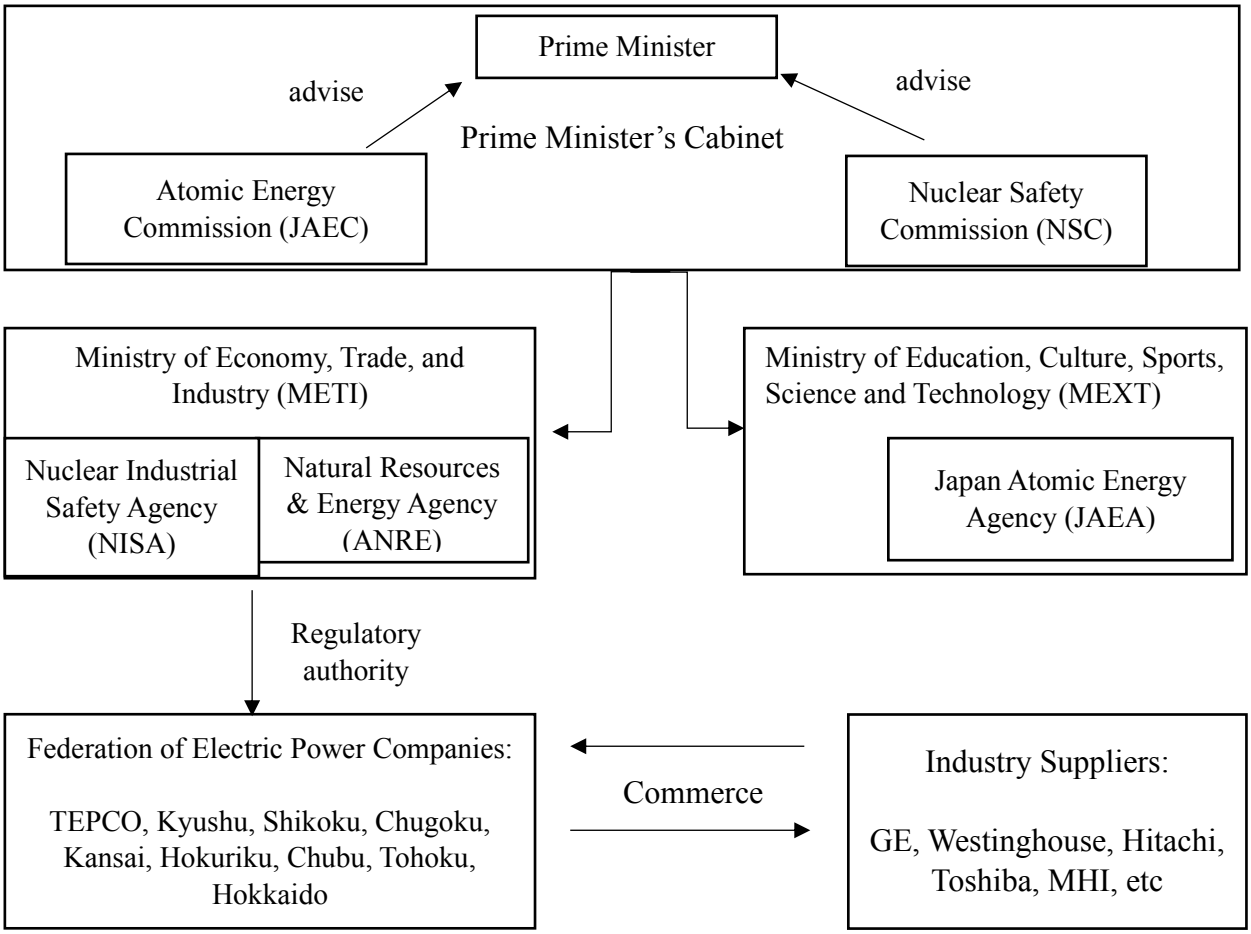

Figure 4. Japan's Nuclear Industrial Complex Organization Chart
Source: Aoki & Rothwell (2013, 242)

Although some factors related to the decision-making process of nuclear energy have been argued in the former sub-chapters, Japanese institutions also have important role in the process. Kurosaki (2017, 51) insists that developing and implementing a strategy of nuclear hedging required the

cooperation of the stakeholders in the civilian nuclear-power dimension with those in the national-security dimension. Because politicians in Japan do not have strong leadership, the decision about nuclear energy is made by mixed and ambiguous interests of the institutions. Aoki and Rothwell (2013, 242) depicts the relations of the actors (Figure 4), but other organizations and people also take part of this complex framework. In the civilian nuclear-power field, the policy network of those informal actors can be seen as a "subgovernment" (Kurosaki 2017, 51).

Governmental authorities and electric companies have had relationship to maintain pro-nuclear policy. Just after the Fukushima accident, the mass media broadcasted the announcements of the Nuclear and Industrial Safety Agency (NISA), the agency for maintaining safety of various energy and businesses. NISA was a branch of the Agency for Natural Resources and Energy (ANRE); and ANRE has been a branch of the Ministry of Economy, Trade and Industry (METI); so, NISA is a part of the pro-nuclear governmental institution METI. This was the reason that NISA did not work well. The role of NISA was regulation and supervision over companies and organizations including Tokyo Electric Power Company (TEPCO). However, many people criticized NISA because NISA did not properly supervise TEPCO and nuclear power plants. This relationship is a typical regulatory capture. In fact, TEPCO had received retired bureaucrats from METI, that is called "Amakudari (天下り)" or that literally means descending from heaven, so NISA was difficult to supervise the ex-bureaucrats who had been bosses of NISA's officers. In 2018, 130 bureaucrats of METI moved and were hired by electric companies or organizations including TEPCO (Wakabayashi 2019). This case has occurred not only in TEPCO but also other electric companies; and Ministry of Education, Culture, Sports, Science and Technology (MEXT) and other agencies also have dispatched retired bureaucrats to electric companies or their related organizations. Some people criticize this relationship as "Regulatory Capture", a theory that regulatory agencies may come to be dominated by the industries or interests they are charged with regulating (Kenton 2019). This research does not argue whether the relationship between the authorities and electric companies has been "Regulatory Capture" or not, but the relationship shows us that regulating governmental authorities and regulated electric companies have cooperated to maintain nuclear energy. Maintaining nuclear energy is an interest of the related institutions: METI can promote economy by nuclear related businesses, MEXT can encourage environment by decreasing green house emission that will be appealed not only to Japan itself but also to the world, and electric companies and their related organizations can continue their businesses.

TEPCO is a private electricity company that owns the Fukushima nuclear power plants, but most of its stocks are now held by the Government of Japan, so TEPCO is now regarded as a de facto state-owned company. The government has been supporting TEPCO through the Nuclear Damage Liability Facilitation Fund that pays a huge amount of money for TEPCO's compensation of the Fukushima disaster.

Japanese mass media is also regarded as a player for pro-nuclear energy policy. But many citizens point the very close relationship of mass media with pro-nuclear actors. Mainly, there are the two problematic elements of Japanese mass media: the Kisha Club or a reporter's club and the closer relationship with nuclear companies. Only large media companies can become members of the Kisha Club, and politicians or authorities mainly announce and speak in the club. The members want to keep the current practice and do not want to invite other Japanese media or foreign media so that the members can monopolize important information about the government. When the Democratic Party of Japan (DPJ) won the election in 2009 and became the ruling party, DPJ wanted to dissolve the club, but it could not. The members of the club do not ask critical questions, so the members did not point our problems of nuclear power plants. Politicians and authorities can control information by using these large media. Meanwhile, nuclear power industries, such as TEPCO, are large sponsors for the mass media. If the mass media criticize TEPCO or other nuclear businesses, they might quit sponsoring. Besides, nuclear related companies sometimes entertain the workers of mass media so that they maintain friendly relationship. For example, when the Fukushima accident happened, Tsunehisa Katsumata the then chairperson of TEPCO was in China for entertaining executive officers of the Kisha Club. When a freelance reporter Ryusaku Tanaka asked Katsumata, Katsumata answered and said, "They were not officers but alumnus of the mass media, and TEPCO did not pay all but paid much money for them." (Tanaka 2011). Although the mass media often argue the problems of nuclear power plants and the merits of various renewable energy, those close relationships lower the number of anti-nuclear reports.

Citizens and institutions in a local city that has nuclear plants have crucial role in argument of nuclear energy. The Three Laws for Power Source Development (Dengen Sanpou, 電源三法) are laws that were passed in 1974 after the 1973's Oil Crisis. The main aim of the laws is to promote construction of power supply facilities for electric stability by paying subsidies to local municipalities which have electric generation plants, especially plants of nuclear power. Power plants have some demerits, so the subsidies are regarded as compensation for the demerits. A local municipality that has nuclear power plants can get huge amount of subsidies so that it can support

its schools, public facilities, local businesses, and so on. Kato, Takahara, Nishikawa, & Homma (2013, 814) surveyed citizens' opinion about nuclear power plants in three Nuclear Villages before and after the Fukushima accident. After the accident, the percentages of citizens who agree with the continuing operation of nuclear plants in the three villages fell by about 15%, 25%, and 20%. However, the interesting thing is that many respondents answered, 'Neither agree nor disagree'. Even after the accident, respondents who answered 'disagree' were only about 20%, 35%, and 35%. This survey shows that many citizens in the villages have complex feeling against nuclear power plants because they have both merits and demerits. Basically, a local city that has nuclear plants has tried to make better relationship with electricity companies legally or illegally. For example, in October 2019, Makoto Yagi, president of Kansai Electric Power Co., Inc. (KEPCO), resigned because it was discovered that he got more than 300 million Yen from Eiji Moriyama who was the deputy mayor of Takahama-cho where the Takahama Nuclear Power Plant is (Wakabayashi 2019). The deputy mayor did that because he believed that maintaining the nuclear power plant was better for Takahama-cho.

Although political leadership in Japan is weaker than other countries, the prime minister plays important role because he or she sits in the highest political position. While Naoto Kan, then Prime Minister who was a member of Democratic Party of Japan (DPJ) when the Fukushima accident occurred, changed his opinion to the idea of decreasing the dependency on nuclear energy, the current prime minister Abe's opinion is as same as the government's policy before the Fukushima accident. The Prime Minister's Official Residence (Prime Minister's Office or Kantei) often announces prime minister's opinion. Its Japan's Intended Nationally Determined Contributions (INDC), which was written in 30 March 2020 for announcing Japan's provision against global warming, describes the government's aim in decreasing green house emission and shows the target of energy source ratio as follows: renewable energy 22% - 24%, nuclear 22% - 20%, coal 26%, LNG 27%, and oil 3% (Global Warming Prevention Headquarters 2020, 12). The ratio of nuclear energy is little smaller than the ratio before the Fukushima accident, which were about 25% or 30% (Figure 1), but he thinks that nuclear energy will still be a main energy resource.

Some citizens criticize that the actors of pro-nuclear energy get together to make a very closed society: it is called "Nuclear Village". So-called Nuclear Village is an institutional and individual pro-nuclear advocate who comprise the utilities, nuclear vendors, bureaucracy, Diet, financial sector, media and academia (Kingston 2012). The term is used for criticizing the policy of nuclear energy, but at least, the actors of pro-nuclear energy do not want to invite other actors who are

anti-nuclear policy to talk about nuclear energy policy. In fact, the practical argument about nuclear energy in Japan is not opened, so it is difficult for some citizens who suspect nuclear energy to participate the argument of the policy.

It is very difficult to point the most important actors in nuclear policy, but mainly three actors, the prime minister, the METI, and electric companies more influence the decision-making than other actors. Prime minister needs to think of all political issues, but it seems that prime minister in Japan more cares about its national security and energy security. METI's primally interest is economy, and METI regards nuclear energy as crucial industry for Japan. Electric companies, like TEPCO, think about their business, but in the same time, they also think of energy security because energy stability is their responsibility. Besides of that, as argued in this chapter, various actors are mixed to maintain policy of nuclear energy, so it will not be expected to change Japan's nuclear policy even if citizens choose alternative political party in future election.

4. GERMANY: CAUSES FOR ABOLISHING NUCLEAR ENERGY

It is very interesting that, after the Fukushima accident, Germany decided to decommission all its nuclear power plants by the end of 2022 although Germany itself did not suffer from the accident. This chapter examines how each factor influences Germany's decision-making to abolish nuclear energy and how institutions affect the decision-making.

4.1. Factors

Main actors who are related to the four factors are the chancellor, ministers, the Christian Democratic Union of Germany (CDU), the Christian Social Union in Bavaria (CSU), the Social Democratic Party of Germany (SPD), the Alliance 90/The Greens (Greens), the European Union, electric companies, mass media, and citizens.

4.1.1. Energy security policy factor

Before the Fukushima accident, Germany had already prepared for changing the balance of energy resources and prepared for the expansion of renewable energy fields. In 2000, the Renewable Energy Sources Act (EEG) entered into force, and the Act had the aim of enabling new technologies such as wind and solar energy to enter the market with support provided by fixed tariffs and a purchase guarantee (Federal Ministry for Economic Affairs and Energy).

Many scholars and professionals who are related energy institutions criticized the decision of decommissioning. Abolishing nuclear energy means that Germany must acquire energy from other resources. Although the government emphasizes the investment in renewable energy, Germany still needs to import energy resources from foreign countries like Russia. Due to the extremely close relationship between Russian energy industry and Russian Government, Russia's oil and gas companies can pursue strategies that serve the long-term interests of the state of Russian by ensuring European dependence on Russian energy supplies (Baran 2007, 135). Thus, many of

German decision makers do not think that the phase-out has security risk, so energy security factor does not directly relate to the decision to abolish nuclear energy in Germany.

4.1.2. National security policy factor

Commercial liberalism insists that interdependence of goods or services increases national security and lowers the risks from the neighbours. France, Poland and Russia expected to increase electricity exports to Germany, mostly from nuclear sources, and Russia started to export significantly more gas (World Nuclear Association). Although importing electricity is generated by nuclear plants in other countries, and although this fact means that the importing energy does not lower greenhouse gas emission in the world, these energy relationships may increase German national security. However, many articles, such as Baran (2007) and Dyson (2016), disagree with the dependence because increasing the dependency lowers Germany's national security. They insist that if the exporting countries stop selling the energy, Germany will be in trouble. In fact, national security is often argued when actors criticize the abolition of nuclear energy. Thus, national security factor is not the reason for the decision on phase-out of nuclear power plants.

4.1.3. Economic factor

When Germany decided to abolish all nuclear plants, the German government mentioned that the reason was not only environmental, but also economic. While some people criticized the decommissioning because of the economic demerits, some scholars says the decommissioning and investing in renewables is a rational choice. Felix Christian Matthes, a research coordinator for energy and climate policy at the Institute for Applied Ecology (Öko-Institut) said, "When empirical observation is analysed in light of a range of economic models, the price effect of the nuclear phase-out can be expected to peak at 5 euros per megawatt-hour or less for a few years around 2020, a reasonably small increase …" (2012, 42).

The Section 1 of the Renewable Energy Sources Act (EEG) emphasizes economic effect of the investment in renewable energy businesses. The purpose of this Act is … to reduce the costs of the energy supply to the economy not least by including long-term external effects, to conserve fossil energy resources and to promote the further development of technologies to generate electricity from renewable energy sources (EEG 2017, 1). Germany's Federal Environment Agency (UBA) estimated that almost two million jobs in Germany could be attributed to the environment protection sector, including waste removal, water protection, air pollution control, environmental

services, and the Renewable Energies Agency (AEE) estimated that 100,000 jobs in the renewable facilities manufacturing sector can be attributed to the export of renewable energy technology (Hockenos 2015). Shaun Burnie, the nuclear adviser for environmental campaign group Greenpeace International, told the BBC World Service that Germany had already invested heavily in renewable energy. He says, "The various studies from the Intergovernmental Panel on Climate Change show that renewables could deliver, basically, global electricity by 2050" and "Germany is going to be ahead of the game on that and it is going to make a lot of money, so the message to Germany's industrial competitors is that you can base your energy policy not on nuclear, not on coal, but on renewables." (BBC 2011).

However, some people criticize the decision on abolition of nuclear energy because the decision would hurt the German economy. Germany would need to import nuclear energy from France, need to import natural gas from Russia, and need to import coal from Poland, and four German energy companies insist that Germany would have blackouts during winter seasons (Gerhardt 2017, 103). Another problem of the decommissioning is that the decommissioning needs huge money for its dismantling and its final disposal. The estimated costs are expected to be at least 50 to 70 billion Euro. The nuclear power plant operators have a provision of 38 billion Euro, but it is not enough to cover the expected costs (von Hirschhausen, Gerbaulet, Kemfert, Reitz & Ziehm 2015, 293). Anyway, the actors who agree with the phase-out of nuclear power mention the economic good point of decommissioning.

4.1.4. Environmental factor

The German citizens' attitude toward nuclear energy has not been favourable. This attitude had started at least before the 1979's Three Mile Island accident in US. For example, in 1975, 28,000 protesters occupied the construction site of a nuclear power plant in Wyhl (in the southwestern state of Baden-Württemberg) and managed to stop construction. The reasons of the protesters are mainly related with environmental reason. Since the number of opponents are many, actors who are related to nuclear energy need to care about public opinion. After the accident at the Three Mile Island in 1979, around 200,000 people took to the streets in Hannover and Bonn, demonstrating against the use of nuclear power (Appunn 2018). On 26 March 2011, fifteen days after the Fukushima and four days before the decision on the German phase-out, over 100,000 people attended demonstrations nationwide, including over 20,000 people in Berlin, protested nuclear energy (Gerhardt 2017, 104). In March 2015, an opinion poll showed that a large majority

(81 percent) of the German population were still in favour of the government's decision to exit nuclear power. Only 16 percent believed that the phase-out was wrong (Figure 5) (Appunn 2018).

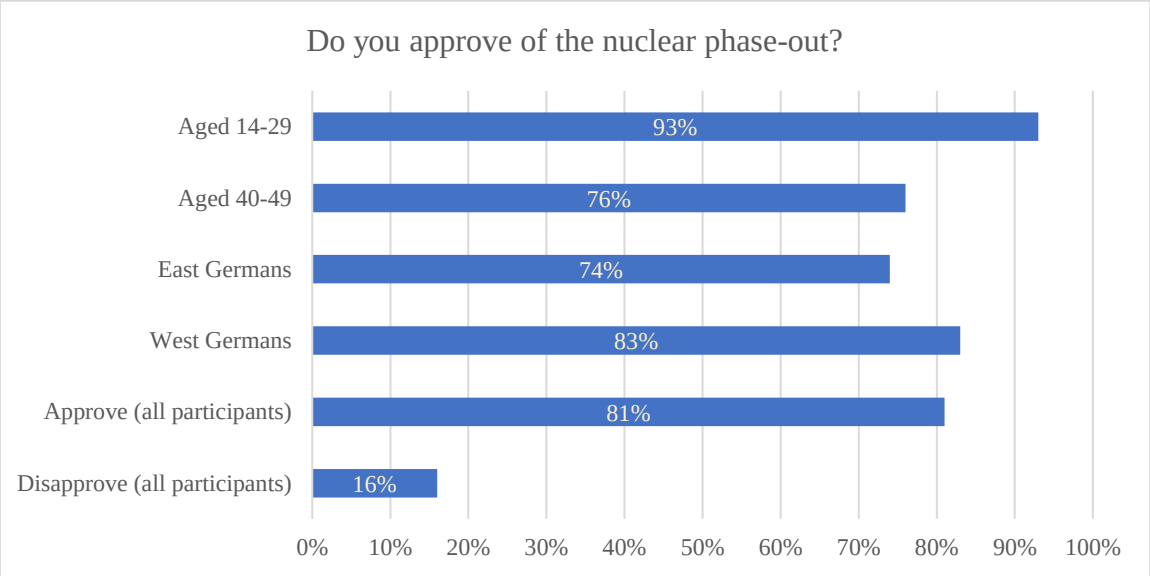

Figure 5. Survey of approval of nuclear phase-out in 2015
Source: Bild am Sonntag/ Emnid. as cited in Clean Energy Wire

Besides, as a member of the European Union, Germany needs to follow the goals of European Union, and the goals also affects on Germany's decision about environmental policy. The targets for 2020 were set by EU leaders in 2007 and enacted in legislation in 2009. The targets for 2020 were 20% cut in greenhouse gas emission from 1990, 20% of EU energy from renewables, and 20% improvement in energy efficiency (European Commission). Because the ratio of anti-nuclear citizens is very large in Germany, decision makers, especially politicians and political parties need to follow the citizens' voice.

4.2. Institutions

The most important institution on decision of public policy is the Federal Government. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU) (2017) summarizes the Federal Government's decision after the Fukushima accident; as a first reaction, the Federal Government and the presidents of the Länder where nuclear installations are located jointly decided on 14 March 2011 that the safety of all nuclear installations in Germany should be reviewed in the light of the events of the nuclear accident at Fukushima.

Unlike nuclear energy policy of Japan or US, Germany's policy on nuclear energy has sometimes changed. Although the number of seats in parliaments is not so many, the Alliance 90/The Greens (Greens) is a key actor for the decision-making process, and this is the different political situation from Japan or US. West Germany's Greens was founded in 1980, and East Germany's Alliance 90 was founded in 1990. The two groups were united and formed the Alliance 90/The Greens in 1993. As the name of the party shows, Greens is an eco-friendly political party that insist on anti-nuclear energy and anti-environmental pollution. In 1998, Greens and the Social Democratic Party of Germany (SPD) cooperated and took the federal office for the first time. The crucial year for not only German politics but also Germany's nuclear energy is the year of 2000 when the government decided to phase-out the use of nuclear energy by 2022. Müller & Thurner (2017, 159) explains the Green Party's role that the openness of the German political system, namely the features of its electoral system in combination with its decentralized federal system, made possible for a Green Party not only to cross the threshold of parliamentary representation, but also to become the 'issue owner' of nuclear energy for a long time. The Greens have their roots in the antinuclear movement of the early 1980s: Resistance against nuclear power is in the party's DNA (Bittner 2020).

Meanwhile, the Christian Democratic Union of Germany (CDU) and the Christian Social Union in Bavaria (CSU) have been relatively favourable toward nuclear energy. Although Red-Green Coalition decided on abolishing nuclear power, political backing for the phase-out disappeared in 2009 when the coalition of CDU/ CSU and the liberal Free Democratic Party (FDP) won the elections because both parties were programmatic supporters of nuclear energy and strict opponents of the phase-out scheme of 2002 (Matthes 2012, 46). Although chancellor Merkel changed the plan of phase-out and postponed the term of nuclear plants before the Fukushima, she revived the original phase-out policy after the Fukushima (World Nuclear Association 2019).

Dyson describes the relationship among governmental ministries. The Foreign Ministry is responsible for coordinating Germany's position on EU energy policy issues but was unable to broker agreement between the Environment Ministry and the Economics Ministry. Environment Ministry wished to place pressure on other European states to promote renewable energy, and the Economics Ministry wanted a stronger focus on the opportunities the EU could provide to deliver greater cost-effectiveness in energy (2016, 507-508). Because of the lack of ministries' power and the rising power of the public opinion, the decision to phasing out nuclear energy has been made.

Unlike Japan or US, German citizens play a crucial role for the decision on the abolition of nuclear energy. As mentioned in the environmental factor in section 4.1.4., many German citizens started suspecting and protesting nuclear energy before the Three Mile accident in 1979. One of the important early reversals in German nuclear energy policy was the halt in the construction of a commercial Fast-Breeder Reactor (FBR) in Kalkar in response to the antinuclear movement's demands. This decision provided clear evidence to observers and activists alike that protests could be effective. The case is essential for the understanding of the history of the anti-nuclear movement and its transformation into the Green Party (Müller & Thurner 2017, 162).

In Japan and US, nuclear industry has an effective influence on the decision-making process by lobbying, advertising or Japan's Amakudari. Although nuclear companies Vattenfall, E.ON, and RWE have filed lawsuits against the forced shutdowns, the power of the nuclear industry is weaker than Japan's and US's. A German conglomerate company Siemens announced in September 2011, six months after the Fukushima accident, that Siemens would finish building nuclear power plants. Peter Löscher, the CEO of Siemens, said that the decision was not only changing its track for renewable energy but also "an answer" to political and social opposition to nuclear power in Germany (Dempsey 2011). Thus, in Germany, citizen's action and public opinion moved politicians and Federal Government, and nuclear industry could not maintain the public policy of nuclear energy.

5. US: CAUSES FOR MAINTAINING NUCLEAR ENERGY

The Unite States of America (US) is the largest nuclear power country. As of the end of December 2018, US had 98 operating commercial nuclear reactors (The U.S. Energy Information Administration 2019). Even after the Three Mile Island accident and the Fukushima accident, US's nuclear policy has not wavered. This chapter examines how each factor influences the US's decision-making to maintain nuclear energy and how various institutions affect the decision-making.

5.1. Factors

The actors who are related to the four factors are the US president, the Federal government, state governments, the Republican Party (GOP), the Democratic Party, electric companies, other energy related companies, scholars, and mass media.

5.1.1. Energy security factor

The aim of US in energy security policy has been to lower the dependence on foreign oil. So, nuclear energy has been important source to gain stable energy resource. However, thanks to the Shale Revolution, US has lowered the dependence on foreign energy resources and has become a net exporter of crude oil and natural gas. The United States Department of Energy (DOE) points out the threats of energy security in the current globalized world because a problem in one country may disrupt other countries or regions. DOE argues that current interests of energy security include the fuel supply chains of electricity generation, transmission, and distribution; the functioning of energy markets; and the ability of the energy system to withstand shocks and disruptions. Under the situation, DOE emphasizes that nuclear power remains an important part of US's energy portfolio, as US strives to reduce carbon emissions and address the threat of global climate change.

Because the Shale Revolution and lowering price of natural gas, US's nuclear generation declines from a 19% share of total generation in 2018 to 12% by 2050. Meanwhile, the share of natural gas

generation rises from 34% in 2018 to 39% in 2050, and the share of renewable generation increases from 18% to 31% (The International Energy Agency 2019). However, as DOE emphasizes, nuclear energy is still regarded as an important energy resource in US.

5.1.2. National security factor

National security factor that related to nuclear energy has two aspects: maintaining resources and knowledge for military use of nuclear and maintaining energy influence over the world.

In theory, US can maintain nuclear weapons without civilian nuclear energy as US had developed the weapons before starting civil use of nuclear energy by the first nuclear power plant the Shippingport Atomic Power Station in 1956, but idea to maintain both civilian nuclear power and military nuclear weapons is natural. The reason is that both have similar characteristics. Although the process of developing nuclear weapons is different from the process of nuclear power plants, and although civilian nuclear industry denies the relationship between the civilian use and the military use, both civilian nuclear industry and military nuclear industry have same elements: uranium enrichment, the process to reprocessing, materials, technology, and equipment (World Information Service on Energy 1999). In fact, the fundamental theory of nuclear fission is used in both industries, so the knowledge and the human resources can be easily interchanged with each other. Sulock (2015) explains the detail examples of the relationship: nuclear power reactors need about 5 percent U-235 isotope of uranium, so natural uranium having less than 1 percent of U-235 needs to be enriched for using as reactor fuel, and the enrichment can increase 5 percent U-235 to 80 percent U-235 that is used for uranium atomic bombs. So, having commercial nuclear can support developing and maintaining military nuclear weapons by exchanging energy resources, human resources, and knowledges.

Besides, there is another relation between them. Civilian nuclear plants produce a problematic waste: this is plutonium. Plutonium can be used for producing atomic bombs. Although the civilian nuclear industry denied the use of plutonium for developing nuclear weapons, it is, at least, possible. Although various proposals have been made for developing nuclear power in forms that are less prone to diversion of nuclear materials for weapons than present nuclear power systems, none of these proposals avoid the production of substantial quantities of neutrons that could be used for making key nuclear materials for nuclear weapons (Taylor 1996). Anyway, pro-nuclear

actors in US believe that having nuclear power plants is beneficial to maintain the ability to produce nuclear weapons and to increase US's national security.

Another reason is that US needs to maintain strong influence upon nuclear business in the world through the exporting nuclear industry. Nowadays, Russia and China are large exporter of nuclear energy. Two-thirds of global reactors under construction use Russian or Chinese designs (Nuclear Energy Institute 2018). If US does not participate to the nuclear economy of the world, US must have risks on its national security because US will lose influence on nuclear business in the world. Nuclear power should be elevated in the Trump administration's US National Security Strategy, including its "energy dominance," defence-industry capacity development, and international partnership efforts with allies (Ichord 2018, 10). Through an agreement with US and an exporting country, US can check other country whether the country is diverted for non-peaceful purposes. So, without the US and other countries with strong accountability and governance as viable competitors, US nuclear safety and security norms, standards, practices, and enforcement would likely become precarious or a secondary consideration (Nakano 2020, 2 & 19). If US abolish civil use of nuclear energy and stop exporting it, US can not maintain nuclear relationship with importing countries and will lose contribution for non-proliferation of nuclear weapons. Thus, maintain commercial nuclear energy means not only generating electricity itself, but also improving US's security.

5.1.3. Economic factor

One of the merits of nuclear energy is that the cost of nuclear energy is stable while oil and natural gas are unstable. Global electricity consumption is on track to grow 45 percent by 2040, and some scholars, such as McCaffrey, insist that the exclusion of nuclear from low-carbon scenarios could cause the average cost of electricity to escalate dramatically (McCaffrey 2018). Thus, US needs to maintain civil use of nuclear energy although it is now producing large amount of oil and natural gas. According to the MIT's calculation of LCOE (Table 4), the cost of nuclear energy in US is little higher than the costs of coal and natural gas. Thus, when thinking of domestic economy, economic factor does not support maintaining nuclear energy.

However, civilian nuclear is exported to foreign countries by economic reason. The value of the global civil nuclear energy supply chain is estimated $2.6 trillion over the coming 20 years, and this supply chain includes new reactor development and construction, myriad fuel cycle services

for existing reactors, power generation equipment, professional services, training, reactor life extension, and decommissioning services (Aumeier & Allen 2018). Founding and maintaining nuclear power plants require various kinds of knowledge and experience. US has a longer history of nuclear energy, so US will still be able to be large exporter of nuclear industry if US wants. If US increases the exporting of civil use of nuclear energy, related domestic businesses will also get more profits and will create more jobs.

5.1.4. Environmental factor

Although the current US President Trump and his government are not so interested in global warming, decreasing the amount of CO2 emission is the common goal of the world. The United Nations describes that global net human-caused emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that the average CO2 emissions rates for electricity generation in the world must decline to a range of 10 to 25 grams carbon dioxide per kilowatt hour (CO2/kWh) from the current average of approximately 500 gCO2/kWh (MIT Energy Initiative, 2018). Nuclear energy is not renewable energy, but it is regarded as zero-carbon resources. Since US is the most CO2 emission country, the good aspect of nuclear energy to decrease the amount of CO2 emission is attracted.

5.2. Institutions

Although most commercial nuclear power plants are governed by private companies, the US Government and its politicians play the most important role in deciding the public policy about nuclear energy. The US government supports civilian nuclear industry by some laws. For example, the Energy Policy Act 2005 (EPA) encourages civilian nuclear industry by production tax credit that subtracts taxes of 6 billion dollars at the maximum over eight years, by federal risk insurance of 2 billion dollars to cover regulatory delays, and by federal loan guarantees for advanced nuclear reactors up to 80% of the project cost. Moreover, US government gives energy subsidies and R&D support that worth 16.6 billion dollars in 2007 (World Nuclear Association 2020).

In the US, both Democratic presidents and Republican presidents have supported the policy of nuclear energy. During his presidential campaign, President Barack Obama stressed the necessity of non-carbon generated electricity, especially nuclear energy. In his 2008's Plan to Make America a Global Energy Leader, he mentioned, "It is unlikely that we can meet our aggressive climate

goals if we eliminate nuclear power from the table". During his presidency on 11 March 2011, the Tohoku Earthquake and Tsunami hit Japan, and it derived the Fukushima Daiichi nuclear accident. On 30 March 2011 after the accident, he again stressed nuclear energy that did not emit carbon dioxide in the atmosphere. He said, "… we've got to recognize that nuclear power, if it's safe, can make a significant contribution to the climate change question… And we're going to incorporate those conclusions and lessons from Japan in design and the building of the next generation of plants. But we can't simply take it off the table."

The next Republican president Donald Trump also supports nuclear energy. In 2018, he signed the Nuclear Energy Innovation Capabilities Act (NEICA) that eliminates some of the financial and technological barriers standing in the way of nuclear innovation, and the act also represents a strong commitment by the government to support the commercial nuclear sector, ensuring that US maintains its leadership around the globe (U.S. Department of Energy 2018). Since he has sometimes mentioned the meaninglessness of US's effort toward global warming and had decided to withdraw from the Paris Agreement, his approval for nuclear energy is not based on environmental factor but based on other factors.

Joe Biden, the Democratic nominee for the next president identifies the future of nuclear energy on his webpage. He mentions that US must look at all low and zero carbon technologies to address the climate emergency threatening communities, economy, and national security, and that that's why he will support a research agenda through ARPA-C (an Advanced Research Projects Agency focused on climate) to look at issues, ranging from cost to safety to waste disposal systems, that remain an ongoing challenge with nuclear power today. Thus, abolishing civilian nuclear energy seems not be his choice. Even if Biden become the president of US, US's nuclear policy will probably not be changed.

Nuclear industry has been lobbying politicians for maintaining current policy of nuclear energy, opinions of the president and politicians will not be changed. Some organizations and interest groups support US nuclear policy by various methods. The Nuclear Regulatory Commission (NRC) is a controversial independent agency that ensure the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environments. NRC describes its role as regulating commercial nuclear power plants and other uses of nuclear materials, such as in nuclear medicine, through licensing, inspection and enforcement of its requirement. In fact, some

application for building new nuclear plants have been denied or suspended by NRC. However, NRC has consistently favoured the interests of nuclear industry, it is regarded as regulatory capture, and has sought to hamper or deny public access to the regulatory process, and this trend has worsened noticeably because NRC has sponsored legislation and enacted regulations that place unprecedented new barriers before public participation (Byrne & Hoffman 1996, 160). Besides that, the important thing is that the NRC's Chair and commissioners are appointed by the US President, so NRC is regarded as supporter of nuclear industry.

The American Nuclear Society (ANS) is a not-for-profit international organization which has a diverse membership composed of approximately 11,000 engineers, scientists, administrators, and educators who represent corporations, educational institutions, and government agencies. According to its website, its mission is that "Advance, foster, and spur the development and application of nuclear science, engineering, and technology to benefit society." Its objectives include "Cultivate grassroots efforts to enable effective communications between members, the public, and policymakers" and "Engage and influence policymakers and opinion leaders through direct dialogue and compelling written, visual, and online materials" (ANS 2018). So, ANS acts not only for spreading merits of nuclear energy but also for lobbying politician. Eugene S. Grecheck, a seasoned executive of ANS with 40 years of experience in commercial nuclear power generation, criticized the Environmental Protection Agency (EPA) and mentioned that EPA's rule does not give credit to existing nuclear plants for their license extension but existing plants should be retained for reaching climate targets of the world (Grecheck 2016).

The Nuclear Energy Institute (NEI) is the policy organization of the nuclear technologies industry, based in Washington, D.C., and NET develops policy on key legislative and regulatory issues affecting the nuclear industry (NEI 2019). NEI uses lots of money for its lobbying both Republican and Democrat. For example, the lobbying report, that was filed on 19 April 2020 describes that NEI's expense is $590,000 for US Senate, US House of Representatives, Department of Defence (DOD), and Department of Environmental Protection Agency (EPA) (Pro Publica). The amount of NEI's donate is nowadays about two million dollars (Figure 6), although the organization itself did not directly donate, rather the money came from the organization's Political Action Committees (PAC), their members or employees or owners, and those individuals' family members (OpeSecrets.org).

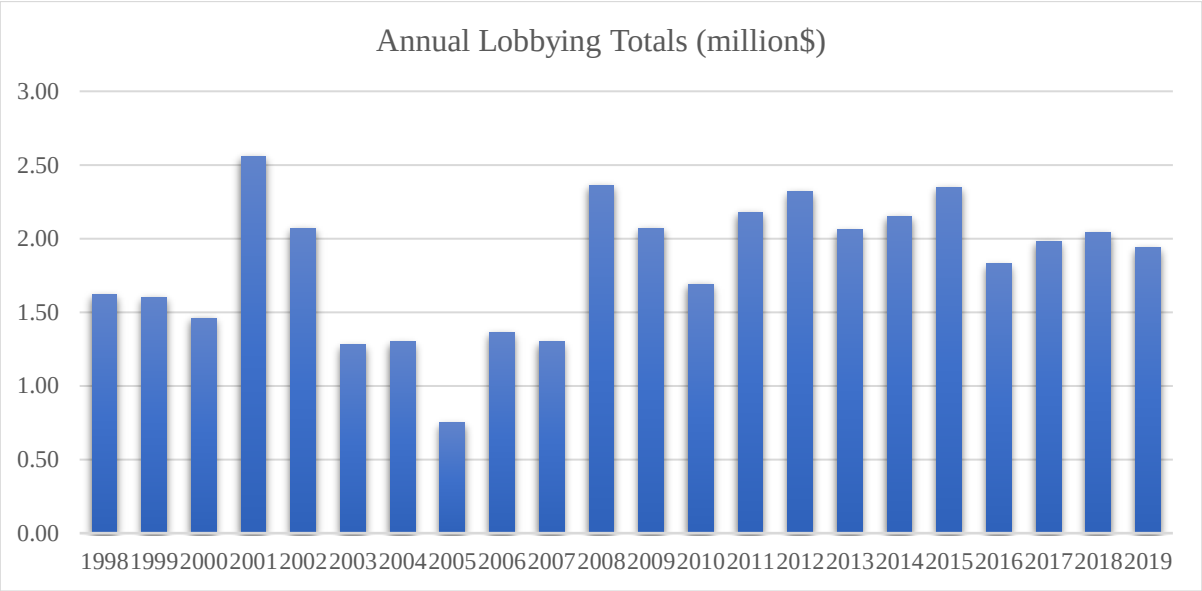

Figure 6. NEI's Annual Lobbying Total Amount of Money

Source: OpeSecrets.org (2020)

NEI also pays money to advertising for influencing public opinion. In order to spread the image of nuclear energy as clean energy, Smith & Harroff, Inc. has provided NEI with print, radio, television and digital advertising for 22 years (Smith & Harroff, Inc). To engineer public opinion, NEI spends millions of dollars annually and puts advertisement in various media, such as Scientific American, the New Yorker, the Washington Post, Roll Call, Congress Daily AM, and The Hill (Caldicott 2006, 3). Lobbying has huge effect upon decision-making in US. The interests of pro-nuclear institutions, such as NEI, are mainly energy and national security, and they also insist environmental merits of nuclear energy. US citizens and their public opinion are also important because they can fail their representatives in the next election, and the politicians do not like to lose her or his seat. However, as the public opinion about nuclear energy is divided and nuclear industry tries to tell useful aspects of nuclear energy to citizens by advertisements and teaching, the public opinion does not seem to dramatically change unless next huge nuclear accident occurs.

US is democracy, so politicians must care about citizens and their interests. Although it was about forty years ago, US had a terrible nuclear accident. In March 1979, the Three Mile Island accident occurred in Pennsylvania. As CBS News/ New York Times Poll shows the change of percentage of the people who are approval or disapproval for building new nuclear plants in US (Figure 3), many people disapprove on nuclear plants soon after serious nuclear accidents, but about half of

the US citizens nowadays think that nuclear plants are necessary for US (Figure 4). So, the public opinion is divided.

After the Three Mile Island accident, high profile protests took place around the country, including one in New York City in 1979 involving 200,000 people (History.com Editors 2009). Besides, according to the CBS News/ New York Times Poll, the citizen's approval for nuclear energy had been declined after the Three Mile accident in March 1979 and after the Chernobyl accident in April 1986 (Figure 3).

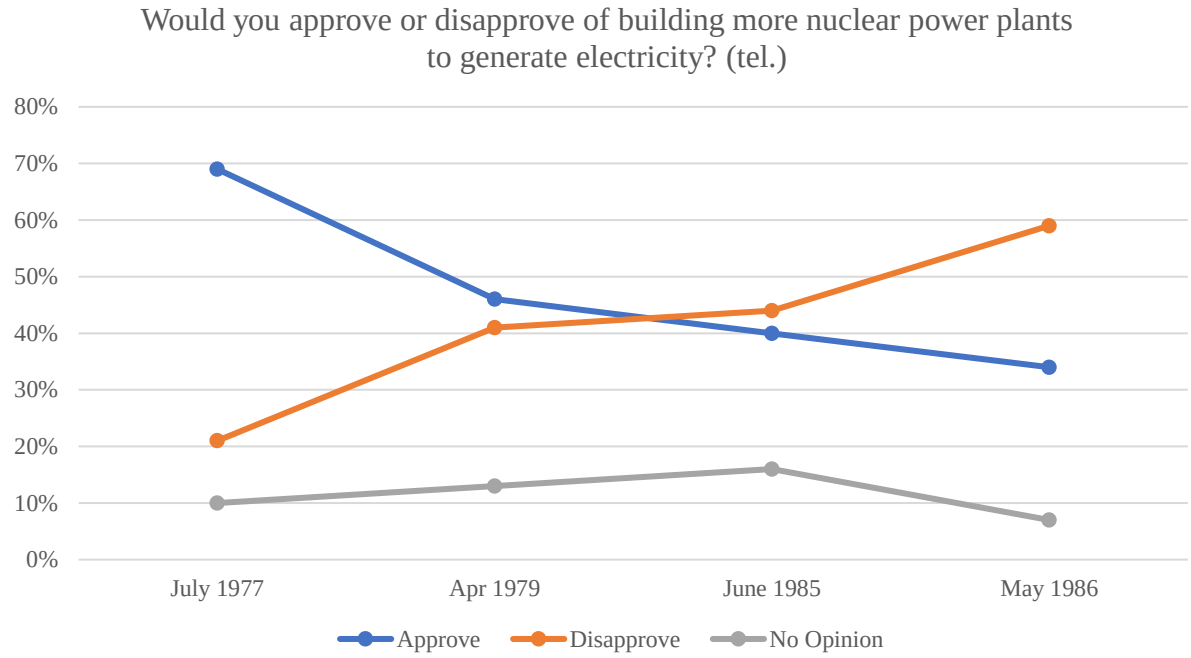

Figure 3. The Results of Surveys about Nuclear Power Plants
Source: CBS News/ New York Times Poll (as cited in Boer 1988)

In fact, citizens' approval declined and disapprove ascended after the accidents. However, according to the GALLUP, the total percentage of favour the nuclear energy was more than 50 percent even after the Fukushima accident in March 2011 (Figure 4).

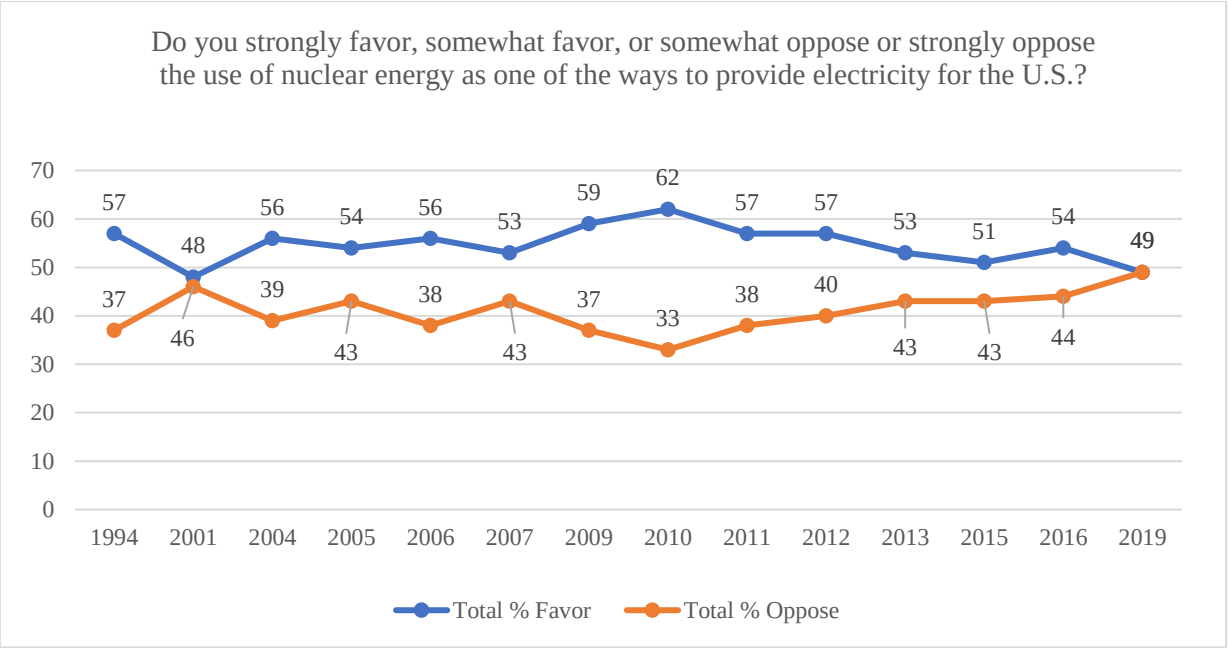

Figure 4. Total % of Favour and Opposition to the Use of Nuclear Energy
Source: GALLUP

The results of these polls show that politicians do not need to insist abolition of nuclear energy because the anti-nuclear feeling in US is not so strong than Japan or Germany. In fact, talking about nuclear energy in US is not beneficial for politicians. If a politician takes a anti-nuclear position, it will be strident in face of the current US's reality to depend on nuclear energy while if a politician takes a pro-nuclear position, it will anger environmental interest groups and will appear to make the politician responsible for some problems, such as radiation injury, massive nuclear costs, the Three Mile accident, and the Chernobyl accident (Zillman 1989, 35). The protests against nuclear energy could limit the politicians' speech but could not limit the nuclear energy policy itself.

Although the citizens' disapproval of nuclear energy went up just after the accidents of the Three Mile, the Chernobyl, or the Fukushima, the disapproval of the public opinion is temporary. Even after the Shale Revolution that changed US as an energy exporter, US still maintains its nuclear energy. Although U.S. Energy Information Administration (EIA) estimates that the capacity of nuclear electric generating will decrease 17% from 99 gigawatts (GW) in 2018 to 83 GW in 2050, nuclear energy will have been important energy resource in US (U.S. Energy Information Administration 2018).

CONCLUSION

The aim of this research was to find which causing factor most affects decision-making in respective countries, and to explain why the decisions of the three countries are different.

In the Japan case study, the main factors that affect decision-making are energy security and national security. For Japan's stable energy resources, most actors who are inside or close to the decision-making process are agree with maintaining nuclear power. The Nuclear Village with the Three Laws for Power Source Development (Dengen Sanpou) is the firm structure to continue nuclear energy policy, and the institution effectively prevents citizens from participating in the decision-making process. Although many citizens care about the bad aspects of nuclear energy, such as the risks of accident and nuclear wastes, politicians of ruling parties tend not to show their pro-nuclear opinion to citizens because they do not want to lose votes of the citizens in the next election. Politicians do not directly mention the name of a threat country because of avoiding regional geopolitical tension, Japan always needs to think of its national security. While the ruling parties and the prime minister Abe have tried to amend the current Japanese Constitution to demonstrate the legitimacy of the Self Defence Forces, they also have tried to maintain better relationship with US. Both the Self Defence Forces and the alliance with US are the current defence policy, but some Japanese, such as communists and very liberals, have objected the defence policy. This sensitive political situation is the reason for some politicians to insist the idea of nuclear latency. If this geopolitical situation changed, the politicians can abandon the idea of nuclear latency.

In the Germany case study, environmental factor strongly affects Germany's decision to decommission all nuclear power plants because abolishing nuclear energy has little incentive from energy security, national security, or economic perspectives. This German case is very interesting because a relatively small political party Greens has played a crucial role to lead German environmental policies, especially abolishing nuclear energy while Japan and US do not have a strong political party that leads a country to anti-nuclear society. The reason that the small political party Greens can keep certain seats in the parliament Bundestag is the German political system.

Germany's political system is a mixed-member proportional, so even a small party can get some seats. Besides, because of the electoral system, German government is basically a coalition government. Thus, Green could become a part of the coalition government in 1998 with the Social Democratic Party of Germany (SPD), and the government made the public policy of the abolition. If the coalition government had not made the phase-out plan in 2000, chancellor Merkel probably could not decide the decommission just after the Fukushima accident.

The final US case study shows that main factors of the US decision-making process are energy security and national security as same as Japan. Because of the Shale Revolution and the current situation of low natural gas price, maintaining nuclear power plants might not be rational when actors think only about US's economics because the cost of nuclear energy is higher than other energy resources. Besides of that, US citizens and political leaders seem to be less interested in environmental issues than German or Japanese. In order for the stability of US interests, the government's will to maintain nuclear energy has not wavered.

Comparing three cases gives us some ideas the reason of the different decisions of the three countries. The large difference of Germany is its geo-political situation. Germany is a member of the European Union and has relatively peaceful environment than Japan or US, so national security is not the most important issue when thinking about nuclear energy policy. The geo-political situation of Japan, having sceptical neighbour countries and not having enough energy resources, influences political actors who think about the stability of energy and national security. Although international pressure for decreasing green house gas has been increasing, US is not so influenced by the international pressure. Although other energy sources are cheaper, US still needs to maintain nuclear energy for its national and energy security. Besides that, electoral system of the three is the reason of the different decision-making. In Japan, LDP has been a primary party except DPJ's era between 2009 and 2012. When the Fukushima accident occurred, the ruling party was DPJ, and both DPJ and LDP supported nuclear energy. After the Fukushima accident, DPJ was dissolved and the members of then DPJ are unpopular now. Thus, Japan does not have a political party that has a possibility to defeat LDP and that can change the nuclear policy. US's electoral system is First-past-the-post, so US has two stable political parties, and there is almost no chance for a small party to influence decision-making. Thus, nuclear policy seems to be very stable.

Nowadays, some countries think of abolishing nuclear energy, but at the same time, other countries think of introducing nuclear energy. This research shows that the opposite decisions of their countries are influenced by their geo-political situation and an electoral system. If an electoral system gives possibility to a small political party, the small party can gather citizens' public opinion and can bring the opinion to the parliament so that the opinion affects on decision-making process.

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