In what way can Japan's energy system make transitions?
-Using Scenario Planning to seek for the plausibility to realize sustainable energy system-

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Abstract

The thesis researches about plausibility of how Japan's energy system make transitions. Incorporating Multi-Level Perspective (MLP) and Complex Adaptive System (CAS) as the theoretical frameworks, the thesis analyzed Japan's historical energy transition as well as basic structure of interdependency in relation to the system's transition. Based on this analysis, the thesis articulates 4 scenarios of Japan's energy transition by 2030 and make an implication for necessary transition managements. On the process of making scenarios, the thesis incorporated Scenario Planning as a research method. The major finding of this research is that each scenario is a product of different actors becoming the main system drivers for different reasons, and that depending on who will be the new niche regime and why, the scenarios differ tremendously. On this point, how consumers are involved with energy production and how consumers value energy is of great influence. Because energy is a substitutable commodity that there is no much variance in the product's quality, without marketizing social and environmental values on it, the market competition would easily converge toward lowering price and cost (and eventually deteriorate profitability) through huge capital investment into scale effect. As a result, capitals, resource, and political power are centralized to a certain actor. Another finding is that putting pressure on politician and METI, the administrative organ in charge of monitoring the fair trade in energy industry, is a key if one wants to keep energy industry away from political cartelization of the incumbents. In this case, the pressure is preferably derived from a social awareness on the issues of the current configuration and is accompanied with citizen's active participations and investments.

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Abbreviation

ANRE	Agency for Natural Resources and Energy	BWR	Boiled Water Reactor
CAS	Complex Adaptive System	CIM	Cross Impact Matrix
DPJ	Democratic Party of Japan	EGMSC	Electricity and Gas Market Surveillance Commission
EPCO	Electric Power Company	FBR	Fast Breeder Reactor
FEPC	The Federation of Electric Power Companies of Japan	FIT	Feed-in Tariff
GHG	Green House Gas	HWR	Heavy Water Reactor
JEPX	Japan Electric Power Exchange	JINED	Nuclear Energy Development of Japan Co., Ltd.
Keidanren	Japan Business Federation [Nippon Keizai Dantai Rengoukai]	LDP	Liberal Democratic Party
METI	Ministry of Economy, Trade and Industry	MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHLW	Ministry of Health, Labor and Welfare	MIC	Ministry of Internal Affairs and Communications
MITI	Ministry of Internal Trade and Industry	MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOF	Ministry of Finance	MLP	Multi Level Perspective
MOE	Merit-Order Effect	MOX	Mixed Oxide Fuel
NDF	Nuclear Damage Compensation and Decommissioning Facilitation Corporation	NPP/NPR	Nuclear Power Plant/Reactor
PWR	Pressurized Water Reactor	RPS	Renewable Portfolio Standard
ST	Socio-technical		

Foreword and Acknowledgement

This thesis is written as completion to the Master of Energy, Environment and Society at University of Stavanger. This two-year program has been full of great memories and precious experiences and has given me so much insights about what I have been eager to study. Regrettably, due to space constraints, I cannot mention every person who I thank for, but I would like to let Professor Oluf Langhelle have my gratitude for creating and coordinating this program. Also, during this 2-year study, I have constantly had the support, encouragement and most importantly, fun moments with my friends that I met here. I am grateful not only for my academic inspiration that we have exchanged but also for sharing the time of struggles and joys as friends.

I have been conducting this research since September 2018. In so doing, I have received great supports and encouragement from my supervisor, Doctor Paul Midford. Without his guidance and persistent help, this thesis would not have been possible. I would like to show my heartfelt appreciation to him.

Background

In July 2018, the Japanese government under LDP's Abe administration approved and published the 5th Basic Energy Plan, showing the basic direction of Japan's energy policy. The plan promises to promote decarbonization of the country's energy system toward 2050, but without mentioning specific numbers as a goal. Instead, it emphasizes the straightening of the efforts to ensure continued, concrete results to achieve the power mix for 2030, envisioned by the 4th Basic Energy Plan, published under the same administration in 2014.

So, what is the goal for 2030? *Figure A* shows the historic power mix of Japan and its plan for 2030. Japan emphasizes the role of renewable energy (including hydro power) for it is to consist 22-24% of the power mix. It is indeed a change from pre-Fukushima state when, for example in 2010, it only consisted about 10%. On the other hand, the proportion of LNG, oil and coal are almost identical to 2010: they are aimed to consist 27%, 3% and 26% in 2030 whereas in 2010, they consisted 29.3%, 7.5%, and 25% of the country's power mix respectively. Nuclear energy, once it was completely disappeared from the energy mix after Fukushima, will come back again to comprise 20-22%, whereas in 2010, it consisted 28.6% (ANRE, 2018a). In other words, what the plan suggests is that the slight decrease of fossil fuel's presence and 8% decrease of nuclear power's proportion will be fulfilled by an 12-14% increase of the renewable energy. This is the 20-year-plan of the country that has experienced the one of the worst nuclear disaster in the world.

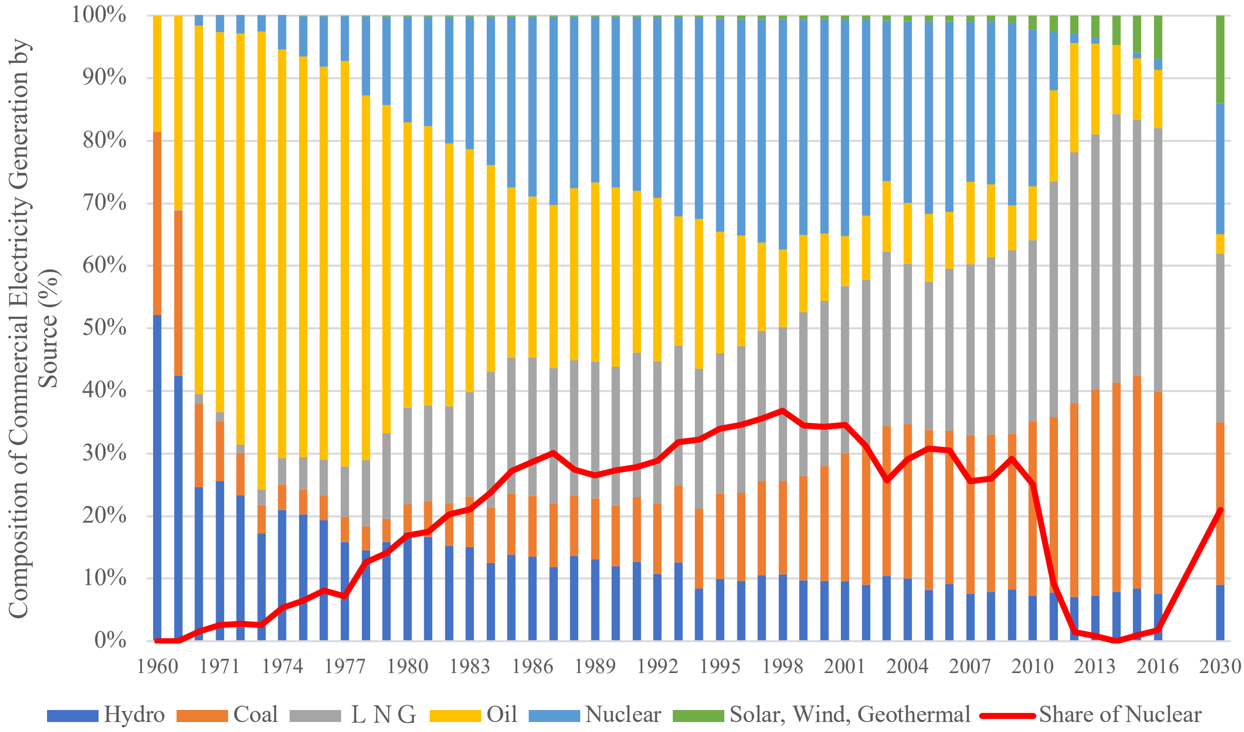

Figure A. Composition of Commercial Electricity Generation in Japan by Source and its plan

(ANRE, 2018a)

Considering that the 3rd Basic Energy Plan, published under DPJ's Kan administration in 2010, suggested an expansion of nuclear energy as to consist 53% of the power mix by 2030, you could say that the Fukushima disaster made the state's policy less ambitious about the nuclear energy. However, the disaster clearly did not contribute enough to an introspection of the country's past energy policy. After all, the government attempts to make the power mix in 2030 somewhat similar to the pre-Fukushima one by restarting nuclear power plants that were once halted.

Is this a right pathway to go? To answer this question, it should require a long-term, multidisciplinary discussions: it is a political, economic, social, environmental, technological and even philosophical issue. Yet, it is an important question that must be continuously discussed. Japan is the 5th largest energy consumer and the 3rd largest economy (in terms of real GDP) in the world. Although its CO2 emission only comprises 3.5% of the world's total, it is still the 5th largest CO2 producers in the world. Its economic, social and environmental impact is simply too big to neglect.

While there are numerous approaches available to this question, the thesis attempts to see it in light of societal transition and transition management. Japan's energy industry (both gas and electricity) has been vertically integrated by regional monopolists since the end of WW2. As the thesis will discuss in more detail in *section 2-2*, the nest of interests, intertwined for the past 70 years, is influential to the country's policy making process, business, shareholders and citizens' lives. This wide web of interest creates homeostasis against changes. However, the Japan's gas and electricity market are now ready to be fully liberalized by 2020, ending the country's long-standing vertical integration of these sectors. How Japan, in this turbulent time of liberalization after the nuclear disaster, changes or resists from being changed may become one of many models to achieve (or fail to achieve) sustainable development through societal transition.

There are indeed large number of literatures researching Japan's energy systems and policy especially since Fukushima, but they are often limited to discussing specific topics (i.e. an influence of incumbents and business model of power companies). Of course, they provide valuable insights that provide leads to understand Japan's transitional issues, but they are not meant to capture the dynamics of societal transition (Aldrich, 2008; Berndt, 2018; Midford, 2014; Moe, 2014; Yamaoka, 2011). Plus, discussions become even rarer when it comes to a topic of transition management. Maybe it is because of theoretical limitations. As the thesis will discuss later in *section 1-2 and 3-1*, the study of societal transition still has a lot of mysteries and theoretical problems to be solved. Besides, we still have a lot to talk about until we can define what a “right” path is, and how the development of human society should be. Or maybe, it is also because of the technical difficulty as the transition management needs to deal with an infinite number of uncertainties that pervert a transition pathway like a butter-fly effect.

Nevertheless, the author would like to conclude that the research of societal transition and its management is of great importance, not only for Japan but for the world. Japan is indeed at a turning point, but so as other countries. The world is seeing the climate change, geopolitical instability, rapid growth of developing nations, stagnations of developed economies, development and diffusion of new technology etc.… Vested interests can be seen in any countries in any forms as long as there are people who have material incentives to support an existing regime. As we are yet to see what we can call as a sustainable society, it is in other words to say that all society are facing to the need of societal transition. For this sense, this thesis does not consider a case of Japan as a peculiarity but as something that can suggest a generality.

Introduction

The purpose of this thesis is to answer its title, that is, in what way can Japan’s energy system make transition? To do so, as its subtitle suggests, the thesis incorporates Scenario Planning as a research method and discusses the plausibility of sustainable energy transition in Japan. That is to say, the thesis first of all tries to capture the current situation of Japan’s energy system as a product of historical societal transition process, and, based on this understanding, the thesis tries to suggest future transition pathways (=scenarios) toward 2030 as alternatives to what the current government envisages.

To further decompose the question, the thesis must know the constituents and their motivation of the Japan’s energy system in 2030. In other words, the question is further specified as who the main system driver is, how and why they drive the system in 2030: are they the traditional incumbents? How do they drive the system? Is it different from what it is now? If so, under what purpose do they drive the system? For their own money, for social benefits or for both? In addition, we also must know what we shall do to achieve sustainable development in order to suggest an alternative pathway to the government’s plan. These two “must-know” are the research questions of this thesis.

However, please be noted that the thesis does not serve as feasibility assessment of transition pathways nor of technological trajectories. The thesis is neither to discuss which transition pathway is the most feasible nor to assess how likely a certain technological breakthrough occurs. Rather, the scope of the thesis is limited to the understanding of societal transition and transition management. The thesis treats uncertainty equally as a possibility to change the societal transition pathway like "if that happens (regardless of how technically feasible it does), it may change a societal transition to this way".

That being said, it is obviously absurd to treat "all" uncertainty equally, as if to say that the likelihood of alien technology being introduced to the human beings to instantly solve our sustainability issues is equal to the likelihood of the decrease in installation cost of solar PV. The bottom line is that the thesis produces scenarios without much focus on technological feasibility but with consideration of reality and causal mechanism. For this, the thesis would like to use the word "plausibility", the quality of seeming reasonable or probable.

The thesis contains the following 6 chapters. Chapter 1 is dedicated to introducing two important themes of this thesis, sustainable development and societal transition. In this chapter, the thesis further formulates theoretical frameworks. Chapter 2 is to holistically understand the problems that the thesis is looking at. Precisely speaking, the Japan's current energy system and historic energy transition are problematized in the eye of the theoretical frameworks introduced in Chapter 1. Based on the problematization in Chapter 2, the thesis sets a hypothesis and research questions in Chapter 3.

To approach toward the research questions, the thesis discusses and develops a research strategy and method to approach toward the research questions. In so doing, Scenario Planning is introduced as a research method. In Chapter 5, the thesis analyzes data collected in a manner introduced in Chapter 4 and creates four different scenarios, each of which represents Japan's energy system in 2030. Finally, in Chapter 6, the thesis makes a discussion to answer the research question through making implications of societal transition pathways to reach each of the scenarios created in Chapter 5.

Incidentally, some readers may be surprised at the length of the thesis. To be frank, the reason is because of its research method. To create scenarios, it requires an extensive understanding of the historical transition to theorize the basic interdependencies of the current system (this is correspondent to Chapter 2). By this, we can comprehend what social factors have been affecting the Japan's energy transition. In order words, to understand how the Japan's energy system may change in the future is likely dependent on how a change of those social factors delivers a change in a system-level. Thus, the possible change of these social factors will need to be discussed (this part is correspondent to Appendix). These parts are indeed space consuming but are definitely needed to make a less biased and less myopic interpretation of the future scenarios. For the readers in hurry, please refer sections' summaries attached in each end of sections.

Chapter 1. Theme

In this chapter, two main themes of this thesis are introduced, sustainable development and societal transition. The thesis further builds theoretical frameworks to capture these themes.

1-1. Sustainability and Sustainable Development

There have been several attempts to conceptualize how human's development should be. However, we still have not reached to the consensus on this matter. The biggest problem in consensus building has long been lied at irreconcilability among economic development, environmental protection and social equity. Those who claim precedence of environmental protections over the development of other fields tend to view the never-ending economic growth as detrimental to the natural environment. On the other hand, the market optimists claim the economic development is the key to solve environmental issues, thus it must be prioritized. There is also an assertion that the economic development model that constantly creates disparity between winners and losers is the root of social issues. Yet it is also discernible that the economic development certainly increased the average level of social wellbeing (Hardin, 1968; Meadows, Meadows, Randers, & Behren, 1972; Næss, 1973; Opp & Saunders, 2012; Robbins, 2012). As to address this issue of disconnections, the concept of sustainable development is attracting widespread interest due to its reconcilability.

According to the so called "Brundtland report", sustainable development (hereafter SD) is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). In other words, what this concept suggests is that "continuous growth is possible if it's done in the right way" (Vig & Kraft, 2013, p. 372). More specifically, it suggests "the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" (Langhelle, 2000; WCED, 1987, p. 43).

OECD later elaborated this idea as the so called The Three Pillar Approach, asserting that the development should ensure that the economic, social and environmental systems are simultaneously sustainable (see *diagram 1-1-1*). Namely, "Satisfying any one of these three sustainability systems without also satisfying the others is deemed insufficient."(OECD, 2016). It also emphasizes that sustainable development is not a local challenge but a global challenge that has to be considered as a common goal for all nations and has to be sought in a co-operation at global level (WCED, 1987). Therefore, this concept aims to harmonize the economic development with social equity and environmental protection at global level, hence the traditional disputes could be avoided at least ideologically.

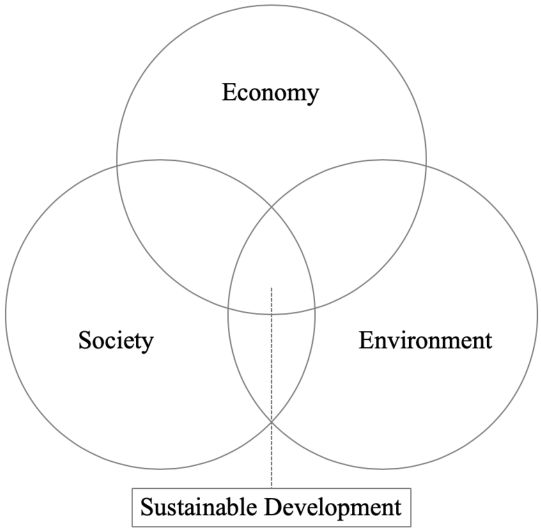

Diagram 1-1-1. Sustainable Development as in Three-Pillar Approach (OECD, 2016).

However, this concept often sparks a criticism on its impracticality. After more than three decades since the concept was introduced for the first time, "no clear definition of sustainable development exists to guide politicians in solving challenges at the global or regional levels. Rather, the concept's use has increasingly reflected socially desirable attributes of solutions to local- and project-level problems", as Holden, Linnerud, and Banister (2014, p. 130) point out. The concept has evolved so inclusive, comprehensive and complex that it is no longer viable as a guideline in policy making (Holden et al., 2014).

Indeed, it is often the case that sustainability issues manifest as local challenges, so it is skeptic that the sustainable development serves as the global guideline for policy-making. Take the global warming as an example. The impact of the warming differs by regions: some regions are more geographically vulnerable to temperature increases. Some regions are in more socially vulnerable structure (i.e. corruption) to tackle with this problem or some are economically incapable of solving these issues.

However, these challenges are often the products of globally-intertwined network (Robbins, 2012). The global warming is an issue attributable to anyone on this plant, and an income disparity among regions and nations is a result of capitalism overarching the global system (Robbins, 2012). Thus, economic, social and environmental issues need to be a challenge tackled at a global level to materialize the sustainable development. Sustainable development does not have to be a guideline for policy making since there are not any "one-fits-all" policy measures to solve various local issues at once. However, the concept can still be seen as a vital component as an ethical standard or a development goal to change the global system (Olsen, Langhelle, & Engen, 2006). How and when to achieve the goal has to be relied at the local policy-makers' discretion.

1-2. Societal Transition

Geels and Schot (2010) claim that there are five basic characteristics in societal transition. First, it is "a co-evolution process that require multiple changes in socio-technical systems or configurations" (p. 11). Second, it is a multi-actor process. Third, it is a fundamental transformation that changes the whole shape of system. Fourth, it is a long-term process that usually takes up to 40-50 years though an actual breakthrough can occur far more rapidly such as in 10 years. Finally, it is "macroscopic" rather than "microscopic", by which it means a collective and societal action rather than individual-level actions (p. 12).

These characteristics demonstrate the great challenge of capturing the dynamics of societal transition because it necessitates us to proceed seemingly contradicting approaches. The societal transition is carried out by multiple actors thus microscopic network analysis is important, but it is a macroscopic dynamic. It is also a long-term and drastic process, but the demarcation issues arise on how drastic and long-term it should be. This implies that we need a framework that captures the societal transition with a right mix of macro (collective and societal level) and micro (individual event) perspective.

1-2-1. Multi-Level Perspectives (MLP)

Multi-level Perspective (MLP) is proposed by Geels (2002) as to bridge the three theoretical backgrounds: Science Technology Study, Evolutionary Economics and Structuration Theory.

> MLP emphasizes how the alignment of trajectories within levels, as well as between levels, will produce transitions. Building on Braudel's notion of different levels of historical time, the MLP starts from three levels: a) technological niches; b) socio-technical regimes; and c) socio-technical landscape. The relationship between the three concepts can be understood as a nested hierarchy, meaning that regimes are embedded within landscapes and niche within regimes. (Geels & Schot, 2010, p. 18)

Each level is comprised of heterogeneous networks (configurations) that represent alignments explained by Science Technology Study (i.e. bricolage, seamless web), and each level produces different kinds of coordination (structure) for local practices, but differ in terms of stability; socio-technical regimes (ST regime) are relatively stable and large in human networks (with already established institutions and infrastructures) whereas niches are more unstable and small in human networks. Inter-level analysis involves the insight from evolutionary economics where niches provide variations and the alignments with regime and landscape perform the selection and retention mechanism (Geels & Schot, 2010).

Incidentally, the term 'socio-technical' implies the multi-dimension of what technology holds in light of societal transition. Technology plays a plural role because "it does not only involve the development of knowledge and prototypes, but also the mobilization of resources, the creation of social networks (i.e. sponsors, potential users, firms), the development of visions which may attract attention, the construction of markets, and new regulatory framework" (Geels & Schot, 2010, p. 12). The technology induces actors to combine various elements extant in the society (i.e. physical artifacts, scientific knowledge, legislative artifacts and organizations), and creates new configurations (Hughes, 1986). Thus, technology, in the perspective of societal transition, does not only refer the technical aspect but also a social aspect (Geels & Schot, 2010).

Socio-technical regime

The rule in ST regime account for the stability and lock-in of ST systems. This is based on the view of Structuration theory. In Structuration theory, "rules and resource" (= *structure*) embody actors where "rules refer to cognitive, interpretive frames and to cultural norms. Resources refer to economic/allocative resources (control over things/money) and authoritative resources (control over people)" (Geels & Schot, 2010, p. 42). Thus, "rules and resource can be combined in different ways, and provide the medium through which social interaction takes place (Tucker, 1998, p. 82). The term "rules" also needs a special attention in this context. Geels (2004) claims that it has mainly three dimensions: regulative, normative and cognitive rules (Geels, 2004 referring to Scott (1995)).

> The regulative dimension refers to explicit, formal rules, which constrain behaviour and regulate interactions, e.g. government regulations which structure the economic process. It is about rewards and punishments backed up with sanctions (e.g. police, courts).[…] Normative rules are often highlighted by traditional sociologists. These rules confer values, norms, role expectations, duties, rights, responsibilities. […] Cognitive rules constitute the nature of reality and the frames through which meaning or sense is made. Symbols (words, concepts, myths, signs, gestures) have their effect by shaping the meanings we attribute to objects and activities. (Geels, 2004, p. 904)

For example, regulative rules may favor the existing regime. Cognitive and normative rules and routines directs engineers and designer into certain focus while hindering to see the possibility that exists outside of the cognition. Those rules can be produced by, for example, people who possess authoritative resources. In other words, actors produce rules and rules direct actors. This iterative cycle bis called duality of structure. Actors are embedded in the structure, but they are also the ones who reproduce the structure through their concrete actions in local practices. Hence the structures are both medium and product of actions (Giddens, 1984).

The stability and lock-in of ST systems are explained by this duality of structure: the rules in ST regime does not only embody the actors within but also they are reproduced by practices in the actors within. The actors in ST regime are embedded in "the webs of interdependent relationships with buyers, suppliers and financial backers […] and patterns of culture, norms and ideology" (Geels, 2004, see Diagram X; Tushman & Romanelli, 1985, p. 177). In other words, ST regime is stabilized by people who have material incentives to back one technology. They often form an interest group or professional association and lobby to represent their interest in politics, to ensure stability of the system that suffices their interests. Of course, it does not mean that the ST-regime stops developing the system, but they do so in a conservative and incremental manner, leading to cumulative technical trajectories (Geels & Schot, 2010, p. 21).

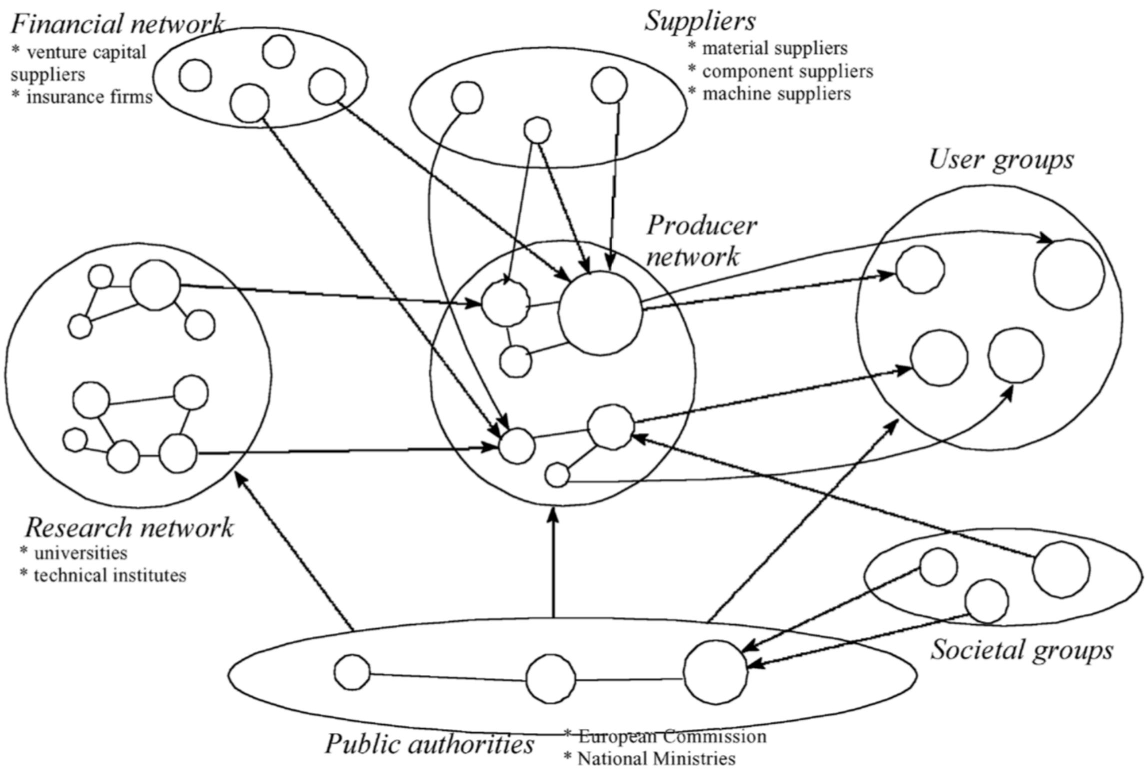

Diagram 1-2-1. The multi-actor network involved in sociotechnical regimes (Geels, 2004, p. 1260).

However, the conservative and incremental development can neglect the needs of radical changes that are essential to increase an efficiency of the system but are disfavored as they harm the incumbents' interest. As Moe (2014), citing the Olson (1982) observation on vested interests, states that "without major shake-ups, any economy gradually becomes ever more inefficient. This has to do with vested interests wresting power away from elected policy-makers, in extreme cases ending up with so much power that politics is reduced to propagating the interests of the most powerful vested interest groups." (p. 279).

Thus, the ST regime tends to avoid radical changes and employ minor changes in the configuration in order to adapt with the changing environment. However, at times, "changes in trajectories are so powerful that they result in mal-adjustments, tensions, and lack of synchronicities. These tensions create windows of opportunity for transitions" (Geels & Schot, 2010).

Niches

Evolutionary economics emphasizes that variation is normally born in the firm-specific technology search process, thus is embedded within the configuration of ST system: they attempt to intentionally deliver new technology through incubating and protecting novelties. However, Schumpeter's evolutionary economics views that "there is a steady rise and fall of industries, linked to technological progress, often grouped in waves of innovation, waves of stagnation, 'waves of creative destruction.'" (Moe, 2014, p. 279). In other words, the change does not necessarily occur within the firm but occur in social contexts. According to Levinthal (1998), "the dramatic breakthroughs that set the technology on a new course were less technological in nature than discoveries of new domains of application" (p. 244). Levinthal takes an example of the internet, the technology that was initially developed exclusive to the domain of military application. When the internet is later applied in private sectors, a number of new ways to use this technology was invented. As a result, the internet diffused throughout the world and changed the basic way of communication. In other words, it implies that "new technologies, markets and user preferences need to be co-constructed" (Geels & Schot, 2010, p. 22).

In the context of MLP, this co-construction process is found in niche-level. The niche level does not only represent an emerge of new technology but it also embodies a learning process, a human network that nourish new technology, and an articulation of visions to direct the actors within. It is set to diffuse throughout the society "not only with improvements in the technology compared to competing technologies, but also with the costs and availability of complementary technologies and with institutional changes in organization, ideas, norms, and values (Rip & Kemp, 1998, p. 328).

Socio-technical Landscape

ST landscape is an exogenous environment that niche and regime cannot directly give influences on (i.e. macro-cultural actions, environmental issues, economic market and social issues). Normally, ST landscape is stable in long term, and changes occur moderately but continuously. Nevertheless, it can also change drastically in short time (i.e. war, natural disaster), which can, at times, destabilize the ST configuration and support niches (Geels & Schot, 2010). In sum, "the socio-technical landscape does not determine but provide deep-structural gradients of force that make some actions easier than others" (Geels & Schot, 2010, p. 28).

Take the public sentiments toward nuclear energy in Japan for example (for more detail, see *Chapter 2-2*). As of 1970s, Japan had become one of the most pro-nuclear state backed by strong public supports toward nuclear energy. Although it had slight backlash during late 80s and 90s due to domestic and foreign nuclear accidents and disaster, the general stance of the public continued to support the use of nuclear energy. However, Fukushima disaster suddenly turned this stance upside down: the majority of people disfavored the continuation of nuclear power plants and preferred either immediate phase-out or gradual decrease of the capacity (Kitada, 2013; Midford, 2014).

Multi-level perspective on transition

Geels and Schot (2010) argues that the societal transition process is a continuous interaction of aforementioned three levels (see *diagram 1-2-2*). X-axis provides a timeframe whereas Y-axis indicates "the increasing degrees of hardness: the socio-technical landscape provides a broad context from which it is more difficult to deviate than from regimes" (Geels & Schot, 2010, p. 28).

ST regime reproduces/revises the rules and routines. They are normally stable with its strong path-dependency for protecting its configuration. On the other hand, niche actors are embedded in different kinds of rules and routines that are yet firmly established. ST landscape plays a pivotal role in this dynamics; they either like or dislike the ST regime and niche actors (i.e. change of user preferences, social awareness) and provides "deep-structural gradients of force that make some actions easier than others" (Geels & Schot, 2010, p. 28). When the landscape either puts pressure on the ST regime or supports (or gives an expectation) on niche actors, the ST regime (and its configuration) gets destabilized and creates a window of opportunities for niche. Thereby the new ST regime will be born and influence on the landscape, and the society changes.

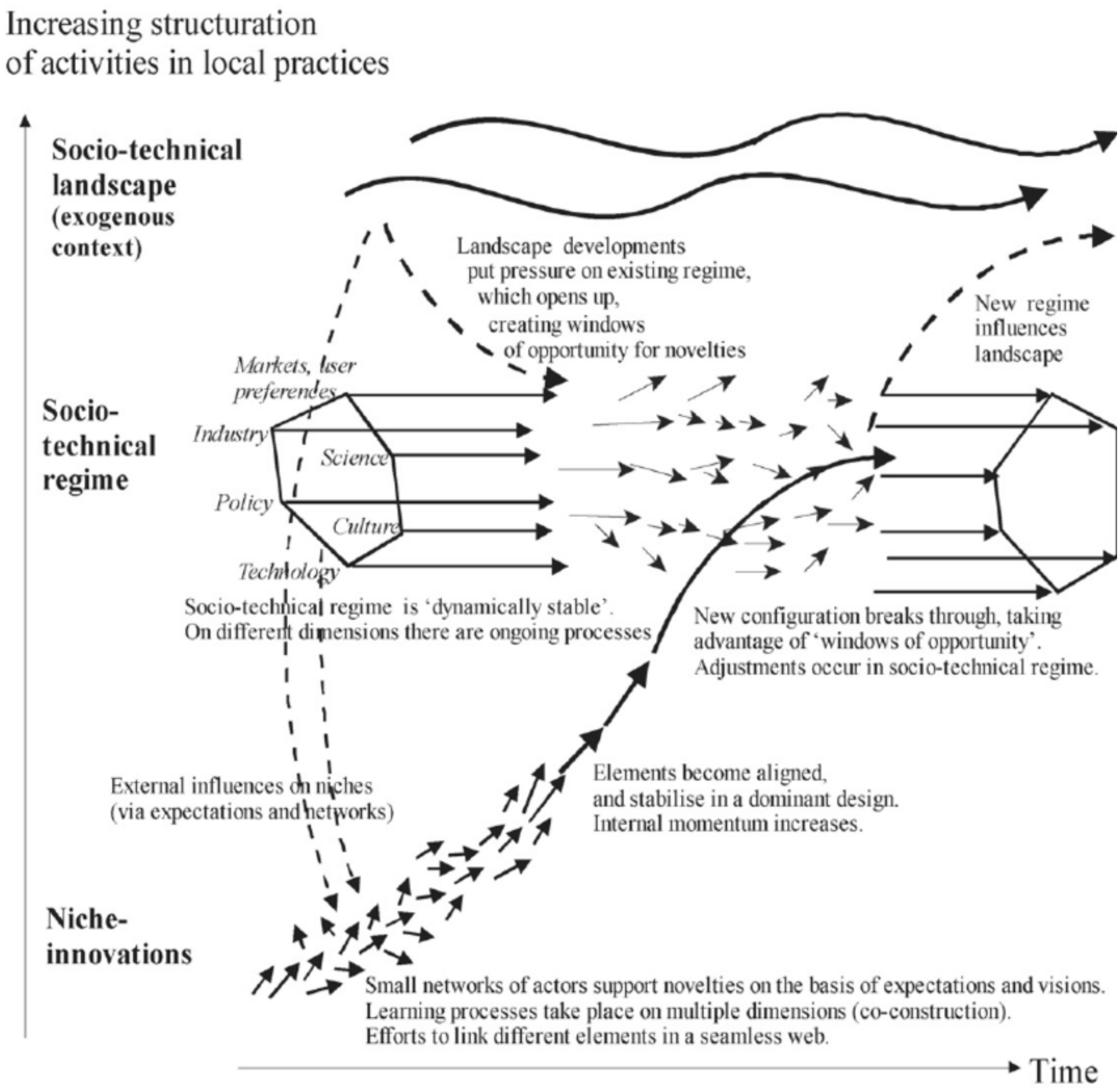

Diagram 1-2-2. Multi-level perspective on transitions (Geels & Schot, 2010, p. 25)

Empirical example

The empirical example can be seen in the hygienic reform of waste disposal in the Netherlands during the late 19th. In mid-19th centuries, working class families in Netherlands did not have in-house sanitary facilities and disposed waste on streets, surface water or in cesspools which were emptied a few times a year. Yet, the cesspools in households also had a pipe to dispose their contents in canals or gutters. As a result, the city in Netherlands were in a serious risk of contamination, and of blocking water circulation due to accumulated excrements and creating stench. Nevertheless, local policies for public health and waste removal was limited as the hygiene was considered as individual's responsibility (Geels & Schot, 2010).

During 1840s and 50s, the waste disposal regime, mainly the city authority, started facing increasing pressure from hygienists doctors who just found the correlation between infectious disease and water quality. In response, the city took an incremental improvement, mainly to improve the water circulation in canals and water ways, using steam engines to pump up more fresh water there. This causes a backlash from ship owners and shopkeepers who used the canals for supplying and producing goods. During 1870s and 80s, the population of cities rapidly increased due to industrialization and the cholera epidemic made the problem more severe. The hygienist doctors formed a coalition with civil engineers for sanitary reform and put stronger pressure on the regime. However, the regime also could not provide feasible schemes to effectively counter the situations so their general responses were simply using the traditional method in 40s and 50s (Geels & Schot, 2010).

During 1890s, an urbanization continued to worsen the problem and the pressure from hygienist's coalition was straightened, but this time, with public opinions emerged from higher awareness toward cleanliness, social issues and the authority's responsibility. With a plenty of tax income yielded from rapid economic growth during 1890 and 1914, the city could take an encompassing solution this time, the sewer system which consists of toilets, funnels and underground pipes connected to a reservoir. Although the sewer system was already introduced in 70s and 80s, it was difficult to implement due to the economic feasibility. However, in 1890s, a new regime made a more favorable circumstances for this scheme, the regime which was growing with the diffusion of piped water systems and WCs (Geels & Schot, 2010).

As you can see from this case, the landscape (= public expectation on the role of authority for hygienic in waterways) and lack of niche actors during 1840s and 50s provided the regime a reason for keeping status quo despite of apparent hygienic issues. Although the hygienic doctors who discovered a correlation between water quality and infectious disease pressured the regime, their voice was not strong enough for the regime to make radical solution. This led the regime to provide incremental changes that they could do in an existing system. However, it did not only solve the problem, but also could not stop an aggravation of the issue. In 1870s and 80s, the landscape pressure was straightened with a support from public opinions. In this time of period, the idea of sewage system (niche) was also introduced but simply could not replace the existing system due to economic infeasibility. Finally, in 1890s, supported by the rapid economic growth (landscape) and the diffusion of piped water systems and WCs (niches) opened a window of opportunities to change the regime configuration.

1-2-2. Criticisms on Multi Level Perspective

MLP can serve as a descriptive framework that understands and captures the dynamics of societal transition as a product of multi-level interactions. However, as Rotmans and Loorbach (2010) argues "the imprecise definition of the vertical axis, a consistent division of what exactly is situated on what scale level is still lacking" (p. 133). This inhibits us to look at the dynamics of patterns to understand "basic interdependencies over time, according to certain laws or rules. […] what we can do, however, is produce best guesses in a qualitative manner, but this is not rooted in scientific laws or rules, and therefore more difficult to verify solidly" (p.133).

Similarly, Smith, Stirling, and Berkhout (2005) criticizes MLP as it devalues the significance of agency and power. This is emphasized by structuration theory, one of the core theories that MLP is supposed to find its theoretical root. They argue that the distribution of agency and power differs in the membership of the ST regime. Indeed, some members in the same ST-system are subjugated by more powerful members. What this implies is that each of the faces of power involves different actors and institutions in relation to one another. The agency enjoyed by any group of actors, and the associated power relations, can only be understood in relation to other actors. This suggests that "an agency-based approach to understanding regime transformations must extend beyond the usual bounds to consider the basis, nature and bounding of regime membership" (p. 1504). However, MLP reduced such complicating structural force into a linear arrow that indicates an interaction of different levels.

Furthermore, the issue of vertical axis in MLP also calls a question, especially about political landscape. Meadowcroft (2011) argues;

> Politics (including not just the behavior of government but also that of other actors) is manifest on each of the three levels of the multi-level perspective. At the landscape level it influences the general economic climate (growth or stagnation, free trade or protection), the orientation of innovation and the ways technologies are deployed (through political projects such as national unification, defense, and so on). At the regime level, legal structures and regulatory initiatives support (or sometimes undercut) dominant regimes; states are dependent on revenues drawn from prevailing economic practices; and political and economic actors become entangled. At the niche level, specific government programs can protect or expose niches and encourage or discourage innovation. (p. 71)

The position of political actors becomes even more crucial in the context of sustainable development. This is because, as discussed in *section 1-1*, sustainable development is a normative project at global level that requires each nation to comply international agreements, thus is explicitly political (Meadowcroft, 2011). MLP fails to acknowledge and understand such 'top-down' transition contexts (Berkhout, Smith, & Stirling, 2005).

1-2-3. Complex Adaptive Systems Perspective

We understand that the existence of x-axis in MLP enables us to capture societal transition chronologically. However, by doing so, the complex interdependencies of agency and power are dampened into vaguely defined three levels and linear arrows. To address this issue, Loorbach (2007) proposes an alternative model, Complex Adaptive Systems (CAS) perspectives.

The CAS attempts to discover and comprehend underlying patterns in complex (seemingly chaotic) systems, the "patterns that describe potential evolutions of the systems" (Dooley, 1997, p. 76). In so doing, CAS is based on the view that "systems transition naturally between equilibrium points through environmental adaptation and self-organization; control and order are emergent rather than hierarchical" (p.76). Furthermore, as for environmental adaptation, it elaborates as that "the system as a whole adapts to (changes in) its environment because of the capacity of the individual components to respond to changes in their environment" (Loorbach, 2007, p. 55). On the other hand, CAS also acknowledges that a system has an ability to create orders without any external control (self-organization) (Loorbach, 2007). In other words, the system adapts with the changing environment as well as tries to create orders on its own. By doing so, new pattern emerges.

For CAS to capture an interaction in the system and an interaction between the system and the environment, it must identify the following three points; system-internal, system-specific and system-external developments. In other words, from the perspective of MLP, it implies that "the dynamics of a societal system are determined by their internal interaction (regimes, niches, co-evolution) and the interaction between the system and its environment." (Loorbach, 2007, p. 21). As for system, Rotmans and Loorbach (2010) further define it as comprised of three different sub-systems at three different functional levels: a regime, a nich and a niche-regime (empowered niche). "A niche-regime represents a niche, that has grown powerful enough to gain a number of new characteristics, most important of which is the ability to attack (sometimes effectively) an incumbent regime (and therefore to potentially take over from it)" (p. 136). Socio-technical landscape, on the other hand, is described as "underlying but powerful currents that inexorably change the context of opportunities, challenges and problems facing both the regime and niches; through differentiated response mechanisms we conceptualize how landscape signals can favor either the regime and stability, or niches and an eventual transition" (p. 136).

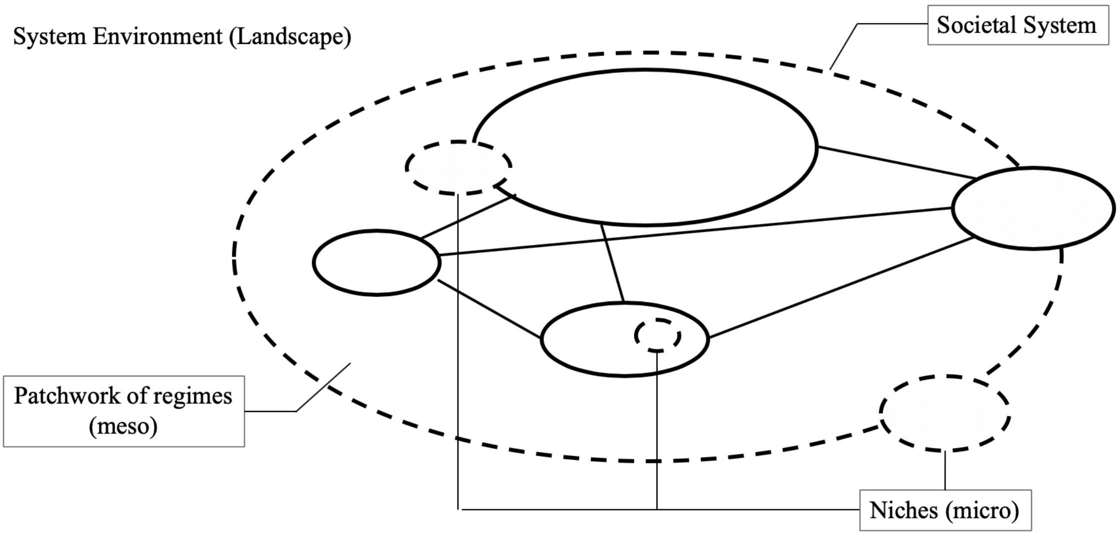

Diagram 1-2-3. Complex Systems Model based on MLP (Loorbach, 2007, p. 21).

Due to the focus on system-internal development, CAS appreciates the significance of agency and power in each level MLP presents. Due to the focus on system-external developments, CAS appreciates the significance of landscape (especially political landscape) that influences on niches and ST-regime in MLP (see *diagram 1-2-3*). However, obviously, CAS only captures interdependency in the system at a specific time while MLP captures it over a transition process. Because it is technically difficult to combine two theories into one analytical framework, what we can do is to use those two perspectives separately. We can use MLP for a holistic, chronological picture of transition. Meanwhile, we can use CAS for more detailed analysis on drastic changes in configuration and create a generalized picture of interdependencies at a certain time frame.

Empirical Example

CAS can apply to the case of the Netherland's hygienic reform of waste disposal, the case which the thesis mentioned above. During 1890s, the public expectation for the authority and sanitary management has changed due to the raising awareness toward the correlation between disease and water quality. This implies that the traditional "taken for granted" that supported the regime configuration had changed its shape and started putting pressure on the city authority to take actions. Simultaneously, new coalition which was formed by hygienists doctors who deeply concern the sewage system at that time, has gained a strong support from public opinions. Furthermore, the alternative technology (=the sewage system with toilets, funnels and pipes to the reservoir) has already existed and due to the market expansion of the water pipes and WCs in 1890s, enabled the authority to furnish the traditional methods for sewage (see *diagram 1-2-4*).

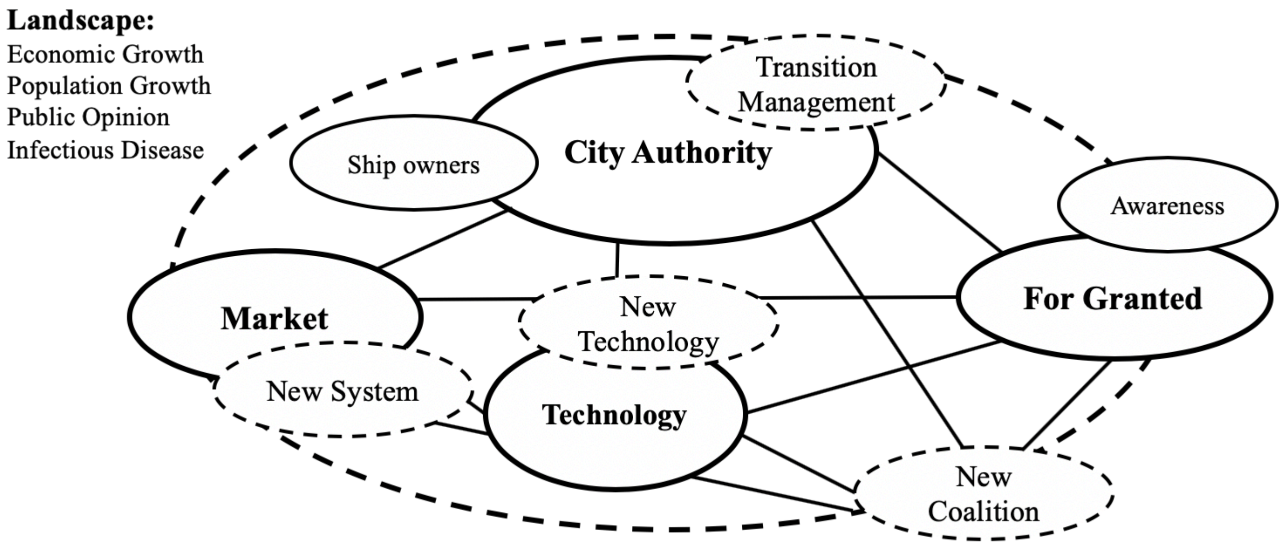

Diagram 1-2-4. the hygienic reform of waste disposal in the Netherlands during 1890s.

Chapter's Summary

In this chapter, the thesis mentioned two themes; sustainable development and societal transition. Sustainable development asserts that human development should suffice the current need, especially the need for the poor, in a way not to exploit the future generation's ability to meet their needs. According to OECD (2016)'s view, this indicates that economic, societal and environmental system needs to be developed simultaneously; "Satisfying any one of these three sustainability systems without also satisfying the others is deemed insufficient."(OECD, 2016).

As for societal transition, the thesis introduces MLP as a macro framework to capture the dynamics of societal transition process. However, it reduces complex interactions of power and agency to the level that inhibits us to capture the structure of interdependencies behind the transition process. To address this issue, the thesis also introduced another framework, CAS. Unlike MLP, CAS can explain the interactions among landscape, regime and niches in agent level, thus contribute to understand the basic mechanism behind the societal transition. However, it fails to capture the multi-sequential dynamics of transition process, the point which MLP appreciates.

Chapter 2. Problem Statement

This chapter serves as to know what the problems are, where they are and how they are. Specifically speaking, the thesis points out the sustainability issues in the current Japan's energy system and characterizes the societal transition pathway that has led to the current status.

The first section (section 2-1) is dedicated to the characterization of sustainability issues. It is discussed from the economic, social and environmental points of view by using OECD's (2005) "three pillars approach" as a guiding tool. The second section approaches to the characteristics of Japan's energy system, in light of societal transition. This section contains two sub sections (*2-2-1 and 2-2-2*). Section *2-2-1* looks at the historical Japan's energy transition, using MLP and CAS as analytical tools. On the other hand, section *2-2-2* tries to capture the current interdependent structure in the system. As such the thesis articulates both sustainability issues and transitional issues of Japan's energy system.

2-1. Are there sustainable issues in Japan's energy system?

Before jumping into the issues in Japan's energy transition, the thesis will look at what sustainable issues the current Japan's energy system contains. To do so, the thesis uses OECD's (2005) "three pillars approach" as a guiding tool and looks at the issues from the economic, social and environmental points of view.

Before going to the specific discussion, for the reality check, there are few basic pictures of Japan's energy system that the thesis would like the readers to keep in their minds. Firstly, please look at the primary energy supply of Japan (see *figure 2-1-1*). It shows that the total primary energy supply has been a downward trend since the early 2000s and you can also see that the country has been reducing the oil dependence since 1970s (replaced by nuclear and gas) although it still accounts roughly 25% of the country's energy mix. It also illustrates that the dependence on fossil fuel suddenly increased since 2011 due to the shutdowns of NPPs after Fukushima. Second, the financial energy consumption is illustrated in *figure 2-1-2*. As you can see, the mining and manufacturing sector is the biggest energy consumer in Japan. However, their consumption has been leveled out since the early 1990s whereas that of other sectors has grown to some extent. Third, the energy efficiency of Japan has increased greatly between 70s and 80s. Although the efficiency stagnated during 90s, it started being improved since 2000s (see *figure 2-1-3*), being one of the most energy efficient country in the world (ANRE, 2018a).

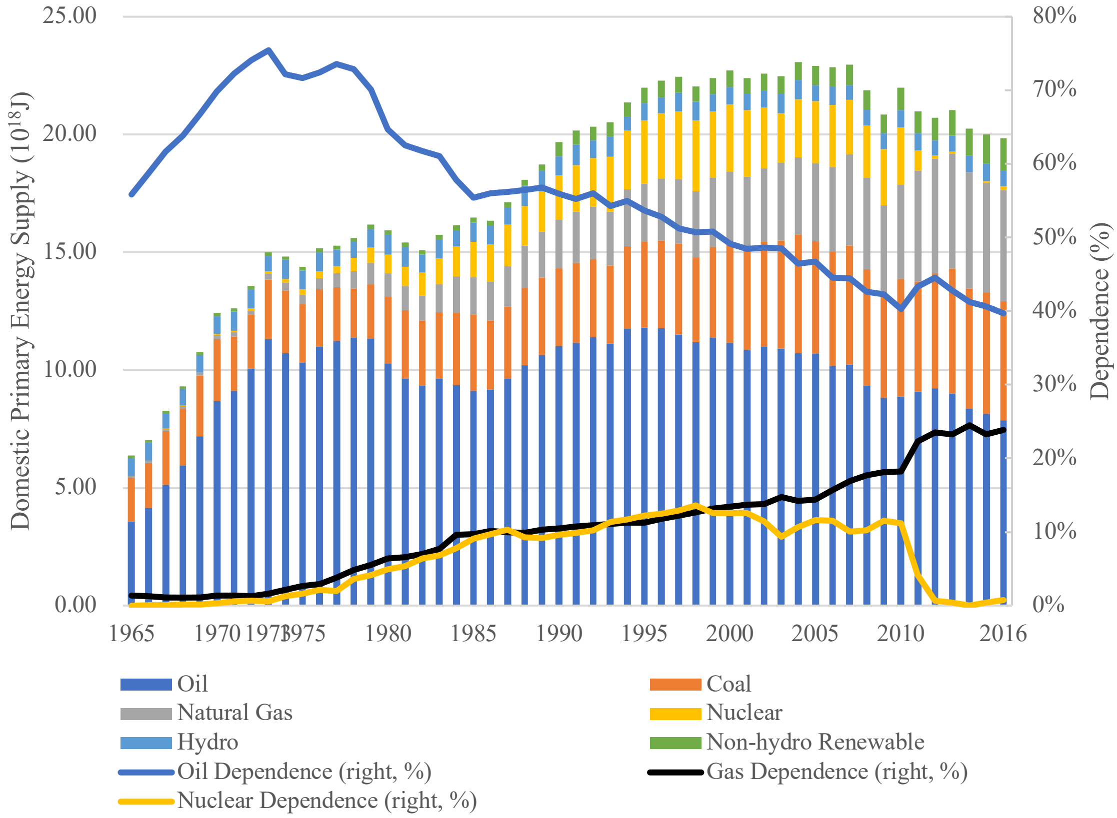

Figure 2-1-1. Primary energy supply of Japan. (ANRE, 2018a)

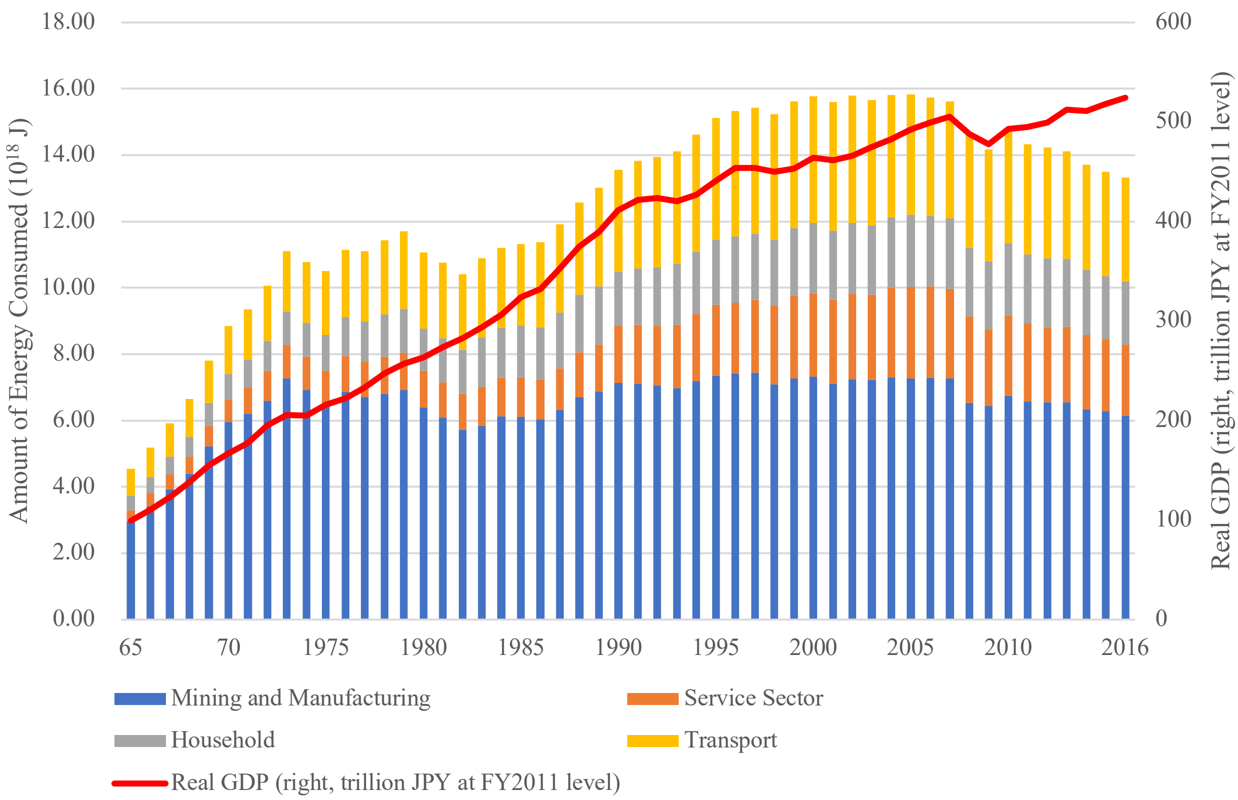

Figure 2-1-2. Final Energy Consumption and Real GDP in Japan (Agency for Natural Resources and

Energy (ANRE), 2018a).

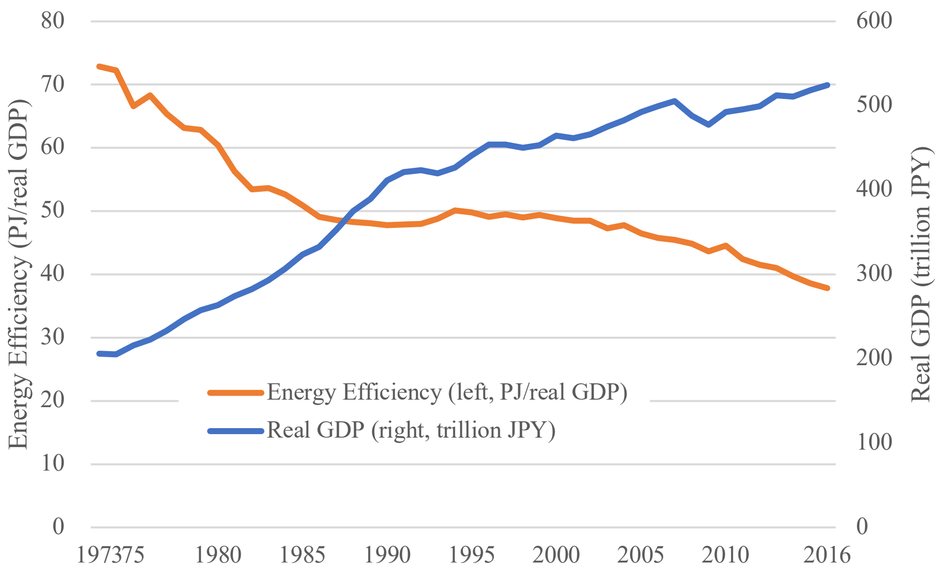

Figure 2-1-3. Energy Efficiency of Japan (ANRE, 2018a).

2-1-1. Economy

The number is significant because Japan is a fossil-dependent country: the fossil fuels comprised 93.7% of Japan's Total Primary Energy Supply (TPES) in 2015. Nevertheless, Japan has not been blessed when it comes to domestic fossil fuel sources and it imported 94% of the fossil fuels it used in the same year (IEA, 2016). This makes Japan's energy industry so vulnerable to turbulence in oil market. *Figure 2-1-4* illustrates the historical relationship between the total value of export and import, and the value of petroleum import (oil, LNG, LG gas and coal) and *figure 2-1-5* illustrates the proportional change in the value of petroleum import to that of total import (ANRE, 2018a). As you can see, the change of total import value in relation to that of petroleum value is relatively moderate in the periods such as between 1988 and 2004. On the other hand, in the periods such as 1970 and 1987, and 2005 and 2016, you can see the higher elasticity. Those are times when Japan experienced surges of oil price as the *figure 2-1-5* suggests. Therefore, Japan's economy is highly vulnerable to the change of oil price. Incidentally, the oil price itself is highly volatile, which renders the dependence of fossil fuel import even more problematic.

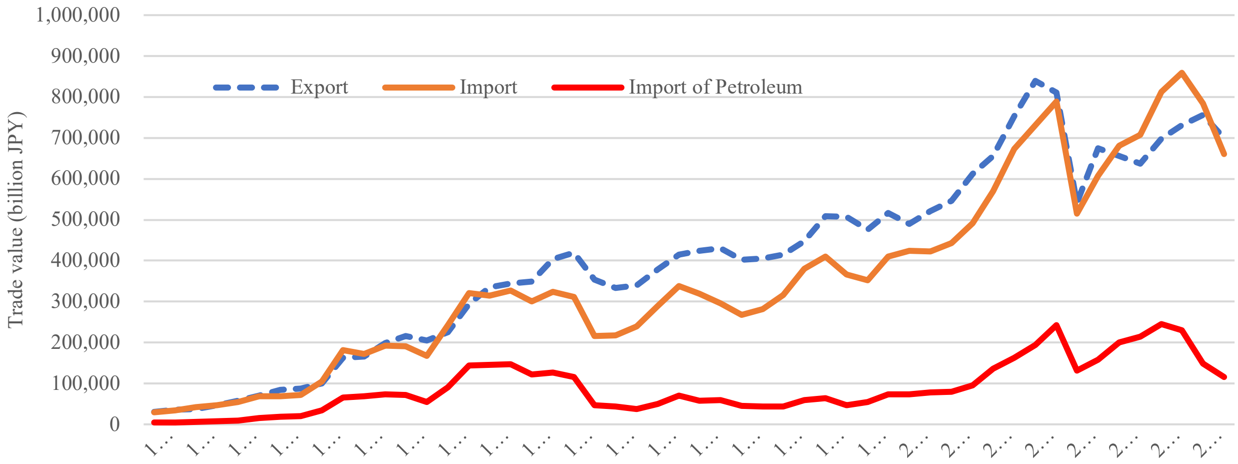

Figure 2-1-4. The relationship between trade value and value of petroleum import (billion JPY). (ANRE, 2018a)

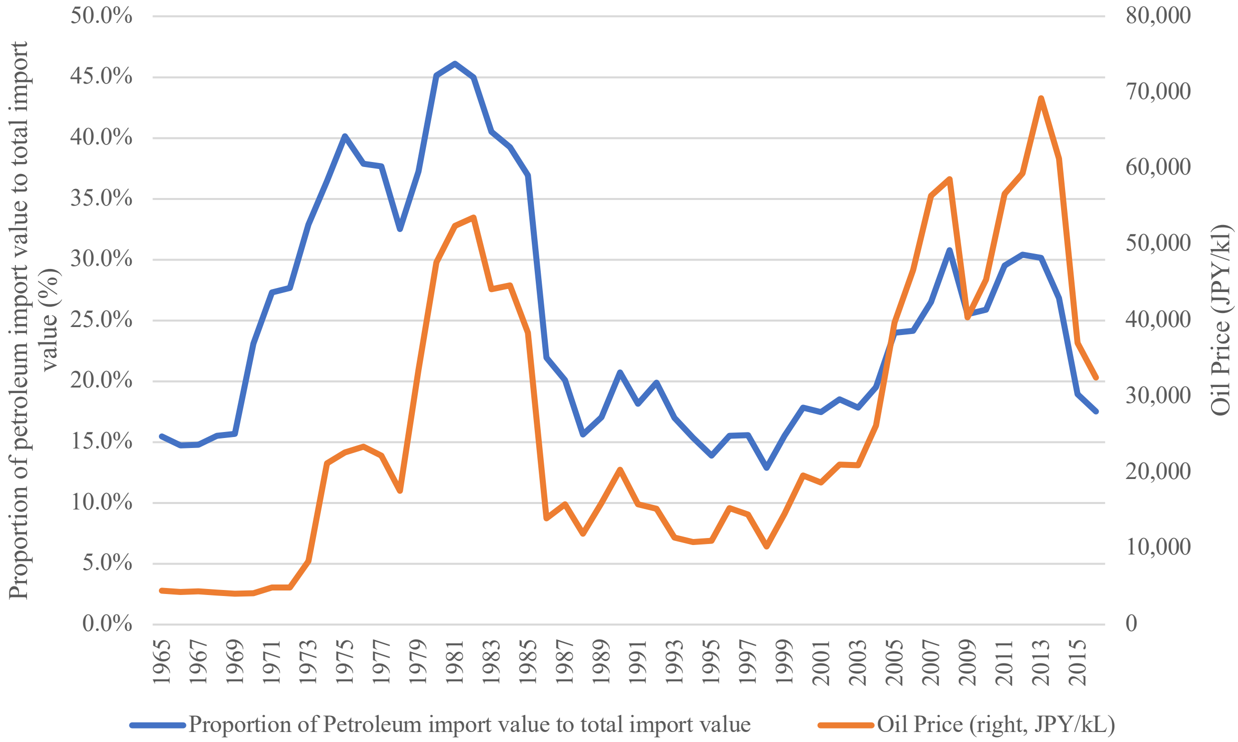

Figure 2-1-5. The proportion of petroleum import value in relation to oil price. (ANRE, 2018a)

The proliferation of spot market transaction and that of wind and solar energy in energy mix can also provide sustainability issues for power mix dependent on fossil fuel. This is explained by Merit-Order Effect (MOE). MOE is the phenomena that the conventional plant with relatively higher marginal cost will be pushed out from the market in the time when the marginal cost of renewable is lower[1] (Winkler

[1] By that, it means operators using fossil fuel need to control the output according to the market price as to ensure enough

et al., 2016).

MOE is already seen in the countries such as Germany, Spain, Australia, Ireland, Czech Republic and Denmark, the nations that achieved high penetration of renewable energy and spot market transaction (Azofra, Martinez, Jimenez, Blanco, & Saenz-Diez, 2014a, 2014b; Claudius, Hermann, Matthes, & Graichen, 2014; Jacobsen & Zvingilaite, 2010; Luňáčková, Průša, & Janda, 2017; McConell et al., 2013; Swinand & O'Mahoney, 2015). Meanwhile, the MOE in Japan is currently not as prominent as the western countries. This is because the wholesale electricity market in Japan (called JEPX) is still small. It only comprises approx. 10% of total transaction and most of the transactions are fossil fuels, as of 2018 (Maekawa, Hai, Shinkuma, & Shimada, 2018). That being said, Maekawa et al. (2018) made an model estimation of the MOE in JEPX and measured that the market price shows a slight decrease in the time with higher solar radiation. Therefore, they conclude that it is very likely that the impact of MOE become stronger if the country keeps expanding its renewable energy capacity and share of spot market.

Nuclear Power Generation

The government claims that nuclear energy is the economically cheapest option, cheaper than renewable, gas, oil and coal (see *figure 2-1-6*)(ANRE, 2017b). The underlying reasoning of this claim is their deductive prediction based on so called model power plant. The advantage of deductive prediction is to equate all external factors that influence on the cost and objectify the comparison. However, this is also a disadvantage because the prediction is largely dependent on the setting of model conditions (Berndt, 2018). In this government's prediction, the study team gathered by the government used a model plant and data provided by FEPC, and assumed that the model plant runs for 40 years at the capacity factor of 70% (ANRE, 2015).

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profit margin to cover various costs including fuel costs, labor costs and initial investment. Thus, by reducing electricity supply in the market, they could raise the market equilibrium (=the market price) in the market without wind and solar energy. On the other hand, marginal cost for wind and solar energy is essentially lower as they do not require fuel input. This also implies that the output of wind and solar energy cannot be controlled by adjusting the fuel input. They can do it only when the operators have electricity storage (which is not very common). In other words, they can't do anything but to provide electricity regardless of the market price. Thus, the higher penetration of wind and solar producers in the market, the market equilibrium decreases and as a result, a market pushes out those with higher marginal costs such as gas and oil power plants (Winkler, Gaio, Pfuger, & Ragwitz, 2016).

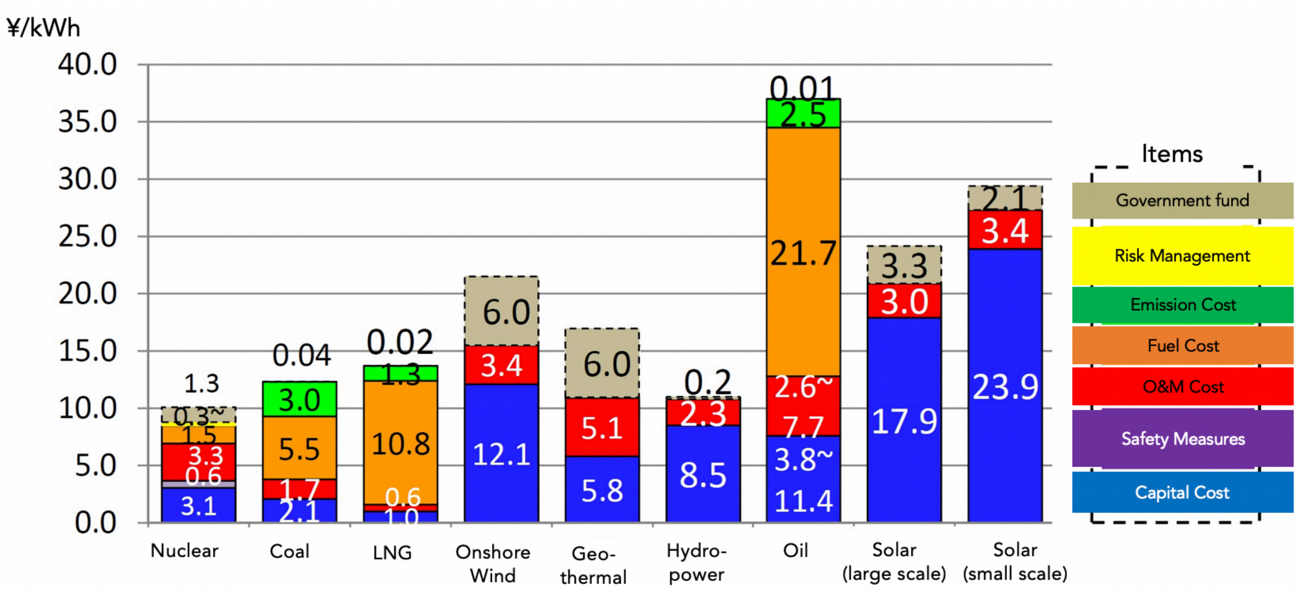

Figure 2-1-6. The government's estimation of unit costs by generation technologies (ANRE, 2017b, translated by the author).

This is already a sustainability issue. To validate this claim, all plants need a stable market and demand for almost a half century. However, in reality, the electricity demand (along with energy demand) already peaked in mid-2000s and has been a downward trend since then (ANRE, 2018a). Considering that the Japan's economy and demography has been in a chronic stagnation since 1990s, it is highly questionable how feasible the 70% of utilization can last for 40 years. Furthermore, the history also supports this skepticism. When you look at the historic change of utilization rate of NPPs (see *figure 2-1-7)*, the rate was constantly above 70% only for approximately 20 years between 1983 and 2002 (plus in 2006). In addition, Japan ended up shutting down all the nuclear power plants after Fukushima, leading its utilization rate to zero between September 2013 and August 2015. Since then, it is still highly uncertain how many of them will restart again passing through tighter measures (Castelvecchi, 2015).

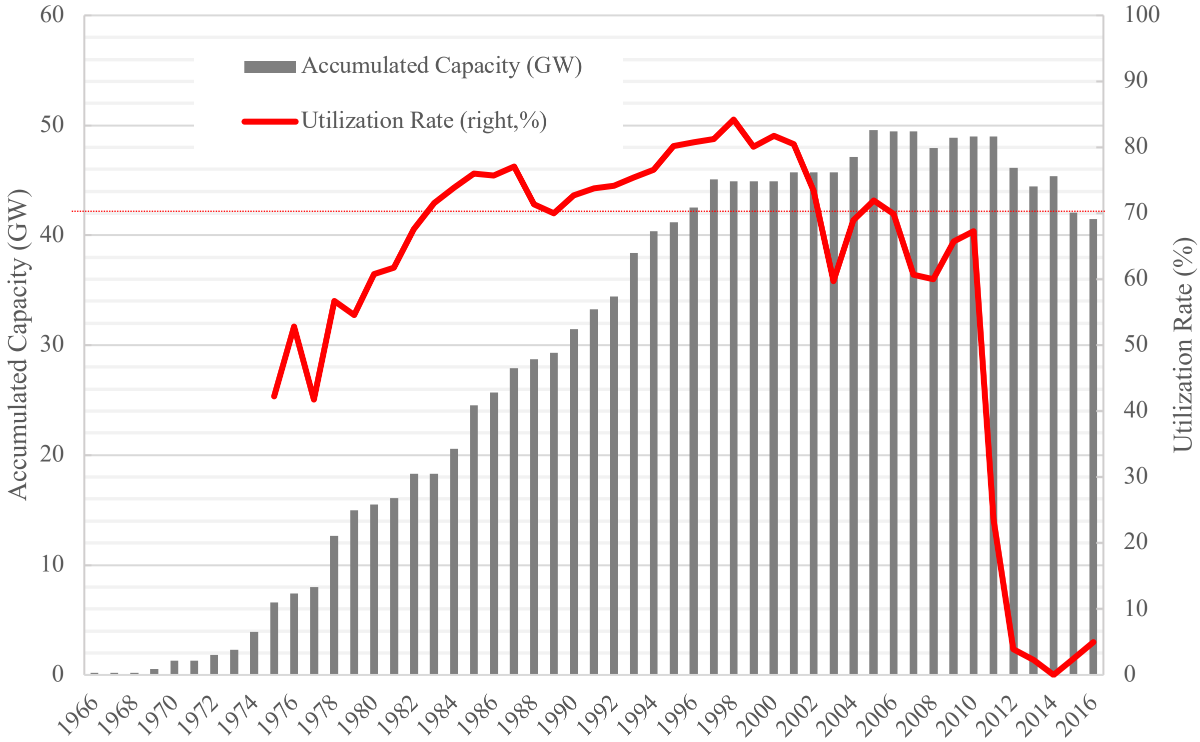

Figure 2-1-7. The accumulated capacity and utilization rate of NPPs (FEPC, 2017; METI, 2018b).

In addition, some variables are heavily underestimated in the government's prediction. The prediction sets the capital cost for NPRs at 400 billion JPY (370,000 JPY/kWh) while the costs of NPR projects by Mitsubishi Heavy Industry in Turkey and by Toshiba in State of Georgia in the US have been over 1 trillion JPY each (Ito, 2018). Furthermore, the government's prediction is criticized as not taking systematic and social costs into account (i.e. government subsidies and guarantees). The notable systematic exclusion is the government subsidy. As *figure 2-1-8* represents, the annual subsidy toward nuclear energy (mostly for site acquirement, R&D and sales promotion) has been over 400 billion JPY between 1990 and 2016 except for during 2012 and 2015 (Berndt, 2018; Oshima, 2011). The government prediction also reduced a probability of severe accidents and related costs from 1 severe accident in 2,000 running years to 1 in 4,000 running years (Berndt, 2018). Therefore, the government's prediction justifies the NPP's economic validity by excluding (and socializing) the social and environmental costs.

The inductive predictions from economists indicate the opposite. Based on historical utilization rate of different generation types, Kumamoto (2011) concludes that nuclear power is more expensive than coal and gas power plants. He criticizes that the government's deductive prediction renders the cost for nuclear power generation unreasonably low by equating the degree of NPPs utilization rate. Oshima (2011), who analyzed the NPP operators' IR-reports, also came to the same conclusion.

Citizen's Nuclear Information Center (CNIC) in 2017 analyzed the government predictions in 2017, reflecting a) a current decrease in fuel prices, b) a damage recovery from 3-11 and c) the currently admitted increase of NPR-decommission costs. They came to the conclusion that the unit cost for NPR is more expensive than that of coal and LNG (Matsukubo, 2017).

In other words, the cost prediction of NPPs differs only as to whether include systematic and external costs. Taken these costs into account, NPPs will lose their cost advantage (Berndt, 2018). However, social risks and costs are undoubtedly extant and are not vanished by externalizing from the marginal cost. The nuclear disaster uncovered such hidden social costs and consequently incur the tax-payers (see *section 2-2-1* for more detail). Here lies a NPP's economic issue of sustainability.

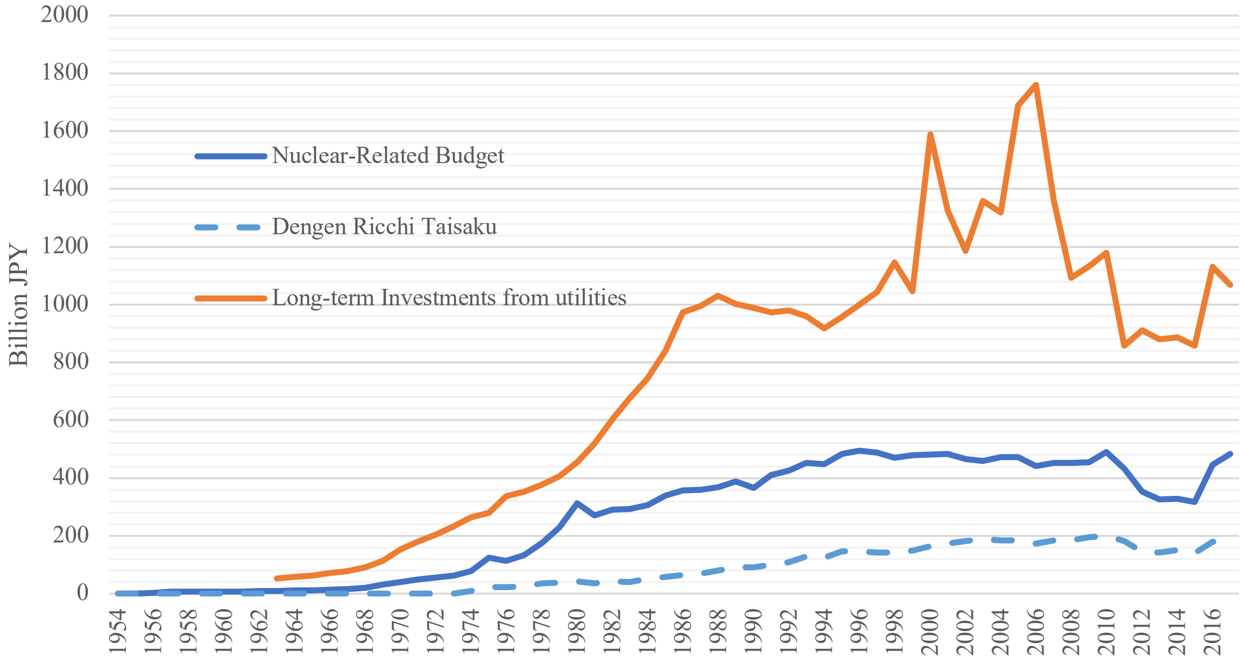

Figure 2-1-8. The Change of Nuclear-Related Budget (Genpatsu Kanren Yosan) and Power Siting Subsidy (Dengen Ricchi Taisaku Koufukin) (FEPC, 2019; Japan Atomic Energy Commission, 2019))

Renewable

Except for hydro and bio-mass, renewable energy (notably, wind, solar and tidal) without electricity storage are intermittent in nature. Since they are technologically difficult to be stored in large quantity in cost effective manner, the energy is generally used as soon as they are generated. This implies that the intermittent renewable energy tend to have lower capacity utilization rate and rely on energy source that can control its output (such as hydro-power and fossil fuels) (Bhattacharyya, 2011). Also, a unit cost of renewable energy is generally more expensive than other power generation technologies, lacking the price advantages in a complete free market. (ANRE, 2018a; IRENA, 2018). According to the government's estimation (see *figure 2-1-6* above), small scale solar PV costs about 30JPY/kWh, large scale solar PV costs about 25JPY/kWh, onshore wind costs about 23JPY/kWh, geothermal costs 23JPY/kWh. On the other hand, it estimates that LNG costs about 14JPY/kWh and coal costs about 13JPY/kWh. Although the government's estimation about the unit cost of nuclear energy is highly skeptical, that of fossil fuel is generally agreed, or even lower than the government's estimation[2] (ANRE, 2017b; Matsuo, Yamaguchi, & Murakami, 2013; Oshima, 2011).

To address the issue of diseconomy, Japan has introduced one of the world's highest rates of Feed-in Tariff system in July 2012 to incentivize more investments for renewable electricity. It successfully increased the installed capacity of renewable electricity by 270% in 5 years, but the problem is that the policy imposes tariffs on consumer's electricity bills. This implies that more renewable electricity supplies to the market, heavier burden that consumers need to take, given that the current policy remains as it is. As of 2017, ANRE (2018d) estimates that FIT comprises 12% of electricity bills, the amount which is equivalent to extra 9,500JPY/year for each household (Ishida, 2017). In response, the government plans to gradually decrease the FIT rate based on the assumption that the unit cost of renewable will decrease as it is diffused and commoditized. By 2030, the government plans to decrease FIT for wind and solar PV to 10JPY which is lower than the unit cost of hydro-power in the government's estimation (see *figure 2-1-9*). In sum, renewable electricity is still too dependent on a policy mechanism to call it economically sustainable. Uncertainty and challenge still lie at how to reduce the unit costs to the level they can be competitive even without supporting scheme.

[2] Oshima (2011) amd Matsuo et al. (2013) estimate the cost of electiricty by generation technologies, inducting from companies' IR-reports. Oshima (2011) estimates the unit costs of fossil fuel-based thermal power is 9.91JPY/kWh and Matsuo et al. (2013) estimates it 10.2JPY/kWh, although it is highly changeable depending on fuel costs.

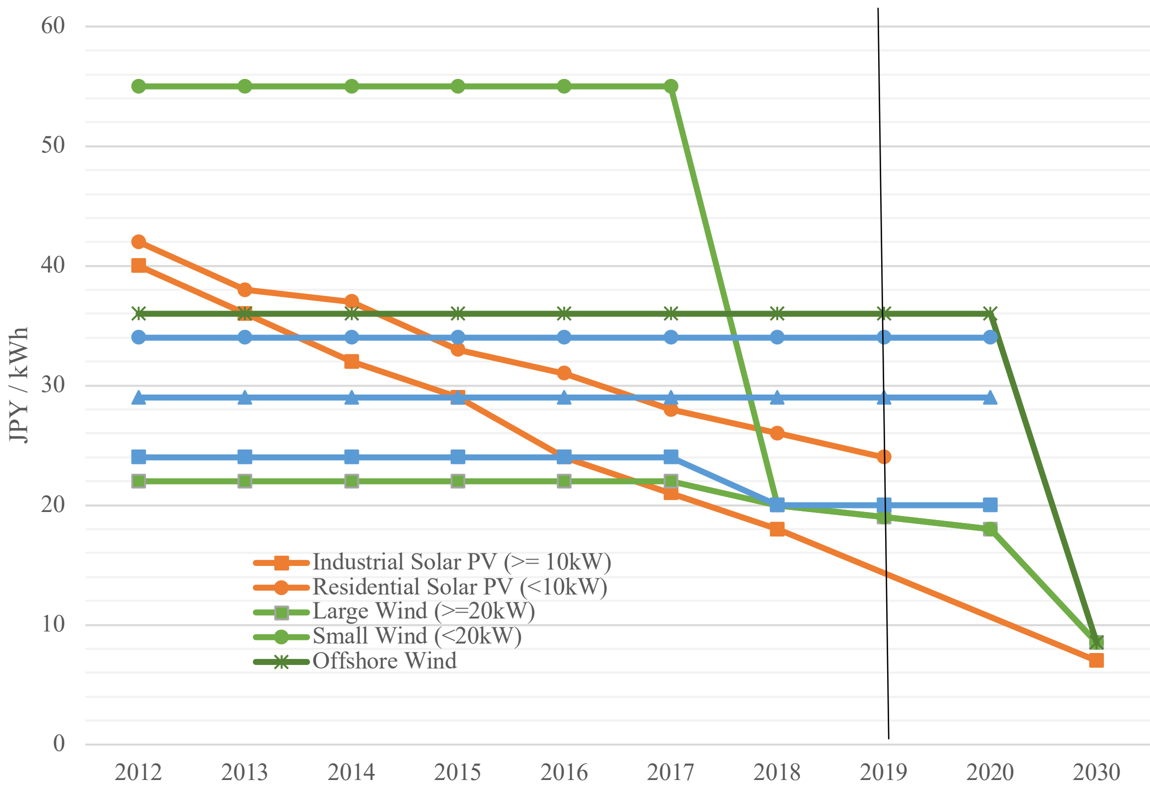

Figure 2-1-9. Historic change of FIT rate and planned changes (ANRE, 2018a).

2-1-2. Society

This part dedicates to the discussion whether the current Japan's energy system is socially sustainable. The thesis has divided Japan's energy source into three; fossil fuel, nuclear and renewable, and discusses sustainability issues in each market.

Fossil Fuel: Geopolitical Risks

As the thesis mentioned in the previous section, Japan relies almost all of their fossil fuel on imports. This is not only about economic risk but also political risk. *Figure 2-1-10* represents where Japan imports natural gas from. According to the figure, the import source for natural gas is quite diverse: 77% of the natural gas is imported from Asia Pacific and other areas whereas only 22.8% are from the Middle East. On the other hand, the oil importation contains more geopolitical risks. According to the *figure 2-1-11* from ANRE (2018b), more than 85% of the oil comes from the Middle-East, the area in which political situation is unsettling.

Japan has been reducing dependence on oil since the oil shocks in 70s, and it only comprises less than 10% of the country's power mix (ANRE, 2018b). However, the country's transportation industry is still heavily dominated by gasolines and light or heavy oils (see *Appendix 12 for detail*): 97% of total fuel consumption in passenger transport is derived from petro-fuels (including gasoline, light and heavy oil and jet fuel) and 99.8% of total energy consumption in freight transport is derived from those (ANRE, 2018a). As a result, oil still comprises 40% of Japan's primary energy supply, the amount which is easily the biggest energy source in the country (see *figure 2-1-1* above).

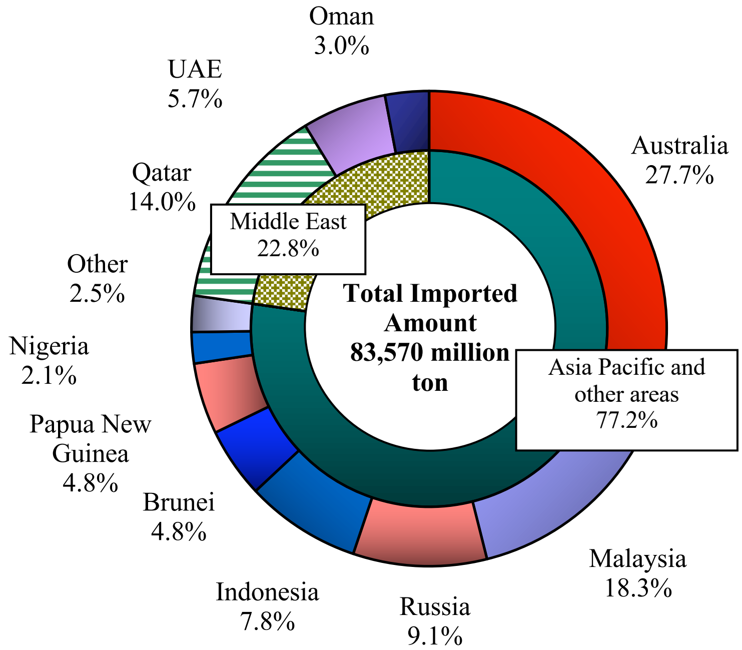

Figure 2-1-10. Import of LNG by countries, as of 2016 (ANRE, 2018a).

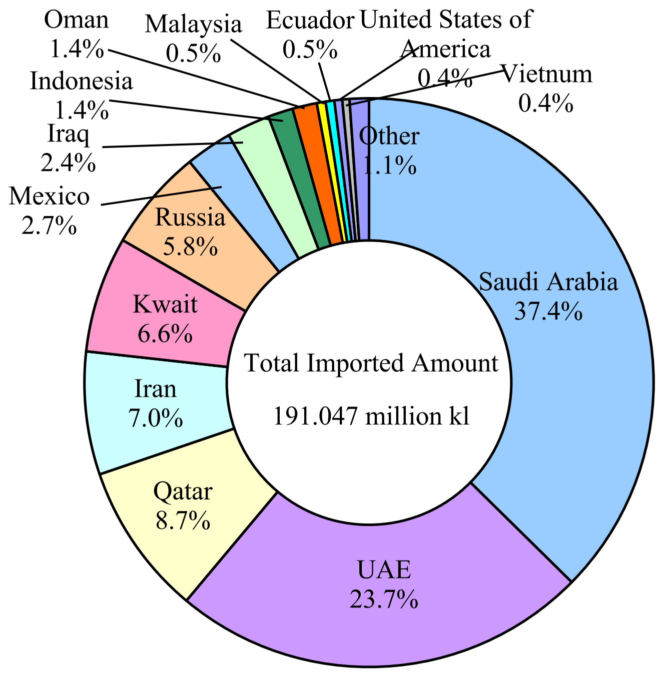

Figure 2-1-11. Import of Oil by countries as of 2016 (ANRE, 2018a).

Nuclear: Overconsumption, risk of disaster, waste storage overflow

Normally, an increase of demand induces suppliers to increase its supply amount. However, in regional monopoly, the relation can become opposite, that is, a demand is increased to justify the expansion of supply capacity. "Since the rapid expansion of NPP capacity in the 70s, electric power consumption in Japan has been boosted faster than real private consumption and real GDP. In other words, supply leads demand, because it becomes critical to increase utilization and fuel demand once expensive and inflexible capacity is installed, and even more so if the installation is heavily subsidized by the state and capital cost can be shifted to consumers as part of the regulated electricity retail price, as was the case until 2016" (Berndt, 2018, pp. 153-154). *Figure 2-1-12* supports this explanation, the electric power consumption index had been in accordance with the real GDP index and consumption index until early 90s. However, it started breaking apart since then. What this indicates is that the electricity consumption grew regardless of real consumption since early 90s, when the Japan's economy and population has entered in a chronic stagnation (hence demand stagnation).

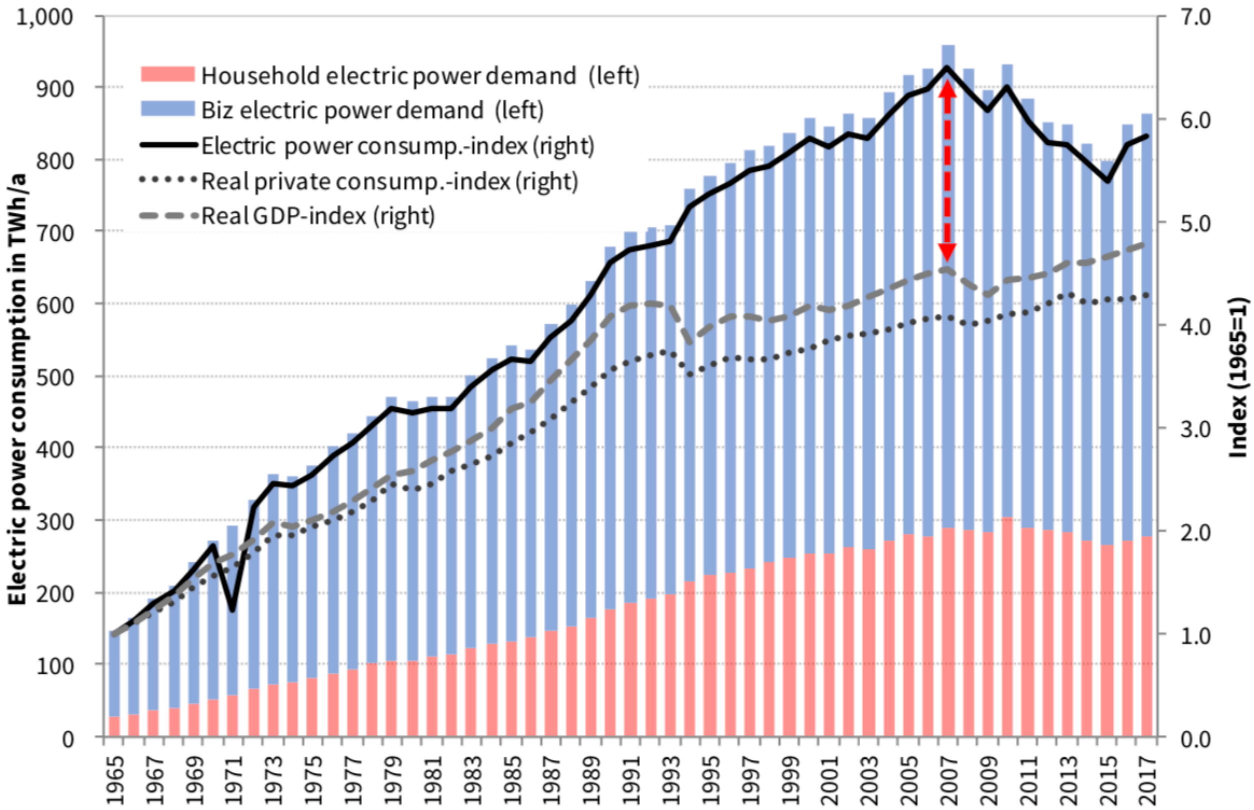

Figure 2-1-12. The gap between electricity consumption and GDP and consumption (Berndt, 2018, p. 153).

Under the circumstances of demand stagnation, baseload such as nuclear power and coal cannot be increased permanently. Peak load can be reduced by introducing tariffs that reward power savings during peak time. But in reality, the electricity companies did the opposite: they encouraged the consumption by lowering electricity price for corporate customers (consuming 70% of the country's electricity) and started full-electrification campaigns for private households (Berndt, 2018).

However, as a side effect, this policy widened the gap between seasonal and daily peak loads and baseload (Berndt, 2018). Namely, the companies and households are encouraged to use electricity during their active times of the day, but in the night when people are inactive, the demand were still low. Stronger the fluctuation of demand, larger the flexible-capacity needs to be installed. *Figure 2-1-13* illustrates this relationship clearly: as the utilization rate of nuclear power goes up, the utilization rate of hydro and thermal power plants decreases while their capacity increases. Overproduction of electricity is absorbed by utilizing (and building) more pumped-hydro capacity. As you can see from *figure 2-1-14*, the electricity generated from pumped-hydro is corresponding to the electricity generated from nuclear power[3].

In sum, the society has developed in a way to encourage consumption to justify the existence of nuclear power. Although the nation-wide Setsuden (saving energy) activities were taken by consumers soon after 2011 and electricity consumption index had started closing the gap to real consumption and GDP index, the index has again started widening the gap since 2015 when Japan restarted the operation of nuclear reactors (*figure 2-1-12*).

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[3] However, pumped-hydro, as in electricity storage, lowers the energy efficiency by approx. 30% because it requires several transmission processes (causing transmission loss) and conversion process (causing conversion loss) (Japan Science and Technology Agency, 2019; Koide, 2011). Thus, it is also an interest of the utilities to minimize the usage of pumped-hydro, resulting into an extreme low utilization rate (3%) and high cost (22.6 kWh) (Japan Science and Technology Agency, 2019).

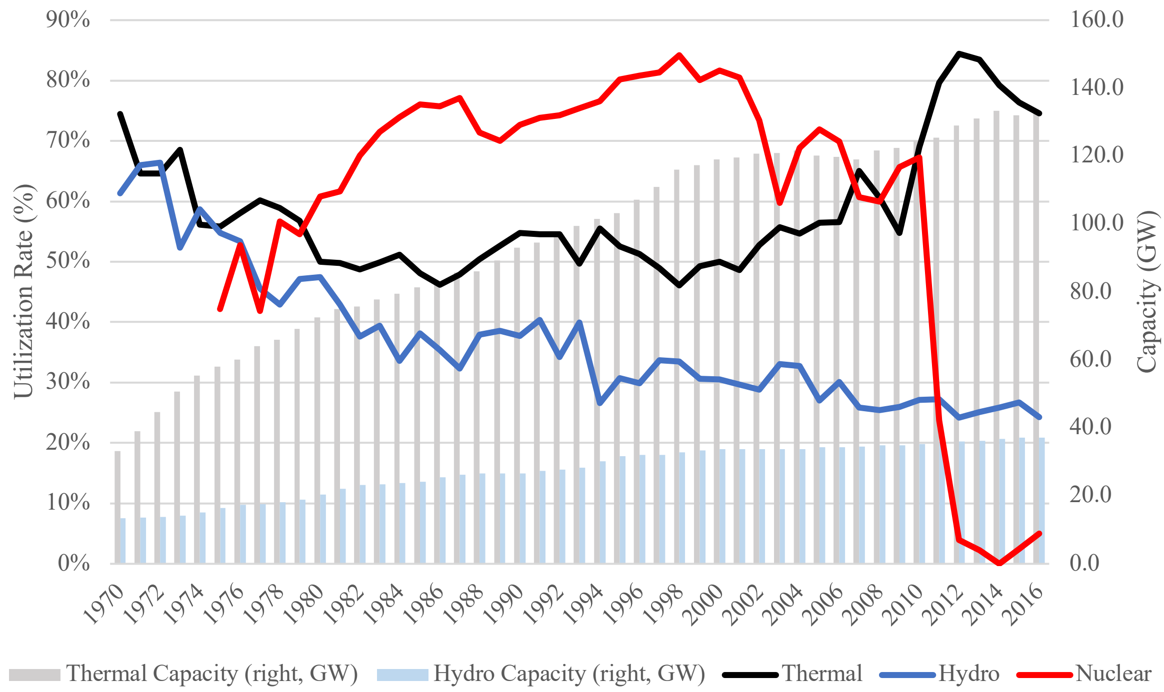

Figure 2-1-13. Utilization Rate by Source (FEPC, 2019).

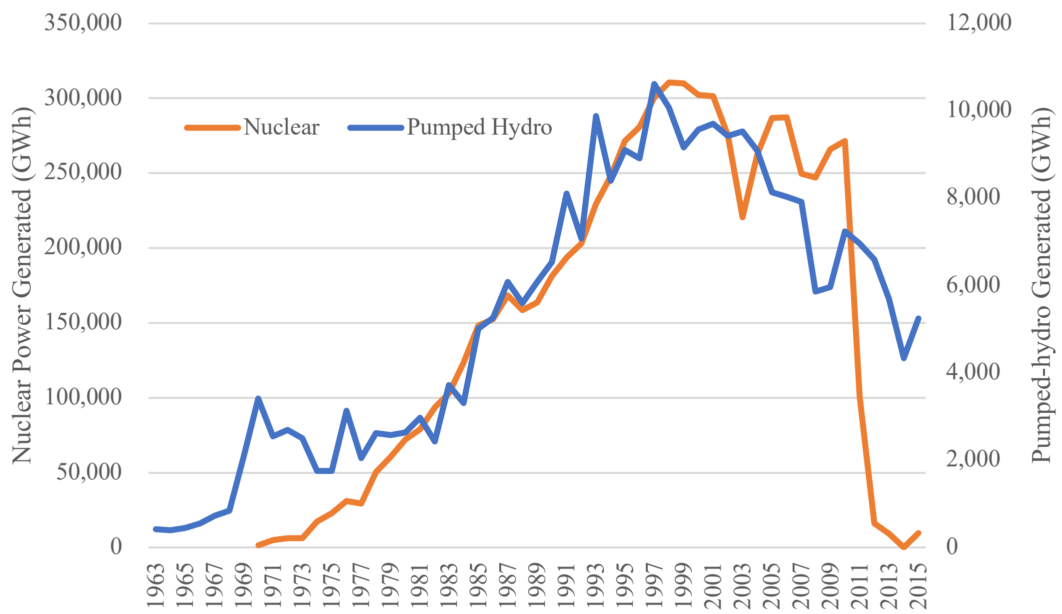

Figure 2-1-14. Generated Nuclear Power and Pumped-hydro (FEPC, 2019).

Aside from the issue of systematic overconsumption, it is also worth mentioning that the nuclear power plants always have the risk of severe accidents. The east coast line of Japan is a convergent point of 4 continental plates; Pacific Plate, Eurasian Plate, North American Plate and Philippine Plate. Because of this geography, 10% of the world's earthquakes with a magnitude 6 or more between 1500 and 2017 occurred in Japan while its territory only accounts 0.1% of the earth's surface and 0.3% of land (Berndt, 2018). Both the number and intensity of heavy earthquakes (the ones with more than 5 seismic intensity) has surged in Japan especially since 1980s, and between January 1st of 2010 and April 4th of 2019, 178 heavy earthquakes occurred (see *figure 2-1-15*). Almost all over Japan are facing to the high possibility of earthquakes with a seismic intensity 5 or more in next 30 years, and the risk of Nankai Through Earthquake (estimated magnitude 8 or 9 in Tokai Area) is also increasing to the possibility of 70%-80% in the next 30 years (Japan meteorological Agency, 2019b; The Headquarters for Eathquake Researach Promotion, 2018).

Diagram 2-1-16 shows the location of NPPs and seismic activities in Japan (Ishibashi, 2015, p. 4). Although NPPs are generally located in the west coast where seismic activities are relatively moderate, it is safe to say that all NPPs have experienced some earthquakes happened in their close proximity. Earthquake and tsunami are not only casting a risk for nuclear power plants, but also for the storage of spent nuclear fuel. They are currently buried underground 300m in Rokkasho Village of Aomori Prefecture and, from July 2009 until the end of March 2018, the village has accepted approx. 800tons of spent nuclear fuel annually, and 3,393 tons of spent nuclear fuel have been stored there. 425 tons of these have been experimentally reprocessed thus the actual buried-waste is approximately 3,000 tons, which is already the maximum capacity of the storage (Berndt, 2018; Ishibashi, 2015). As Berndt (2018) puts it, “Japan is literally overflowing with the spent nuclear fuel and radioactive residue” (p.170). Worse yet, those high-level radioactive waste stored in Rokkasho village needs to be safely kept for 100,000 years to decrease the radioactive to the same level as uranium ore (Koike, 2017). However, there is certainly no guarantee that anyone can store something safely for 100,000 years without any troubles.

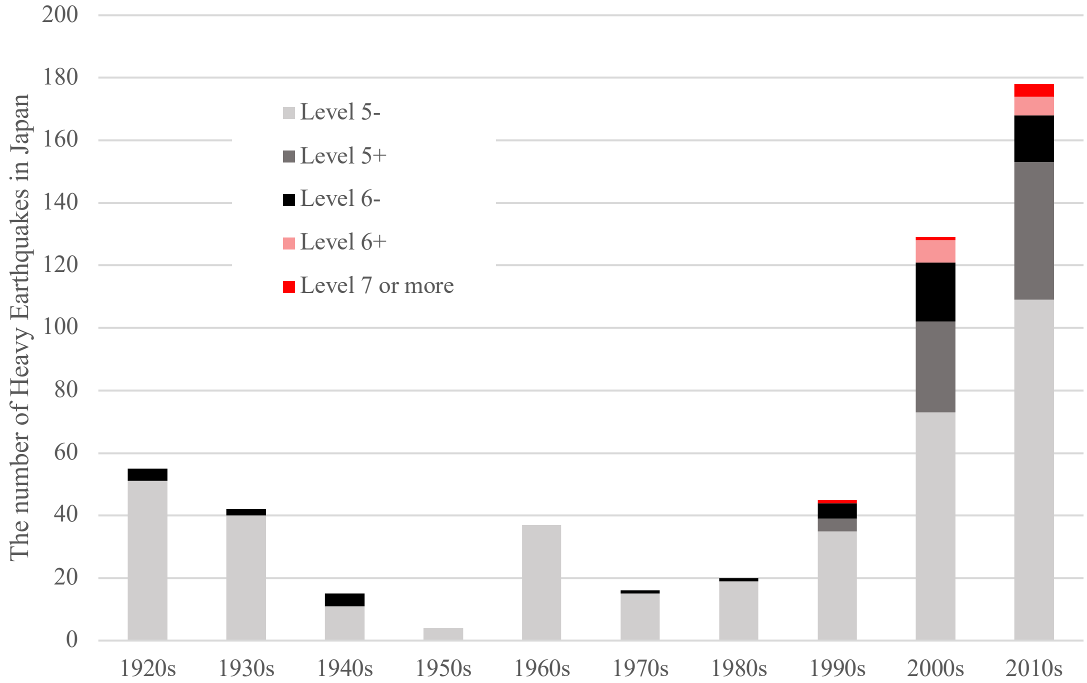

Figure 2-1-15. The number of earthquakes with high seismic intensity (Japan Meteorological Agency, 2019a).

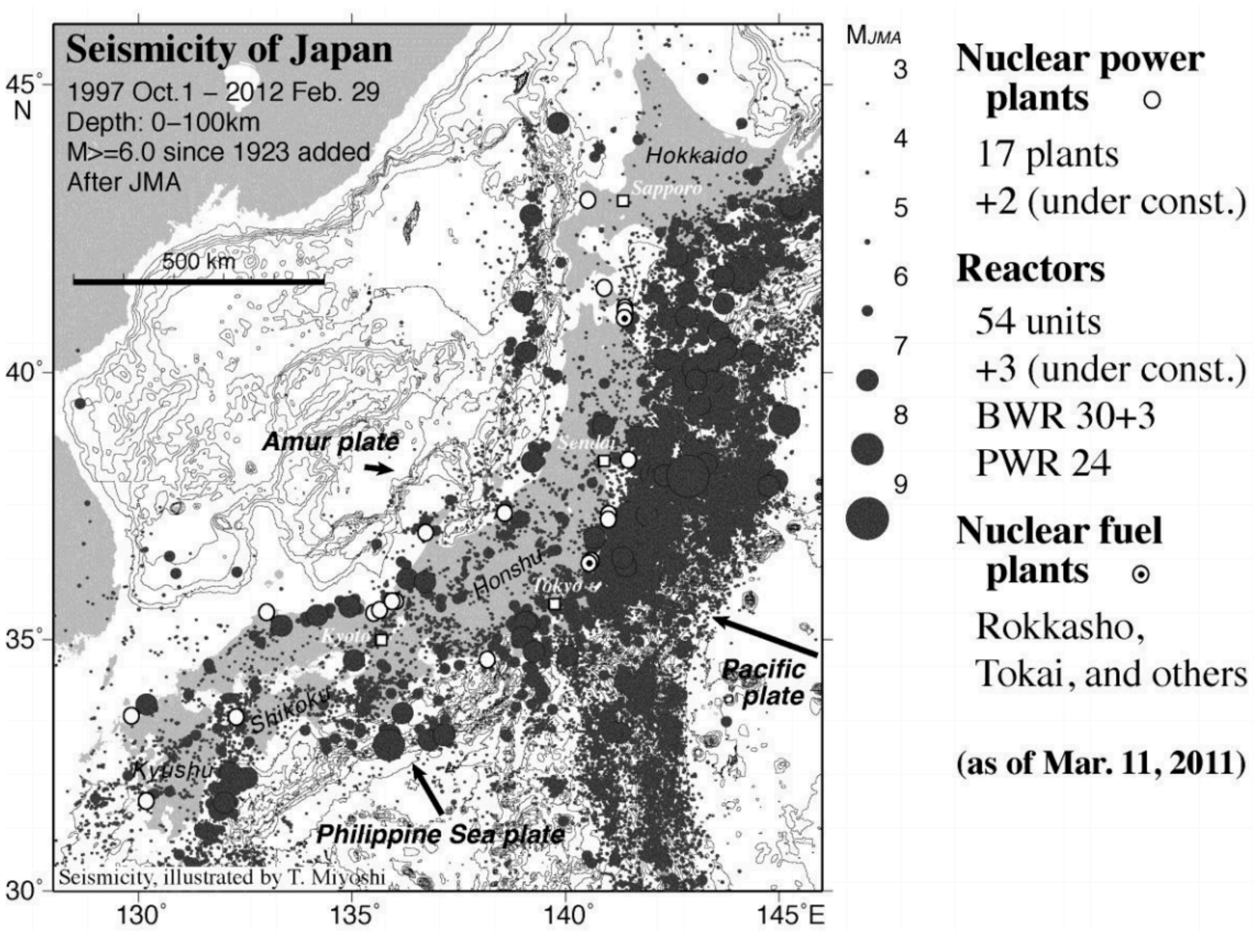

Diagram 2-1-16. Seismic Activities and Nuclear Power Plants in Japan (Ishibashi, 2015, p. 4).

Renewable

Unlike nuclear energy, renewable energy is free from the risk of causing severe disaster and radioactive pollution. Unlike fossil-fuel, renewable energy is generated from non-deplorable domestic sources, which makes it relatively safer from geopolitical risks. That said, it is too early to call the Japan's renewable industry is completely free from social sustainability issues. As you can see from *figure 2-1-17*, the presence of capacity from solar PV has surged after the introduction of FIT in 2012 and it comprises approximately 40% of renewable electricity market. However, almost all mining, production and processing of rare earth metal (i.e. lithium, cobalt and indium), the metals which are widely used in solar PV technologies, take place in China (O'Sullivan, Overland, & Sandalow, 2017). Although it is difficult to quantitatively or qualitatively capture the risk embedded in the Japan-China trade relation regarding those sources, as a matter of possibility, China's dominance may manifest as geopolitical risk in the future. To attenuate this risk, Japan is required to expand renewable capacity not only from solar PV, but also from other technologies, such as wind power.

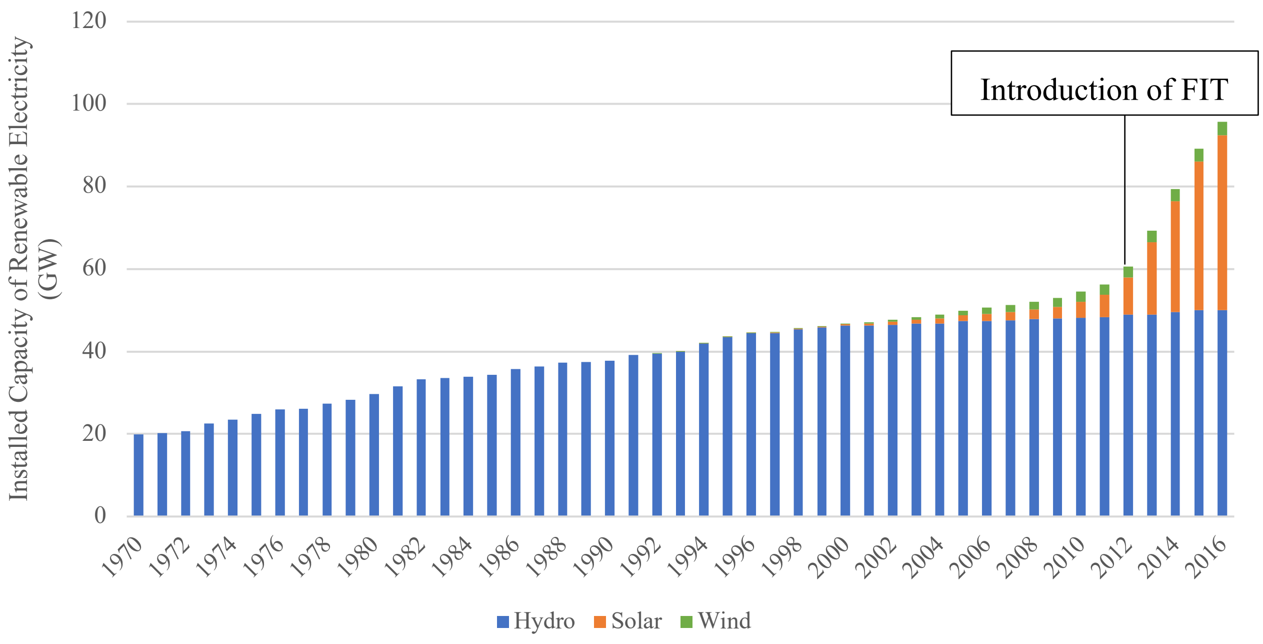

Figure 2-1-17. Installed Capacity of Hydro, Solar and Wind Power Generators. (ANRE, 2018a)

2-1-3. Environment

According to Japan Meteorological Agency (2019), the temperature of Japan has been increasing at the speed of 1.21 degree Celsius per 100 years since 1890s. The *figure 2-1-18* illustrates this trend. As you can see, the temperature increase has suddenly boosted since 1990s, and 2018 was the year which marked 0.68 degree higher than the 30 years average between 1981-2010, the 6th highest temperature since the record began in 1898. The temperature increase of Japan is also relatively higher than the world average. The agency analyzes that it is because Japan is located at the middle latitude in the Northern Hemisphere, the area which tends to receive stronger impact from the global warming. Because of this, the number of heavy rainfalls (more than 100mm/h) has been inclined to increase and the sea level has been increased by 44mm as of 2018 compared to the average sea level between 1981 and 2010 (Japan Meteorological Agency, 2019c).

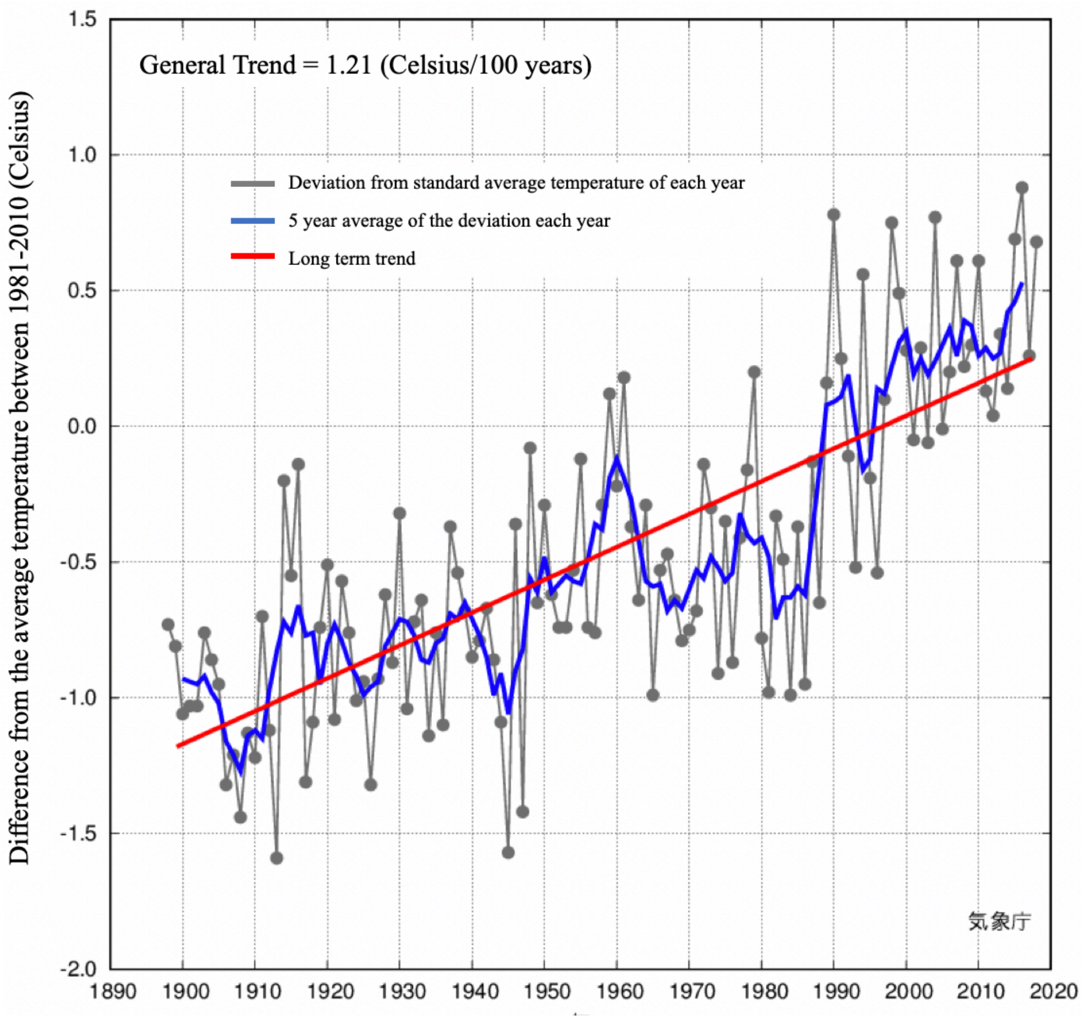

Figure 2-1-18. Historic change of Japan's mean temperature deviation (Japan Meteorological Agency, 2019c, translated by the author).

That said, Japan is not only a victim of climate change but also one of the biggest causes. *Figure 2-1-19* illustrate the historic change of Japan's GHG emission. According to the figure, since 1990, Japan's GHG emission has been fluctuating between 1.2 billion tons and 1.4 billion tons of CO2 equivalent[4].

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[4] By CO2 equivalent, it means each gas has different effect (=Global Warming Potential, GWP) in relation to the warming so the emission of different types of gas are recalculated as in CO2 emission. For example, the GWP of CO2 is one whereas the GWP of CH4 (methane) is 25. This means that, in *figure 2-1-19* a ton of methane emission is considered as being

According to the indicator shown by Climate Tracker (2019), the country is required to cut the GHG emission to 1,196 tons of CO2 equivalent by 2020 and to 1,016 tons by 2025 to keep the global warming at 3 to 4-degree increase since pre-industrial era. To be compatible with Paris Agreement to keep the global warming within 2-degree increase, Climate Tracker (2019) suggests Japan to cut the emission to 811 tons of CO2 equivalent by 2020, and 565 tons by 2025, the target which is undoubtedly unrealistic for Japan without major technological breakthrough. However, the country still requires major efforts even to achieve the 3 to 4-degree target by 2020, as the country has never achieved such number in past 30 years. The closest number was 1,252 tons in 2009 after the world-wide financial crisis in October 2008 affected industrial sectors of Japan. Would this number indicate a sustainability issue in *energy system*? Yes. According to the report published by Greenhouse Gas Inventory Office of Japan (GIO), more than 90% of the country's GHG emission is derived from energy-related activities (= fuel combustion)[5].

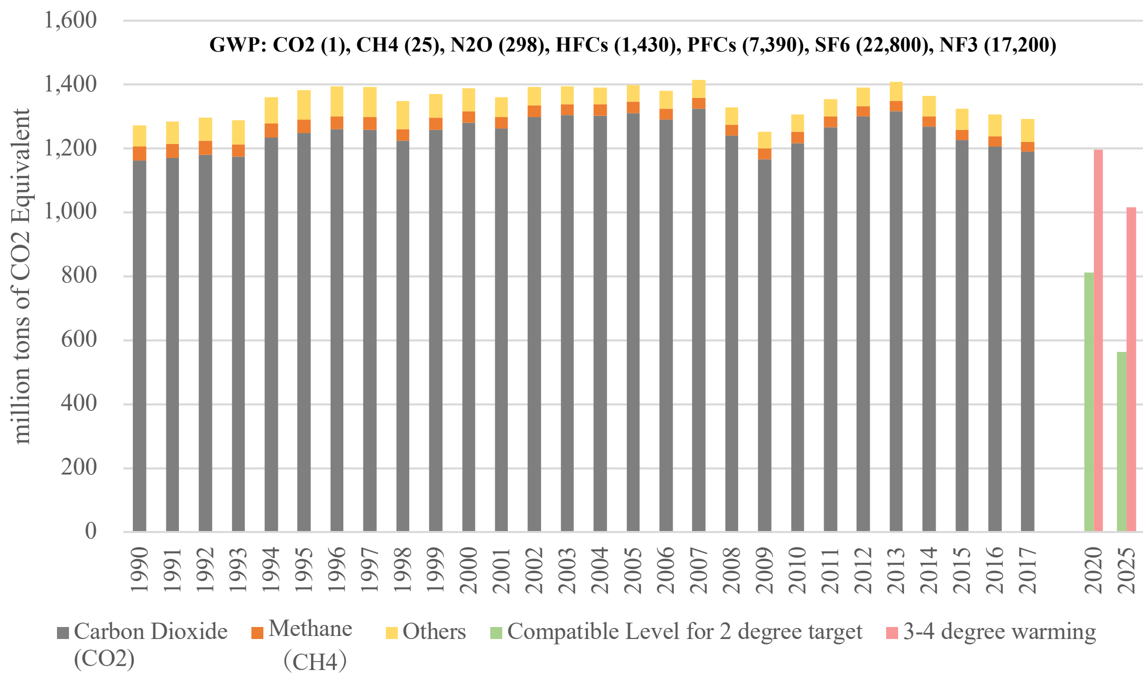

Figure 2-1-19. GHG emission of Japan and reduction target of Japan (Climate Tracker, 2019; Ministry of Environment, 2017).

But who produces such emission? There are two ways of understanding this. First, we can comprehend it from the production side. Energy industries produce energy in response to the demand. If they do so by combusting fuels (in a mean to produce CO2), they will eventually produce more CO2 than the

equivalent to 25 tons of CO2 emission in effect to the warming.

[5] GHG emission are also derived from non energy-related activities such as chemical reaction on the industrial process and combustion of wastes. Approximately 90% of them are from cement production (GIO2019).

other sectors. *Figure 2-1-20* clearly illustrates the increasing weight of energy industry for CO2 emission: the major producers such as industries and transportation are decreasing their CO2 emission. On the other hand, emission from energy industry has been in an upward trend since 1990 (GIO, 2019). Second, we can capture the producers of CO2 emission from the consumer side (see *figure 2-1-21*). In this figure, the weight of industries and transportation are less responsible for CO2 emission compared to 1990 although they are still the biggest producers in Japan. On the other hand, more and more households and commercial industries have become responsible for emission (GIO, 2019).

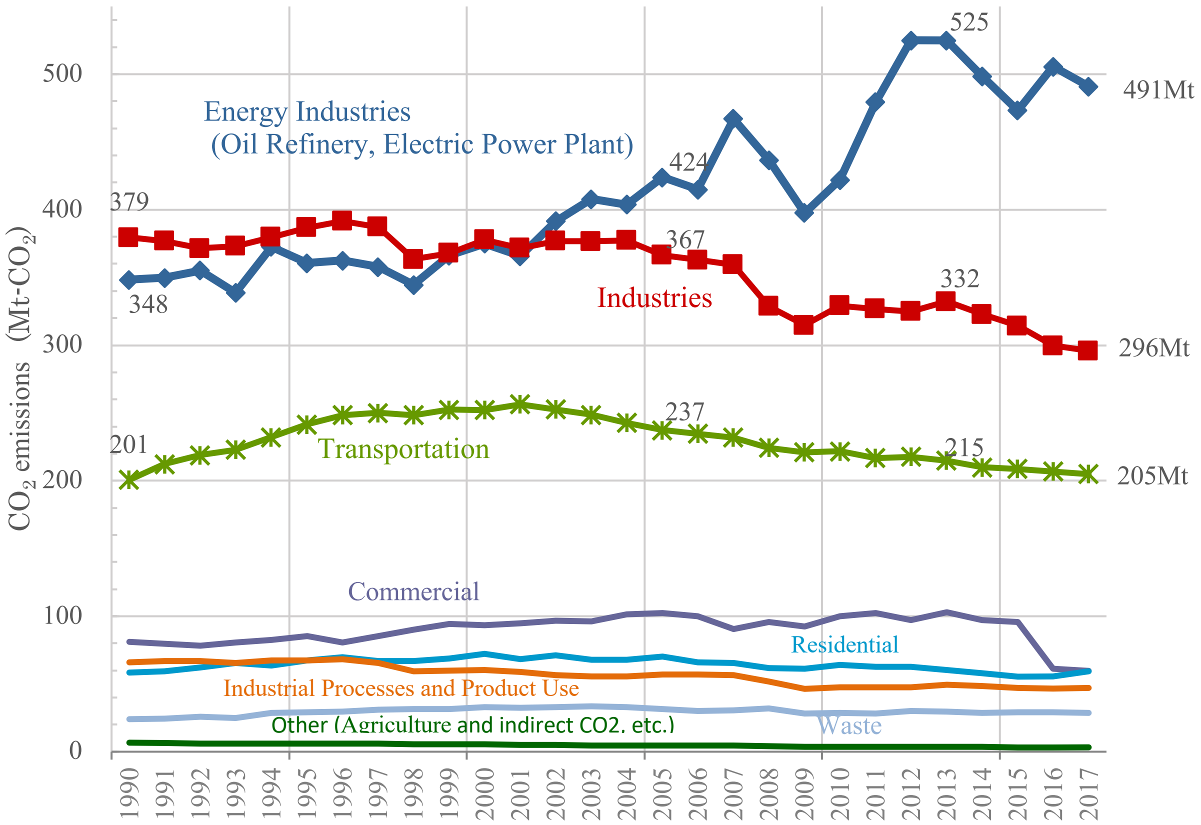

Figure 2-1-20. CO2 emission by sector (before allocation) (GIO, 2019).

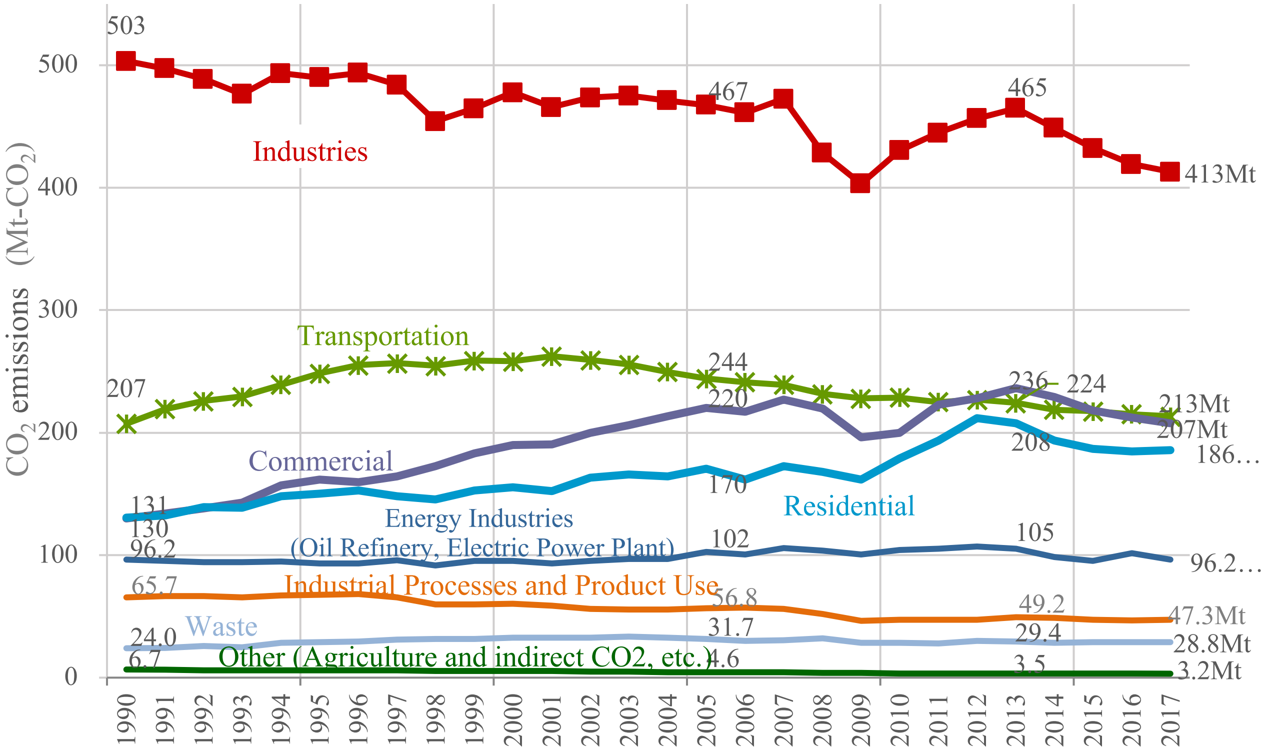

Figure 2-1-21. CO2 emission by sector (after allocation) (GIO, 2019).

Indeed, energy industries produce energy simply upon demand. However, this does not mean that the energy industries are not responsible for CO2 emission, rather it is opposite. The growing dependence on energy industry indicates the environment receives larger impact from how they generate energy. *Figure 2-1-22* illustrates the generated electricity by types of energy sources. The amount of coal they used for electricity has been increased by 470% since 1990 and it generates 32% of total electricity as of 2016. As you can see from *figure 2-1-23*, the coal used for steel, coke and ceramics industry has been almost unchanged since 1980, but the coal used for electricity generation has surged since then. It clearly illustrates the increasing weight of coal in the electricity production.

The expansion of coal usage in electricity generation is environmentally problematic due to its carbon content. According to the report from Imamura, Iuchi, and Bando (2016), the coal are the most carbon intensive power generation technology over oil and LNG: it averagely produces 943g of CO2/kWh whereas oil averagely produces 738g-CO2/kWh, LNG (only steam) produces 599g and LNG (combined cycle) produces 474g (see *figure 2-1-24*). Although LNG and oil are much less carbon intensive generation methods, they still produce more than what nuclear energy does: nuclear energy BWR and PWR only produce 19g and 20g respectively. In other words, the rapid decrease of nuclear power since 2011 had to be replaced by fossil fuel, particularly LNG and oil. As a result, CO2 intensity (million tons of CO2 per TWh) rapidly increased from 0.36 tons/TWh in 2010 to 0.49 tons/TWh in 2011 (see *figure 2-1-22*) (ANRE, 2018a; GIO, 2019).

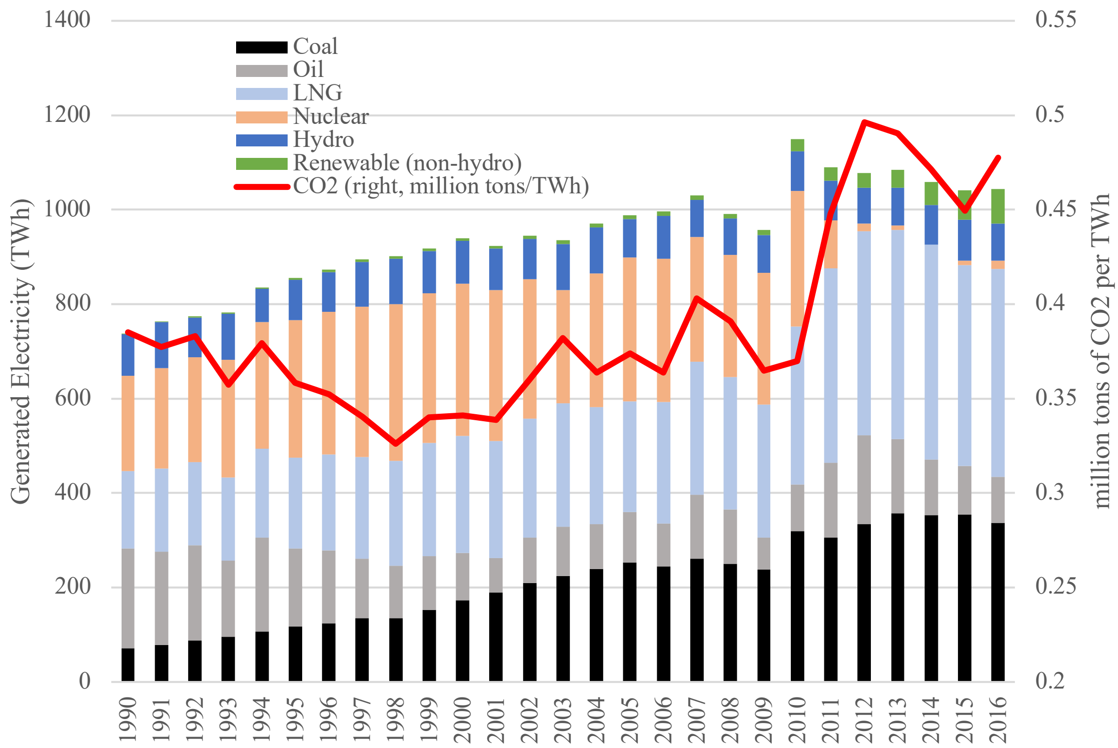

Figure 2-1-22. Generated Electricity and CO2 (ANRE, 2018a; GIO, 2019).

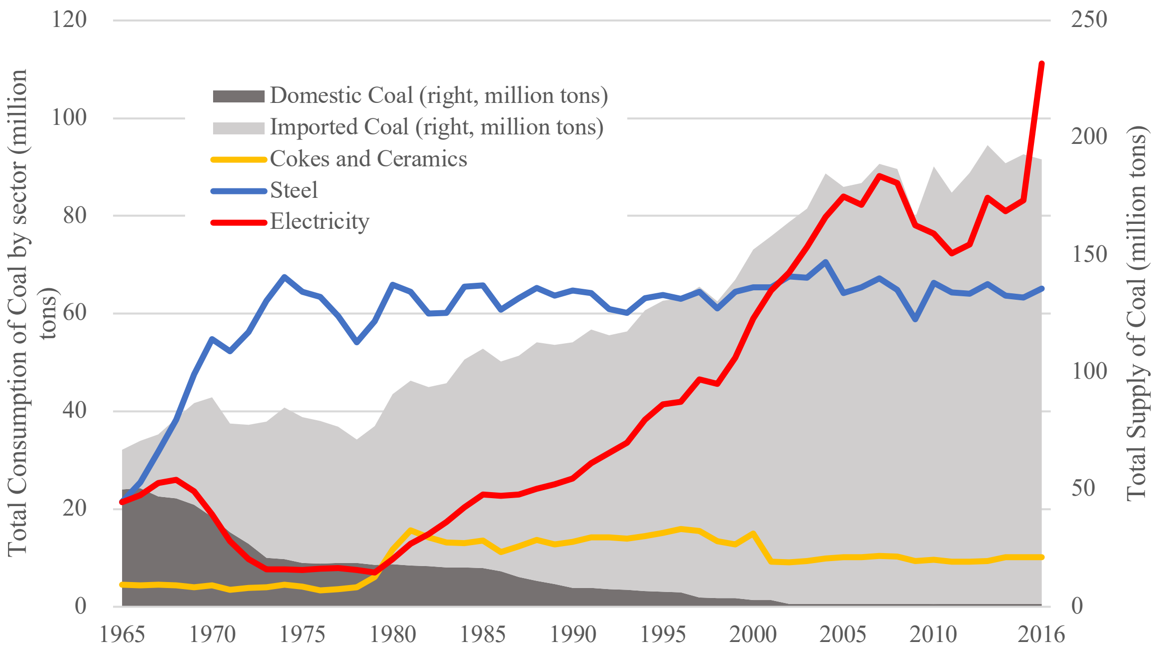

Figure 2-1-23. Total coal supply of consumption by sectors (ANRE, 2018a).

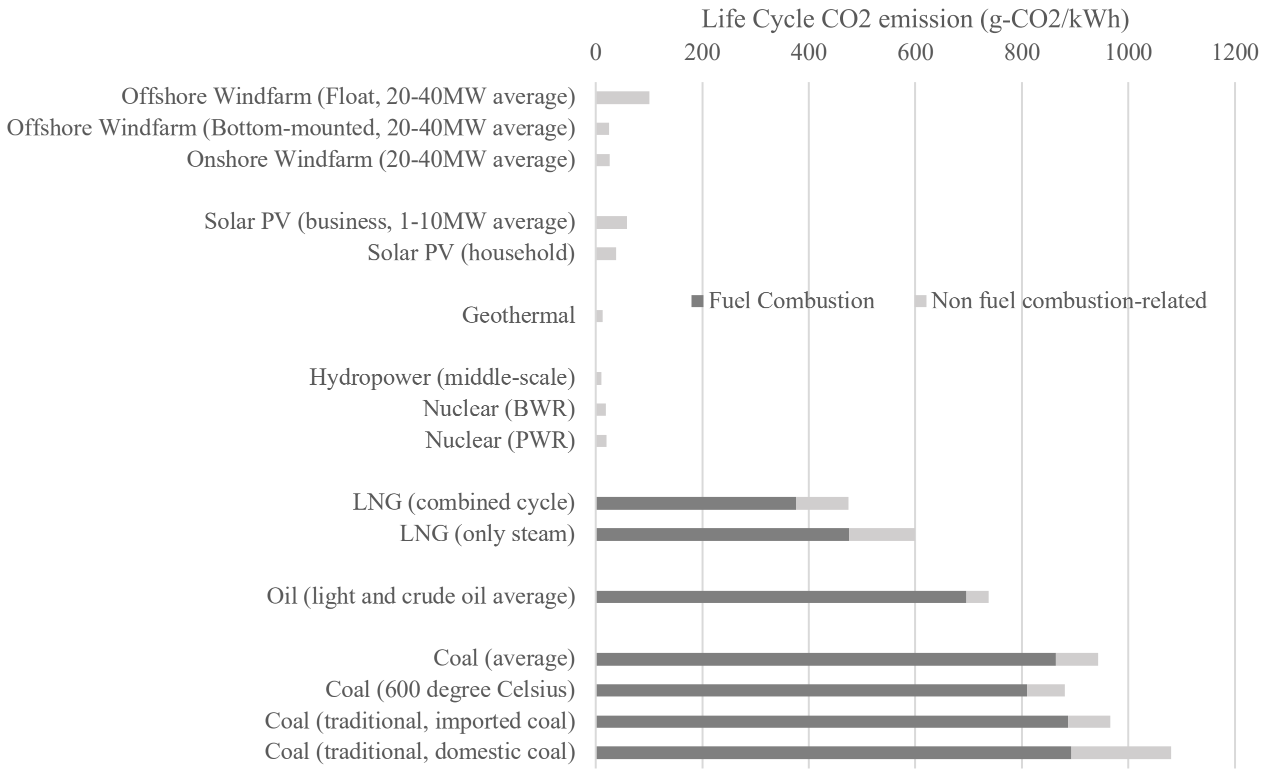

Figure 2-1-24. Life Cycle CO2 emission in Japan (Imamura et al., 2016).

Figure 2-1-24 also reveals that nuclear energy is a technology which produces CO2 as low as onshore wind farms and even lower than solar PVs. That being said, nuclear energy has several issues to call it a sustainable energy: there is always a risk of severe accidents, or even disasters that cause pollutions in air, water and soils. For example, in 2011 a large amount of Cesium 137 (Cs-137) leaked from Fukushima nuclear power reactors (see *diagram 2-1-25*). The substance has a half-life of about 30 years, requiring several hundreds of years to be fully de-contaminated. (Imanaka & Fukumoto, 2015; Koide, 2011; Nuclear Regulation Authority, 2019).

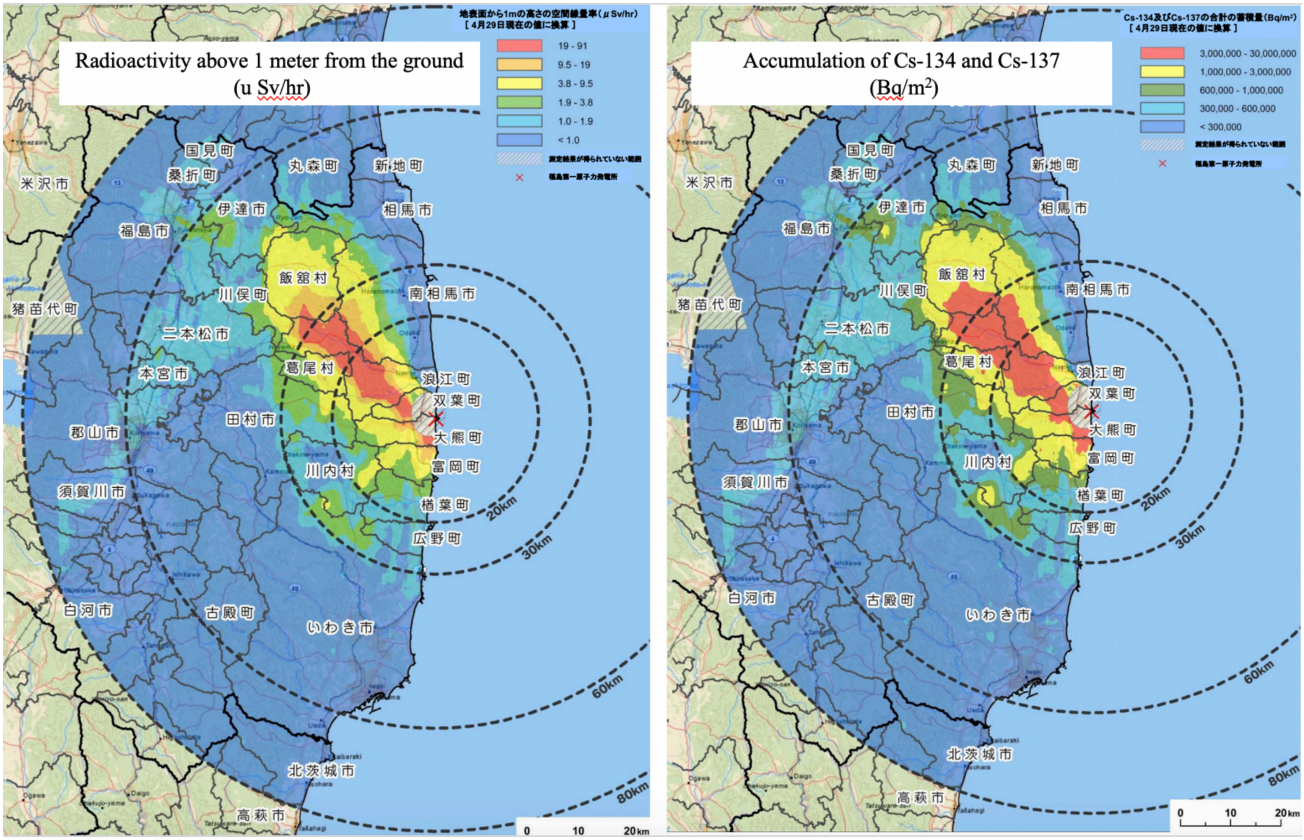

Figure 2-1-25. Radioactive soil and air pollution as of 29th April, 2011 (Nuclear Regulation Authority, 2019).

Summary of the section

In this section, the thesis briefly analyzed sustainability issues inherent in Japan's energy system. Fossil fuel exposes Japan to economic and geopolitical risks and, obviously exacerbate the global warming. Nuclear energy does not only cast uncertainty in its economic validity, but also essentially contains social and environmental costs. That being said, the proliferation of renewable energy also contains geopolitical issues, risk of resource depletion and cost disadvantages.

What this implies is not only the fact that Japan's energy system is unsustainable, but also how difficult the issue is. One thing for certain is that the government's power mix plan for 2030 does not serve as a fundamental solution for these sustainable issues. Most likely, it is not even meant to be. However, without contemplating feasible plans to address these sustainability issues, the development plan only aggravates these issues through externalizing (or more precisely socializing) the economic, social and environmental costs that are deliberately ignored.

2-2. Are there sustainable development issues in Japan's energy system?

> It is absurd to think that we can derive the contour lines of our phenomena from our statistical material only. All we could ever prove from it is that no regular contour lines exist... We cannot stress this point sufficiently. General history (social, political and cultural), economic history and industrial history are not only indispensable, but really the most important contributors to the understanding of our problem. All other materials and methods, statistical and theoretical, are only subservient to them and worthless without them. (Freeman, 2004, p. 548)

In the last section, this thesis states that Japan's energy system is unsustainable. However, this casts a further question, that is, why is it how it is? Those sustainable issues simply illustrate the consequence of certain actors' certain actions and are not sufficient to understand how such system has been established nor why the government is still willing to carry on such system.

This section dedicates to understand the following two points; 1) historic transition of Japan's energy system and 2) a picture of structural interdependencies in the current energy system. The first question serves as to understand the dynamic process of societal transition in Japan. The importance of this perspective is as explained by structuration theory (see s*ection 1-2*), that is, structure is just a product of past actions. The second question is to discuss and interpret the current picture of energy system; what constrains/enables who in what actions, or what agencies own how much power over whom. For both discussions, the thesis incorporates MLP and CAS as analytical tools.

2-2-1. Historical Development of Japan's energy system

This section is dedicated to comprehending the historic development of Japan's energy system, with a particular focus on understanding the process to configurate the ST-regime so called "nuclear village". The term is commonly referred to represent the powerful conglomerate that influences on the country's policy making processes in favor of the current market integration under regional monopolies and promotion of nuclear power in Japan's energy mix (Hymans, 2011; Kingston, 2012; McCormack, 2011).

The current configuration of ST system in Japan's energy system can date back to the end of WW2, when Japanese government started reforming the country under the command of Supreme Commander for the Allied Powers, known as General Headquarters (GHQ). Since then, energy policies, especially the ones in regard to nuclear power generation, have been developed with symbiosis of multiple actors' visions and geopolitical situations.

This thesis analyzed the nearly 70 years of transition process with focuses on four timeframes; the first timeframe is between 1945-1960. 1945 is when Japan surrendered to the allied powers and started establishing a new constitution under control of GHQ. 1960 is when Japan constructed its first nuclear power plant (Tokai NPP) in Tokaimura village. Therefore, in this timeframe, the thesis captures an emerge and early configuration process of Japan's nuclear regime. The next timeframe is between 1960 and 1998. After the construction of the first reactor in Tokaimura, NPPs started to rapidly diffuse throughout Japan (see *figure 2-2-1*). However, in 1998, the Tokai NPP ended its operation and entered into the decommission process, which marked the first time in its post-war history that Japan decreased its nuclear capacity. In this timeframe, the thesis captures institutionalization (structuration) process of nuclear regime. The third timeframe is between 1999 and 2011. In this period, the increase in the capacity of NPP was more moderated compared to before (*figure 2-2-1*). In 1999, Japan experienced the third criticality incident in its history, JCO accident which is evaluated as level-4 in the International Nuclear Event Scale (INES). It was the worst nuclear accident that Japan had experienced before 2011. In this timeframe, the thesis is particularly interested in capturing interactions between ST-landscape (i.e. public opinion) and the nuclear regime. The final timeframe is since Fukushima Nuclear Accident occurred in 2011, the accident which is rated as the most serious (level-7) at INES. This accident led NPP operators to halt their reactors for temporal inspections, and as a result, in September 2013, all NPPs in Japan were off to cables (McCurry, 2015). In this timeframe, therefore, the thesis particularly looks at the impact of Fukushima in the contexts of Japan's energy system.

In each timeframe, the thesis looks at the change of Japan's energy system in the context of societal transition, incorporating MLP and CAS. By using MLP, the thesis captures the temporal dynamics of transition. With using CAS, the thesis focuses on system-internal, system-specific and system-external developments in a certain timeframe and pictures the interpretation on basic interdependent relationship and interactions in the Japan's energy system. Based on this analysis, the thesis interprets transition pathways that Japan has followed.

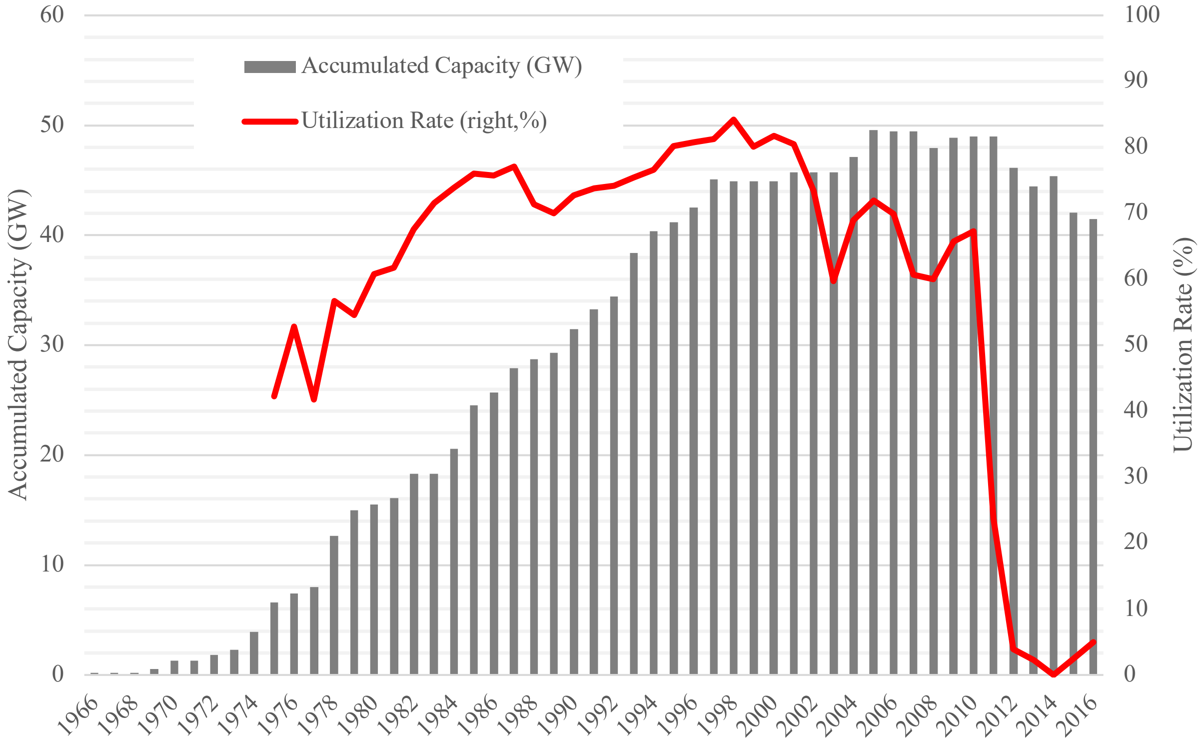

Figure 2-2-1. The accumulated capacity and utilization rate of NPPs (FEPC, 2017; METI, 2018b).

1945-1960: Before the dawn of nuclear power generation

Socio-technical landscape

The end of WW2 was the start of the Cold War and nuclear arm technology became no longer the US's monopoly after Soviet Union demonstrated the functionality of its own atomic bombs. Under such circumstances, Japan became the particular interest of the U.S defense policy as well as commercial policy: the U.S's NPPs producers sought for technology licensing as new business opportunities was in conformity with the country's defense strategy that integrate their allied nations into nuclear armament race[6]. Thereby, in 1951, Japan was given an independency as a state as well as an approval

[6] In 1949, the US President Harry, S. Truman announced the beginning of a bilateral nuclear arm race. Furthermore, in the same year, US Senate was able to add amendment to the 1946 Atomic Energy Law to the agenda, in order to permit the commercialization of nuclear technology with a foreign partner yet keep nuclear technology under control in the US power bloc (Takao, 2016). What these two events indicates in the contexts of Cold war is a mutual interest of military and NPP manufacturers; the former envisions to integrate the allied nations into the nuclear arm race whereas the latter envisions new business opportunities regarding licensing and maintenance of NPPs.

As Berndt (2018) argues, "For the civilian use of nuclear power, fissionable and weapons-grade uranium 235 must be enriched. Neutron exposure of uranium 238 generates weapons-grade plutonium 239. To build NPPs, producing nuclear fuel and disposing of it or reprocessing it require huge investments. In view of the quantitative nuclear arms race, it was in the interest of the military to industrialise the production of weapons-grade uranium or plutonium. This, in turn, corresponded to the economic interest of electric power companies to rapidly amortise high investments and increase profits through economies of scale." (p.136) to do atomic research by its own. Since then, Japan's nuclear industry started developing with a non-military intent in accordance with "Atoms for Peach Speech"[7] delivered by the US president Dwight Eisenhower in 1951 (Berndt, 2018; Takao, 2016; Yamaoka, 2011).

Public, although feeling fierce against nuclear bombs from the sentiment of Hiroshima, Nagasaki and fishermen who died during the U.S's experiments of Hydrogen Bombs in Bikini Atoll in 1954[8], largely supported the use of nuclear power for a peaceful purpose, that is, the electricity generation. This blight image of nuclear power was also emphasized by pro-nuclear media. Their pro-nuclear campaigns worked so efficiently that the public perception toward nuclear had changed drastically in the late 50s[9] (Aldrich, 2012; Kuznick, 2011; Trumbull, 1955; Yamaoka, 2011).

Niche to socio-technical regime

Japan, under the rightwing coalition (LDP), rapidly started nuclear development with a bipartite organizational structure. On one hand, there was the government agencies (i.e. Ministry of Science) who took responsibility of slow, unprofitable, experimental and domestic development of nuclear technology. On the other hand, there was the conglomerates of private sectors in Japan (particularly utilities), who sought for the quick commercialization of NPPs through technology licensing from the US/UK[10]. The private coalition was led out by Ministry of International Trade and Industry (MITI,

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[7] In fact, the speech did not include the enunciation of military use. However it paved the way to develop and control a commercial use of nuclear power under international agency and agreements (Kuznick, 2011; Trumbull, 1955) .

[8] The Japanese public had a fierce feeling toward atomic bombs. As Aldrich (2012) states, there was so called "Kaku Arerugi (Nuclear Allergy)" in the public, largely from the sentiment of two atomic bombs dropped on Hiroshima and Nagasaki, and the Daigo Fukuryumaru Incident in 1954, when two fishermen died by the U.S experiment of hydrogen bombs taken place in the Bikini Atoll. "Motivated by this tragedy [Daigo Fukuryumaaru Incident], residents of the Suginami Ward in Tokyo began a petition drive to ban hydrogen bombs, and by August of 1955 they had secured more than 30 million signatures. Put another way, roughly one-third of the people of Japan expressed their support for a nuclear weapons ban." (Aldrich, 2012, p.2)

[9] Iconic figure in this media's coverage is Matsutaro Shoriki, who ran "Yomiuri Shimbun" newspapers and "Nippon Television Network". He was once imprisoned for two years as a class-A war criminal but had released without trials (Kuznick, 2011; Yamaoka, 2011). He ran for national election as a strong advocate of nuclear power. During the national election between 24 January, 1955 and 27 February, the Yomiuri Shimbun also held the pro-nuclear campaign to support him. He was successfully elected as the member of Democratic Party, the party which successfully took the office. As soon as Shoriki got elected, he help to establish Liberal Democratic Party (LDP), the political coalition established in in 1955 as a merger of two right wing parties; Democratic party and Liberal party (Yamaoka, 2011).

[10] Aforementioned politician, Shoriki played a pivotal role. On 1st January of 1956, the central government formed Genshiryoku Iinkai, the Atomic Energy Commission (AEC) within the prime minister's office to manage nuclear power policy" (Aldrich, 2012, p. 124). Shoriki Matsutani became the first chairman of AEC, and during the first assembly on the 4th January, he declared to commercialize NPPs within 5 years. At that time, no commercial reactors were in operation in the world. Many committee members from scientific communities were opposed to this idea. Because they sought for

now called METI), an administrative organ who took a responsibility for making a bilateral nuclear agreement, integrating the developers and providing political support. In 1960, Japan Atomic Power Company, the first NPP operator in Japan, was founded with investment of government (20%) and private investors (80%), the entity which largely reflects the commercial interests of utilities (Berndt, 2018; Yamaoka, 2011).

The electricity sector was vertically integrated by regional monopolies, the market form which lasts even today. Back in during WW2, Japan's electricity industry was under the complete state's control. Yet, after the war ended, General Headquarter (GHQ) ordered Japan to separate the state company into 9 utilities, each of which is allowed to monopolize a certain region. Although each company vertically integrates a generation, transmission and distribution sector in, an electricity price became the subject of state control by MITI. (Berndt, 2018; Nishino, 2013)

Pro-nuclear politicians (often associated with right-wing politicians, i.e. Yasuhiro Nakasone, Shoriki Matsutani) rushed for institutionalizations for nuclear development; "In 1955, MITI set up a nuclear energy division and petitioned the Diet for 5.1 billion yen ($14 million at 1955 exchange rates) for nuclear energy research with the encouragement of the Liberal Democratic Party. In December 1955, these joint efforts culminated in the passage of the Basic Atomic Energy Law, which established a framework for civilian use of nuclear power" (Aldrich, 2008, p. 124). Furthermore, in 1960, Act on Compensation for Nuclear Damage Caused by NPP was passed. This law initially imposed the indefinite liability to NPP operators except in the case of natural and social disaster, but "the Act left the settlement of claims exceeding the recovery limits of insurances of 50 million JPY" (Berndt, 2018, p. 136). These institutions successfully rendered NPP as risk-free business that attract investments.

Analysis

The general transition process in this period is illustrated in *diagram 2-2-2*. An absolute state-control of electricity market was de-configured into 9 private companies. Those companies were allowed to regionally monopolize the electricity market but were subjected to the price control by MITI. In this re-alignment process, a new technology (nuclear power generation) came into the core of new energy

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starting from basic researches, it was thought to be unfeasible to commercialize in such short time (Yamaoka, 2011). Shoriki also paved the other development path: technology licensing (import of technology). He gathered private sectors (9 utilities, Keidanren, and Institute of Physical and Chemical Research) and established Japan Atomic Industrial Forum Inc. (JAIF), in order to strengthen the partnership between state, enterprise and science (Yamaoka, 2011).

policy of Japan. Thereby, new socio-technical regime (fossil-nuclear regime) started configuring with newly established institutions and agencies.

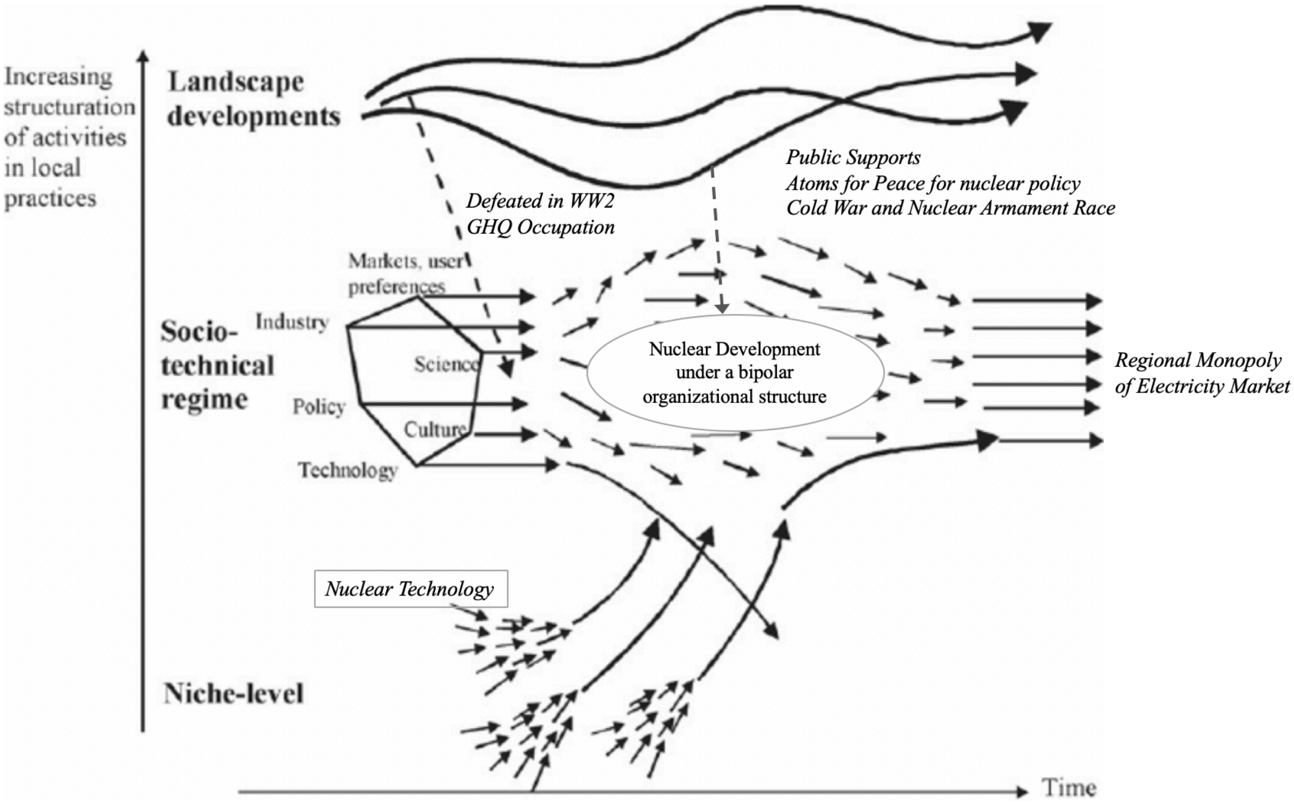

Diagram 2-2-2. De-alignment of wartime configuration and Re-alignment into nuclear regime.

However as illustrated in *diagram 2-2-3*, the underlying societal system was more complex than it looks in MLP. The nuclear regime is mainly composed of two different interest groups; utilities and MITI for commercial NPPs, and domestic development of nuclear technology led by Ministry of Science. These are also embedded in industrial policies and safety standards which are enacted by administrative organs or commissions. Due to the Compensation Act and regional monopoly, liability of utilities were greatly exempted, which rendered nuclear power less uncertain projects for operators. This institution allowed MITI and utilities' commercial reactors to take initiatives to experiment, commercialize and diffuse the nuclear power plants. Also, the public, if not whole, also supported the nuclear power for electricity generation while having a fierce feeling against nuclear weapons. This was due to the blight image of nuclear power emphasized by "Atoms for Peace" speech, and the efforts of campaigns held by pro-nuclear media (i.e. Yomiuri Shimbun).

Thereby, the regime gains its power under the regulative rules (risk-free investments and stable refinancing method) and cognitive rules from the public that believes the safeness of nuclear energy. The utilities under regional monopoly could embrace all electricity consumers in Japan (except for prosumers), secure stable income, thus serves the interest of lenders as well as of pro-nuclear politicians. Under this interdependent structure, the rules and resources (authoritative power of utilities) were constantly enhanced and reproduced by almost all actors in Japan (because the utilities' consumers can be considered as the parts of the regime due to monopolization).

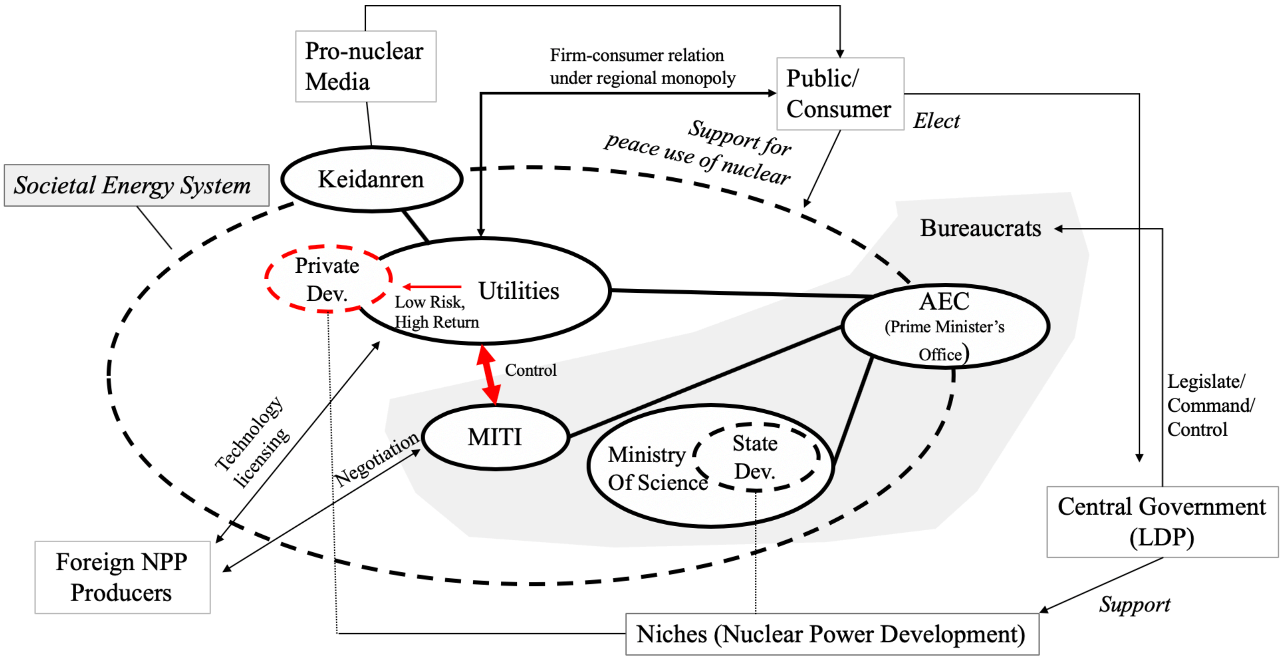

Diagram 2-2-3. Complex System of Japan's societal energy system during 1945-1960.

1960-1998: Prevalence of Nuclear Power, Site Fights and Emergence of Renewable Industry

Socio-technical landscape

In 1960s, Japan was in economic euphoria and the GDP growth rate was constantly around 10% (see *figure 2-2-4*). Correspondingly, the energy demand also surged, and the utilities were in need of expanding its production to catch up with the growth speed. As such, the expansion of cheaply financed nuclear power became an urgent agenda. "Increasing the production of electricity beyond a maximum utilization of existing capacities requires investment in new power plants. These must be cheaply financed with outside capital, used to full capacity and quickly amortised" (Berndt, 2018, p. 135). In 1970s, oil shocks stroked the world economy. Japan, the country which relies almost all fossil fuel sources on imports, had suffered from trade slumps. Thereby, Japan took an energy policy to reduce dependence on oil and instead diversify the energy mix as to utilize more domestic energy source; nuclear[11] and renewables (Aldrich, 2008). You can see that Japan successfully reduced the oil

[11] Uranium is energy intense, storable and recyclable. Therefore, although Japan does not own developable amount of uranium, nuclear energy is considered as "semi-domestic energy source" (ANRE, 2018a).

dependence in the country's electricity mix in response to the increase in the oil price (see *figure 2-2-5*) (ANRE, 2018a).

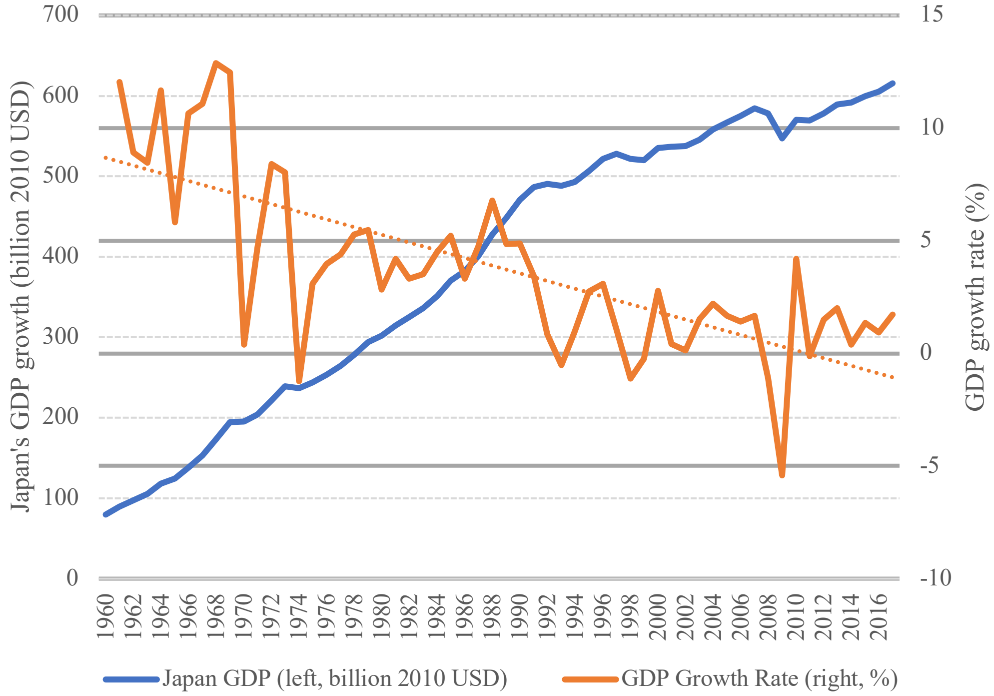

Figure 2-2-4. Japan's GDP (left, billion 2010 USD) and its GDP growth (right, %) (World Bank, 2019)

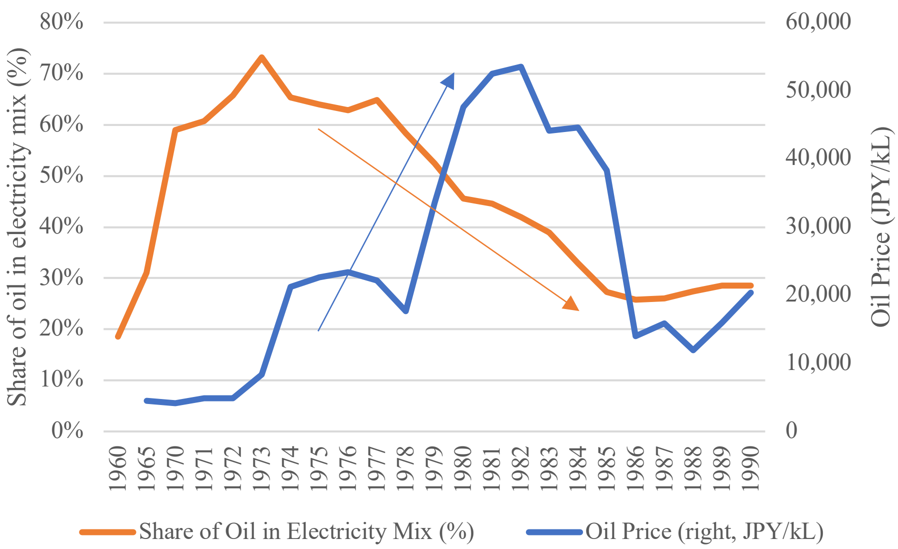

Figure 2-2-5. Oil price and the share of oil and electricity mix between 1960 and 1990 (ANRE, 2018a).

Back in 1960, the construction of the first NPP in Japan (Tokai NPP) started, the plant which later came online in 1965. During 1960s and early 70s, the public seemingly accepted the idea of commercial NPPs.[12] However, voice of opposition groups had begun to be stronger and more organized and informed since mid-1970s[13]. In this period, two national-level anti-nuclear groups were created, and they served "not only as umbrella organizations for smaller NGOs and social movement organizations but also as sources of anti-nuclear information"[14] (Aldrich, 2008). Such anti-nuclear voice gradually swelled especially during 80s and 90s due to several nuclear accidents; the Three Mile accidents in 1978, Chernobyl disaster in 1986[15].

The turning point for Japan's nuclear power can be found in 1990s when the nuclear accidents became no longer "somebody else's problem". In 1991, the public-driven developer led by the Ministry of Science and Power Reactor and Nuclear Fuel Development Corporation (hereafter: PNC) started the

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[12] According to Aldrich (2008), citing a series of surveys by Ministry of Management and Coordination (Somucho) in 1968, 1975 and 1976, the Japanese public largely supported Japan's NPP policy: close to 70% of respondents answered to support continuation of ongoing NPP policies while about 10% preferred either status-quo or stop building plants and 20% refused to answer. Aldrich (2008) analyzes that it shows some citizens had become more comfortable with the concept of commercial NPPs. Hence, by 1976, "the Japanese public became one of the most pro-nuclear publics in the world" (Midford, 2014, p. 70). Plus, apparently, there was no public protest reported when MITI selected the location for Tokai NPP (Aldrich, 2008; Midford, 2014). Rather, "the local Tokai community had actively campaigned for the first plant siting with the stipulation that the reactors conform to the "Atoms for Peace" ideology" (Aldrich, 2008). Furthermore, when MITI and Tokyo EPCO demonstrated the interest in Okuma village as the site for the second commercial NPP, it was reported that the village quite welcomed the offer and in 1961, the town council officially invited NPP through public votes (Aldrich, 2008). Such positive response from the public was considered as a product of "determined efforts by policymakers, and the demonstration effect of Japan's first nuclear reactors, which operated safely and apparently without problem" and it fostered the growth of Japan's nuclear developments (Midford, 2014, p. 71).

[13] In 1963, local citizens in Ashihama demonstrated a public protest when Mie prefecture pushed Ashihama area for potential NPP site to Chubu EPCO. This resulted in an act of violence by local fishermen who attempted to interrupt a sight inspection of Nakasone, and Chubu EPCO was forced to change the site to Hamaoka city in Shizuoka prefecture (Yamaoka, 2011). In late 1969, local fisherman practiced several demonstration activities against a plant expansion of Tokai NPP; "on 4th of October, 200 boats rallied in the sea near the proposed site, and on 11 October 1,000 boats from local fishermen's cooperatives gathered to demonstrate against plans to a fuel recycling facility on sites

[14] Aldrich (2008) elaborates: "In 1975, Professor Jinzaburo Takagi, a nuclear chemist, left his career as a research scientist to start the Citizens' Nuclear Information Center with administrative and financial support from the anti-nuclear group Gensuikin. Under his leader- ship, the CNIC began publishing Japanese- and English-language materials on the dangers of nuclear power and holding a series of conferences and colloquia about plutonium, reprocessing, and nuclear waste. […] The second national-level anti-nuclear organization that both disseminates information and organizes smaller networks is the National Liaison Conference of the Anti-Nuclear Movement (Hangenpatsu Undo¯ Zenkoku Renraku- kai), formed in 1975." (p.134)

[15] According to Aldrich (2008), citing a series of surveys by Ministry of Management and Coordination (Somucho) in 1978, 1980, 1984, "polls in 1980 showed that only 30 percent of citizens were willing to continue building plants—down from 50 percent in February 1979, before the accident" (Aldrich, 2008). In 1986, the far more serious accident, Chernobyl accident occurred in Societ Union. This pushed the public sentiment even more toward anti-nuclear power.

test run of Monju NPP, the prototype of Fast Breeder Reactor (hereafter: FBR). Monju reached at the critical state in April 1994, and connected with the grid in 1995 for the first time (MEXT, 2013). However, in December 1995, Monju leaked a large amount of sodium due to mechanical damage on equipment. The emergency precedents were poorly complied as Monju NPP had kept running for one and half hour after the alarm was triggered (Yamaoka, 2011). Later, the Ministry conceded that there were lack of inspections and maintenance for more than 10,000 equipment in the Monju NPP (MEXT, 2013). According to Midford (2014), "this accident also represented an important turning point in two respects: first, for the first time public opinion effectively closed a plant, and second, it ushered in a new period that showed the limits of even massive subsidies, as communities began to turn down reactors anyway" (p. 72). Although the anti-nuclear movements in Japan were not as big as to change a state's nuclear energy policy fundamentally, it was strong enough to close or postpone some of the ongoing NPP projects effectively (Aldrich, 2008; Midford, 2014).

Socio-technical regime

Let us go back to 60s again. The economic boom and oil shocks in 60s and 70s paved the way for utilities to expand NPPs. In this period, utilities issued a special kind of corporate bond called "Denryoku Sai (Electricity Bond)" to leverage their finance to invest for expansion of NPPs (Miura, 2013). Because utilities are allowed to gain profits equivalent to 3% of total assets they own, they naturally sought to expand their assets volume to increase their absolute profits (for more detail, see *section 2-2-2. Utilities*). Blessed with regional monopolization of electricity market and regulated price settting, utilities could avoid short- and medium-term refinancing risks (Berndt, 2018; K. Hirose, 2017; JSDA, 2019). As illustrated by *figure 2-2-6 and 2-2-7*, except for during oil crisis in 70s, "the regional monopolists boosted their total asset volume faster than the sales turnover through financial leverage, which is why the asset turnover rate has dropped" (Berndt, 2018, p.191).

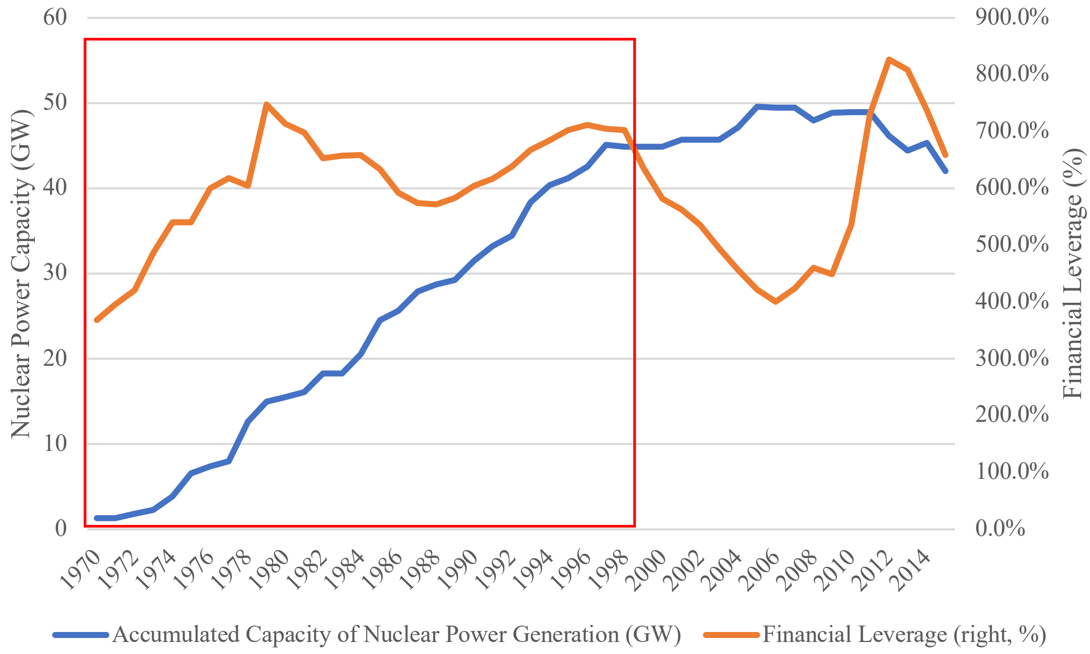

Figure 2-2-6. Financial Leverage and growth of nuclear capacity (FEPC, 2017; FEPC, 2019; METI, 2018b).

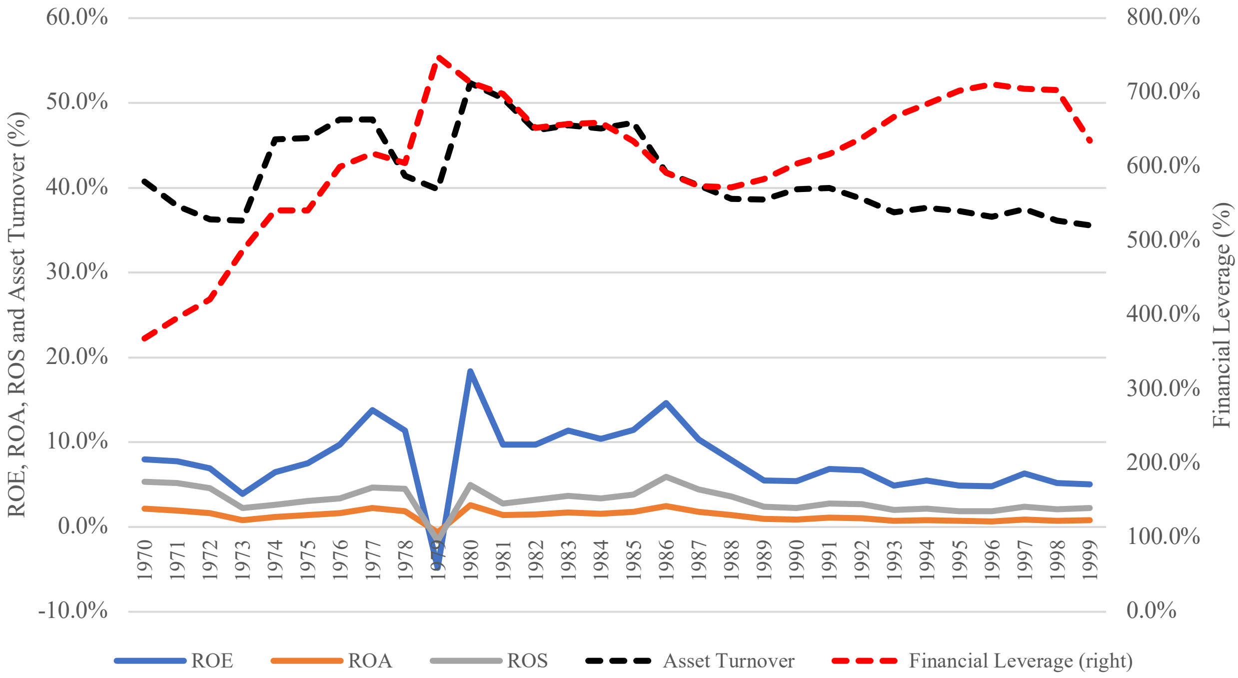

Figure 2-2-7. Financial indicators of utilities during 1970 and 1999[16] (FEPC, 2019).

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[16] Berndt (2018) provides an extensive explanation for those financial indicators: "The return on equity (ROE) can be calculated as the product of return on assets (ROA; how much profit was generated from investing into and utilising assets?)

Although the electricity market and nuclear power looked blight for utilities, they were facing a barrier that they need to overcome. Building NPPs require a consent from the local citizens who resides nearby potential sites for NPPs, but as mentioned earlier, the public slowly had become skeptic about nuclear energy since 70s and 80s. To address this issue, nuclear regime employed the following three approach to mitigate a growing concern over nuclear power and get consents from the public; subsidy scheme, advertisement and public hearings.

Bureaucrats, politicians and industrial actors employed those approaches in a more coordinated way by establishing Ministerial Council for Promoting a Comprehensive Energy Policy (MCPCE, Sogo Enerugi Taisaku Suishin Kakuryo Kaigi) in 1976 under the chairmanship of prime minister; "While MITI oversaw core licensing and promotion issues, the Ministry of Construction issued relevant construction permits, the Ministry of Finance vetted the budget, and the Environment Agency could theoretically suspend siting on environmental grounds, although it never did so" (Aldrich, 2008, p. 134; Yamaoka, 2011).

The subsidy scheme called "Subsidy on the Site for Power-Related Activity [Dengen Ricchi Sokushin Taisaku Koufukin]" was legislated in 1974 during LDP's Tanaka Administration. The subsidy provides a tremendous amount of money (roughly at 2 billion JPY a year) and infrastructure services (i.e. road and school) to potential siting municipalities in impoverished economic situations. Since a large amount of subsidy flows into a municipality for several decades, there is a criticism that this policy gets local economy reliant (or addicted) on NPPs, encouraging them to invite more and more plants as years gone by (see *section 2-2-2 "Local Municipality"* for more detail)[17] (Cho, 2014; Onishi &

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and financial leverage (how much are assets refinanced with debt?): ROE = ROA × leverage. Further, ROA can be broken down into the return on sales (ROS; how much profit was generated from sales?) and the asset turnover rate (ATR; how much sales was generated from utilising assets?). Therefore, profit/equity (ROE) = profit⁄sales (ROS) × sales⁄assets (ATR) × assets⁄equity (leverage). It is now possible to determine which of the factors affects the return on equity to what degree." (p.191)

"

[17] The subsidy scheme was largely expanded during 1990s responding to a growing public sentiments against nuclear energy. In 1994, MITI eliminated ceilings of subsidies for host communitires. Furthermore in 1992, the MITI raised the electricity discounts for host communities "from a range of 10 to 15 percent to 30 to 50 percent", providing extra compensation for local communities (Aldrich, 2008, p. 137).

Fackler, 2011; Yamaoka, 2011).

Public hearings were held in order to provide local citizens opportunities to hear explanations from bureaucrats and NPP operators. However, this practice had an aspect of social-control, that only pre-selected members could participate, and only pre-submitted questions were allowed to be said. Explanatory meetings were also held, where bureaucrats and utility representatives described plans to local citizens. Although such meetings can only be held under the strict guard of riot police, MITI officials and NPP operators were busily negotiating with land owners and opposition groups like fishermen, explaining how nuclear energy suffices the nation's energy safety as well as the local economic prosperity. (Aldrich, 2012).

Pro-nuclear agencies also started advertisement. In 1991, MITI started placing advertisements in national newspapers in the form of article, and "began distributing 500,000 copies of a 100-page pro-nuclear brochure in an attempt to 'target the moderates'" (Aldrich, 2008, p. 137; Perry, 1991). By doing so, the coalition of bureaucrats and utilities formed a consent from local citizens to accept NPPs and carefully propitiated the backlash against nuclear energy.

Niche

Due to intense state's support, nuclear had rapidly and widely started spread throughout the country between 70s and early 90s. However, in this period, MITI also set up 'Sunshine Project', a governmental R&D project, and actively started supporting solar PV. Solar industry was perfect for MITI whose clients are utilities and private corporations. Namely, rooftop PV producers are a collection of small individuals rather than business conglomerate. So this policy does not destabilize basic configurations of the nuclear regime and it serves as to support Japan's manufacturing industries (i.e. Sharp, Sanyo, Kyocera). Although the huge capital investment did not lead to sufficient diffusion of the technology, MITI kept upscaling the investments: the cumulative investments had reached $7.5 billion by 1993. In 1980, the industry group for solar PV, New Energy and Industrial Technology Development Organization (NEDO) was founded (Asano, 2014; Moe, 2014).

While roof-top solar PV industry was somehow managed to take off, wind power industry was still unseen in Japan's energy system. This may seem odd when you look at other leading countries in renewable energy field such as Denmark and Germany where development (both policy-wise and technology-wise) of wind power primed that of solar PV (Brunekreeft, Goto, Meyer, Maruyama, &

Hattori, 2014; Meyer, 2004). On this matter, Moe (2014) argues that 1) wind power producers tend to be bigger in terms of both capacity and capitals while rooftop PVs are mostly brought by individuals or small corporations. 2) Secondly, there were no major interests that would develop wind power producers in Japan whereas solar PV were favored by the other big manufacturing business. Therefore, MITI/METI disfavors to support wind power as it could potentially destabilize not only electricity regime but also manufacturing industry. Consequently, "Wind energy was not chosen as a principal technology of the Sunshine Program, meaning that RD&D support for wind, which began in 1978, had much smaller total budget than solar or geothermal" (see *figure 2-2-8)* (Mizuno, 2014, p. 1000).

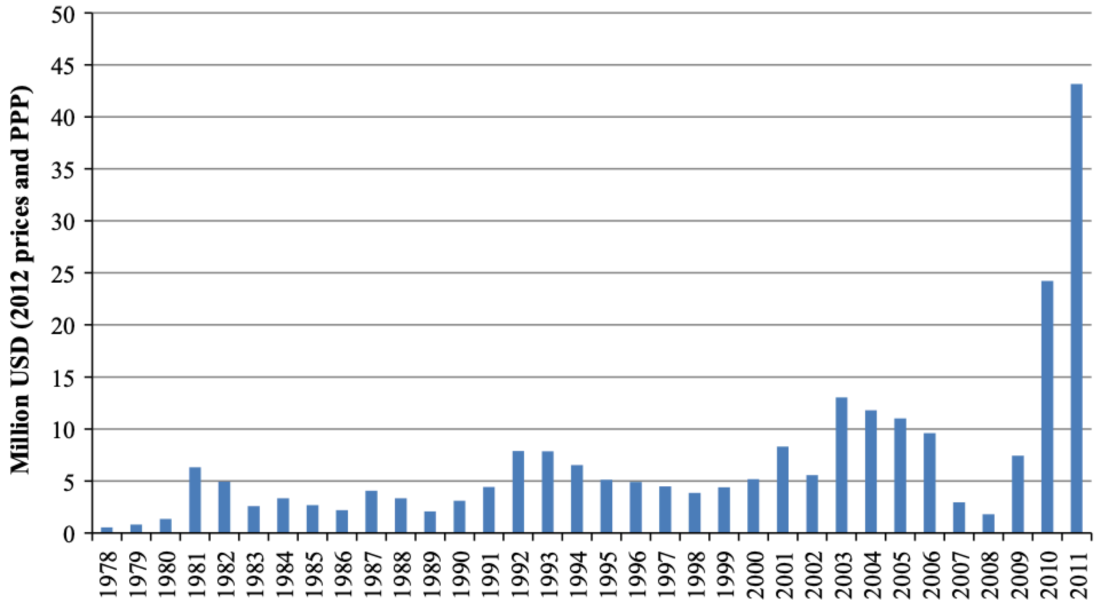

Figure 2-2-8. Government RD&D funding for wind energy in Japan (1974–2011) (Mizuno, 2014, p. 1001).

Analysis

The period between 1960 and 1998 has the following 4 features; 1) the rapid and constant growth of NPP capacities in Japan. 2) The gradual change in public's perception regarding nuclear power, shifting from 'for' to 'against'. 3) The promotion of nuclear energy in the coordination of the central government, administrative organs and utilities. 4) Intensive R&D investment of MITI toward Solar PV. The transition had a transformative feature in that a) nuclear regime utilized the rapid economic growth (and demand growth) and oil shock as a window of opportunities to expand nuclear capacity while it protected its basic configuration and nuclear policy from anti-nuclear movements. Plus, b) despite the emergence of niches, MITI promoted them in a way to synthesizes with the ST configurations. These dynamics are illustrated in *diagram 2-2-9*.

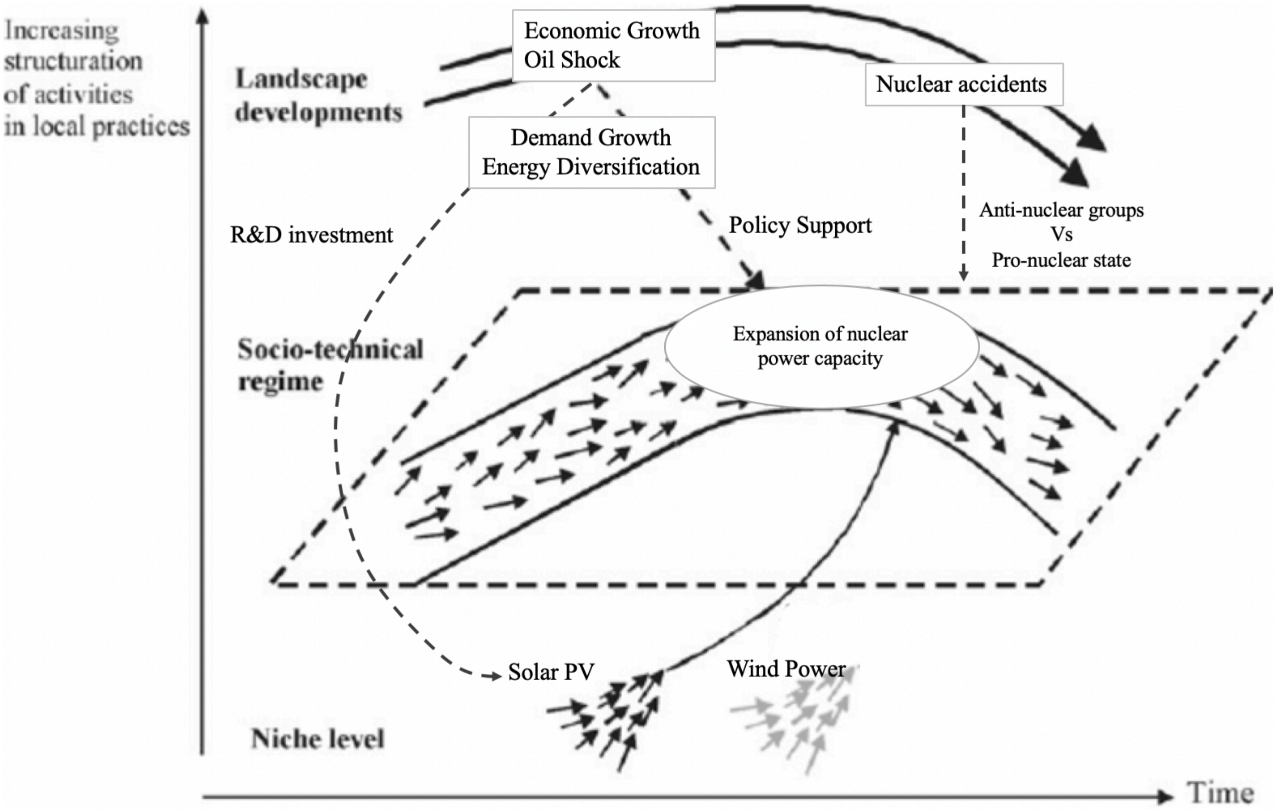

Diagram 2-2-9. The rise of nuclear regime.

However, when you look at the dynamics closely (see *diagram 2-2-10*), it becomes clear that the role of MITI and utilities were particularly significant in this period. MITI coordinated other bureaucratic organs under MCPCE and provide extensive supports to utilities for achieving public consents, sometimes by using private media for pro-nuclear advertisements. The subsidy scheme, legislated in 1974 during Tanaka Cabinet, also effectively mitigated the siting issues through substantial amount of subsidy. Thereby, pro-nuclear actors could rapidly expand the nuclear capacity during this period. MITI also took a pivotal role to kick-start Japan's PV industry.

In sum, in this period, the coordination of the regime, presented in the analysis of the last timeframe, was further straightened by the regime's adaptation to the changing environment (economic boom and oil shock). To respond to the landscape pressure to diversify the Japan's energy source, the METI attempted to nurture niche technology (solar PV) in a way that does not destabilize the basic regime coordination but straightens it. The public backlash toward the regime is tailored by the act of soft social control (influence on cognitive rules), and by the introduction of subsidy scheme for siting (influence on regulative rules). This led some local impoverished economies into a center of the regime coordination, being interdependent with the nuclear regime.

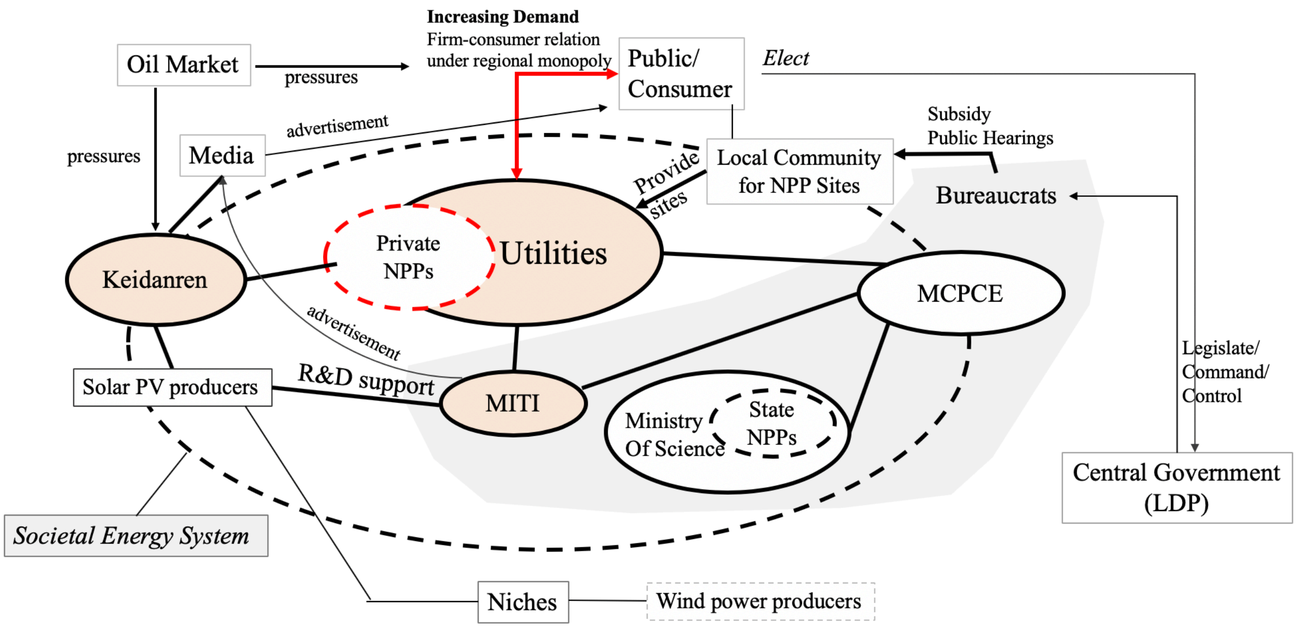

Diagram 2-2-10. Increasing Power of MITI in energy policy during 1960-1998.

1999-2010: Collapse of Safety Myth and Nuclear Renaissance

Socio-technical landscape

In 2000s, the U.S's power industry increased the dependency on oil: 36% in 1973, 44% in 1990, 53% in 2000 and 57% in 2003. The petroleum price was also increasing at the same time, accelerating the country's trade-deficit (Nakano, 2015). To tackle with this problem, Bush administration legislated "Energy Policy Act of 2005", to promote the development of nuclear energy for the purpose of securing the domestic energy supply and the country's decarbonization scheme[18]. Finally, in 2008, the U.S signed the Atomic Energy Agreement with India, the country which is not a member of NPT (Nakano, 2015). Thereby, the nuclear power gradually started expanding its market involving non-NPT countries.

Meanwhile in Japan, the macro economy entered into persistent deflation and demographic stagnation. Japanese manufacturers were challenged by emerging economies such as China[19]. Economic deflation and demographic stagnation also meant a stagnation of energy demand. This is problematic for regional monopolies whose only way to expand sales is to increase the demand in a monopolized region (Nakano, 2015).

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18 This act includes the exemption of production tax for newly built NPPs, the expansion of the insurance for the developers in case of nuclear accidents, the expansion of R&D on nuclear and hydrocarbon power generation, the promotion of the development project for next-generation reactors. (Nakano, 2015)

19 For example, the Japanese makers such as Toshiba and Hitachi were used to be the leading companies in semiconductors, computers, TV and home appliances but slowly struggled to compete with the emerging Chinese and South Korean makers. As a result, they were being forced to either downsize or retreat the business. (Nakano, 2015)

The public stance also showed backlash against nuclear power after JCO's criticality accidents in 1999[20]. Together with the revelation of Tokyo EPCO's cover-ups of severe nuclear accidents before, "public support for unconditionally building nuclear power plants almost vanished, while those conditionally in favor of building new plants also declined, from approximately 46 percent in September 1990 to 38.8 percent in November 1999. Meanwhile, those calling for maintaining the status quo declined from 17.9 percent to 14.8 percent, and those who favored reducing or eliminating nuclear power increased from 26 percent in 1990 to 27.8 percent in 1999" (Midford, 2014, p. 74). During this time, some ongoing projects were either postponed or terminated by public referendum (i.e. Kariwa village and Miyama city rejected the use of MOX by referendum in 2001; the cancellation of long-planned NPPs in Suzu city in 2003 and Kumihama NPP in Kyoto in 2006 etc…) (Midford, 2014).

Nonetheless, the public, in general, still did not abandon nuclear energy. According to Midford (2014), citing a cabinet office poll and Asahi Shimbun (2009), 59.9% of respondents supported the use of nuclear power while 53.9% demonstrated concerns over nuclear power due to lack of transparency. On this point, Kitada (2013) also complements that people in favor of "reduction or complete phase-out" during 1978 and 2010 were still minority, or even at the similar level as 1978, the time before neither domestic NPP accidents nor cover-up scandals were revealed (see *figure 2-2-11*). As of 2009, the nuclear power supplied 29% of the country's electricity demand. The government during DPJ's Kan Administration (2010) published the 3rd Basic Energy Plan in June 2010 that seeks to expand nuclear power as to consist 53% of the country's power mix (ANRE, 2010; ANRE, 2018a).

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[20] Two nuclear accidents happened in 1997 and 1999 in Tokaimura Village, the first town to host NPPs in Japan. On March 11th of 1997, two fires broke out in JCO's NPP, and "an abnormal increase in the level of cesium – a byproduct of nuclear fission – was seen in 35 miles southwest of the plant" (Brown, 1997, p. 2; Capital, 1997). In September of 1999, plant workers in JCO's uranium reprocessing facility in Tokaimura misconduct the designated instruction and caused a criticality accident. As a result, the plant emitted a considerable amount of neutron radiation, resulting into two causalities and 3 heavily radiated victims (Kobayashi & Tamura, n.d.)

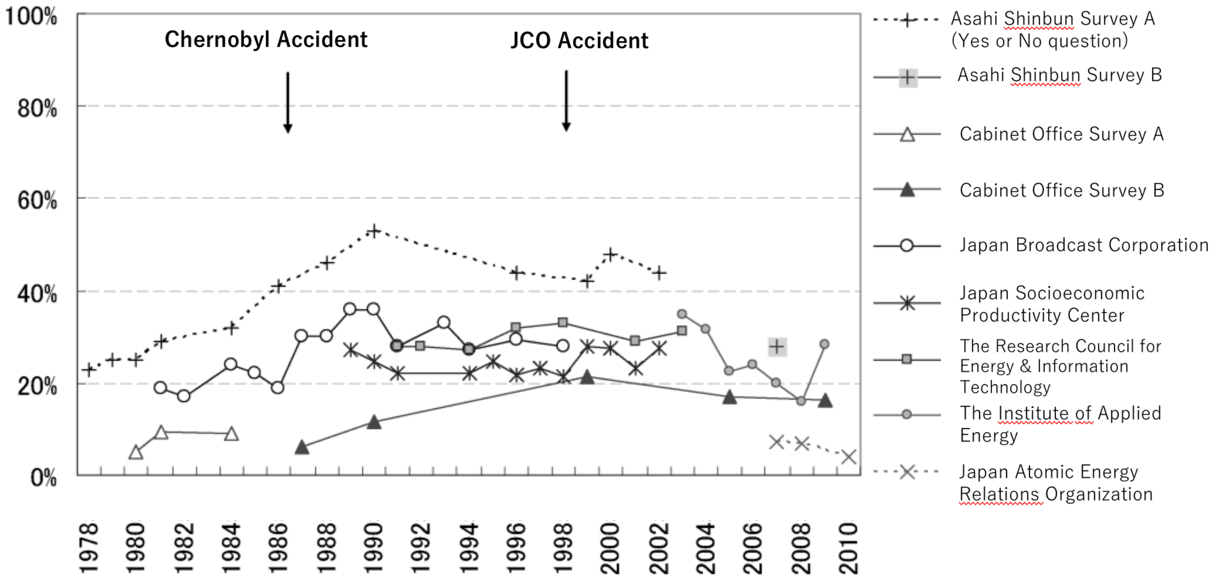

Figure 2-2-11. The percentage of public opinion in favor of "reduction or complete phase-out" 1978-2010 (Kitada, 2013, p. 178. Translated by the author).

Socio-technical regime

JCO's criticality accidents also affected to Ministry of Science, the administrative organ which was responsible for state's development of nuclear power. The ministry was not only responsible for JCO's accident in 1997 and 1999 but also Monju accident in 1995. Thereby, in 2001, the Ministry of Science was dissolved as an independent ministerial department and its remaining sector, the FBR development, integrated into the MEXT. This has led to an end of bipolar organizational structure of Japan's nuclear development[21](Berndt, 2018; Yamaoka, 2011).

Meanwhile, a series of institutional change toward liberalization came onto the table in response to the public's demand. The first amendment is partial liberalization of electricity market. In 1995, the electricity market allowed the entry of non-utility power supplier (they are called Independent Power Producers [IPP]). IPPs, only those who own supply capacity over 2 million kW, were allowed to generate electricity and sell it to a retailer (this meant utilities in this time as they monopolized retail market) through utility-owned transmission lines. Correspondingly, Japan adapted competitive bidding system in the same year. This brought competitive principles in electricity market, addressing the issue

[21] Monju, the experimental reactor, had been stopped since 1995's accident. It started operating again on 6th May, 2010 but again stopped operating on 28th August of the same year due to equipment impairments. Finally, without restarting again since then, the central government formally decided the decommission of Monju in December 2016. Japan has other experimental FBR, Joyo. Yet, it has been un-operating since 2007 due to equipment impairment. The development plan is being aborted since Monju's decommission.

of high-cost structure of regional monopolies by competition mechanism (Miura, 2015; Yamaguchi, 2007).

In 2000, Japan partially liberalized a retail sector, that is, ultra-high voltage (contracted power 2,000kW or more), the sector which consisted 20% of total electricity market in Japan. Due to this deregulation, the actors so-called “Specific Power Producer and Supplier (PPS)” entered to the market. Basically, they are the retailers who deliver electricity to their customers using transmission lines owned and managed by utilities (Miura, 2015; Yamaguchi, 2007).

In 2003, more extensive deregulation was carried out. This time, a retail segment for high-voltage (contracted power between 50kW and 2,000kW) was liberalized, which implied the liberalization of 40% of Japan’s electricity market, together with aforementioned ultra-high voltage segment. In 2004, Electric Power System Council of Japan (ESCJ) was established to monitor and regulate transmission sector to ensure fair competitions. In 2005, Japan Electric Power Exchange (JEPX) was established, an exchange that facilitates with spot and forward transactions (Miura, 2015; Yamaguchi, 2007).

In a situation that the macro economy is in persistent deflation and demographic stagnation (hence a stagnation of energy demand), utilities who were exposed to competition in supply and price had to change their business model: because the demand is stagnant, base-load such as nuclear power could no longer increase permanently. Thus, instead of expanding their fixed assets though financial leverage, utilities needed to make best use of the assets they had already owned, lowering prices and costs though realizing economies of scale in order to avoid losing their shares (Berndt, 2018). The *figure 2-2-12* and *2-2-13* confirm this: as a series of deregulation in electricity market started in 1999, utilities decreased the capacity investment and financial leverages while the capacity of nuclear power (=volume of assets) increased only slightly. As a result, the liberalization forced utilities to minimize the non-fuel cost and the overall electricity bill had decreased (as illustrated by *figure 2-2-14*).

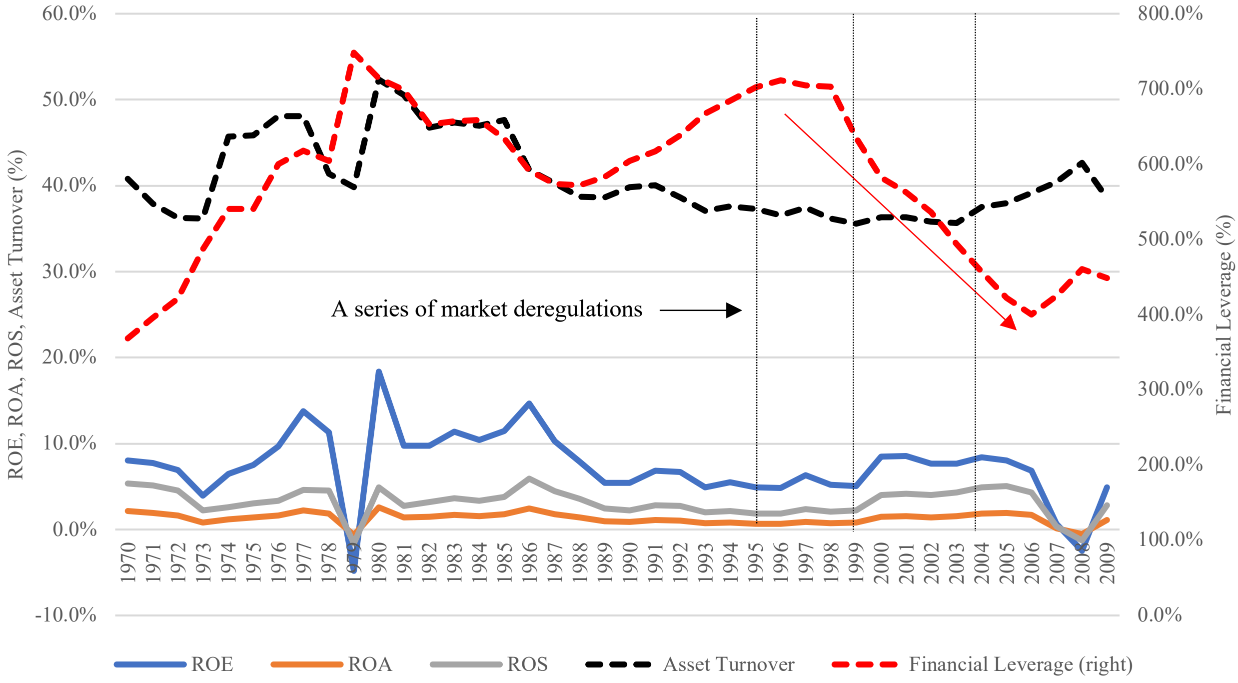

Figure 2-2-12. The change of utilities' business model (1970-2009) (FEPC, 2019).

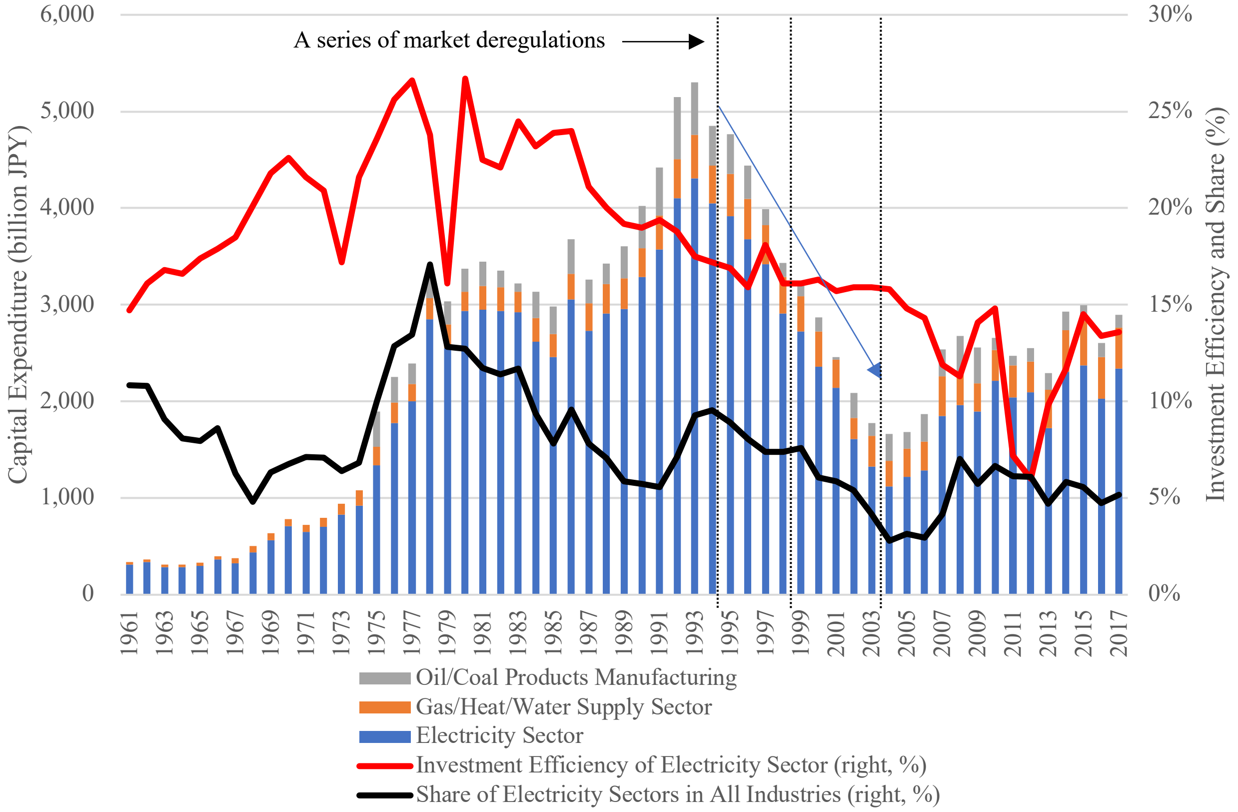

Figure 2-2-13. CAPEX in Energy Industry and Investment Efficiency of Electricity Sector (Ministry of Finance, 2018a).

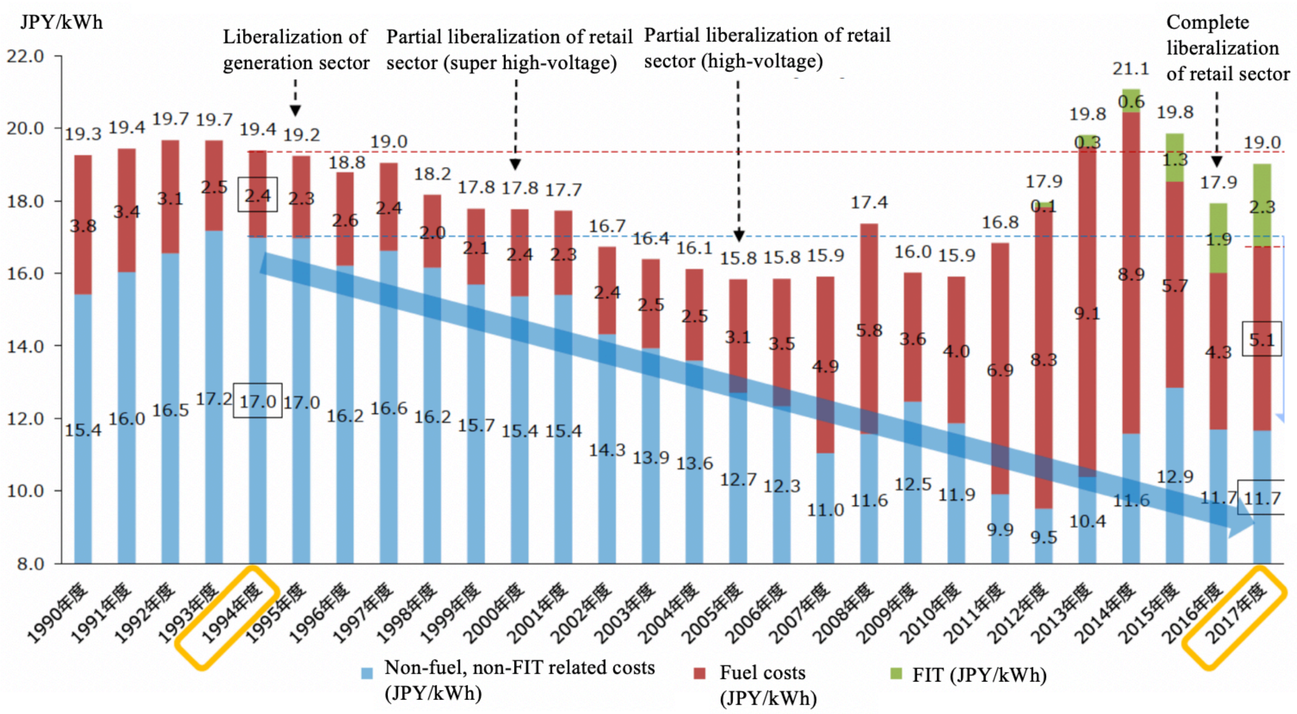

Figure 2-2-14. The average electricity bills of utilities (ANRE, 2018c, p. 3, translated by the author).

To overcome the NPP's growth constraint, METI and utilities started looking at new business opportunities, NPP exports. This was a perfect opportunity for Japan's manufacturing sector which had been losing share against emerging competitors in foreign countries. Toshiba acquired 77% majority stake of Westinghouse Electric Corporation (WH) in 2006 (which it later took another 10%). In the same year, Mitsubishi Heavy Industry founded a joint enterprise with Areva S.A in France. Furthermore in 2007, Hitachi merged its nuclear development department with that of General Electric Company (GE) (Berndt, 2018; Nakano, 2015; Tomita, 2014). Those three companies founded International Nuclear Energy Development of Japan Co., Ltd (JINED), sharing 5% each, together with 9 utilities (total 75% of total share) and Innovation Network Corporation of Japan which shares 10%. JINED was a national, political project where MITI and politicians took responsibility for bilateral agreements with other states (International Nuclear Energy Development of Japan (JINED), 2010).

Niche

In this period, several institutional changes affected renewable industry. The first one is down-size and abolishment of long-running subsidies for PV, in 2004 and 2005 respectively. The impact of the policy change was so eminent that the installed capacity of solar PV suddenly stabilized and eventually the share of Japanese makers in PV market started to fall rapidly (see *figure 2-2-15*). (ANRE, 2018a; Moe, 2014).

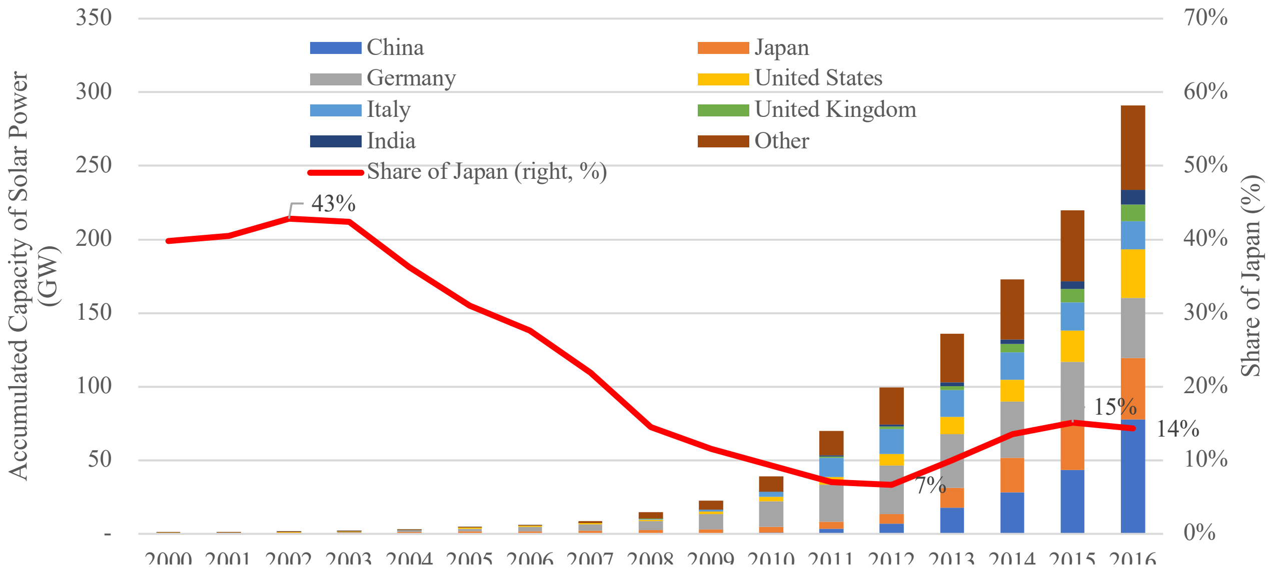

Figure 2-2-15. Accumulated Installed Capacity of Solar Power (left), and share of Japan (right) (ANRE, 2018a).

Instead of capital subsidies, the government introduced Renewable Portfolio Standard (RPS) mechanism in 2003. Asano (2014) explains; "Similar to FIT, RPS ensures that output from RE is purchased at a price exceeding that of normal wholesale electricity. Although the FIT and RPS mechanisms are the same in that they both incentivize increased RE output and are being adopted in countries around the world, they differ in that government regulation under FIT targets the purchase price, while under RPS it targets installed capacity. That is, if FIT is subject to price regulations, RPS is subject to quantitative regulations" (p. 168). The mechanism effectively curtailed the configuration of nuclear regime in a manner that it ensures wind power not to take too much share in the electricity market (*figure 2-2-16*).

Thirdly, as mentioned above, Japan started liberalizing its electricity market in this period. This allowed PPS to enter the renewable electricity market. However, the effect was small as they need to transmit electricity through utilities-owned transmission lines, the line which utilities imposed an expensive fee to use (Berndt, 2018; Yamaguchi, 2007).

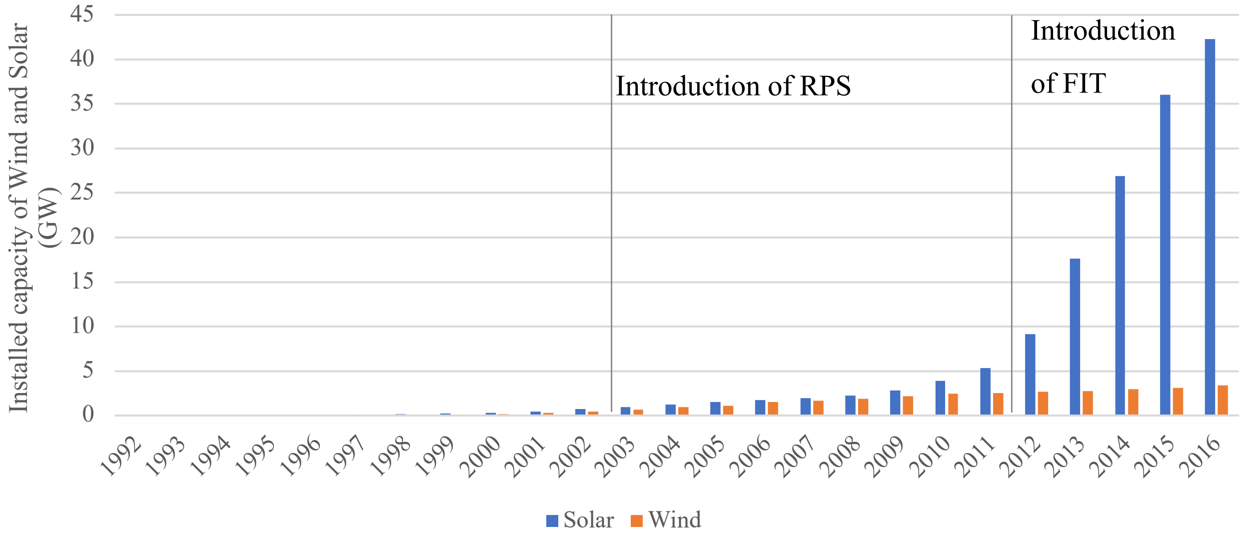

Figure 2-2-16. The impact of RPS and FIT in terms of diffusion of renewable electricity capacity (ANRE, 2018a).

Analysis

The impact of JCO's accident did not create backlash strong enough to destabilize the regime configuration, while economic deflation and demographic stagnation together with competitive bidding system pressurized utilities to modify their business models. Opportunities came from the U.S during Bush administration which announced to seek for expansion of NPP exports. METI (former MITI), utilities and Japanese manufacturers (Toshiba, Hitachi and Mitsubishi) started a joint corporation to sell NPP plants to overseas. As shown in the 3rd Basic Energy Plan, Japan still sought for the further expansion of nuclear power as to consist more than 50% of its energy mix by 2030. Therefore, during this period, the Japan's energy system adapted to changing environment rather than being re-configured nor de-configured.

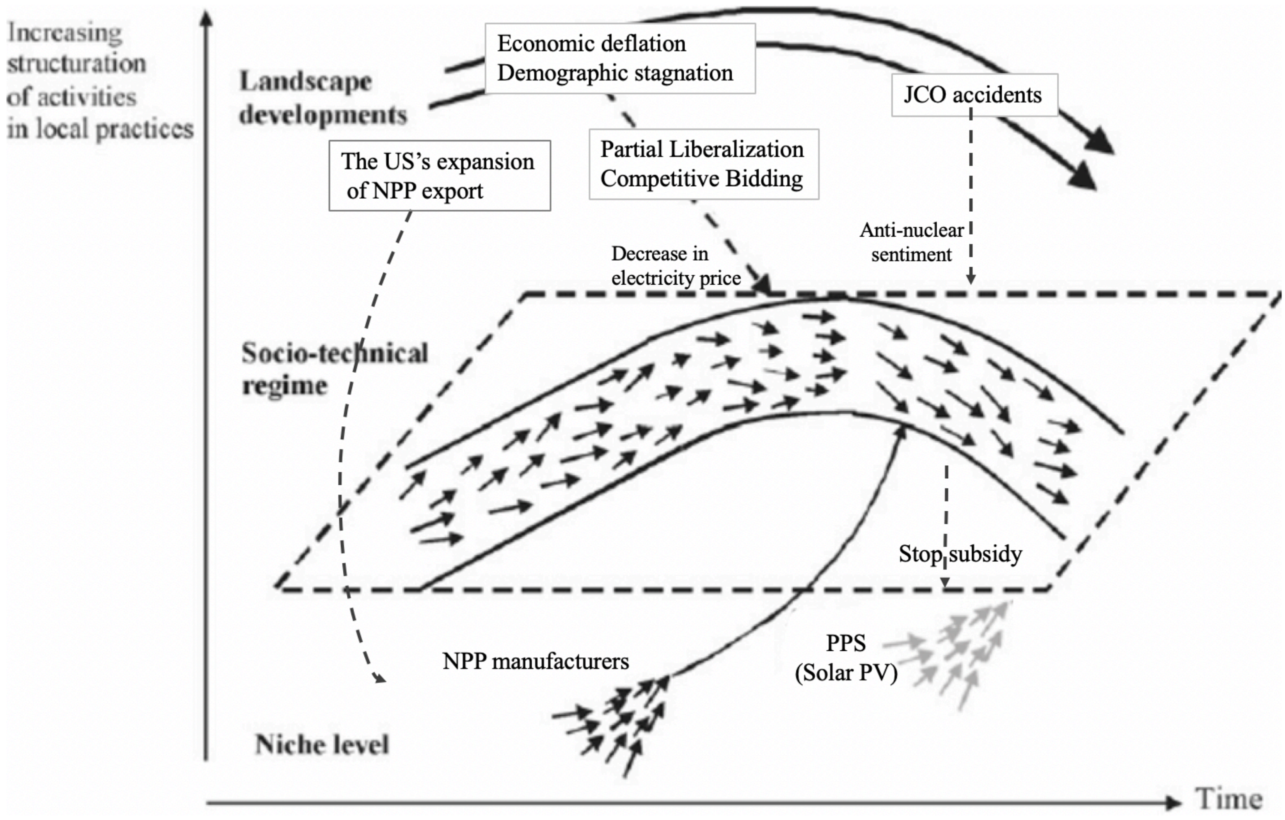

Diagram 2-2-17. Nuclear regime adapts to changing environment.

Though the basic configuration remained similar, but the characteristics and membership within the regime has changed. First, the organizational structure became unipolar. Second, nuclear regime started having NPP manufacturers (Toshiba, Hitachi and Mitsubishi). Third, partial liberalization of distribution sectors allowed independent producers (PPS) to enter the electricity market through utilities-owned transmission lines. The liberalization also, theoretically meant that commercial scale customers were no longer tied by a monopolistic relation with utilities.

In sum, in this time frame, the landscape (i.e stagnant economy and public backlash) pressurizes the regime to change its coordination presented in the last two timeframes. The power reproduction mechanism of utilities, backed by the demand growth and regional monopoly, was no longer as valid as before. As the utilities' refinancing activities weakened, the vested interests of lenders should stop scaling. Although most consumers were still embedded in the regime's basic coordination (as most of them were still dependent on the service from the utilities), the partial liberalization allowed some consumers to be less dependent on the utilities. While the liberalization pressurizes the utilities and forced them to change its business model, METI also presented NPP exports as a new business idea. Thereby, the regime coordination placed the manufacturers as new important actors to keep their basic coordination.

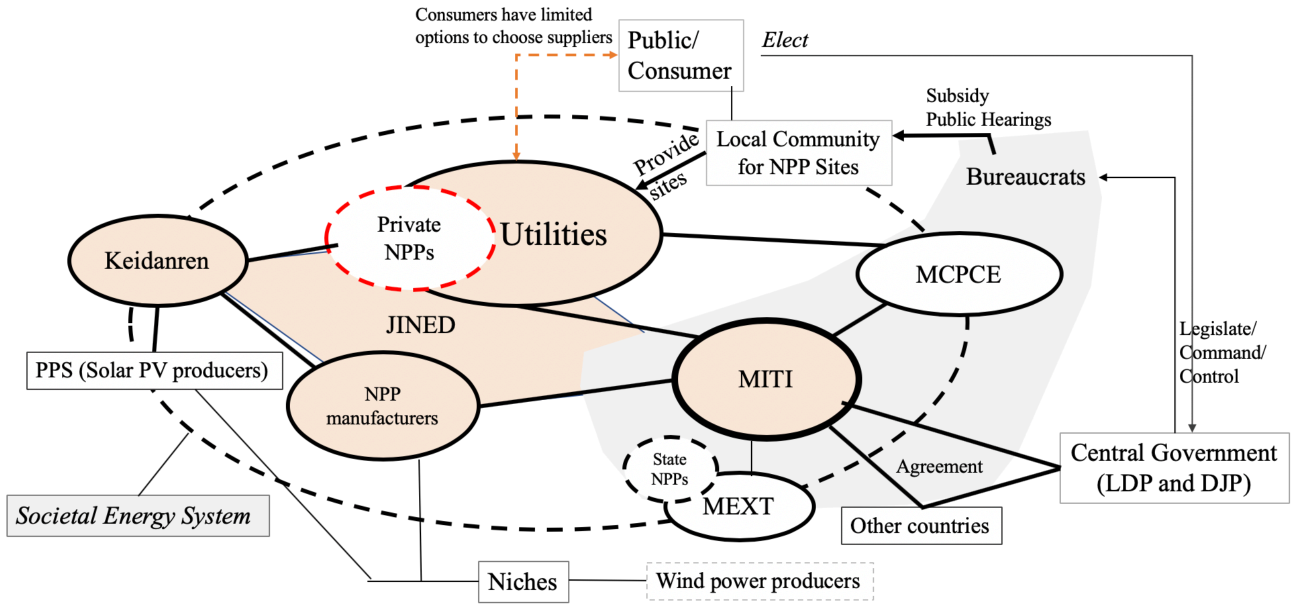

Diagram 2-2-18. Fossil-nuclear coalition in the time of demand stagnation

2011 - 2017: Impact of Fukushima Nuclear Disaster

Socio-technical landscape

The Fukushima Nuclear Accident, unsurprisingly, triggered the public opprobrium against nuclear energy. Several survey results show that roughly 70% of the public showed distrust on nuclear power (see *figure 2-2-19*) (Kitada, 2013; Nakano, 2015). Furthermore, other surveys demonstrated the public's distrust on the government as well: Mainichi Shimbun conducted a survey on 11th April, 2011, asking if you trust the information published by the government, regarding the radioactive materials from Fukushima NPPs, 64% answered "no" whereas 26% answered yes. The survey of Mainichi Shimbun, conducted on 28th and 29th May, 2011 with a similar question, revealed that 80.8% of respondents disbelieved the information published by the government regarding the accidents and the radioactive materials. The survey of Yomiuri Shimbun, conducted on 3rd and 4th of June, 2011 revealed that 78% of respondents distrust on the government's information regarding the accidents whereas 14% does (Nakano, 2015).

The public opinions, if not wholly, were translated into Japan's energy policy especially in the two ways. First, on March 31, the prime minister Naoto Kan (2010-2011) from Democratic Party (DPJ) announced that the Basic Energy Plan would be revised and re-written from scratch. Second, on the 6th May, 2011, Kan also ordered to shut down all three reactors in Hamaoka NPP and four days later, he publicly announced the energy policy that is less reliant on nuclear power (Ramana, 2011). In July, Kan went even further and announced that Japan should gradually make a complete phase-out from nuclear power (Midford, 2014). Since then, nuclear reactors started being shut down due to temporary safety inspections and finally on the 17th of September 2013, Japan turned off the last reactor in the country (Inman & Macalister, 2013).

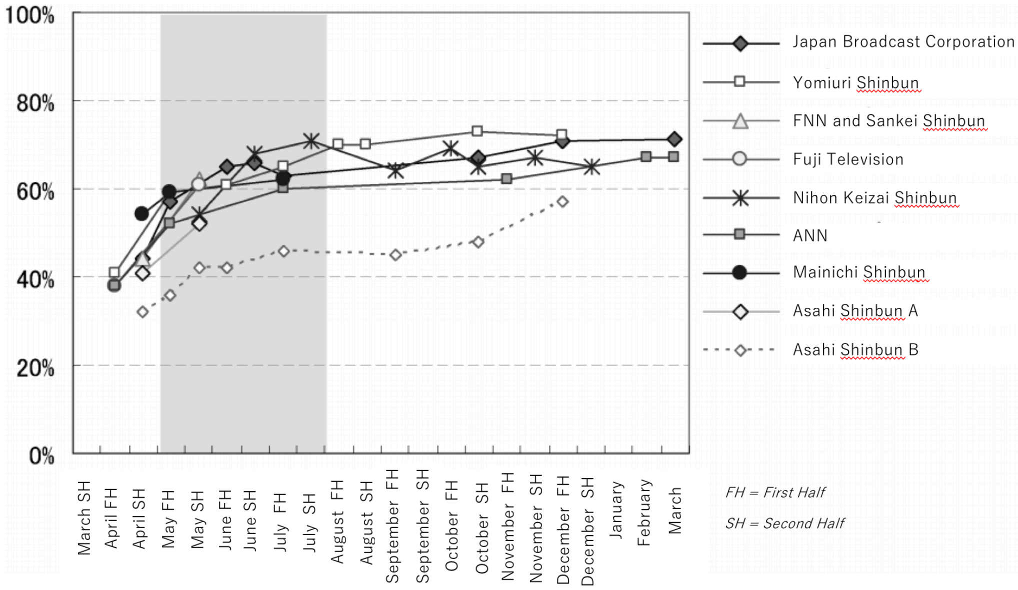

Figure 2-2-19. The percentage of public opinion in favor of "reduction or complete phase-out" in 2011 (Kitada, 2013, p. 180. Translated by the author).

In addition, Kan also suspended "Japan's exports of nuclear reactors and proposed separating power generation and transmission in order to give renewable energy producers better access to the grid" (Midford, 2014). Simultaneously, Japan's energy policy turned to be more in favor of renewable energy: Kan's cabinet proposed more robust and ambitious FIT scheme than the one which had been proposed before Fukushima happened (Midford, 2014).

Although the public appreciated his robust change toward energy policy, they did not support his administration. Kan resigned its position as prime minister in August 2011 and DPJ's Yoshihiko Noda became its successor. Although Noda took more careful stance for putting an end to nuclear power, he delivered a speech at the 67th general assembly at UN and announced that Japan should make a complete phase-out from nuclear power in 2030s (Midford, 2014).

Three month later, Noda Cabinet (DPJ) called new elections for the Lower House in 2012 and consequently, LDP and its coalition partner Komeito won a huge victory. While DPJ declared to phase-out from nuclear power in 2030s (which was supported by the majority of public), LDP, the most pro-nuclear and only party which did not promise the phase-out from nuclear, won. The 4th energy basic plan, published in 2015 during LDP's Abe administration, proposed that nuclear power will comprise of 20-22% of the country's energy mix by 2030 while renewables (including hydro-power) comprises 23%. The target is still unchanged in the 5th energy basic plan published in 2018 (ANRE, 2015a; ANRE, 2018a). Japan once again got back to nuclear development.

Socio-technical regime

Utilities made record breaking deficits during the business year between FY2010[22] and FY2012 (see *figure 2-2-20*). As you can see from *table 2-2-21*, most of the losses in FY2010 was derived from Tokyo EPCO, the company liable for Fukushima NPPs. On the other hand, all EPCOs but Okinawa EPCO started suffering substantial losses, at least a month after the Fukushima, particularly during FY2011 and FY2012 (1st April 2011 – 31st March 2013). What this indicates is the impact of aforementioned temporal shut-downs of NPPs. As discussed in detail in the *section 2-1-1*, NPP operators had to bear the maintenance and inspection costs for NPPs while the reactors themselves do not produce electricity (=income). Okinawa EPCO, the only utility which does not own NPPs, could still manage to make profits during this period, although it also experienced a robust decline of net profits (from 69 billion in 2010 to 31 billion in 2011).

The effect is also prominent in utilities' IR-reports: as *figure 2-2-22* shows, ROE, ROA and ROS of 10 utilities significantly dropped in FY2010. The rate of financial leverage, once it had dropped to 400%, suddenly surged to over 800%. Unlike before, financial leverage did not lead an expansion of asset volumes, as it was simply to compensate the damage caused by the disaster.

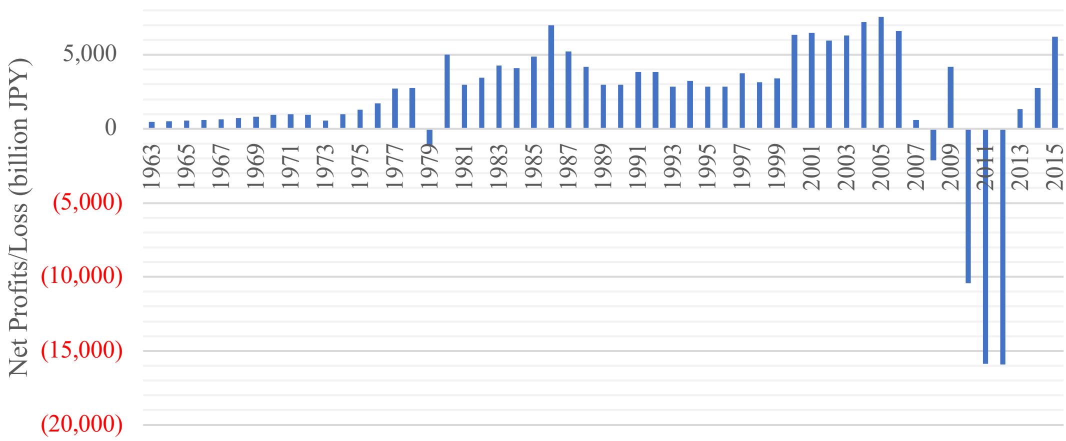

Figure 2-2-20. Net Profits/Loss of 10 Utilities (FEPC, 2019).

EPCOs	2009	2010	2011	2012	2013

[22] Japan's fiscal year (FY) starts on 1st April and ends on 31st March. East Japan Great Earthquake and Fukushima Nuclear Disaster happened in March 2011. This means that the damage and loss caused by the disasters affect the accountancy of FY2010.

Hokkaido	54	94	-745	-1,201	-642
Tohoku	201	-331	-2,102	-592	360
Tokyo	1,023	-12,586	-7,584	-6,944	3,989
Chubu	1,065	758	-946	-353	-673
Hokuriku	152	167	-66	-23	16
Kansai	925	1,033	-2,577	-2,729	-931
Chugoku	225	-30	-14	-267	-189
Shikoku	193	208	-116	-462	280
Kyushu	283	204	-1,750	-3,381	-909
Okinawa	73	69	51	31	39
Total	4,194	-10,414	-15,851	-15,920	1,341

Table 2-2-21. Net Proceedings of 10 utilities during 2009-2013 business years (billion JPY) (FEPC, 2019).

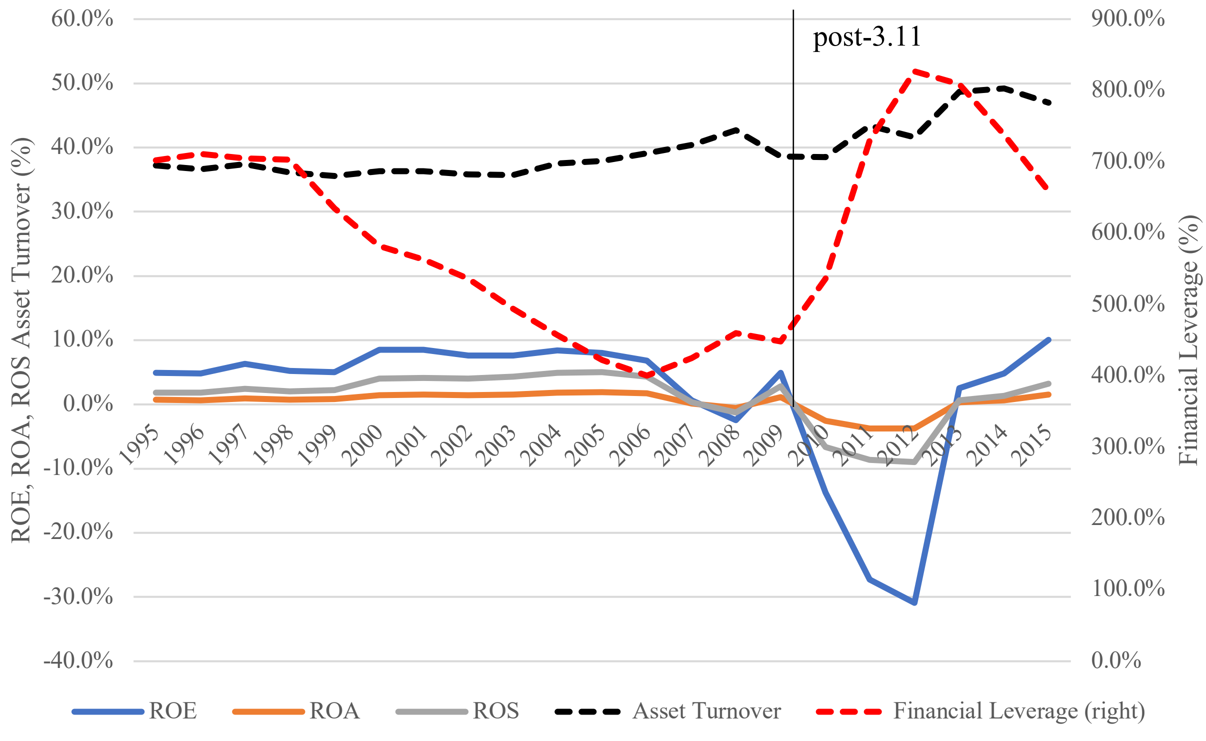

Figure 2-2-22. Financial indicators of utilities (FY1995-2015) (FEPC, 2019).

Tokyo EPCO was at a peril of bankrupt since 2011. Fearing that the bankruptcy of Tokyo EPCO could potentially lead to the collapse of energy infrastructure in a capital city, the state and NPP operators founded "Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF)" in September 2011 and granted 55.8 billion JPY to Tokyo EPCO. NDF later expanded the financial support, and in July 2012, bought the majority of the company's stock with 1 trillion JPY. Thereby, Tokyo EPCO became a de facto state enterprise. The central government initially estimated the damage compensation for Fukushima disaster to be roughly 6 trillion JPY (5 trillion JPY for damage compensation and 1 trillion JPY for decontamination), but it re-estimated to 11 trillion JPY as of 2013. This was also an underestimation and later revised as 22 trillion JPY (Usami, 2017).

NDF articulated a policy measure to compensate this money in the following 4 ways. 1) A state-owned Tokyo EPCO is liable for 16 trillion JPY. 12 trillion JPY of it will be repaid by Tokyo EPCO within 20-30 years. 2) the other 4 trillion JPY will be repaid by capital gains from stock improvements of Tokyo EPCO. 3) The remaining amount of 6 trillion JPY will be covered by the raise of electricity price. After the liberalization in 2020, non-utility companies will also contribute to the cover from its gain (Usami, 2017). This implies that Tokyo EPCO will be owned by a state at least for 30 years.

However, Japan Center for Economic Research (JCER) (2017) analyzed reports from Tokyo EPCO regarding damage compensation and concluded that the NDF's estimation has two flaws: firstly, it is highly doubtful whether Tokyo EPCO can compensate 16 trillion JPY by their revenue and capital gains from stock improvements. Because of competition under the liberalized market, there is no logical grounds that they can achieve enough profits for mid- or long-terms. Their biggest money sack, thermal power generation, is also vulnerable to fluctuations of oil prices (Japan Center for Economic Research, 2017).

Secondly, JCER asserts that the 22 trillion JPY is far too optimistic. For example, NDF is currently proceeding a plan to store 22 million cubic meters of contaminated soils but has no concrete plans how to de-contaminate them. JCER assumed the unit cost based on low-level radioactive waste in Rokkasho village in Aomori (8 to 19 billion/10,000 tons) and estimated that the soil decommission alone would cost 30 trillion JPY. As for decommission cost, the government estimated based on Three Mile Nuclear Accidents, JCER calculated based on the assumption that all melt-downed reactors (Fukushima No.1,2,3), and estimated that the decommission of reactors alone would cost 11 trillion JPY. Overall, JCER estimates the damage compensation for Fukushima disaster would become 50 to 70 trillion JPY (Japan Center for Economic Research, 2017).

The disaster also created an uncertainty in NPP export. As Berndt (2018) states; "due to the Fukushima nuclear disaster of March 2011: new orders for NPP/NPRs were held off. Whether domestically or abroad, almost all new NPP/NPR building projects have seen huge delays and cost overruns. Despite intense political, financial and diplomatic support by Japan's government, Japanese export projects have been cancelled in Vietnam, Taiwan, the US, suspended in Lithuania, delayed in India" (p. 148).

Facing a series of troubles, Toshiba (the one that acquired WH) "manipulated its financial accounting to avoid impairments on its WH-related goodwill to an amount that exceeds its equity capital" and eventually decided to let its subsidiary WH go bankrupt in March 2017 (Berndt, 2018, p. 149).

One of the biggest institutional change after Fukushima is the legal unbundle of distribution and transmission segments of utilities; the former came in effect in April 2016, and the latter will come in effect in April 2020. Legal unbundle will come along with liberalization of electricity sector, and orders a utility to separate its generation, transmission and distribution sector into different companies. However, it still allows companies to have financial ties and this could potentially result into nepotisms among former utilities. To ensure neutrality and fair competition in the market, METI founded a regulatory authority, Electricity Market Surveillance Commission (EMSC) in September 2015, which later expanded its surveillance area to gas and heat market and was renamed as "Electricity and Gas Market Surveillance Commission (EGMSC)" in 2016 (IEA, 2016).

However, it is skeptical that liberalization will give an impact to destabilize the current configuration, as Berndt (2018) retrospect the response of regional monopolists toward past liberalization process; "former regional monopolists and NPP operators concentrated their resistance on preventing the neutralisation of onward and outward electricity flows, that is, equal access for all suppliers to the electricity grid. As a matter of fact, they have succeeded in introducing expensive transmitting and imbalance fees"[23](p. 186).

Niche and niche-regime

As you can see from *figure 2-2-23*, renewable source-based electricity surged after 2011 by the introduction of Feed-in Tariff policy to the small-scale solar PV for households in 2012. Yet still, the industrial policy strongly prefers to keep the current utility-centered configuration, and wind power capacity had not increased. Moe (2012) argues that the household solar PV was a perfect compromise in a way that it suffices the public demand for renewable policy while it won't destabilize the nuclear regime configuration. On the other hand, the wind power which is normally operated by large capitals

[23] New entries have been charged tremendously high fee for using transmission lines and, in addition, they are also charged significant amount of imbalance fee (48JPY/kWh, three times of standard cost price as of 2008-2016), a compensation for any gap between actual electricity supply and demand over 3% that a transmission sector cannot balance within 30 minutes. This is applicable not only in case of shortage but also in case of surplus. As a result, an imbalance fee amounted national average of 14.3JPY/kWh as of 2016 (Berndt, 2018; Yamaguchi, 2007).

and produces larger amount, was considered as the potential threat to the regime configuration. As a result, among the approximately ¥100 billion a year of a budget for promotion of renewable energy, very majority is spent on the promotion of PV, neglecting the wind power (Maruyama, Nishikido, & Iida, 2007).

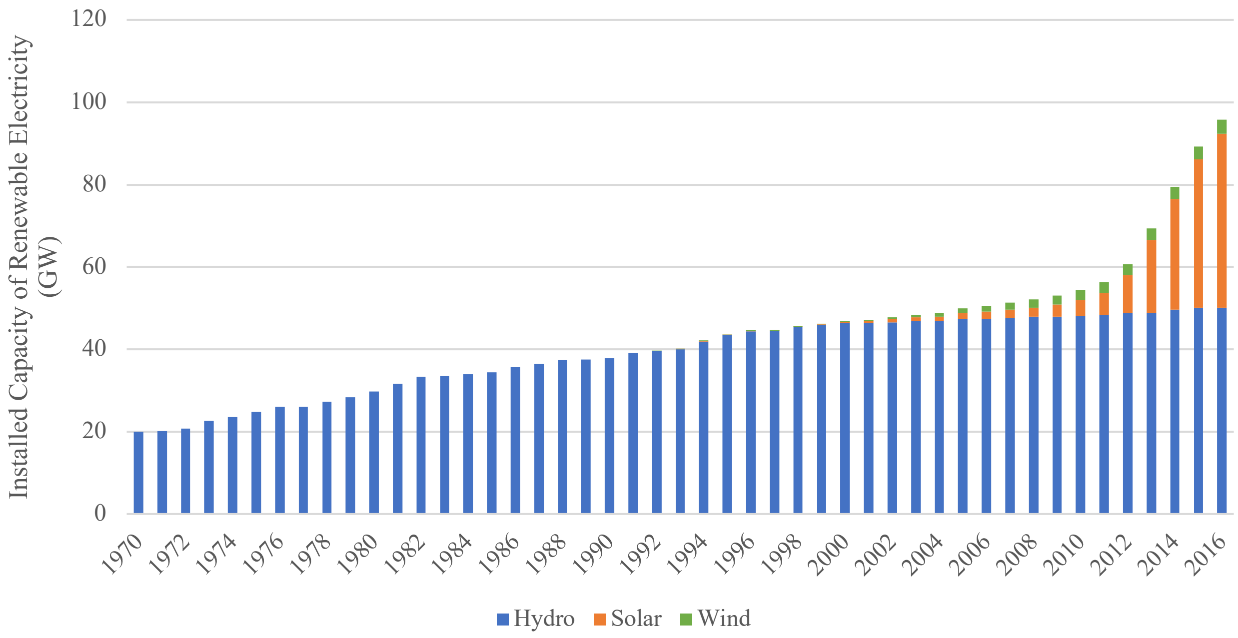

Figure 2-2-23. Installed Capacity of Hydro, Solar and Wind Power Generators (Agency for Natural Resources and Energy (ANRE), 2018a)

Due to the full liberalization of retail segments, JEPX, Japan's electricity spot market has seen an upward trend since April 2016; while the transaction of JEPX only consisted 2% of total sales volume as of April 2016, it consists 32% as of November 2018 (see *figure 2-2-24*). However, most of this transaction are done by non-renewable energy (oil and gas), whereas in the wholesale market in the countries such as Germany, France or the United Kingdom, "the total transactions being traded on the exchange market often account for at least 40% of the whole market, of which renewable energies make up for about 30% of the energy mix" (Maekawa et al., 2018, p. 2229).

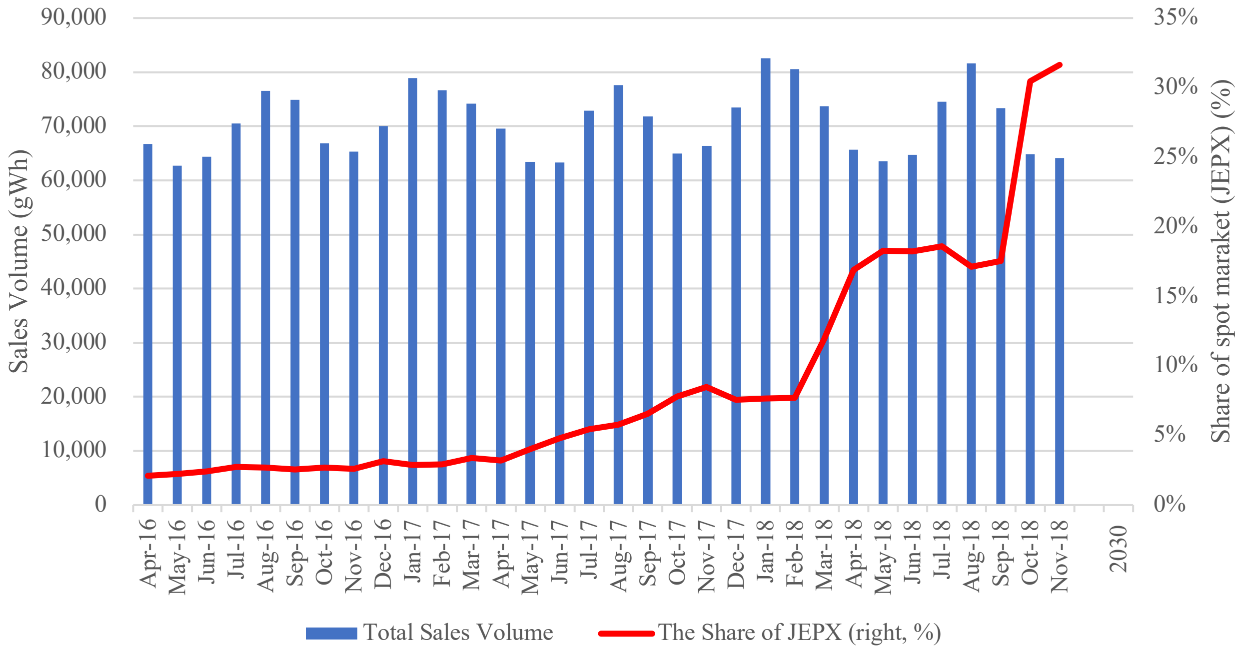

Figure 2-2-24. The share of spot market transaction (JEPX) in total sales volume of electricity (EGMSC, 2019; JEPX, 2019).

Correspondingly, a number of customers started switching their contracts. "In Japan, within 6 months of liberalization of the retail market for households, 1.88 million households had switched providers, and 1.76 million households had renegotiated the terms of their contracts with incumbent providers; the number of households accounts for 3% and 2.8% of household consumers who became eligible to choose among multiple providers after the reform" (Shin & Managi, 2017, p. 677)

Despite of such deregulatory reforms, the large majority of the public demonstrates the passive stance toward switching their electricity providers. The survey done by Shin and Managi (2017) collected the data concerning the change on switching behaviors of Japanese households before and after the liberalization of retail markets. The study shows that there is a correlation between incentives (both monetary and non-monetary) and actual behavior – "Respondents who placed importance on additional discounts when choosing their provider were 8% more likely to switch, on average" (p. 681) and "the respondents who put more importance on zero nuclear energy were 18% more likely to switch providers. While anti-nuclear energy sentiment seems to promote switching, finding green energy appealing does not affect switching behavior" (p.681).

On the other hand, the study also found that the inertia toward change still remains significant in Japan even after the liberalization of retail market. "The respondents who valued management stability were 15% less likely to switch providers, and the respondents who had management concerns with new entrants were almost 17% less likely to switch compared to their less concerned counterparts" (Shin & Managi, 2017, p. 681). As a result, as of 2017, "the switching rate is already stabilizing around 3%, which is significantly lower than that of other advanced economies" (p. 682).

Analysis

Fukushima Nuclear disaster certainly changed the public's view on nuclear power, and DPJ's Kan and Noda Administration drastically changed the country's energy policy from the one heavily reliant on nuclear to the one aiming for a complete phase-out from nuclear. However, though such policy was largely supported by the public, the public chose LDP in the 2012 election, the only party which did not include phase-out from nuclear into manifest. The energy issues, for public, were rather minor determinants in politics.

Temporal shut downs of NPPs caused a record high deficit in all utilities but Okinawa EPCO, the only utility that owns no NPPs. Tokyo EPCO, the biggest utility, liable for Fukushima Disaster, became a de facto state-owned company, compensating the damages by tax and raising electricity price.

Due to rigorous FIT policy, the installation capacity of Japan's solar PV has once again revitalized. However, the industrial policy still disfavors the development of wind capacity as to protect the nuclear configuration. In 2016, the distribution sector was completely separated from utilities. Although the transmission sector is still owned by utility, and independent power suppliers will need to pay expensive fees for usage. Thus, the basic configuration of regime has yet been changed, but rather still vertically integrated.

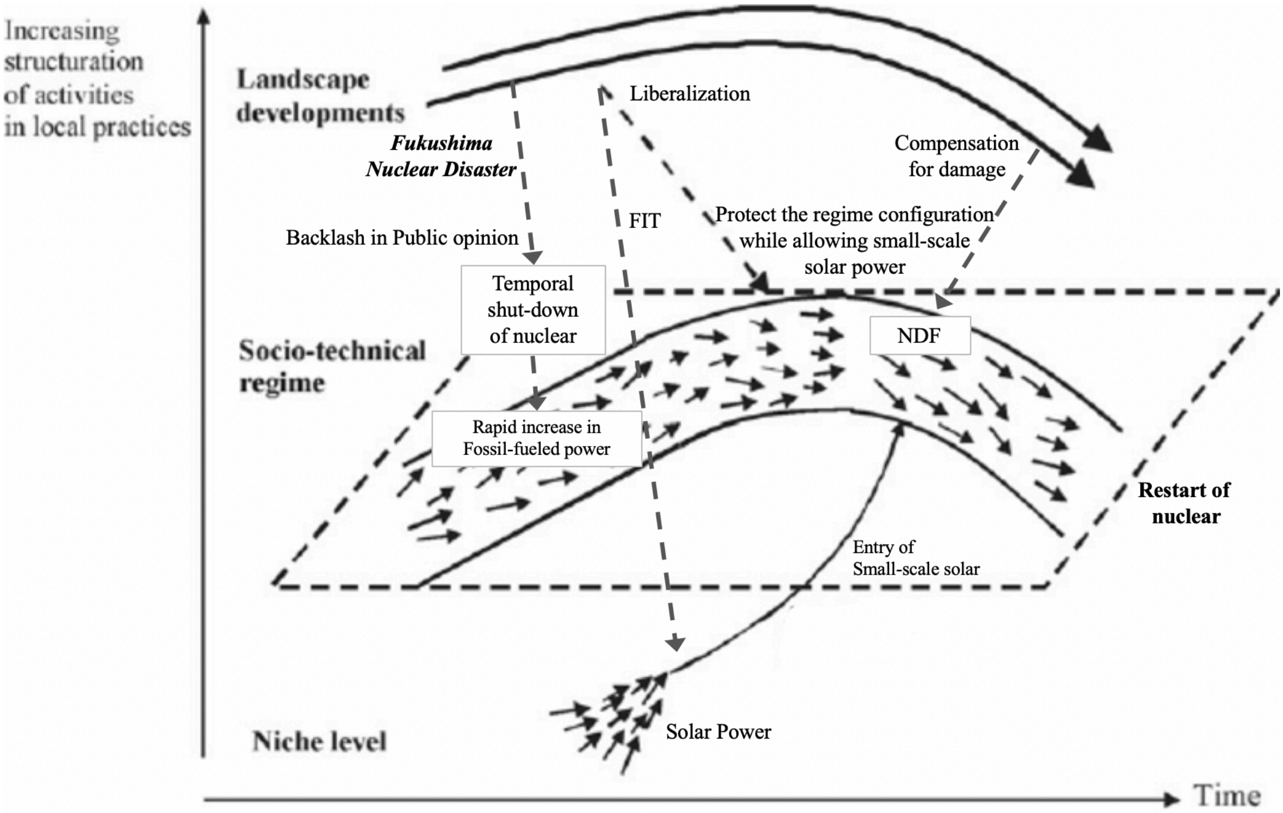

Figure 2-2-25. Balancing between renewable promotion and protection of nuclear regime

Although the basic configuration remains the same, the characteristics of configuration has been changed. First, the biggest utility Tokyo EPCO is now a state-owned enterprise. Second, due to the shut-down of NPPs, almost all EPCO's has suffered deficits, and it became highly uncertain how much of them can be restarted in the future. Third, due to rigorous FIT policy, the capacity of solar power once again surged. Fourth, due to liberalization of retail market, new actors partly entered to the electricity market although it is still dominated by utilities.

However, in this period unlike the past, the public opinion against nuclear power was so strong that the central government (especially DPJ) took a robust change. Although it still actively protects nuclear regime (especially Tokyo EPCO), the political action put all NPPs to shut down for the first time in history. However, the economic and social costs incurred by the nuclear disaster and policy changes are covered by taxpayers and customers of de facto regional monopolists. They need to save utilities from bankruptcy while it was utilities, bureaucrats and the central government who caused this as a result of neglecting opposing voice and underestimating disaster risks.

In sum, the cognitive rules that once supported the regime turned upside down after the disaster. However, the basic configuration of the regime has not drastically changed mainly due to the regulative rules that saves EPCOs from disaster compensation and that allows the regional monopolization of transmission segments. That being said, the complete liberalization in the generation and retail segments and the surge of renewable energy opened up a new window of opportunities for niche actors and created new types of interdependencies. Although the new coalition is not yet as strong as to destabilize the regime structure, it has taken some of the consumers that were once embedded in the regime coordination.

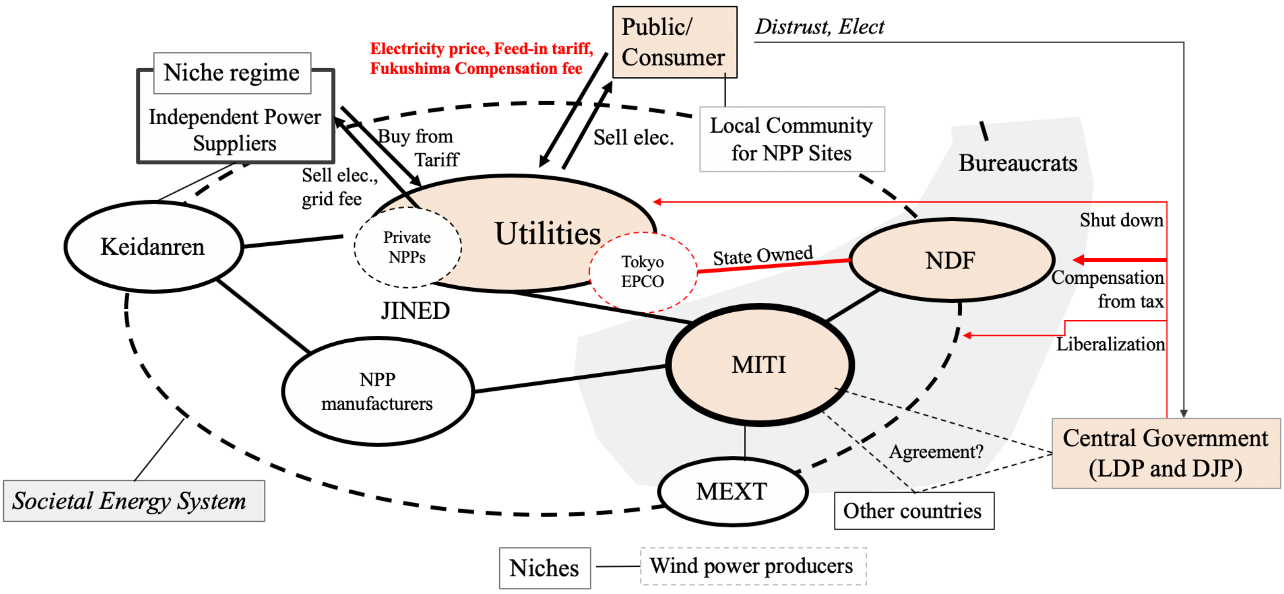

Diagram 2-2-26. Interdependent structure after 2011

Section's summary

During 1960s, the regime gained its power under the regulative rules (risk-free investments and stable refinancing method) and cognitive rules from the public that believed the safeness of nuclear energy. The utilities under regional monopoly could embrace all electricity consumers in Japan (except for prosumers), secure stable income, thus serves the interest of lenders as well as of pro-nuclear politicians. Under this interdependent structure, the rules and resources (authoritative power of utilities) were constantly enhanced and reproduced by almost all actors in Japan (because the utilities' consumers can be considered as the parts of the regime). During 70s and 80s, the regime further straightened and expanded this interdependent structure. The policy makers within the regime legislated several regulative rules that lubricate the process of developing NPPs and these rules, in turn, straightened the vested-interest.

The regime also employed regulative, cognitive and normative forces to filter out the seeds of destabilization. The regulative rule that allowed utilities to regionally monopolize the electricity market effectively protected the regime coordination until 1990s. Even after a series of liberalization started, the regime (especially transmission companies) utilized the normative forces to charge tremendous amount of penalty to new entries and effectively tailored the market as a de facto monopoly state. When the public stance toward nuclear energy leaned onto skepticism (such as in 1950s and 90s), the regime utilized various media and public hearing as a means of soft social control to placate the backlash and pushed a blight and safe image of nuclear power plant.

The Japan's electricity sector has been changing in the symbiosis to match with the interest of the regime actors. There is a homeostasis to adapt changes not in order to restructure the basic system but in order to perpetuate it. The web of vested interest has become so strong and widespread that the government needed to take careful actions in the reform of the electricity sector in Japan, socializing the damage of Fukushima nuclear disaster in order to save Tokyo EPCO and allowing the utilities to restart their NPPs under the tighter standard.

2-2-2. Structural Interdependency in the current Japan's energy system

In the last section, the thesis depicted the brief dynamics of how Japan‘s energy sector has changed its shape over the last 70 years. In this section, the thesis dedicates to picture the structural interdependency in the current Japan's energy system.

Utilities

Japan's electricity market is unique in the following 4 points; 1) Privatized public utility system (Minnei Koekizigyou Hoshiki), 2) a product cannot be differentiated (homogeneity), 3) a product cannot be stored (in-storability) and 4) it requires a constant capital investment (Miura, 2013). Because utilities are considered to be responsible for a public and social infrastructure that require a constant investment, their receive various privileged rights in the market: dominative power to control the electricity price, electricity bond, and taxation/policy supports.

Electricity Price

The regional monopolists set the electricity price based on "Fully-Distributed Cost Method (hereafter FDC method)", with the mixture of "rate base method", "fuel-cost adjustment system [Nenryo Chousei Seido]" (Tanie, 2013). Each utility has a right to propose an electricity price for its region but it has to be approved by METI along with the capital investment plans and management plans (Miura, 2013).

FDC is a cost basis pricing that allows utilities to set the electricity price as to cover all the costs necessary for their stable operation (see *figure 2-2-27*). It embodies the cost items such as depreciation, maintenance, employment, back-end cost for NPPs (i.e. decommission fee). The fuel cost and the cost of electricity purchase (mainly the electricity from the renewable sources that is sold to utilities) are also parts of the full cost but, these prices are monthly adjusted to the actual fuel price and impose users depending on their usages (Fuel cost adjustment system) (ANRE, 2018b). Furthermore, FDC adapts base-rate method for net margin, which enables the utilities to set the electricity price as to gain the net profit up to 3% of the total assets they own[24]. (Tanie, 2013)

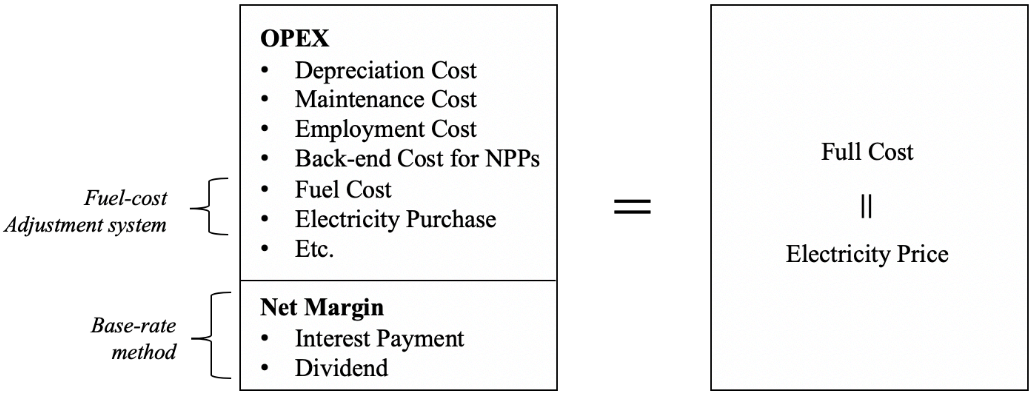

Figure 2-2-27. Electricity Pricing under FDC method.

Thus, this logic justifies the utility to seek for expanding their asset volumes (i.e. large-scale power plants and its technology, such as nuclear) as to increase a net profit. Because of this privileged power to control the electricity price, their business is highly credible for investors, which renders utilities to be able to leverage their finance to invest for capacity.

Electricity Bond and Corporate Stock

Utilities need to finance themselves when they construct new capacity. For this, they issue so called "electricity bond (Denryokusai)", a type of corporate bonds to leverage their finance. Unlike ordinary

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24 The assets include specific fixed assets (including electricity-related fixed assets, lending facilities, idle facilities., shared fixed-assets with subsidiary business), assets under construction, nuclear-fuel assets, specific investment (the long-term investments that are approved as necessary and valid for R&D, resource development, and optimization of managements), working capital and amortization of deferred assets (Tanie, 2013). For example, Tanie (2013) researched Tokyo EPCO's assets on base-rate in 2030 and found that the item "specific fixed-assets" consists the majority of the costs (*see figure X*). Furthermore, the annual report for 2012 published by Tokyo EPCO illustrates that nuclear-related facilities worth 749,169 million JPY, consisting 9.5% of total "specific fixed-assets" at that time (Tokyo EPC, 2013). Together with 722,300 million JPY worth of Nuclear Fuel Assets, nuclear-related assets in 2012 at least accounted for 15% of assets of total net-profits (roughly 44,144 million JPY).

corporate bond, electricity bond put up all utilities' equity as security for loan, a lien that a shareholder can claim to seizure with priority. Authorized amount of issuing is also two times higher than normal corporate bonds. For these reasons, utilities were considered as low-risk or almost risk-free borrowers, and the bond became popular: in the late 70s and early 80s, an outstanding issue of electricity bonds consisted two thirds of total corporate bonds in Japan. (Berndt, 2018; Miura, 2013). However, after 3-11, the credibility of electricity bonds got largely depreciated because the utilities' earing capacity had been overshadowed by uncertainty in restarting NPPs and in damage compensation from Fukushima disaster (Miura, 2013).

That said, electricity bond is still a powerful credit in Japan's economy and is still seen as a relatively stable bond. This is partly thanks to Bank of Japan's easy money policy that has been acquiring a large amount of national bond. Namely, because of this, the bond market views electricity bond as an alternative to a short supply of national bond. As of March 2017, an outstanding issue of electricity bonds consisted roughly 20% of total corporate bonds issued by private companies excluding financial industries in Japan and represents 4% of all outstanding corporate loans provided by Japanese banks (see *figure 2-2-28*). (Berndt, 2018; K. Hirose, 2017; JSDA, 2019). Thus, as Berndt (2018) puts it, "the related credit risk so concentrated that lenders have a strong interest in avoiding a default of these debtors – writing-offs would be huge and affect the financial health of the lender immediately" (p.194). Here draws an interdependency between Japan's financial industry and utilities; the financial sector is highly exposed to heavily leveraged utilities as their lenders while utilities also depend on financial sector for stable and low-cost funding.

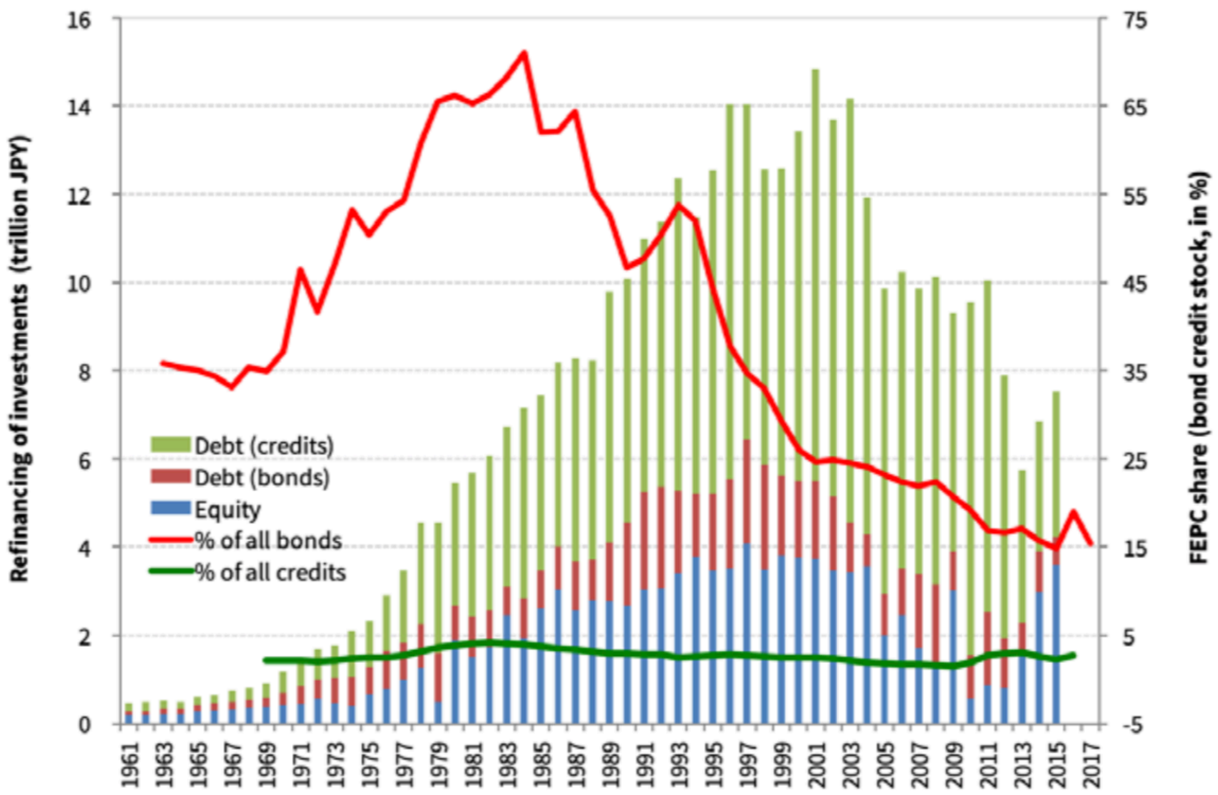

Figure 2-2-28. Refinancing of investments by FEPC-firms (flow) and FEPC-firms share of corporate bonds and credits in Japan (Stock) (FY except 2017) (Berndt, 2018, p. 194).

According to Berndt (2018)'s analysis of the utilities' shareholder structure, as of 31 March 2018, the two biggest shareholders are financial firms (32%) and individuals (31%) (see *figure 2-2-29*). The public sector also owns 12% of utilities' stock; some municipality such as Tokyo, Osaka, Kyoto, Kobe own shares in utilities, and the central government acquired majority stocks of Tokyo EPCO as mentioned in *section 2-2-1*.

> The commitment by the central government and METI to TEPCO – their ongoing financial and administrative support and promotion of nuclear power – has reduced the risk for domestic institutional investors considerably and provided risk-tolerant foreign institutional investors (hedge funds) with an opportunity to realise big capital gains by taking a long position (buying based on the expectation that the value of their stock holdings will rise). (Berndt, 2018, p. 195)

When you look at a share of major stockholder in utilities, banks are the biggest stakeholders for utilities except for Tokyo EPCO whose 55% of the stock is owned by NDF (*figure 2-2-30*). They have strong influences on the utilities' policy makings. As for stocks, dividends are allocated from the profit margin (which is 3% of total assets), thus in order for them to receive more dividends, they want utilities to expand the scale of electricity-related assets, which could lead utilities to build more capacity through highly-valued assets such as NPPs.

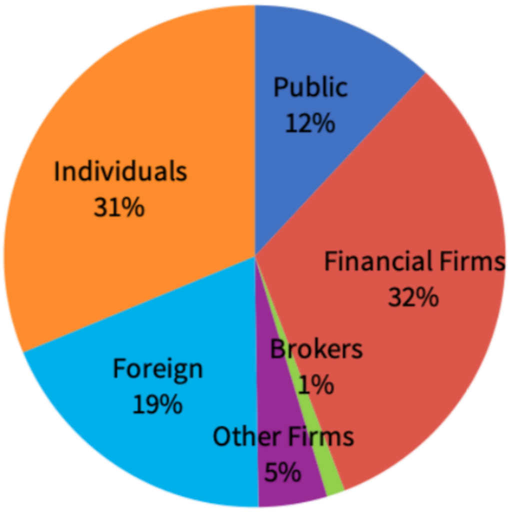

Figure 2-2-29. Shares in 10 regional monopolies by investors as of 31 March 2018 (market capitalisation weighted as of April 2018, government's holding of preferred TEPCO stocks included). (Berndt, 2018, p. 196)

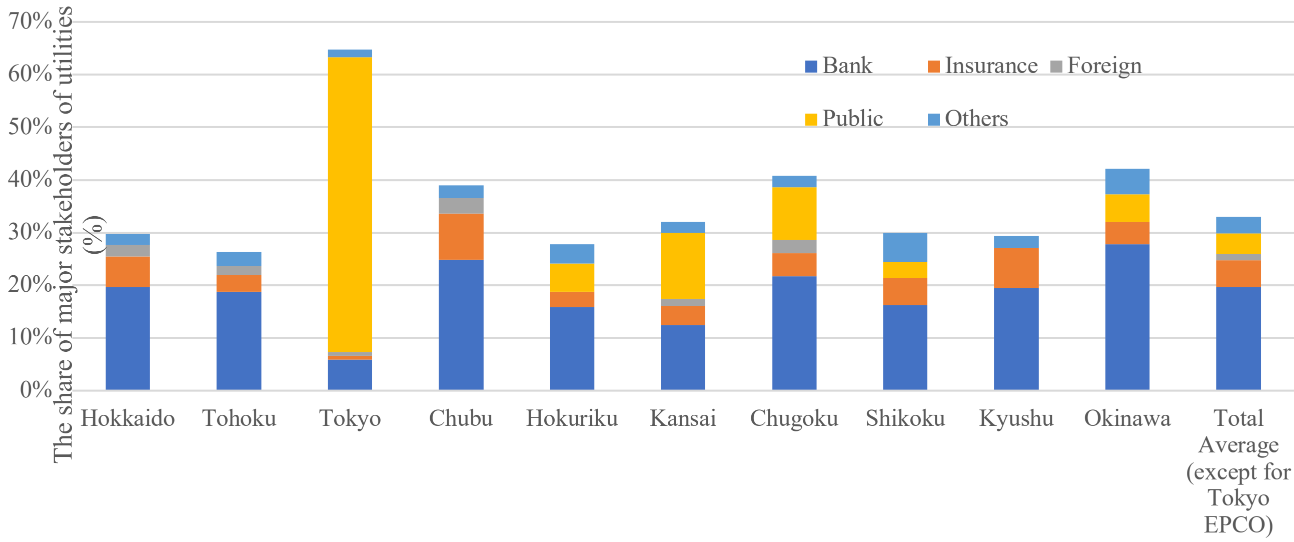

Figure 2-2-30. The share of major stakeholders in utilities (from IR-reports, 2018).

Tax/policy supports

As illustrated in *figure 2-2-31*, the nuclear regime has been encouraged by intense tax inflow, the subsidy which aims to promote nuclear energy through R&D support and power siting subsidy (*see section 2-2-2*, Local Municipality for more detail) The amount of nuclear-related budged surged after the legislation of Three Power Laws in 1974, together with the resource diversity policy trigged by oil shocks and peaked at 494.6 billion JPY in 1997. After that, the amount stabilized until 2011 when it slumped due to Fukushima Nuclear Disaster. However, the amount once again surged since 2015 when the NPP restarted for the first time since Fukushima, and as of 2017, the amount became the same level as 90s.

Furthermore, nuclear business premises on the compensation act that evades NPP operators from indefinite liability in case of nuclear disaster. In case of Fukushima, the central government, by issuing governmental bonds, has provided total 13.5 trillion JPY to NDF, and as of February, 2019, NDF has spent 8.57 trillion JPY as compensations to Tokyo EPCO (Tokyo EPCO, 2019). On the other hand, Tokyo EPCO's contribution to the compensation has been 58.4 billion JPY between 2011 and 2017 whereas the other utilities have also contributed 54 billion JPY in the same periods (Watanabe, 2018). NDF estimates that the total compensation would cost 22 trillion JPY but, as discussed in *section 2-2-1*, a report from Japan Center for Economic Research (2017) claims the actual compensation fee would possibly become 50-70 trillion JPY, and that Tokyo EPCO's compensation plan is based on a frail, optimistic assumption. If Tokyo EPCO won't be able to fulfill their obligation, the society (more specifically tax payers) will need to incur them though it is already doing some. In other words, the nuclear disaster is not something EPCOs alone can fulfill their liability, and they are hugely dependent on the government (and the society) for hedging their disaster risk accompanied with their service.

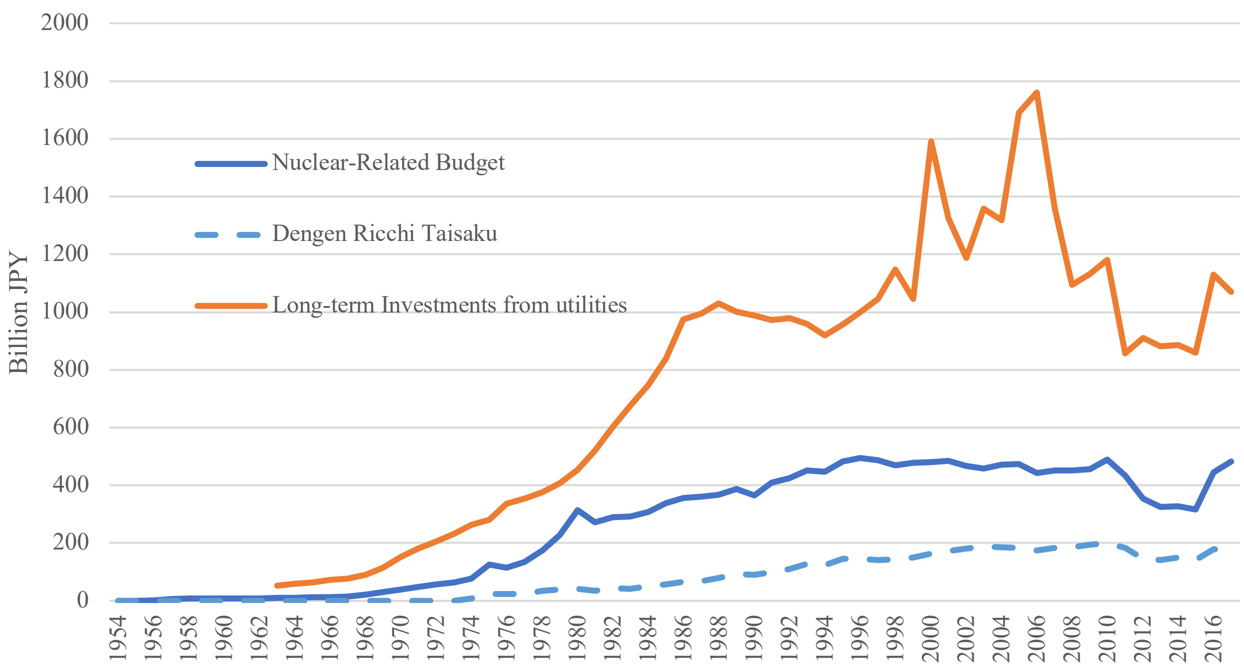

Figure 2-2-31. The Change of Nuclear-Related Budget (Genpatsu Kanren Yosan) and Power Siting Subsidy (Dengen Ricchi Taisaku Koufukin) (Federation of Electric Power Companies of Japan (FEPC), 2019; Japan Atomic Energy Commission, 2019))

In sum, utilities are dependent on the following three aspects; dominative power to control the electricity price, stable and low-cost funding through electricity bond, and taxation/policy supports. Utilities used to own a dominative power to set an electricity price so that they could easily cover their capital investments required for building more capacity. Yet, this has somehow been changing since the liberalizations in 2000s and utilities are now exposed to the harsher price competitions as well as demand stagnation, therefore has been downsizing financial leverages. Still, electricity bond, a way that utilities leverage finances, has been a powerful factor in Japan's bond market. Although its share in total bond market has been decreasing since early 80s, it is still so powerful that defaults of utilities can immediately affect to Japan's private companies, financial industries and individuals. Thus, lenders who try to avoid default of those debtors are the huge interest throughout the public. This also explains why utilities' liability of nuclear disaster is largely exempted. Without this exemption policy, utilities and nuclear business would be more risky option.

Diagram 2-2-32 describes the structure of interdependency in the eyes of utilities. The regime structure is reproduced by utilities and the political, administrative, financial and individual actors. The lenders gain profits from the utilities and the utilities gain finance from the lenders. The interest group is so large and diverse that the political actors set regulative rules to allow utilities to operate its business smoothly for them to serve the lender's interest. The consumers are also embedded in this structure and constantly reproduces it by providing utilities the electricity bills.

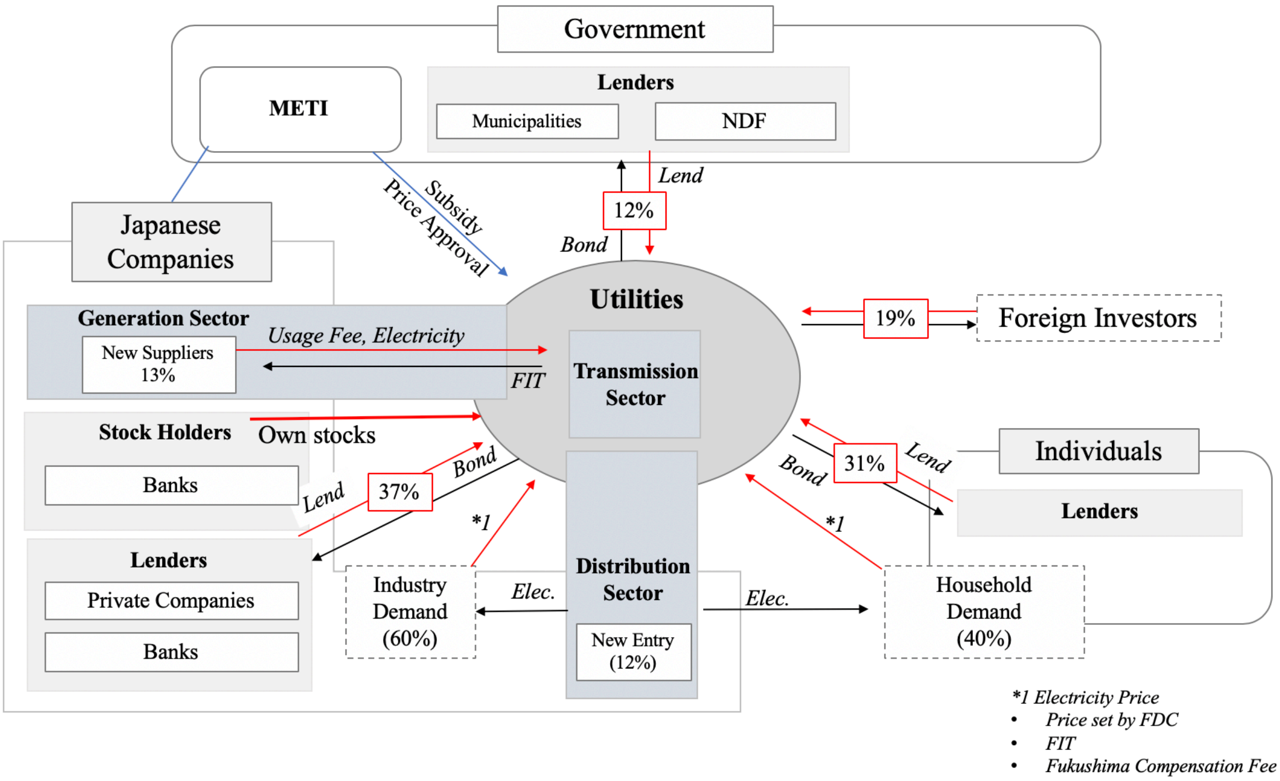

Diagram 2-2-32. Structure of interdependency and power distribution (utility-centered).

State's Policy makers and enforcers

Politicians

Politicians also played a pivotal role in forming the energy policy of post-war Japan. Name it as their business model or not, politicians do represent a certain interest in the society and obtain votes from them. The interest group, on the other hand, financially support the politicians who may realize their interests in policy.

Koga (2004) researched the income source for political party. According to his study, the right-wing coalition party, LDP, which had been ruling the Diet between 1955 and 1993, was initially run based on the donation from major banks, steel industry, and electricity companies. Since the late 60s, it has also received a large amount of donation from automobile industries. Even though the electricity sector publicly announced the retreat from the political donation to LDP in 1974, FEPC still kept financing LDP as a form of "advertisement fee" for LDP's organ at approximately 10 billion JPY a year, the form of money which is not legally required to report as political donation.

In 1993, LDP lost against the alliance of socialists' parties, but again got back in charge in 1996 as a ruling party in the corporation with Social Democratic Party. Despite of this structural change, the financial tie between industries and LDP was still active. More than 200 board members of utilities, equivalent to over 80% of the total members, except from Okinawa EPC, donated LDP in an organized way, as a form of "individual donation" to the organization called "Citizen Political Society" which is the general foundation that manages the political donation to LDP (Koga, 2004).

Bureaucratic Actors

Japanese bureaucracy traditionally has a very strong preferences and influences on policy-making process with its historically strong link with industries and LDP. The majority of Japan's legislations are derived from cabinet bills, a policy devised by bureaucratic actors instead of by elected politicians, and the enforcement of legislations are also majorly operated by the bureaucrats. Thus, Japan's politics is often referred as "bureaucracy-driven politics (Kanryo Shudogata Seiji)" (Asano, 2014; Ramseyer & Rosenbluth, 1993; Tsuneki, 2011).

In contexts of energy, METI (former MITI) has historically been a pivotal bureaucratic actor whose main clients are electricity utilities and other business group such as Keidanren, the federation of large Japanese companies from various industries. In addition to them, there are also other bureaucratic actors influencing Japan's energy policy such as Ministry of Finance (MOF) which is responsible for budget allocation, Ministry of Foreign Affairs (MOFA) which provides diplomatic support for import/export of NPP technology, the Ministry of Environment (MOE), being responsible for environmental issues and the Ministry of Land, Infrastructure and Transport (MLIT), being responsible for siting issues (Aldrich, 2008; Moe, 2014).

The bond between METI and industries has been straightened by the practice called "Amakudari". Amakudari is literally translated as "descendent from heaven", the term which refers to "the practice of government officials retiring into industries and institutions, often those that they have formerly been involved in regulating" (Jones, 2014, p. 880), and which is, by some scholars, considered as "an endemic feature of the Japanese system (Johnson, 1974; Jones, 2014, p. 880; Wolferen, 1989; Woodall, 1996).

Dreiling and Nakamura (2018) researched on the data of personnel interchanges (Amakudari) in Japan's energy industry from 2006 to 2012 and depicted "the institutional connections formed through the career paths and joint board memberships of personnel from nine nuclear utilities and various government ministries to positions in Keidanren member companies, universities, nonprofits of all types, local governments, media companies, and others" (p. 1, s*ee figure 2-3-33*). According to the research,

> Keidanren, the top corporate federation in Japan, is second in centrality to METI. These two form large cores in the network. During this time frame, METI shared 115 personnel with other entities in the network, notably forging ties to eight of the nine nuclear utilities. Nested between METI and Keidanren are several nuclear industry advocacy groups, some of the largest nuclear utilities, and a number of financial and manufacturing firms. The Tokyo Electric Power Company (TEPCO), like Toshiba and Hitachi, bridges both Keidanren and METI, having shared officials from both institutions over many years. Crucially, as the visualization portrays, the broader partnership between industry and the state is mediated by organizations such as the Japan Atomic Industrial Forum (JAIF), the third most central body in the network, which also maintains expansive ties via personnel exchanges among major universities, media, major corporations, and government officials. JAIF is a decades-old creation of industry and the state designed to promote and develop a world-competitive nuclear power sector. To the left of JAIF, we see close ties to numerous universities, well known for their expertise in nuclear chemistry, denoted in light purple. Japan's largest corporations (brown) and financial firms (yellow) are proximate to Keidanren at the top right of the graph. At the bottom left, we find a clustering of environmental organizations (green) closely connected to the Ministry of Environment and the Ministry of Land, Infrastructure, and Transport, consistent with accounts that show the state playing an active role in facilitating specific environmental causes (Dreiling, Lougee, & Nakamura, 2016). The structure of the network thus reflects the close partnership among the Japanese state, industry, and civil society in the development of nuclear energy capacity since the late 1950s. (Dreiling & Nakamura, 2018, p. 3)

In conclusion, the bond between industries and politicians are straightened by political donations and the bond between industries and bureaucratic are straightened by Amakudari. Not to mention, there is a strong relation between politicians as legislators and bureaucrats as enforcers who effectively suggest policies to the legislators to materialize their interests. Thereby, the structure of duality is established. The regulative rules are reproduced by the actors within the coalition of bureaucrats, LDP and industrial actors. The rules, in turn, are designed to serve their interests, as a form of political donation or Amakudari (see *diagram 2-2-34*).

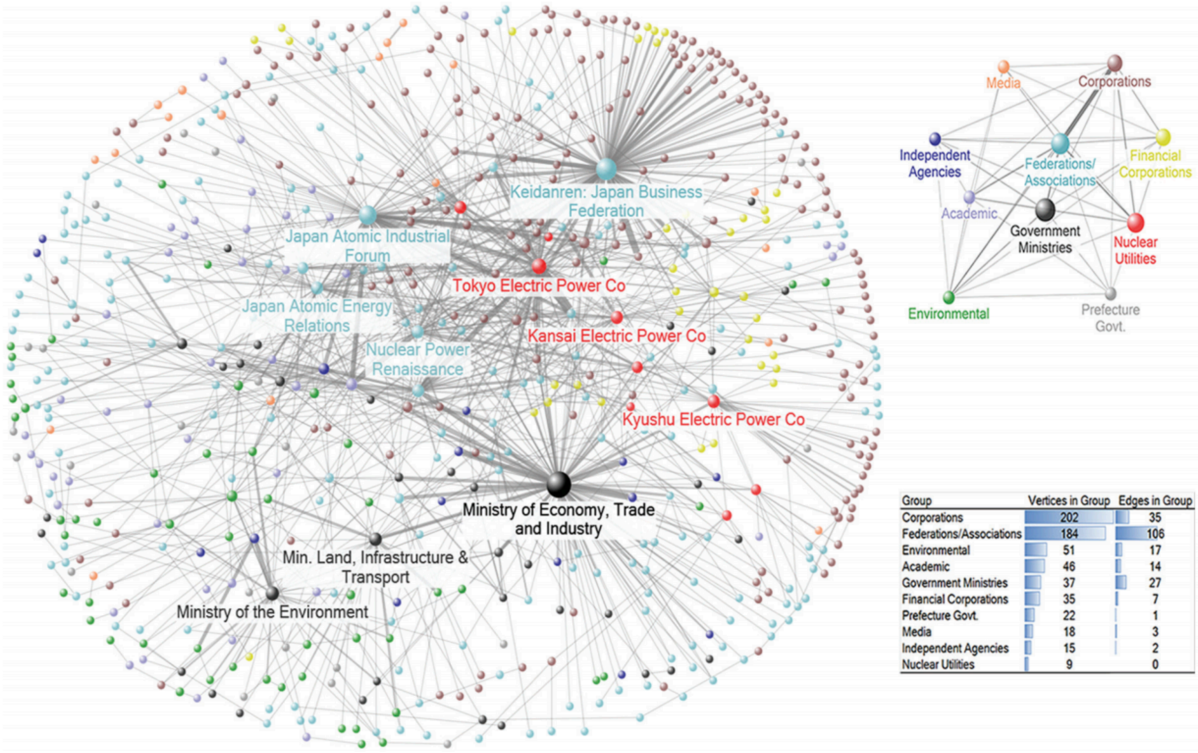

Figure 2-2-33. Network Visualization of a Nuclear Energy Complex in Japan, 2006 to 2012 (Dreiling & Nakamura, 2018, p. 2).

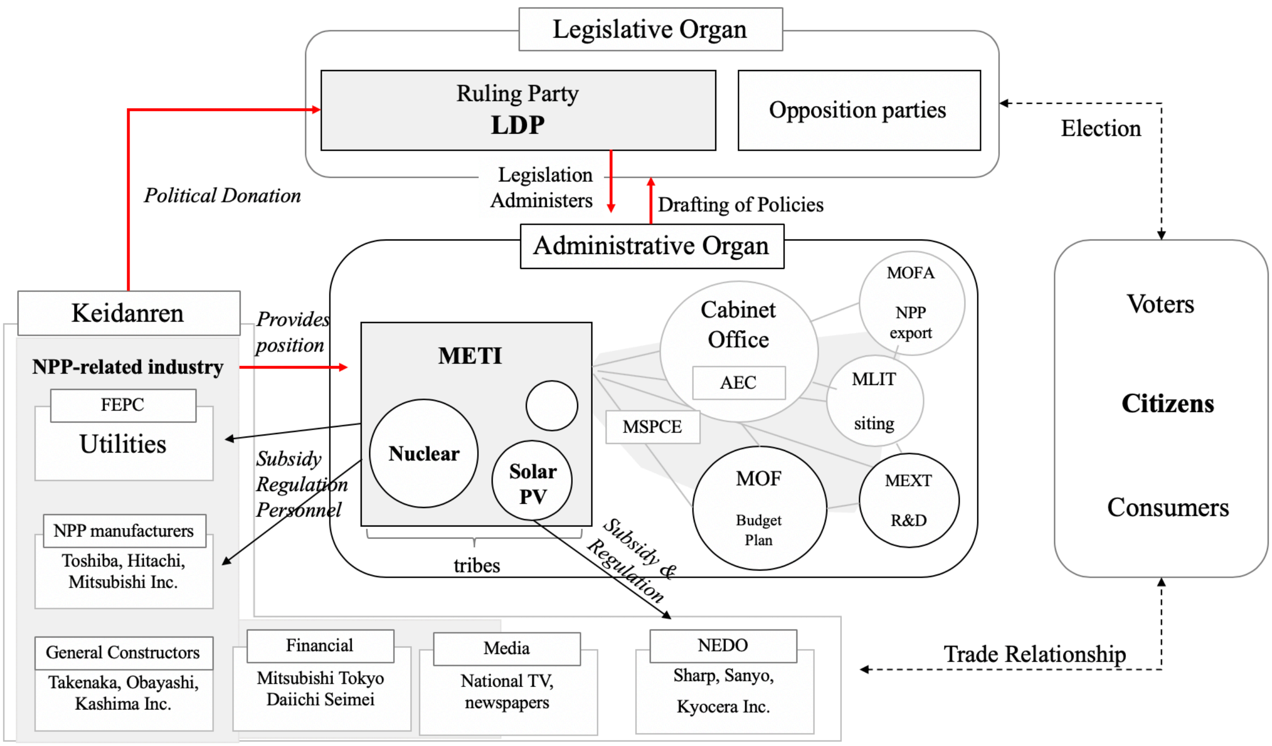

Diagram 2-2-34. Structure of Interdependency (bureaucrats centered)

Local Municipality

The *figure 2-2-35* depicts the historic change of Japan's nuclear-related budget (Genpatsu Kanren Yosan). As you can see, the amount surged after the legislation of Three Laws on Power (Dengen Sanpo) in 1974, the law includes the subsidy scheme (Power Siting Subdisy a.k.a *Dengen Ricchi Taisaku*) for local municipality that has accepted NPPs. The amount of subsidy had almost continuously increased since its legislation and reached its peak at 194.3 billion JPY in 2009, consisting a considerable proportion of total nuclear-related budget.

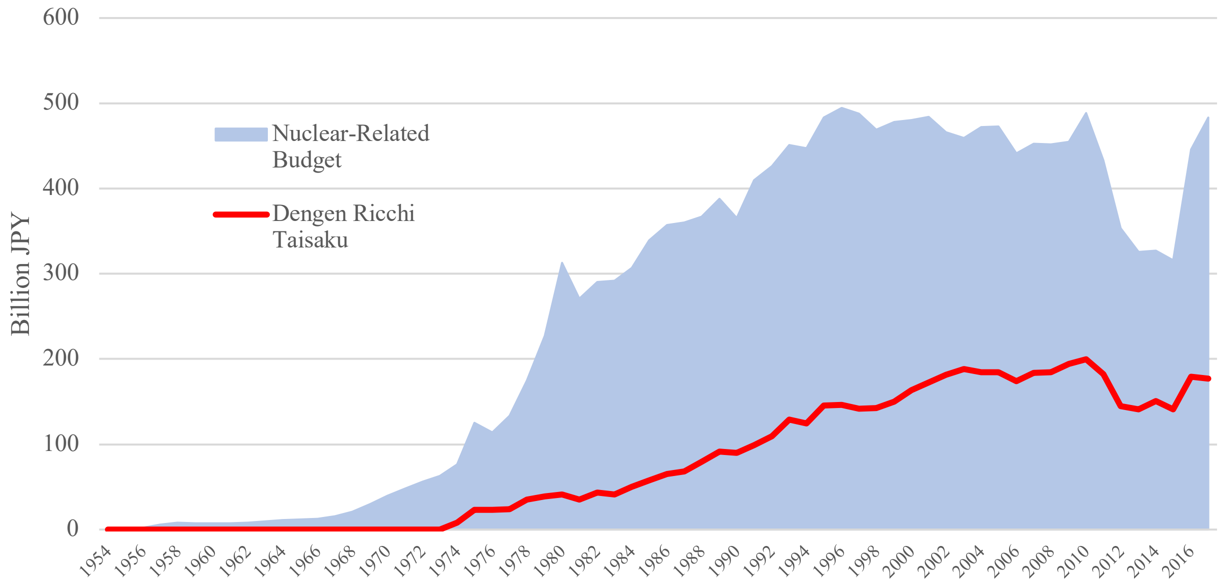

Figure 2-2-35. The Change of Nuclear-Related Budget (Genpatsu Kanren Yosan) and Power Siting Subsidy (Dengen Ricchi Taisaku Koufukin) (Japan Atomic Energy Commission, 2019)[25]

The subsidy's economic effect in a model case is calculated by ANRE (2016). The model case assumes that 135 million kW capacity of new NPP project for 54 years: being expected to run for 40 years after 6 years of investigation and 8 years of construction (*figure 2-2-36)*. As the model case represents, the amount of subsidy suddenly surges as the construction starts (the 6th year) as the onset of the promotion subsidy. After that, the amount stabilizes at around 23-25 million JPY/year. However, in contrary to the model case, Cho (2014) points out that, in real-life case, the municipality tends to receive less subsidy as the plant is aging. That said, even if the municipality is subsidized exactly according to the model case, it will lose 23-25 million JPY/year of financial source after the plan finishes its work. Cho (2014) argues that the core problem of this scheme is the length and scale of the subsidy – over 54 years, the local municipality receives a large amount of subsidy and economic effect from nuclear-

[25] Nuclear-Related Budged consists of two sections: General Accounting and Energy Special Accounting. The latter includes Power Location Subsidy, Power Diversity (and Development) Subsidy.

related business without cultivating their own economy, hence increases the reliance on NPPs.

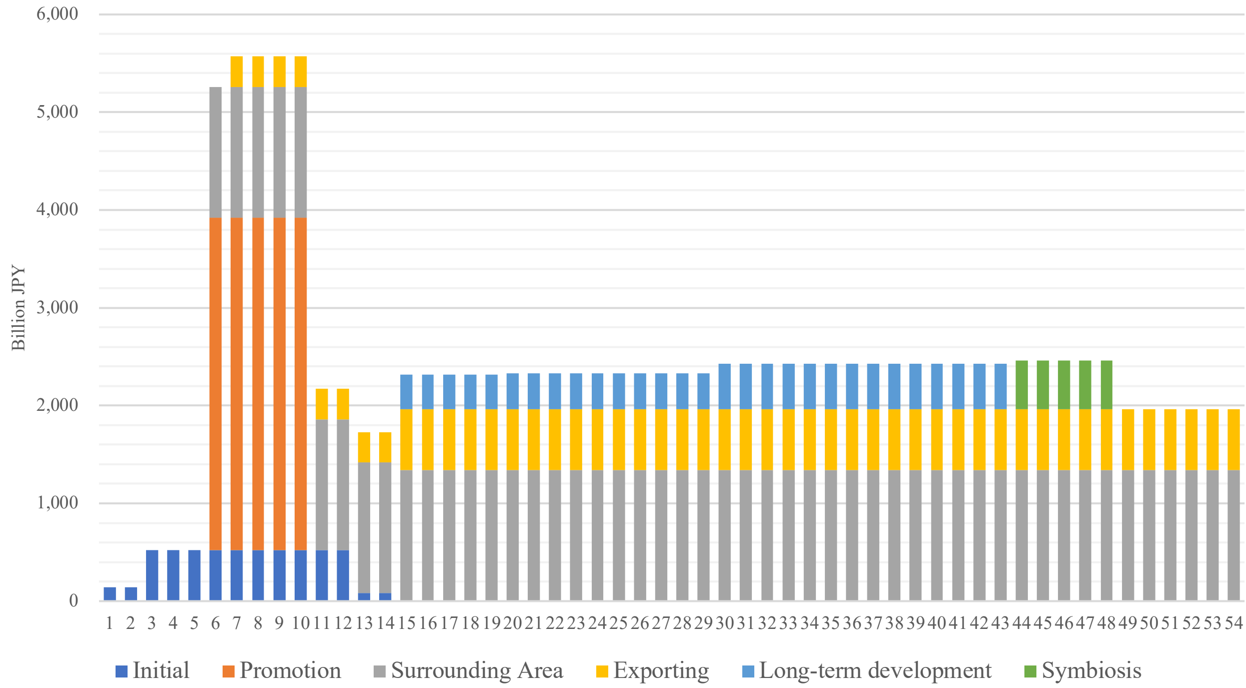

Figure 2-2-37. The subsidies on a model case (X-axis: year since the project starts, Y-axis: million JPY) (ANRE, 2016, p. 4)[26]

Furthermore, the job creation capacity of nuclear power generation is also worth mentioning. As *figure 2-2-38* represents, there are 13,032 people in utilities engaged in NPP industry as of 2017, among which 8,078 or approx. 62% are local residents. The number further increases if we include vendors of NPP business: there are 35,506 people working in vendor firms for NPP as of 2017, among which 15,534 or approx. 43% are hired from local area. Therefore, in order to sustain its economy, the municipality will likely need to allow either to extend the running period of NPPs or invite new plants (Cho, 2014). This hypothesis is visualized in the *figure 2-2-39*.

[26] The Power Siting Subsidy consists of 5 items, each of which is subsidized in different process at different amount: 1) Initial subsidy (*Dengen Ricchi tou Shokitaisaku Koufukin*), 2) Promotion subsidy (*Dengen Ricchi Sokushin Taisaku Koufukin*), 3) Surrounding Area subsidy (*Genshiryoku Hatsuden Shisetsu tou Shuhenchiiki Koufukin*), 4) Subsidy for Electricity Export to Differerent Prefecture (*Denryoku Ishutsuken tou Koufukin*), and 5) Subsidy for long-term development (*Genshiryoku Hatsuden Shisetsu tou Ricchi Chiiki Choukihatten Taisaku Koufukin*). In addition, the government offers another subsidy scheme for a municipality with a NPP older than 30 years (Subsidy for symbiosis in municipality with NPP: Genshiryoku Chiiki Ricchi Chiiki Kyosei Kofukin) (ANRE, 2016).

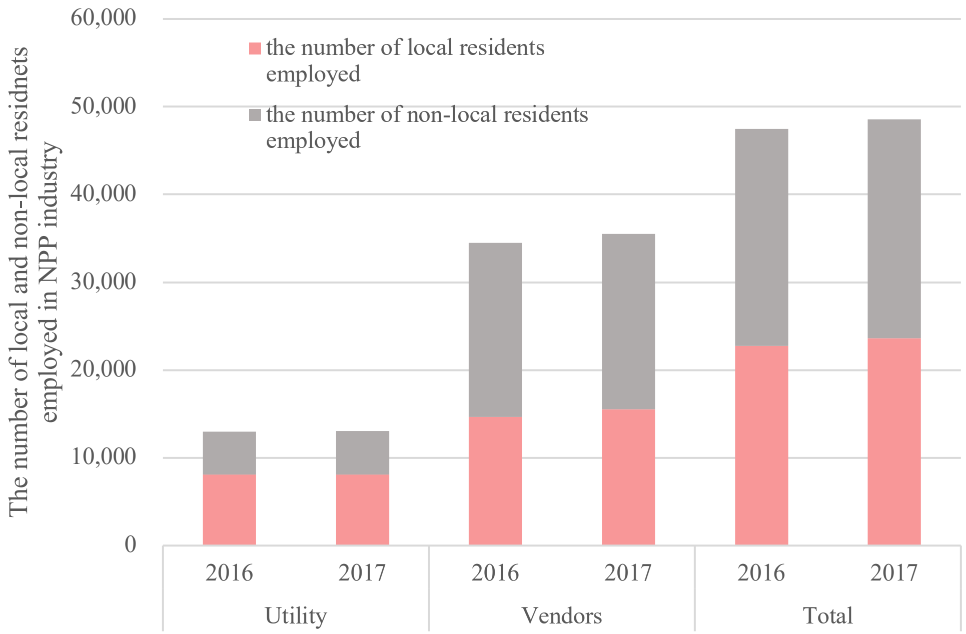

Figure 2-2-38. the number of local and non-local residents employed in NPP industries (JAIF, 2017).

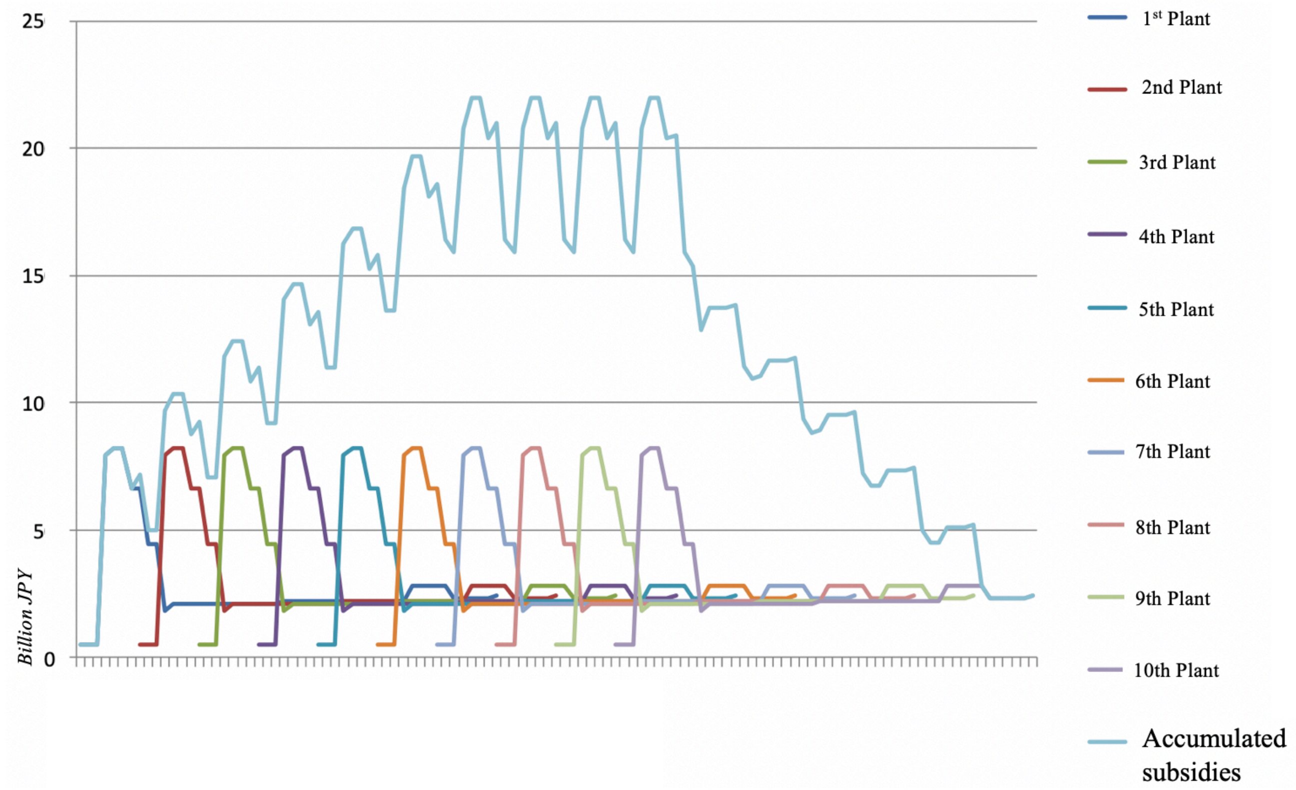

Figure 2-2-39. Cho (2014)'s hypothesis – development model of municipality with NPPs (Cho, 2014, p. 12)

In conclusion, NPP can be a perfect economic policy for impoverished rural areas: it is accompanied with a constant supply of political subsidies for mid-tern, the support for infrastructural construction and a strong job creation capacity. The local economy, if accompanied with its citizens' consent, will likely to either keep inviting NPPs or approve the extension of NPP running time. Thereby, the duality of structure is established. the regulative rules set by the central government provides economic incentives for the local economies, and the local economies, in turn, actively seeks for continuation of status quo, reproducing the structure as it is.

Other industrial actors

The nuclear business is not only important for utilities, but also for vendor firms such as manufacturing and construction. Nuclear power is a long-term project. The utilities prospect for a plant to run at least for 40 years, plus the length of construction and decommission. Furthermore, vendors have utilities as their final customers, the customers that are protected by the government and that are allowed to yield certain profit from regulated prices. These explain why NPP industries expanded so rapidly once it took off. According to the research done by Japan Atomic Industrial Federation (JAIF) in 2017, there are 35,506 people working in vendor firms for NPP industries, the sales worth approximately 1,775 billion JPY as of 2017. At least 393 companies are involved in this process (see *figure 2-2-40*).

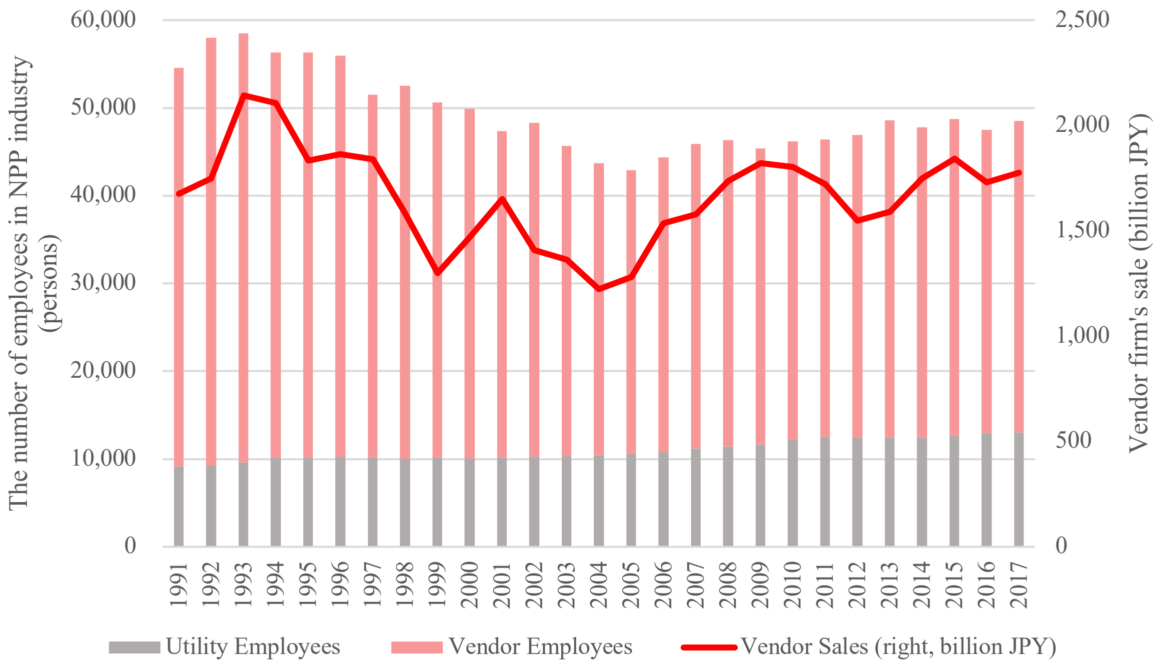

Figure 2-2-40. The number of employees in NPP industry and sales volume of vendor firms (Japan Atomic Industrial Forum (JAIF), 2017).

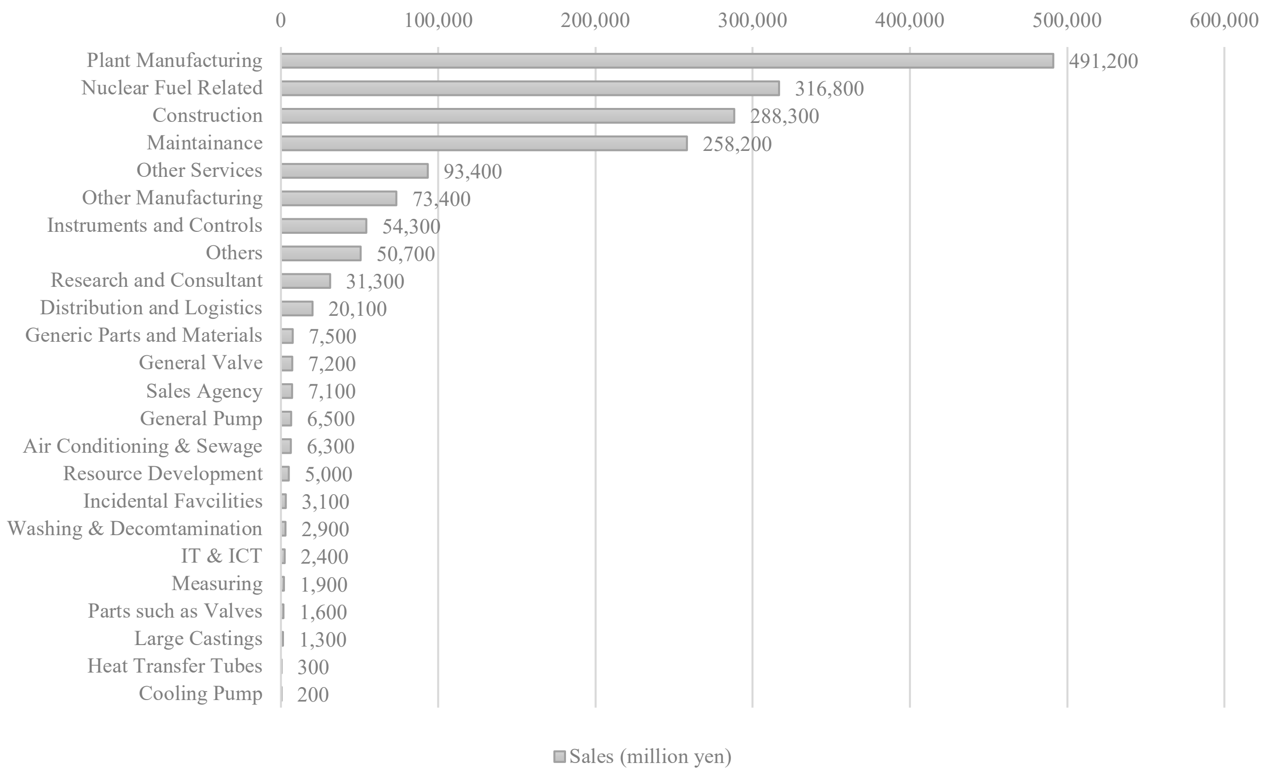

Figure 2-2-41. Sales in Nuclear-related Industry by Sector (JAIF, 2017, p. 8)

Among vendors, the plant manufacturing sector earns the most (*see figure 2-2-41*, (JAIF, 2017, p. 8)). In commercial NPPs, there are mainly two types of manufacturer; those who produce Pressurized Water Reactor (PWR) and those who produce Boiling Water Reactor (BWR). One of the major manufacturers for the former was Westinghouse Electric Corporation (WH) in the United States, the company which got acquired by Toshiba in 2006, and Mitsubishi Heavy Industry which founded a joint enterprise with Areva S.A in France. On the other hand, the major producer of BWR is General Electric Company (GE) in the United states which merged the NPP-related development with that of Hitachi (see *diagram 2-2-42*) (Nakano, 2015; Tomita, 2014). Each of the three Japanese manufactures funds to International Nuclear Energy Development of Japan Co., Ltd (JINED), sharing 5% each, together with 9 utilities (total 75% of total share) and Innovation Network Corporation of Japan which shares 10%. This company has an aspect of a national project, with the legislative and financial support from METI, aiming to promote the NPP projects overseas under the unification of various industrial actors (JINED, 2010). It is a national project that prime ministers themselves support their sales.

Berndt (2018) estimates how much these companies rely on NPP exports for their business; it predicts that NPP exports comprised nearly 10% of total sale from Toshiba and Mitsubishi around 2010 but suddenly slumped since 3-11. On the other hand, for Hitachi, sales from NPP exports have consistently comprised around 2% of their total sale (see *figure 2-2-42*). That said, NPP exports were a stable, almost promising business thanks to comprehensive state supports and monopolistic or oligopolistic electric power companies as final client (Berndt, 2018).

In conclusion, the nest of utilities reaches not only to the electricity industry but also to a wide variety of industries. Utilities, protected by the state support, are the stable customers for their vendors and NPPs, also supported by the government, are stable industries to place investments for. The interdependent of interest is so strong that the coalition of bureaucrats, politicians are in tandem with the plant manufacturers for their plant exporting business.

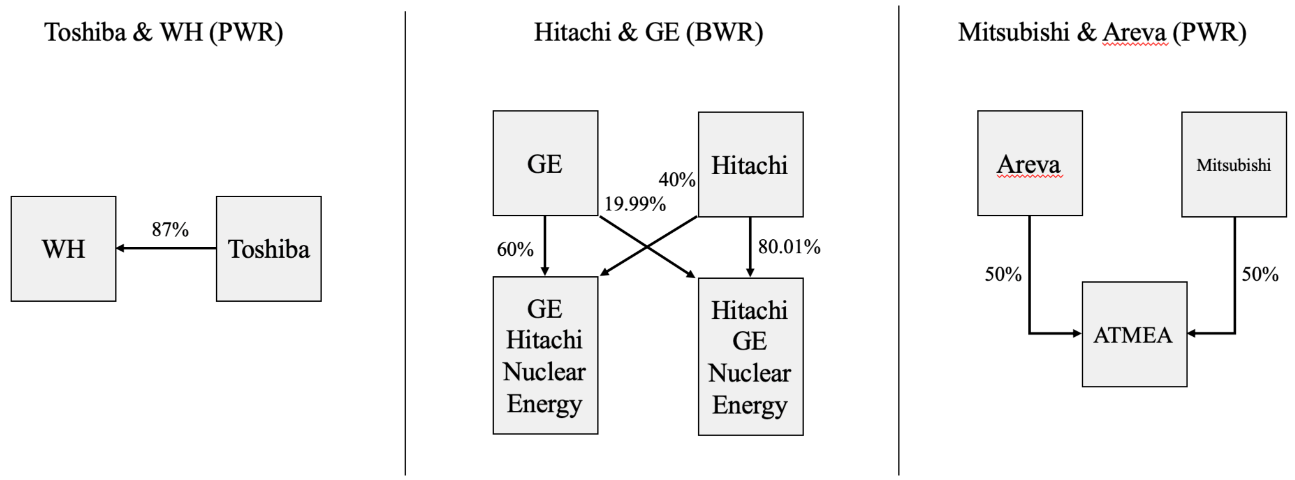

Diagram 2-2-41. Three forces in NPP (Tomita, 2014)

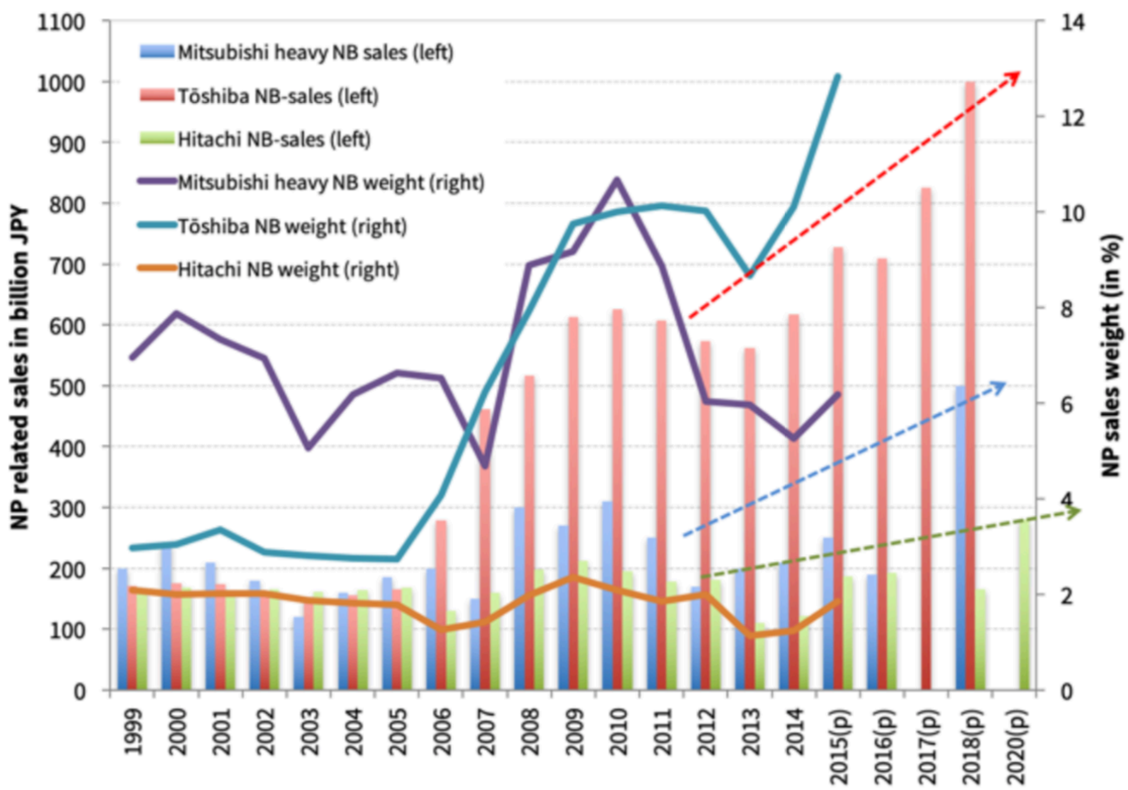

Figure 2-2-42. Estimation of nuclear power plant business sales and weight of total sales at Mitsubishi Heavy, Tōshiba, Hitachi (FY) (Berndt, 2018, p. 147).

Advertisement and Media Industry

The historic analysis also revealed how the public opinion is changed depending on the information they receive. Hence the advertisement and media industries should have had a strong impact on social policies. In this section, the thesis would like to focus on the following two points; 1) structure of advertisement and media industry and 2) the advertisement of utilities.

Structure of Advertisement Industry

The structure of Japan's traditional mass-media easily reflects the interests of the government, bureaucrats and business clients and the tie among nuclear industry, advertisers, and media is widely known (Gaulène, 2016; Honma, 2016; Manabe, 2015). According to revelations from Honma (2016), who spent 17 years as the salesman at Hakuhodo, the one of two giant advertising agencies in Japan (refer below for detail), due to this structure, Japan's national-wide media (TV, newspaper and radio) has traditionally propagated the bright side of nuclear while kept silent for affairs that could harm utilities, trying to manufacture a public consents toward nuclear power.

Though it is the nature of any agents to represent an interest of their clients, in case of Japan, the social issue lies at the structure of the advertisement industry. Japan's advertisement industry as a whole, particularly the traditional media (newspaper, magazines, radio, and TV) is largely dominated by two mega-agencies (Dentsu and Hakuhodo)[27], the companies that bundle the processes of advertisement production and slot purchase. Thus, the agency naturally has to represent and promote multiple companies even if they are in the same industry. Furthermore, this structure also indicates the asymmetry of power where media has very limited option to choose customers (agencies) for their ad

[27] According to Dentsu's research (2018a), in 2017 the total sales of Japanese advertisement industry as a whole was 6,391 billion JPY, of which TV consists 30% (1,947 billion JPY), the internet consists 23% (1,509 billion JPY), newspapers consist 8% (514 billion JPY), magazines and radio consist 3% (202 billion JPY) and 2% (129 billion JPY) respectively. There are advertisements for other types promotions that consist roughly 32% of total, such as flyers (417 billion JPY), direct mails (370 billion JPY) and exhibitions (338 billion JPY). Dentsu and Hakuhodo are two largest corporations and especially powerful in media where Dentsu and Hakohodo consist 37.5% and 22.3% of the total share in TV advertisement, 17.8% and 11.4% of that in newspaper, 14.5% and 9.9% of magazines and 13.1% and 10.0% of radio (Dentsu, 2018b; Hakuhodo, 2018).

inventories whereas the agency still have variety of options. Therefore, the Japan's advertisement industry has evolved based on the close tie between ad-agencies and media (Fair Trade Commission, 2005).

Structure of Media Industry

In such market structure, Dentsu and Hakuhodo are able to propagate their own interests through media; when two confrontational arguments are brought into, there is no other ways for clients but be reliant on the discretion of mega ad-agencies about how the advertisement is made and how it is delivered. Furthermore, Dentsu and Hakuhodo are not only members of Keidanren, but also of Japan Atomic Industrial Forum (JAIF), the industry group that supports nuclear power (Japan Atomic Industrial Forum (JAIF), 2018; Japan Business Federation (Keidanren), 2018). Undoubtedly the members of both industrial groups are the biggest clients for Dentsu and Hakuhodo. This casts a structural difficulty on airing the statements that confronts against them.

As for media, the biggest mass communication media is terrestrial TV who receive income by selling their ad-inventories (except for the national public broadcasting organization (NHK) which takes charges from whoever owns TV thus being free from commercial advertisements). Terrestrial TVs are also de facto oligopoly of five groups of private enterprises, forming 6 main "key stations" if you include NHK. Each of the key stations owns a number of local TV broadcasting station and nation-wide newspapers and radio stations (Niho, 2006). In other words, 5 media conglomerates share the same goal, that is, to attract the advertisements coming from the same source.

This oligopolistic nature is protected by Broadcasting Act, which makes the usage of terrestrial broadcasting signals only exclusive to those who hold a license given by MIC. Due to this oligopolistic nature, each media is legally responsible for "political neutrality" in the contents they produce (). Yet, whether the content is politically neutral or not is at the discretion of the government (MIC). The government's right to shut down broadcasters that is determined by political bias, is arguably contradicting if one wants to bring political neutrality in broadcasting (Uozumi, 2018).

Some journalists, if not all, are also the parts of vested-interests. For this matter, Kisha Club system (or Press Club system) is being internationally criticized. It is an exclusive group that certain members can only access to the primary data such as the governmental announcement from press conferences. Au & Kawai (2012) points out the three features of Kisha Club: "First, membership to the club is limited to an exclusive group of news organizations (including major newspapers, broadcast stations, and wire services) that hold a virtual monopoly over news sources. Second, there are strict rules governing activities of members that limit independent and investigative reporting. Finally, there are strong punishments against violators of these rules and effective means of enforcing them" (Au & Kawai, 2012, p. 131). As a result, the journalists gathered in the conference will obtain the same information. Such feature has been also concerned by FreedomHouse:

> More than half of the national newspaper market share is controlled by "the big three": the Yomiuri Shimbun, the Asahi Shimbun, and the Mainichi Shimbun. There is considerable homogeneity in reports, which relate the news in a factual and neutral manner. […] Concerns continue regarding the lack of diversity and independence in reporting, especially in political news. This is facilitated in part by a system of kisha kurabu, or journalist clubs, in which major media outlets have cozy relationships with bureaucrats and politicians. Exposés by media outlets that belong to such clubs are frowned upon and can result in the banning of members from press club briefings. Smaller media organizations and foreigners are excluded from journalist clubs altogether. The kisha kurabu have been criticized by Reporters Sans Frontieres and the European Union because the government gives club members exclusive access to political information. In return, journalists tend to avoid writing critical stories about the government, thereby reducing the media's ability to pressure politicians for greater transparency and accountability (FreedomHouse, 2007)..

Advertisement of the energy regime

When you look at utilities' business sheet, you will find an item named "expenses related to development and dissemination [Fukyu Kaihatsu Kankeihi]". This may sound odd because utilities are regionally monopolistic, namely the dissemination activities may be unnecessary. Anyway, this expense aims to advertise the utilities' business activities through media such as TV, newspaper and radio[28].

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[28] Although the utilities are not normally obliged to disclose the specific use of this budged, the exception still exists. On 24th May 2013, upon their plan to raise the electricity price, Shikoku EPC had to disclose the detailed content of this expense to the Cabinet Office, because these expenses can be retained by FDC pricing that this thesis mentioned above. Note that the provided information on expense is not the one they have used for but the one prospected to be used averagely between 2013 and 2015. According to the disclosure, the Shikoku EPC's expense consists of the following 4 items: Safety information (9.5%), requesting for demand restrain (1.1%), publication of safety measure on NPPs (47%) and Others for public goods including energy education and holding seminars etc.. (41%). While still obscure on what this "education" indicates, we can clearly see their efforts on subduing the public's distrust on nuclear energy.

According to the financial statements of 10 utilities between 2004 and 2017, you can see the historical change in the amount of "the expenses related to development and dissemination" (*see figure 2-2-43*). The amount suddenly started decreasing in 2011 and hit the lowest in 2013 and 2014. After that, the number slowly started recovering since 2015. Honma (2016) analyzes this drop as that EPCs had to minimize the costs incurred by temporally shut-down of NPPs, and that they thought Fukushima accidents would nullifies any advertising efforts. Overall, Asahi Shimbun (2012) conducted a research on this item for 9 utilities that own NPPs and found that at least 2.4 trillion JPY have been spent between 1970 and 2012 (*figure 2-2-43*), which is, they claim, a similar amount to that of giant corporations in automobile and home appliances. To media, this drop means the loss of good customers with good payment, with whom no longer have to sympathize.

In sum, advertisement agency holds a wide variety of industrial clients to represent. Traditional media also relies on the income from those advertisement agencies. These media are embedded in the regulative rules that allow oligopolization of information and broadcasting rights, paving a solid ground to ensure an audience rating. Thereore, the journalists who retrieve information from Kisha Club and opinionate through media, need to be careful not to offend the advertiser's interests as well as not to lose the participative rights for Kisha Club. Resource and power (capitals and information) are constantly reproduced by the actors who enjoy the oligopoly. This structure makes advertisement agencies, traditional media and journalists difficult to criticize the nuclear promoting activities of the utilities.

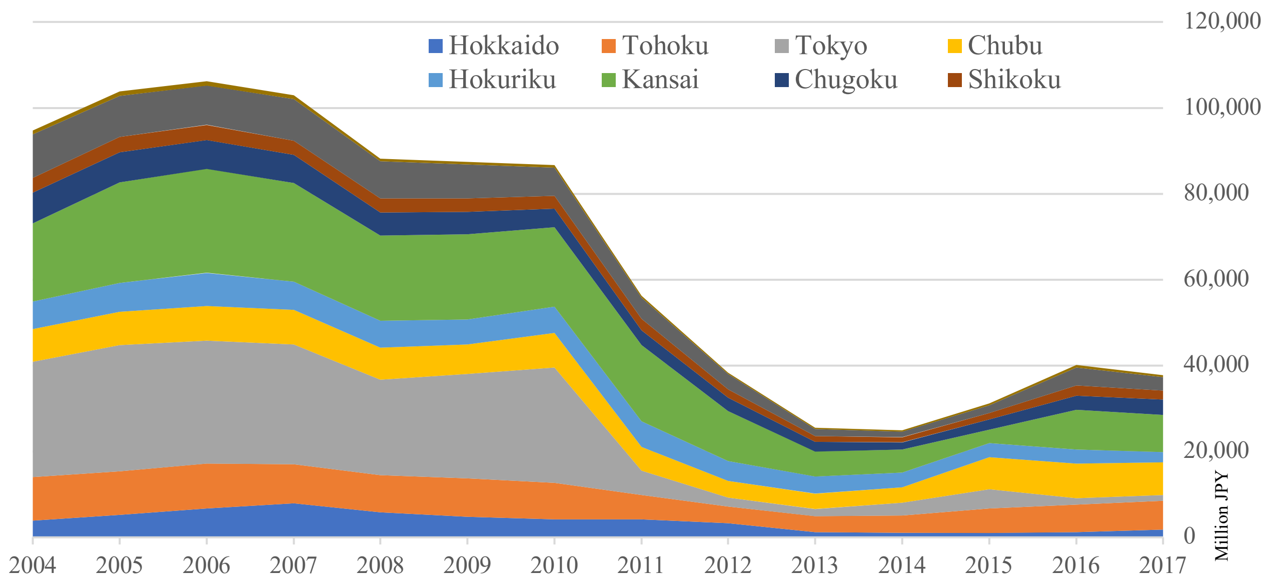

Figure 2-2-43. The expenses related to development and dissemination (from the IR-reports of 10 utilities between 2004 and 2017)

New Energy Companies

Under the circumstance that the renewable energy is not yet cost-effective, the penetration of renewable energy is reliant on the supports they receive: "the support scheme influences both the trading behavior and the plant design by the degree to which plants are dependent on price developments and thus demand conditions on regular electricity markets" (Winkler et al., 2016, p. 158). In Japan, FIT has been a core of supporting installation of renewable electricity. Between July 2012 and December 2018, 283TWh (or 9.9 trillion JPY) of electricity has been purchased with FIT. 53% of the purchased electricity (158 TWh) and 62% of purchased volume (6.2 trillion JPY) are derived from the solar power with capacity over 10kW. As you can see from *figure 2-2-44*, the other sources such as wind, hydro and biomass have also been grown under FIT, but the effect is obviously less compared to solar PV[29]. That said, FIT alone creates the market worth 2.1 trillion JPY in 2018 and many electric producers rely on this policy for their revenue (ANRE, 2019).

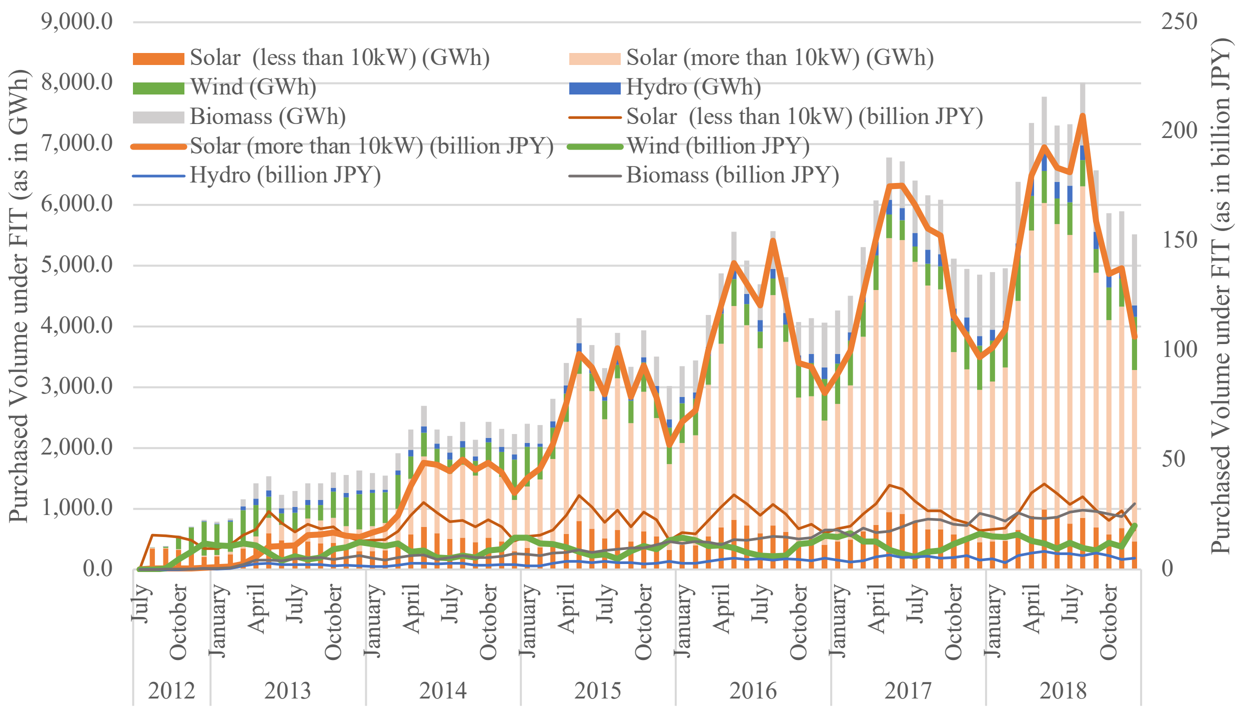

Figure 2-2-44. Purchased volume using FIT (except for geothermal) as in GWh and billion JPY. (ANRE, 2019)

FIT relies its funds on electricity consumers. This means that more electricity is purchased under FIT, more electricity bills that consumers will have to bear. As mentioned in *section 2-1-1*, ANRE (2018d)

[29] Between July 2012 and December 2018, under FIT scheme, wind energy supplied 34 TWh (or 0.7 trillion JPY worth) under FIT scheme, biomass supplied 38 TWh (or 0.9 trillion JPY worth), hydro supplied 10 TWh (or 0.2 trillion JPY worth).

estimates that FIT comprises 12% of electricity bills, the amount which is equivalent to 9,500JPY/year for each household (Ishida, 2017). In other words, yearly electricity bills risen by approx. 10 thousand JPY in just 5 years since the introduction of FIT. Ultimately, this could result into a decrease in electricity demand and instead switching to other types of energy such as town gas.

The sales share of non-utilities has increased from 5% in April 2016 to 14% in November 2018 in the electricity market (see *figure 2-2-45*). Correspondingly, the spot-market (called JEPX) got vitalized too: while the spot market only comprised 2-3% of total sales volume during April-September 2015, it comprised 18% during April-June 2018 (EGMSC, 2018).

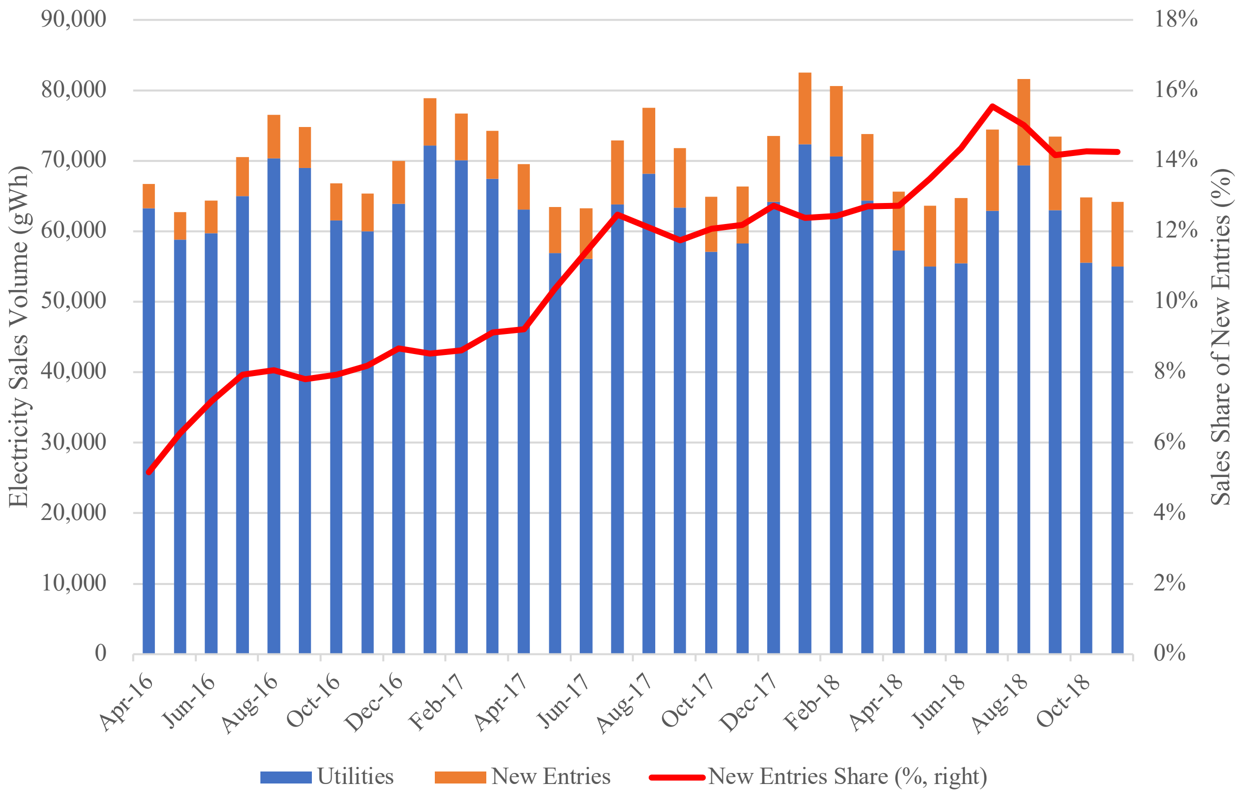

Figure 2-2-45. Change of Electricity Sales Volume by Sellers. (EGMSC, 2019)

Retail companies have to offer consumers with an electricity price as to cover generating cost, O&M cost, FIT, compensation fee for Fukushima nuclear disaster and fee for using transmission grids operated by the utilities. As of April 2016, the fee for grid usage is between ¥7.81/kWh and ¥9.93/kWh for low voltage grid, ¥3.53/kWh and ¥5.20/kWh for high voltage grid, and ¥1.62/kWh and ¥3.01/kWh for ultra-high voltage grid, together comprising approximately 25~30% of total electricity price. As Nikkei (2015) reports, the price is so high that discourages the new entries into retail market as well as price competitions among retailers. Furthermore, some scholars criticize that new entries have been charged tremendously high fee for using transmission lines and, in addition, they are also charged significant amount of imbalance fee (48JPY/kWh, three times of standard cost price as of 2008-2016), a compensation for any gap between actual electricity supply and demand over 3% that a transmission sector cannot balance within 30 minutes (Berndt, 2018; Yamaguchi, 2007).. This is applicable not only in case of shortage but also in case of surplus. As a result, an imbalance fee amounted national average of 14.3JPY/kWh as of 2016 (Berndt, 2018; Yamaguchi, 2007).

In sum, retail companies are hugely reliant on cost of generations, consumer's purchasing decision and more importantly, discretion of transmission segments. Berndt (2018) and Kumamoto (2011) point out the structural deficit of this liberalization that the utilities still have dominant power to control the retail price even after the liberalization of retail market. Because utilities own transmission grids, they can impose high usage fees to block new entries to the retail sector. Utilities, on the other hand, are also reliant on the renewable producers to some degree, for the damage compensation of Fukushima nuclear disaster as well as for the transmission fees. *Diagram 2-2-46* explains this interdependent structure.

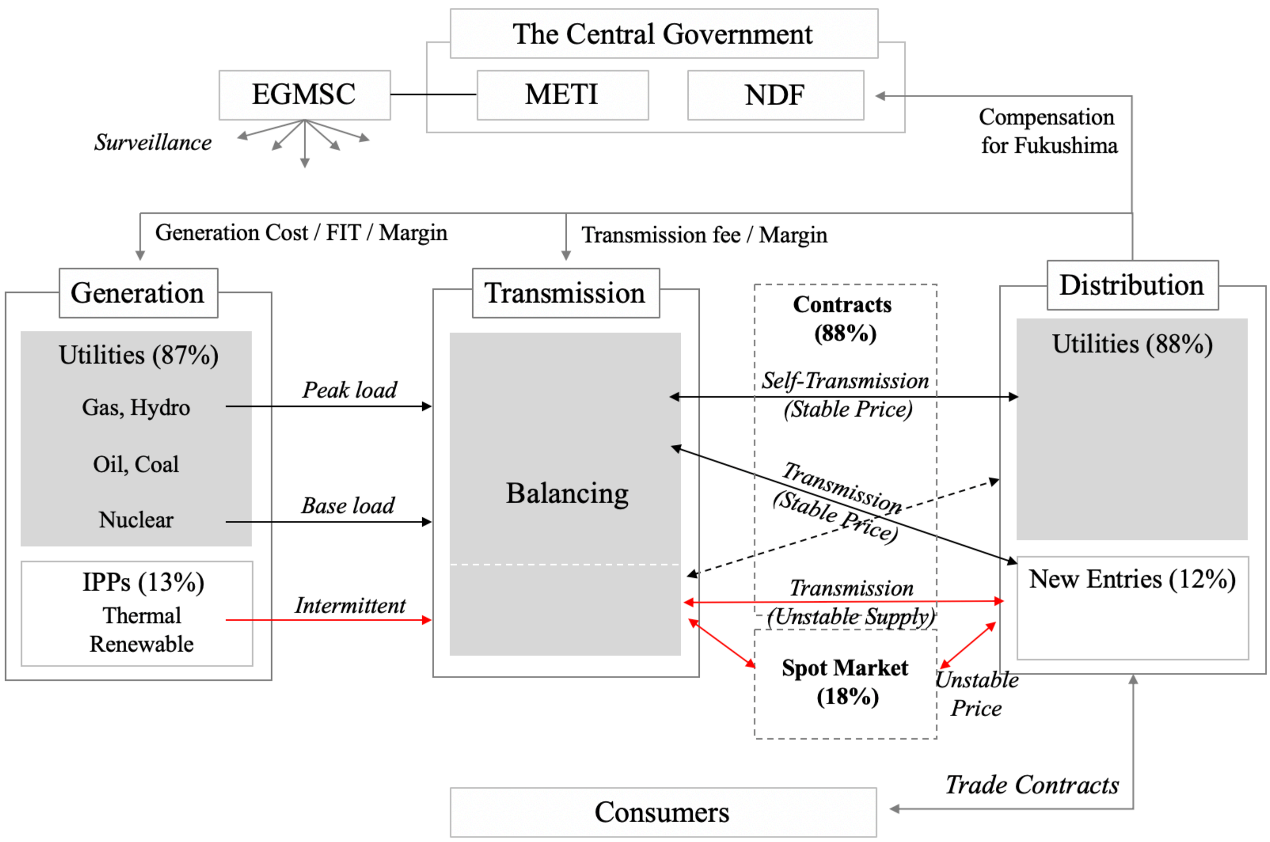

Diagram 2-2-46. Structure of Interdependency (Electricity market-centered)

Section's summary

The web of interdependency is widely and deeply extant in the Japan's society. Yet, the most element of this interdependency is the centralization of energy production, energy-related assets, financial capital, and political power to the utility. The utilized the centralized power and resource as a catalyst to further widen the web of interests to industrial vendors, other industries such as media, financial sectors, politicians and bureaucrats. As such, more actors are more strongly embedded in the interdependent structure, and hence they attempt to produce/reproduce the regulative, normative and cognitive rules to reinforce the structure.

Diagram 2-2-47 illustrates the basic interdependent structure of the current energy system. Please be noted that it is only for an illustrative purpose. The political power of the regime is enforced in favor of the utility by the pronuclear and industrial groups in a form of political donation and Amakudari. They produce/reproduce regulative and normative rules in favor of the utility. The new entries are also embedded in these rules.

The capitalists who own electricity bonds, are also strong stakeholders of the regime, which will reflect to the votes. The media and advertisement agencies, whose main clients are Keidanren and utilities, are also important stakeholders of the current regime. As reveled by Honma (2016), they are also accountable for enforcing cognitive rules in favor of the nuclear power generation, which will reflect to the votes. These political powers are also strongly backed by capitals. The banks, the member of Keidanren and the strongest shareholders of utilities and their vendors, receive returns from the utilities. The individual lenders are also the second biggest bond-holding group for the utility. Under such circumstances, a force to reproduce the current structure is created.

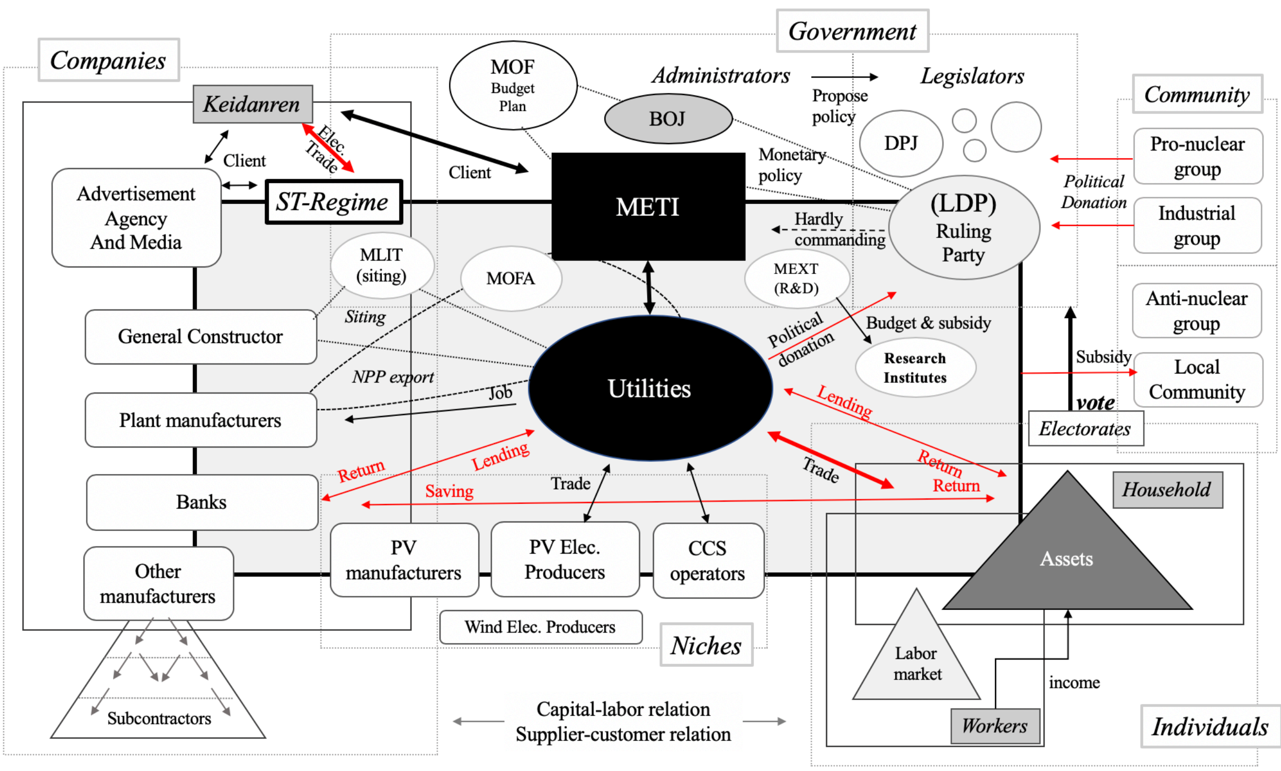

Diagram 2-2-47. The macro relationship with ST-regime.

Chapter's Summary

In this chapter, the thesis firstly argued that Japan's energy system is not sustainable. Economically, Japan's high dependence on imports of oil and gas makes the energy system vulnerable to an oil/gas market, and especially for oil, makes Japan highly exposed to geopolitical risk. Currently, Japan attempts to attenuate such risk by replacing the oil with gas, coal and nuclear power, the energy source with much less geopolitical risk. But by doing so (especially for coal), the 2-degree target becomes more difficult to achieve whereas further efforts on reducing GHG emission is required.

In terms of GHG emission, nuclear power is considered to produce less CO2 than fossil fuel. However, economic feasibility of NPP is based on the frail assumption that the plants would run for 40-60 years at capacity factor of 70%, the desire which the history proves difficult to make come true. The risk of nuclear accidents is also being overly underestimated. In the situation that nobody knows the marginal/social cost of de-contamination, de-commission, health risk of Fukushima nuclear disaster and that nobody can deny the possibility of stronger earthquakes in the future, it suffices to say NPP is a sensitive time bomb that can incur tremendous cost for Japan's economy, society and environment.

It is clear that being status quo only keeps inflating not only environmental risks, but also economic and social risks to the level that the current system will no longer be able to absorb. Thus, Japan needs to make a transition. Here, one of the biggest issues in transition is the existence of nuclear fossil regime. Since the end of world war, the regime has had strong influence on Japan's energy policy. The nest of interests that regional monopolies have weaved reaches from central government, construction, manufacturing, media and advertisement industry, local government and community to households. Developing and utilizing regulative, normative and cognitive forces, the regime carefully nurtured the regime coordination, straighten and expand the interdependent actors, isolate the potentially threatening niche actors and incrementally adapt with the change of ST-landscape. Now, economic performance of utilities is an interest of many individuals and companies, and the social and environmental costs they externalize are easily lost in their accountancy.

Chapter 3. Research Question and Hypothesis

> Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones.
> - Donald Rumsfeld, during a Pentagon news briefing on February 12, 2002

The problem recognition in chapter 2 invokes a question, that is, how to make a transition. In this chapter, the thesis takes transition management as hypothetical solution for Japan's energy system to take sustainable development pathway. After that, the thesis articulates specific research question to look into.

3-1. Hypothesis and Research Question

3-1-1. Transition management

Transition management is a type of governance mode that attempts to deliberately manage and influence the direction of transition to address societal issues. Transition management does not consider complexities and uncertainties as obstacle but as a means of leverage for management through 1) adjusting while the structure of a system is changing (*adaptive management*) and 2) directing while estimating the possible future behavior of the system (*anticipative management*) (Jackson, Lederwasch, & Giurco, 2014; Rotmans & Loorbach, 2010).

Rotmans and Loorbach (2010) articulated guidelines for transition management; 1) management at the system level is important because such perspective helps to recognize possible spillovers and emerging factors of complex problems. 2) Observers must capture the dynamics of the system; process trancing itself is insufficient for effective management as it lacks an understanding of preconditions regarding how the system works. 3) Because unintentional change is inevitable, objectives need to be flexible and adjustable. 4) Because a system is changing constantly, timing of intervention is crucial to maneuver a transition to a favorable pathway, thus a maneuverer has to be aware of plausible scenarios and prepare for the intervention. 5) Creating diversity stimulate and align small actors to new configuration, which can become an emerging structure to break through the current regime configuration.

Transition management can posit the long-term sustainability as its goal and achieve it by adjusting the transition pathway and by anticipating and preparing for plausible events that could pervert the pathway. Based on this understanding, breaking up the path dependency that exists in Japan's current energy system and guiding a transition to a sustainable future is theoretically possible. Furthermore, as a hypothetical goal for transition management, a utilization of renewable energy source and a promotion of self-sufficient energy cycle in a locally-integrated system is presented as one possible solution for current sustainability issues.

Incidentally, it has to be noted that the thesis lets "sustainability" remain at an abstract goal. This is because, to be frank, nobody has a concrete idea in what state we can confidently call an energy system sustainable. Strictly speaking, even if the whole world suffices its energy demand only by renewable energy, huge amount of deplorable materials would still need to be put for production /renewing/ maintenance of the facilities that generate renewable energy. However, in light of transition management, it is also true that we need a certain goal that serves as a milestone to transition our energy system to the "relatively-more-economically-socially-and-environmentally-sustainable-and-probably-effective-enough-for-mitigating-current-developmental-issues" system.

3-1-2. Research Question

The theory of transition management also indicates some premises to materialize theoretical possibility in real life; 1) Drivers in Japan's energy system are aware of sustainability as a goal and 2) cognizant of complexity and uncertainty in the system, so that 3) they can intervene to change the system's direction toward more sustainable way if something unfavorable happens or is about to happen. 4) At the same time, strategists deliberately need to nurture diversity within the system and align them so that they could break through the path-dependent tendency of the current ST-regime configuration. In other words, the following two research questions must be answered;

- Who will be the main system driver, how do they drive the system and why in 2030?
- To achieve sustainable development, what kind of transition management will be required in different scenario by 2030?

The thesis sets the timeline as 2030, in hope of representing an anti-thesis of the government's energy plan (see *Background* for more detail about the government's plan). The first question serves as to recognize uncertainty and complexity of the system. The transition driven by the current utilities and the transition driven by, for instance, new electricity suppliers should be largely differed. This leads to our second question; we must be aware of plausibility because it is a basis for operating adaptive and anticipative management. Being deterministic and assuming linear management process, on the other hand, is vulnerable to uncertainty and complexity.

3-2. Empirical data to support hypothesis

Aside from theoretical perspectives, the thesis would also like to look at the transitional possibility empirically. First, as discussed above, nuclear regime has been leading the transition of Japan's energy system. The regime has attempted to adapt their nuclear business to the energy system with intense financial and policy supports, taming public opinions, and nipping industrial actors who could potentially harm their configuration. In other words, the current shape of the Japan's energy system is already a product of transition management. Aside from motivation, it is still the fact that METI had historically encouraged Japan's PV manufacturers and successfully pioneered the renewable industry that the world had yet seen. It is also plausible, if not likable, that METI takes an initiative for the sustainable future.

On the other hand, Zha (2016) observes several new and active actors in energy system in Japan especially since Fukushima. The first one is NPO. For example, in Yasu city of Shiga prefecture, a citizen-funded NPO "Ecological Yasu" takes an initiative to ask donation from citizens to establish solar PV farm in the city. Donators, instead, receives coupons that has value equivalent to 110% of donated money and they can use it in the local area to purchase goods and services from local shops that sponsor the NPO and public facilities. It has been reported that this coupon transaction consists 3-10% of the whole local trade. The city of Higashi Omi in the same prefecture also carries out this model, and as of 2012, the local coupon was issued as much as 20 million JPY, contributing to recirculate the local economy as well as to promote renewable energy. Furthermore, Sanagochi village in Tokushima prefecture provides local products to donators instead of coupons. (Zha, 2016)

Another model is driven by a leading community in impoverished villages to sustain their economy. Unlike the model mentioned above, this model does not have an economic aspect to recirculate local economy, but an aspect to reduce the cost of livings. Another diffrence is that this type of model tends to be driven by a leader (such as Mayer) in community rather than by a wide commitment of citizens. For example, Yoshino village in Nara prefecture and Itoshiro area in Gifu prefecture took initiatives to installed small-scale hydro power plants on agricultural waterways to compensate the energy demands from lightings. Itoshiro area is currently aiming to establish the complete self-sustainable energy grid. (Zha, 2016)

Finally, Zha (2016) also observed a corporation between local business and local authority. Katsumaki city in Iwate prefecture formulated "New Energy Vision of Katsumaki City" in 1999 and has been promoting renewable energy since then. The notable policy is the subsidy to local business for establishing wind, biomass and solar power stations. Unlike the above-mentioned models, citizens are not actively involved into this project, which leads to low awareness among citizens of the connection between their lifestyles and local renewable industry. Yusuhara City in Kochi prefecture also provide subsidies to local business and citizens to promote installation of renewable electricity plants. Instead of consuming on their own, they sell all the electricity to Shikoku EPCO. Together with higher FIT rate for wind power since 2013, the city estimates the average annual revenue of 53 million JPY (Zha, 2016).

When we widen our view to the world, several projects are already transitioning local energy system to self-sufficient one (Muller, Stampfli, Dold, & Hammer, 2011). For example, the city of Gussing in Austria has approximately 3,800 inhabitants in an area of 49.31 square meter where 46% is forest and 40% is used for agriculture. Before 1990, the city had spent 1.5million Euro per year on fossil fuel, however, with an initiative of municipal government who promoted renewable energy, the city installed the first biomass power plant in 1996, which could meet the heating and electricity demand for the city’s households and industry. Furthermore, with several programs to support R&D and innovation activities and to enhance tourisms, “the attractiveness of the city increased and tourism picked up, with about 400 persons per week now visiting Gussing”, creating roughly 1,000 new jobs and 50 new companies in the area (Muller et al., 2011).

As you can see, although all the system drivers are somewhat producing the same product, electricity, societal contexts behind are largely differed by their development models. Some depend on FIT and aim for financial revenue whereas some install renewable energy for using on their own. Some stimulate citizens participation whereas some focus on the relationship between city authority and local business. Not to mention, we still cannot forget about utilities. They are still dominant actors in energy system, seeking for economic of scale and providing stability in centrally integrated electricity grid.

Chapter 4. Research Design

This chapter dedicates to the discussion of research strategy and its method. The thesis first introduces theoretical framework to capture societal transition, and secondly, designs and strategy to incorporate the framework with this research. Finally, the thesis would like to mention how to collect data and analyze it.

4-1. Theoretical Framework and Research Strategy

Thomas (2009) explains that there are two paradigms in thinking about the social world. One is positivism, which refers to the view that knowledge about the world can be obtained objectively, thus positivists view that social phenomena can be "observed, measured and studied scientifically, in much the same way that physicists study levers, atoms and pulleys" (p. 74). Positivists are particularly interested in a relationship with dependent and independent variables as a data and observe/measure these variables. The other is interpretivism, which views that knowledge about the world is not simply out there but rather it is constructed in a different way in each of us. Therefore, interpretivists are more interested in how people perceive and form ideas about the world rather than variables and quantification.

Although positivists and interpretivists have different views on the world, both attempts to reason a relationship between theory and data to understand social phenomena. Therefore, the reasoning is also an important element to look at. According to Blaikie (2009), there are mainly four types of reasoning: deductive, inductive, abductive and retroductive. Deductive reasoning starts from theory (or premises) and test it with data. As a result, observers can either confirm or disconfirm the validity of the theory. On the other hand, inductive reasoning starts from data to formulate the theory through finding a pattern in data (Thomas, 2009). Abductive, on the other hand, is to re-interpret and re-contextualize an individual phenomenon within a conceptual framework. It therefore aims to provide an alternative explanation (or hypothesis) to the phenomenon by looking at it through a new set of ideas and providing enough data to support the hypothesis (Danarmark, Ekstron, Jakobsen, & Karlsson, 2002; Dey, 2004). Finally, retroductive aims to discover underlying mechanisms to an observed phenomenon. It starts from finding and describing a possible regularity in the phenomena, and establishes a mechanism(s) that can provides the best explanation in the contexts (Blaikie, 2009).

4-1-1. Capturing societal transition

So what is the most suitable research strategy for our research questions? There are two suitable types for explaining societal transitions; 1) to explain outcome through causality and 2) to explain the process by identifying underlying patterns and causal mechanism. The former perspective is called variance theory which is compatible with positivist's view on social phenomena, and the latter perspective is called process theory, which favors interpretivism[30] (Geels & Schot, 2010). Variance theory is compatible with retroductive approach as it aims to find out regularity and mechanism while the latter is compatible with abductive approach as it attempts to find a better explanation of transition through looking into process.

	Variance Theory	Process Theory
Acting	Fixed entities with varying attributes ⇨ Variables do the "acting"	Entities participate in events and may change over time. ⇨ Actors do the 'acting'
Meaning in entity	Attributes have single meaning overtime	Entities, attributes, events may change over time
Time ordering	Time ordering among independent variables is immaterial	Time ordering of independent variables is critical
Emphasis	Emphasis on immediate causation	Explanations are layered and incorporate both immediate and distal causation
Generality	Generality depends on uniformity across contexts (search for law)	Generality depends on versatility across cases (variation between overall pattern)

Table 4-1-1. Comparison of Variance and Process Approaches (Geels & Schot, 2010, p. 93; Poole, Van, Dooley, & Holmes, 2000, p. 36)

Variance approach explains outcome as a causality of independent variables acting on dependent variables whereas process approach tries to follow a series of specific events. These two different approaches emphasize different aspects of societal transition. Variance theory looks at societal transition on the assumption that each entity possesses fixed meaning overtime, which necessitates an observer to "variabilize" the world, that is, to see an observed phenomena as comprised of variables in relation to other variables (Poole et al., 2000). On the other hand, process theory looks at it on the assumption that each entity may change its meaning through events, choices and activities (see *diagram 4-1-2*) (Geels & Schot, 2010).

Therefore, to operate variable theory, it requires an observer to capture causal connections of variables at a certain timeframe whereas in process theory, by its nature, temporal sequences become crucial

[30] That being said, process theory also involves the use of variables, attempting to produce alternative explanations and inferences on certain events or trends (Bennet, 2010).

because each entity is expected to change[31]. Thus in variance theory, a force that pushes transition is simply reduced as a quantitative scale in relation to other variables (historical contexts are not accounted), whereas process theory explains does not favor to reduce to quantitative representations but instead explain societal transition through qualitative tracing of events, change and activities[32] (Poole et al., 2000).

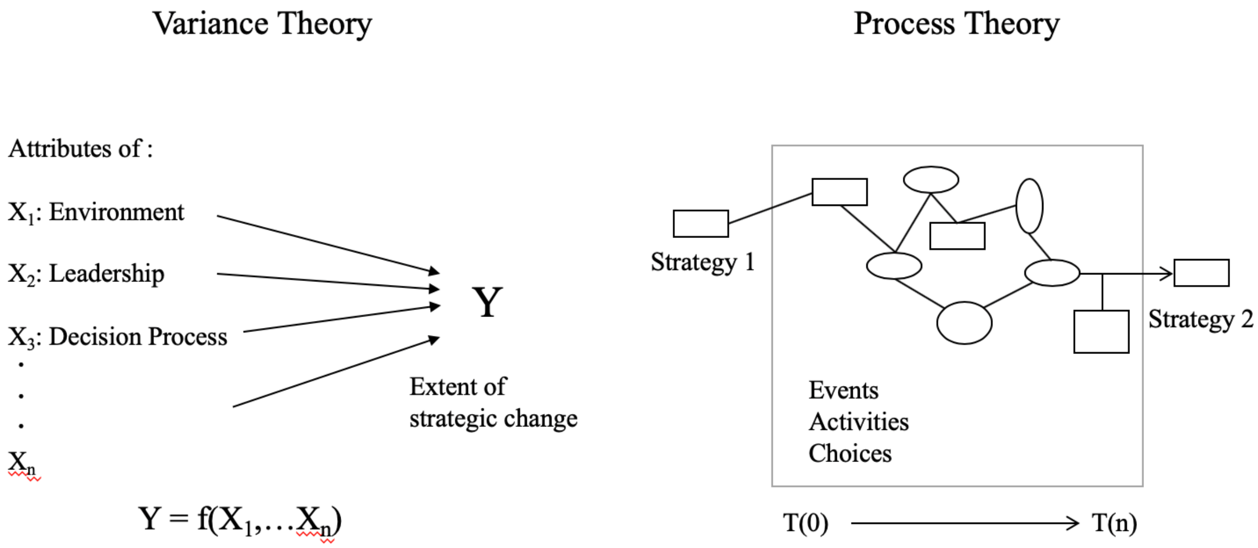

Diagram 4-1-2. Two approaches to explaining processes (Langley, 1999, p. 693)

Geels and Schot (2010) argues that MLP is a process theory instead of variance theory due to the following five characteristics;

> Ad 1) Transitions are enacted by different social groups. Ad 2) Actors change their perceptions of interests, preferences, and identity during transitions. Ad 3) The timing of events and multi-level linkages is important, influencing the type of transition pathway. Ad 4) Explanations in the MLP are layered and involve the tracing of twists and turns and alignments of event sequences and trajectories. Ad 5) The MLP has generality because it is versatile and maintains its basic character in different case studies and transition pathways. (p. 95)

Indeed, societal transition consists of macroscopic, complex dynamics that deny the simple cause-and-effect relations. Furthermore, what MLP captures is the co-evolution of "alignments and linkages

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[31] That said, temporal sequencing also matters for variable testing, A causes B generally assumes that A appears before, or at least simultaneously with B. If B occurs firt, that tends to falsify the original causal statement.

[32] Please note that we can also have qualitative variables that are not simply measured through a number, but a bit more qualitatively: high, medium, low etc. The passage is whether the phenomenon that we are looking at is reducible to the numbers.

between different processes" (p.96) – reducing such complex evolution process into a simple causality could lead to neglect developments of other trajectories. Thus, "in general, analysts should not over-emphasize individual actions when it comes to entire transitions." (p. 97).

However, process approach is insufficient to understand the basic dynamics of the system as it leads to the devaluation of agencies and power as discussed *in section 1-2-3*. This limits our analysis to provide new, alternative paradigm and prevents us from developing strategies to deal with structural uncertainty. This is a critical problem in light of transition management (adaptive and anticipative management). In this sense, variance theory, can provide us a different aspect of societal transition in a way to reduce complexity with quantitative representation of causal mechanism. However, there is a constraint to deliver dynamics of co-evolution process because it only captures interrelations of variables at a specific timeframe, so it must assume that meanings of entities do not change overtime.

4-1-2. A bridge between variance and process theory

The thesis requires an appropriate framework that incorporates the strengths of both approaches without inhibiting neither of them. Here, this thesis examines the possibility of scenario planning for its use in societal transition research. In this section, the thesis first discusses how scenario planning has the potential to bridge between variance theory and process theory and later it discusses the theoretical grounds of how scenario planning contributes to transition management.

Scenario planning aims to advocate "the construction of multiple stories that encompass a variety of plausible futures" (Chermack, 2004, p. 301). Rather than forecasting, it provides a view of what the future might be, and a blueprint for managing uncertainties. It has largely been used as a strategic exercise by organizational entities such as corporations, governmental bodies and non-profit organizations as part of tabletop exercise (Evans, 2011; Holloway, 2007). Although its origin was not entirely academic, but rather was a decision-making tool for the US military and Royal Dutch Shell (Bentham, 2014), it is claimed that Scenario Planning shares a theoretical ground with evolutionary theory, experimental economics social sciences, societal safety, psychology and politics (Chermack, 2004; Evans, 2011; Holloway, 2007; Renn & Klinke, 2015).

Scenario thinking involves the following two approaches; 1) cross-impact methodology and 2) process theory. First, "the basic idea of cross-impact analysis is to gather judgments – usually through expert solicitation concerning the impact of each factor on each of the other factors, to arrange these judgments in a"cross-impact matrix" (Fuchs et al., 2008, p. 10).

Unlike variables defined by variation theory, driving factors (variables) can change their nature when influenced by other variables. In other words, it assesses how a change of a variable influences on a change of other variables.

Diagram 4-1-3 illustrates a simple example of cross impact matrix (CIM) where A indicates active value and P indicates passive value. A factor X_1 gives small impact on X_2, whereas it receives no impact from other factors. On the other hand, X_2 gives strong impact on X_3 and X_4, and little impact on X_5 while it also receives strong impacts from X_3 and X_4, and little impact from X_1. What this indicates is the following two points; 1) a driving factor X_2 is more uncertain than X_1. It can greatly change its nature overtime by receiving impacts from many other factors. 2) a driving factor X_2 is also more powerful than X_1. The change of X_2 can greatly influence on many other factors. Thereby, CIM and driving factors help show us why a system may develop in particular way by specifying characteristics of variables; each variable's 'impact' and 'changeability' in an observed social system.

	X_1	X_2	X_3	X_4	X_5	A
X_1		1	0	0	0	1
X_2	0		2	2	1	5
X_3	0	2		0	0	2
X_4	0	2	1		2	5
X_5	0	0	0	2		2
P	0	4	3	4	1	

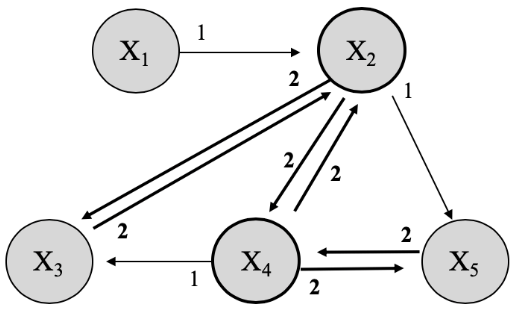

Diagram 4-1-3. A simple impact network of binary factors, represented by a cross-impact matrix (left) and the corresponding system-graph (right) (Fuchs et al., 2008).

Secondly, scenario thinking involves process approach. Here we start looking at the characteristics of driving factors (see *diagram 4-1-4*). The factors with low active and passive value are autonomous and the ones with low active values and high passive values are dependent on other values. In other words, they do not actively bring a change in societal transition but rather change their nature by being influenced by other factors. On the other hand, the factors with high active value and low passive value is independent. It strongly influences to the other variables yet the factor itself is less likely to change its nature. Considering that the societal transition is a "co-evolution process" of variables, as Geels and Schot (2010) says, this thesis think that they are not most suitable as scenario drivers although such factors might in fact exert significant influence on societal transition. Rather, the one with high active values and passive values are more preferred for scenario regarding societal transition. They are highly changeable by receiving influence from other factors and their change strongly influences to the change of other factors. These factors are called scenario drivers.

As you plot two scenario drivers into a four-field matrix (FFM), you will produce four quadrants (see *diagram 4-1-5*). Because these variables are highly changeable and impactful, each quadrant indicates different societal transition models. Implication of each model can be done by analyzing both active and passive value of all driving factors (how strongly X affects to Y and is affected by Y).

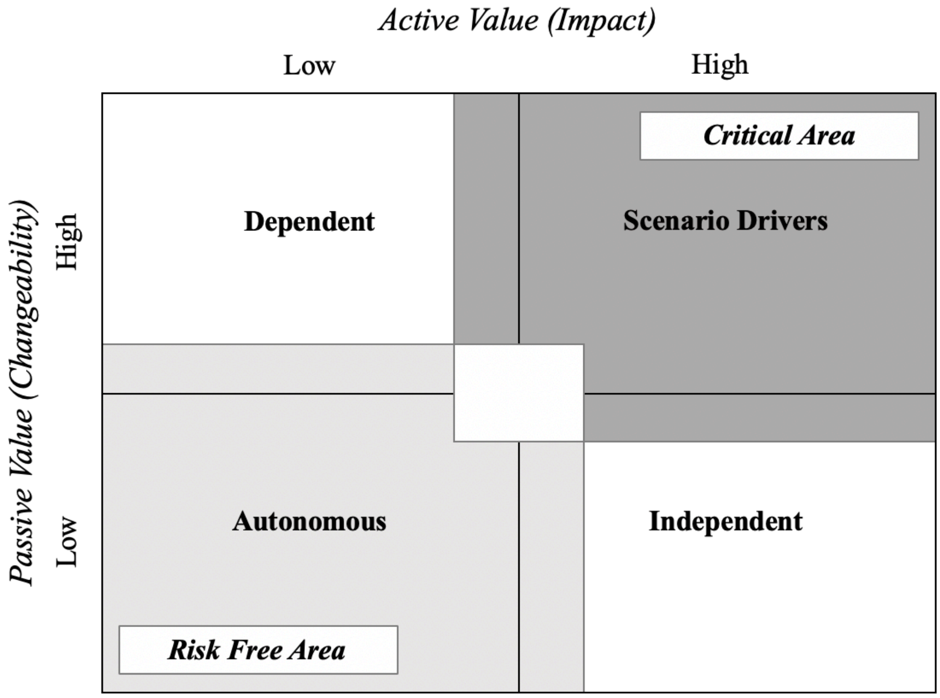

Diagram 4-1-4. Characteristics among Driving Factors.

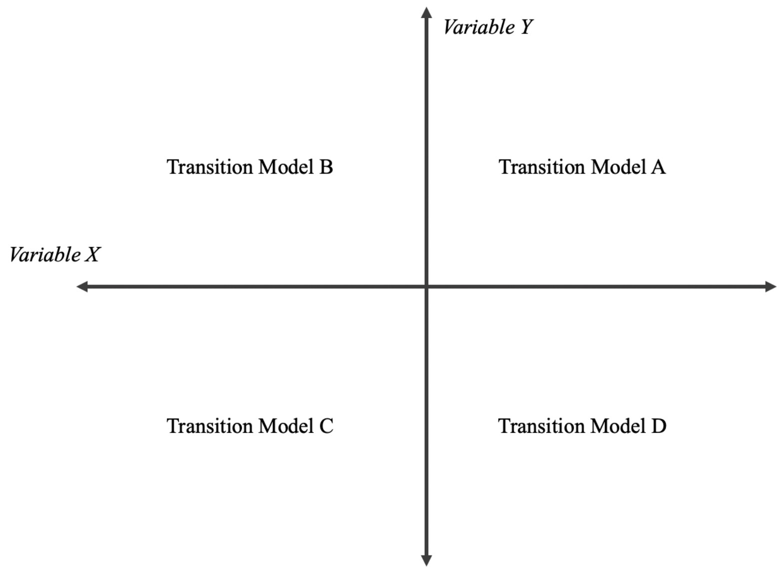

Diagram 4-1-5. Four Field Matrix

In sum, the scenario approach is a mixture of positivists' and interpretivists' views of social phenomena and a mixture of abductive and retroductive approaches. Variation theory had a problem in the fixed nature of its variables, which can mistakenly reduce the complexity of transition processes into frail causality. However, variable in scenario thinking qualitatively provides potential conjunction of variables and represents it as a "co-evolution of variables". Process approach, on the other hand, had a problem in understanding regularity and proposing new paradigms, which is necessary insight for developing knowledge about how Japan can make an energy transition. However, the "variabilizing" aspect of scenario planning provides rich contexts to operate process approach more creatively, and implicate the plausible societal transition pathways; this interpretation reflects a virtue of interpretivists' view of social event.

4-2. About Data Collection and Analysis

4-2-1. Driving Factors

Obviously, driving factors cannot be chosen with fancy. In Chapter 2 (Problem statement), the thesis analyzed a historical transitions of Japan's energy system and current interdependency based on MLP and CAS as analytical frameworks. This analysis revealed number of important factors that have influenced to the Japan's energy system and societal transitions. From that analysis, the author created a macro model that shows a basic interdependent structure regarding Japan's energy system, which *diagram 2-2-47 in section 2-2-2* shows. Please note that this diagram is not intended to reflect every detail but, for the sake of simplicity, it is to serve as a holistic picture that encompasses powerful actors and their relationship.

From *diagram 2-2-47*, the following driving factors are chosen (see *table 4-1-6 and diagram 4-1-7*). Because each driving force is a product of social interactions, practically it exists in multiple areas. For instance, "1. Grid Integration and Balancing" is posited in the trade relationship between PV electricity producers and utilities because the transmission/balancing is currently in charge of utilities while the surge of PV provides an intermittency in the grid and confronts the current responsiveness of demand-supply balancing mechanism. That said, it is also related to the consumer sides, legislators and administrators as well. **Please refer Appendix for detail discussion on each driving factors**.

1	Grid Integration and Balancing	13	Electrification
2	Sense of Community	14	Industrial Structure
3	Spot Market	15	Purchasing Decision
4	Advertisement	16	Social Welfare System

5	Media	17	Social Awareness toward Environment
6	Sense of Ownership	18	Taxation
7	Local Economy	19	Liberalization
8	Working Time and Leisure	20	Meaning of Labor
9	Demographic Distribution	21	Structure of Labor Market
10	Household Income and Assets	22	Gender Gap
11	Innovation Policy	23	NPO and Social Enterprises
12	Transportation		

Table 4-1-6. Driving Factors.

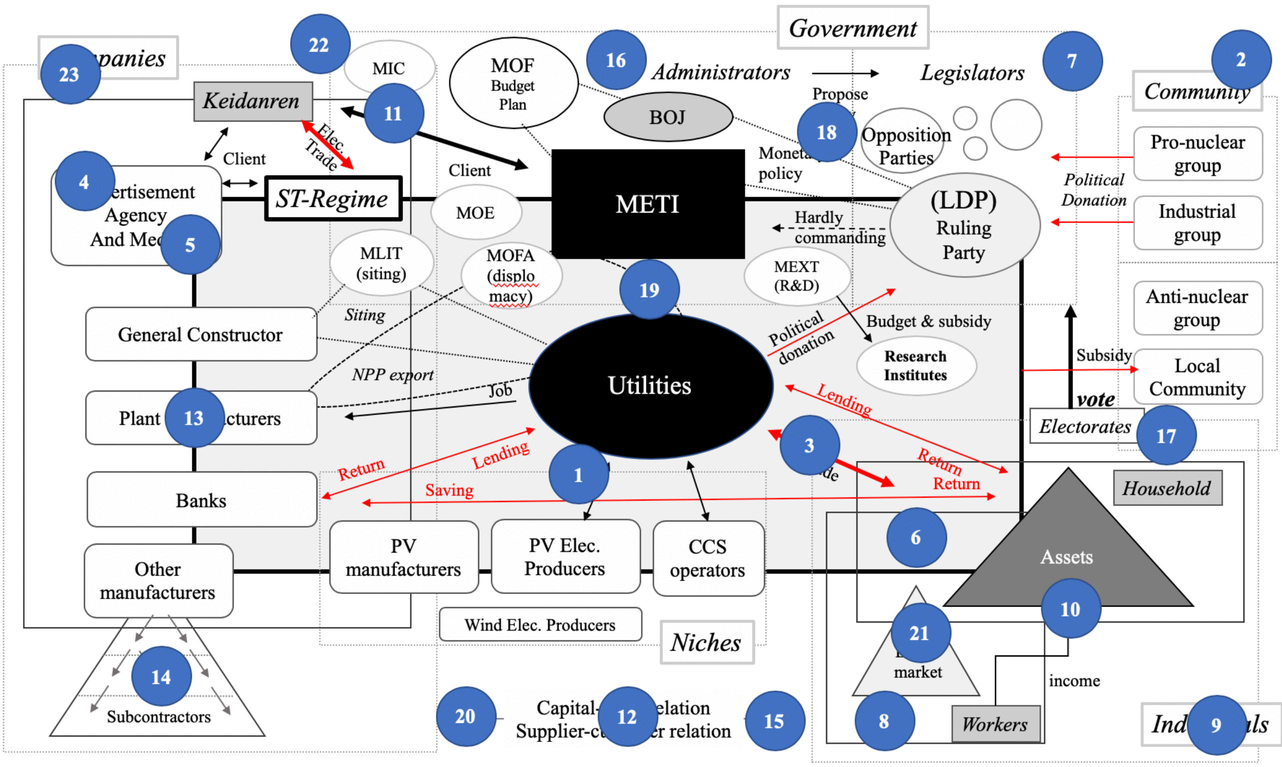

Diagram 4-1-7. Selecting Driving Forces from Macro Diagram

4-2-2. Delphi Method, Matrix survey and Analysis

Collecting judgements from experts are based on the method called "Delphi Research" whose objective is "to obtain the most reliable consensus of opinion of group of experts. It attempts to achieve this by a series of intensive questionnaires interspersed with controlled opinion feedbacks" while avoiding "any direct confrontation of the experts with one another" (Dalkey & Helmer, 1962, p. 458). By keeping the anonymity and being free from peer-pressure, we can remove "certain social constraints that could affect the outcomes if all of the experts were face-to-face, with the more dominant, or powerful, voices gaining more weight" (Kennedy, 2004, p. 505). For this advantage, “they have been used extensively in many scientific disciplines to identify priorities and essential elements in the area of inquiry” (Kennedy, 2004, p. 511).

Based on this understanding, the thesis conducts a matrix (grid) survey to collect judgement of 6 experts who already have profound knowledge about either Japan’s energy system and societal transition. All of participants receive clear information about the thesis’s theme, problem statement, research questions, research design and driving factors. Respondents are required to fill in CIM forms in rating scale. In Likert-type scale, determining optimum response categories is important as it defines the discretion of raters; too few scales may limit raters’ expressivity while too many scale may beyond rater’s ability to express their judgements. Although there is no concrete evidence that suggest specific number of scale points, it is generally preferred to use either 5 or 7 points scale (Preston & Colman, 2004). Although the suitable number of scale points are differed by research questions, Diamantopoulos, Sarstedt, Fuchs, Wilczynski, and Kaiser (2012) claim that at least four scale points are needed for evaluation of internal consistency.

In this thesis, the author would like to use 4 point-scale; 0 for “gives no impact, 1 for “gives relatively small impact”, 2 for “gives impact” and 3 for “gives strong impact”. Although a higher number of scale points can reflect a more subtle nuances of raters’ opinion (Diamantopoulos et al., 2012; Willits & Theodori, 2016), in this assessment, the subtleness may, on the other hand, confuse the raters; even if the 7 scale points are given to raters, it should be difficult for them to clearly differentiate between, let’s say, 5 to 6. Rather, the thesis wants to encourage them to simplify their complex thoughts about social relationship into few numbers. Finally, collected data will be summed and plotted into scatter graph (*diagram 4-1-4*). The driving factors in critical areas have strong impact on other factors and they receive strong impacts from other factors. They are therefore suitable for scenario drivers.

Chapter 5. Data Collection and Analysis

In this chapter, the thesis analyzes the collected data from CIM surveys. Then, based on the survey result and analysis, the thesis chooses scenario drivers and create four different energy system of Japan in 2030.

5-1. Cross Impact Matrix

The CIM result is shown in *table 5-1-1* and *figure 5-1-2*. The result reveals following 4 points. First, factors that reflect individuals' perception, such as Sense of community, Meaning of labor, Purchasing decision, Social awareness toward environment, and most importantly, Sense of ownership, tend to give stronger impact on the other social factors. On the other hand, except for "15. purchasing decision" and "6. sense of ownership", they are less likely to receive impacts from the change of other factors, in other words, they tend to be more independent. One of the possible explanations for this is because the Purchasing decision and Sense of ownership have generally stronger ties with economic, social and environmental factors while the others tend to receive impacts rather exclusively from the change of social and environmental awareness (see *figure 5-1-3*).

Second, the factors that reflect economic interests tend to be dependent on the change of other factors. The factors such as 16. Social welfare system, 21. Structure of labor market and most notably, 10. Household income and assets, and 15. Purchasing decision, have lower active values and higher passive values. These 4 factors are strongly influencing each other but are inclined to give weaker impact for the other 18 factors although they receive strong impacts from particular factors such as 18. Taxation, 20. Meaning of labor and 22. Gender Gap. This point is also supported by *table 5-1-4* that shows the mean score and standard deviation of active and passive values in those factors: these four factors have higher standard deviation in active value, implying that they provide impacts only on certain factors, while they have lower standard deviation in passive value, implying that they are inclined to receive impacts from other factors rather evenly.

Third, with an exception of "1. Grid Integration and Balancing", factors regarding regulative institutions tend to be autonomous, that is, giving and receiving less impacts to/from other factors. 19. Liberalization and 3. Spot market are especially noticeable. The common features of both factors are that they both provide and receive strong impact on each other, and both provide and receive strong impact on the change of "1. Grid Integration and Balancing". The difference between those two factors are that Liberalization is inclined to receive impacts from other factors more evenly than Spot market. On the other hand, Spot market generally receive weaker impacts than Liberalization but with an exception from 13. Electrification. Therefore, one possible interpretation of why these two factors are rather autonomous is because they are largely electricity-centered topics and thus provide weaker contexts for societal transition as a whole. More specifically, how liberalization will be delivered or how spot market will be expanded is of importance in shaping electricity market, but they have little connections with other social factors.

Similarly, public policy such as 18.Taxation and 11. Innovation policy are also found in autonomous zone, although, compared to Liberalization and Spot market, they are much more influential on other factors that they can potentially be considered as independent factors. Taxation strongly gives impact to economic factors such as 7. Local Economy, 8.Sense of Ownership, 10. Household and 16. Social welfare system while Innovation policy strongly influences on the change of 1. Grid integration and moderately influences on aforementioned economic factors. However, they both receive weaker impacts from the changes of other factors: as for Taxation, the sources of passive values are largely from factors such as Local economy, Household Income and Asset, and Social welfare system and as for Innovation policy, they are largely from Industrial structure, Household and Grid Integration.

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Active Value
1. Grid Integration and Balancing		9	15	4	5	10	7	4	7	6	8	11	10	10	6	3	7	4	13	3	3	4	5	154
2. Sense of Community	8		3	5	7	11	14	8	6	7	2	5	5	4	7	11	10	4	3	8	5	6	11	150
3. Spot Market	9	2		3	3	5	6	3	3	5	7	7	8	5	7	4	4	5	11	3	4	2	4	110
4. Advertisement	5	6	4		10	4	6	6	5	3	4	7	8	5	10	4	9	2	4	3	2	4	3	114
5. Media	4	10	3	15		7	9	8	8	5	5	4	7	3	8	4	10	5	4	6	5	9	5	144
6. Sense of Ownership	7	11	4	6	6		13	10	6	9	8	11	9	8	11	8	6	7	8	11	7	6	8	180
7. Local Economy	9	11	6	5	4	10		7	14	11	6	5	6	10	5	10	3	9	9	4	6	5	9	164
8. Working and Leisure Time	2	8	3	2	8	6	7		5	11	3	8	3	4	8	6	4	1	2	8	11	9	7	126
9. Demographic Distribution	9	8	4	3	4	6	11	11		7	5	8	5	5	8	7	5	7	4	7	10	8	6	148
10. Household Income and Assets	5	4	3	1	3	10	8	12	9		1	9	7	3	12	11	5	12	2	6	6	9	2	140
11. Innovation Policy	10	3	8	4	6	6	8	5	7	6		8	8	8	7	3	4	5	8	5	8	4	7	138
12. Transportation	10	3	6	4	3	6	4	3	7	6	4		10	6	6	5	7	4	6	3	4	2	2	111
13. Electrification	13	4	14	3	3	4	3	3	4	7	4	12		8	6	4	6	5	6	2	3	3	4	121
14. Industrial Structure	10	2	6	5	5	4	8	6	7	5	12	5	6		3	4	3	4	7	7	13	6	8	136
15. Purchasing Decision	6	6	8	4	5	10	9	10	5	8	2	10	7	3		5	7	7	7	7	4	5	4	139
16. Social Welfare System	4	6	3	2	4	5	10	8	6	11	2	5	3	2	6		2	11	3	11	8	6	8	126
17. Social Awareness	5	9	4	8	6	8	8	7	3	4	3	9	8	3	11	6		6	4	10	2	9	12	145
18. Taxation	6	4	6	2	3	10	9	6	4	10	5	5	5	6	7	9	4		5	6	6	4	9	131
19. Liberalization	13	3	9	5	4	6	7	3	4	5	6	5	8	5	6	4	3	4		2	4	2	6	114
20. Meaning of Labor	1	10	1	3	5	9	10	14	8	8	3	2	2	7	8	9	8	3	2		12	11	11	147
21. Structure of Labor Market	2	5	1	2	3	7	6	12	9	12	4	3	2	10	6	7	4	6	5	9		14	6	135
22. Gender Gap	2	5	1	4	4	4	3	9	4	12	2	2	1	5	6	9	8	2	1	9	13		11	117
23. NPO and Social Companies	5	9	3	6	8	7	10	8	2	3	5	3	5	6	5	11	12	6	3	9	5	9		140
Passive Values	145	138	115	96	109	155	176	163	133	161	101	144	133	126	159	144	131	119	117	139	141	137	148	

Table 5-1-1. CIM Result

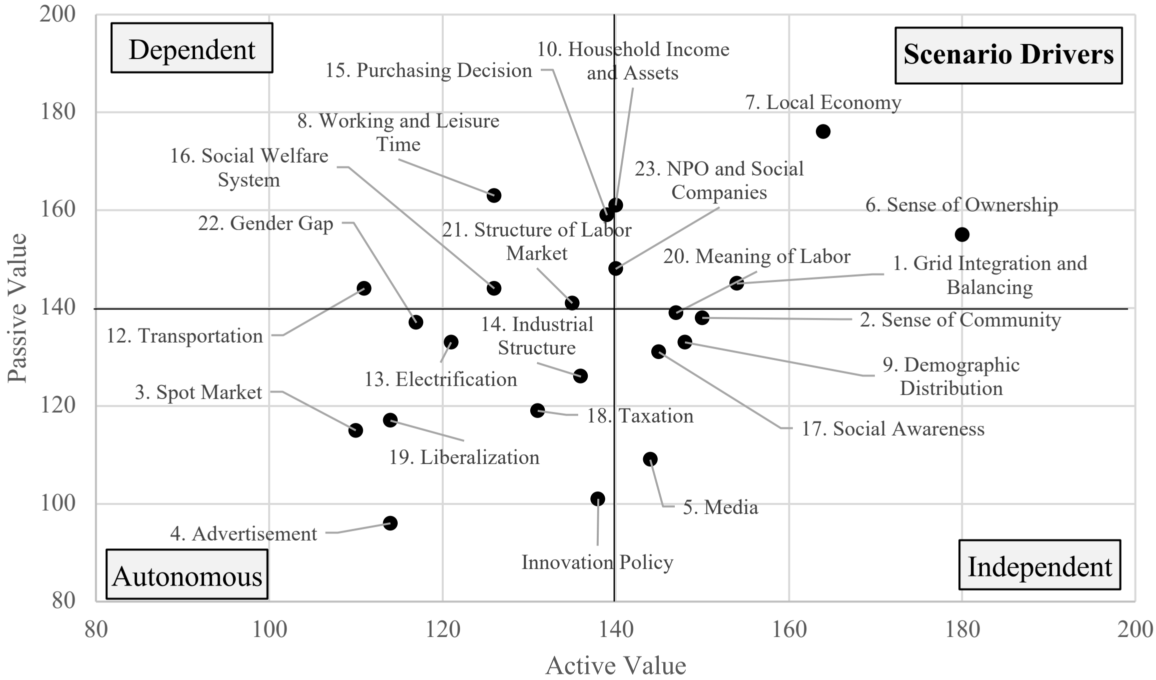

Figure 5-1-2. CIM in System Grid.

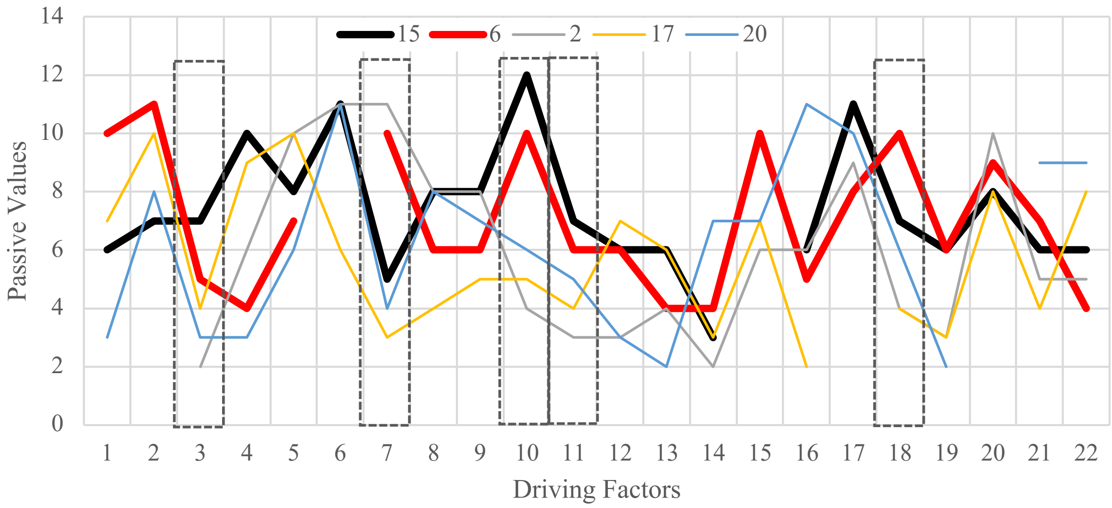

Table 5-1-3. Passive Values in Factors regarding People's Perception.

	Factors	16	21	10	15
Active Values	Mean	5.73	6.14	6.36	6.32
	SD	3.10	3.60	3.74	2.28
Passive Values	Mean	6.55	6.41	7.32	7.23
	SD	2.77	3.45	2.85	2.18

Table 5-1-4. Mean and Standard Deviation of Active and Passive Values in Factors regarding economic interests.

Finally, the factors that give and receive strong impact are 7. Local economy and 6. Sense of ownership. Local economy has the biggest passive values, implying that this factor is likely to change drastically in the future as a result of receiving impacts from the change of other factors. It also entails the second biggest active values, implying that the change of Local economy will drastically change the other social factors. On the other hand, Sense of ownership has the 5th biggest passive value: although the factors such as Local Economy, Household Income and Assets, Purchasing Decision and Working and Leisure Time are more exposed to the change of other factors, Sense of ownership is still highly changeable as a result of receiving impacts from the change of other factors. More importantly, this factor gives tremendous amount of impacts to the other factors, implying that the change of this factor delivers drastic changes throughout the society.

5-2. Four-Field Matrix

Based on the data collected, the thesis chooses two system drivers and plot them into matrix to create four different scenarios.

Choosing Scenario Drivers

The thesis chooses 6. Sense of ownership and 7. Local economy as scenario drivers due to following 3 reasons. First, as mentioned above, these are the factors that receive strong impacts from other factors. In other words, the characteristics of these factors are highly changeable in the future as a result of interactions with other factors. Furthermore, Sense of ownership and Local economy also hold strongest potential to drive the changes of other factors. In other words, the characteristics of these two factors drastically change the states of other driving factors. Combined these conditions together, the thesis assumes that these two factors are largely exposed to the social interactions among driving factors (thus, most influential in societal transition).

Second, each of these two factors appears to have different inclinations in active values while both tend to receive impacts from similar factors. This point can be visually explained from *figure 5-2-1*: as for active values, the factors that 6. Sense of Ownership gives weaker impacts on tend to have stronger impacts from 7. Local Economy. In turn, the factors that Local Economy provides weaker impact on tend to have stronger impact from Sense of Ownership. What this implies is that these two factors are influential to the society in different ways and they complement each other. On the other hand, these two factors have more in common with passive values: the shapes of mountains and valleys are more matched between these factors.

Lastly, these two conditions strongly influence each other, as *figure 5-2-1* illustrates. Active value of

Sense of Ownership towards Local economy is 13 and that of Local economy towards Sense of Ownership is 10. This is one of the strongest ties that the survey revealed (see *table 5-1-1*).

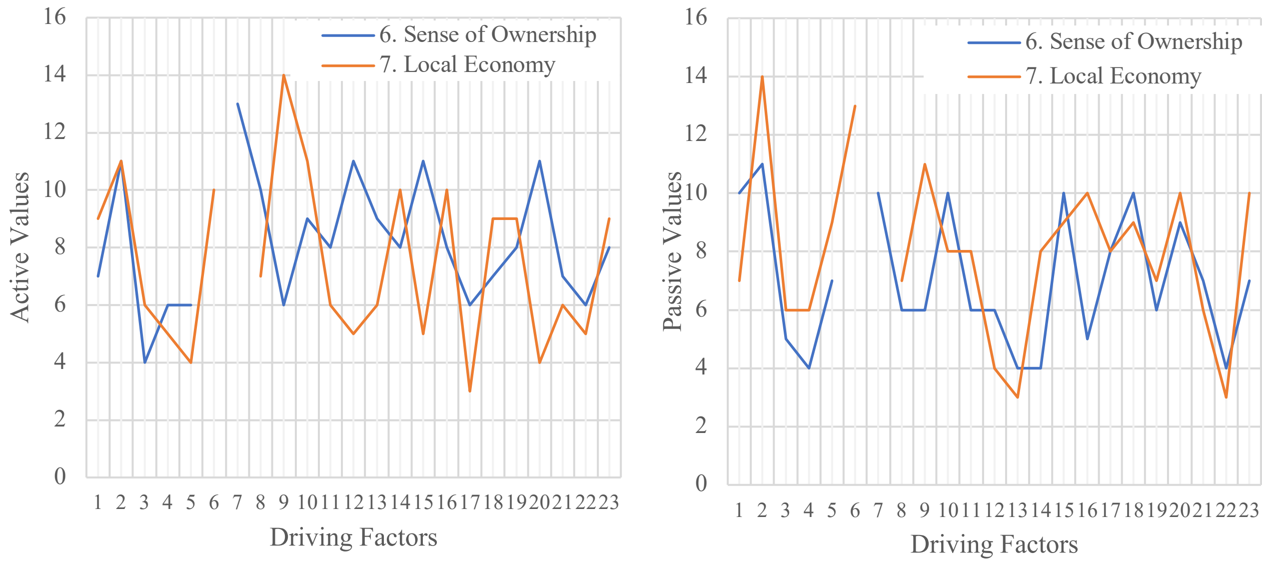

Figure 5-2-1. Active Values and Passive Values in 6. Sense of Ownership and 7. Local Economy.

Therefore, 6. Sense of Community and 7. Local economy 1) strongly influence each other, 2) strongly influenced on other factors and 3) can be strongly influenced by other factors. Based on this understanding, the thesis creates four-field matrix using these two factors as variables.

Plotting Scenario Drivers into FFM

As mentioned above, each driving factor entails own transition scenarios. Transition scenarios for scenario drivers are mentioned in *table 5-2-2* below. Due to space constraints, the thesis will not mention all of driving factors' scenarios here but the detail discussion can be found in *Appendix*.

As for 6. Sense of Ownership, there are mainly two points in arguments: First, there is uncertainty in how widely the notion of sharing spreads inter-industries by 2030. More specifically, some segments, such as transportation and house, are starting to see new market based on sharing while the other segments, such as goods, skills, people and energy are more dragged. Whether there will be new business models that captures people's heart and needs in those segments remains as uncertainty. Second, there is an uncertainty in how much the market can scale up. On this matter, a generation gap also plays a crucial role: younger generations are much more open with the idea of sharing goods and service with other people while older generations tend to prefer owning goods and service privately (Nomura Research Institute, 2018).

7. Local Economy also had two key points in the argument: First, there is uncertainty in who takes a major role in local economy. Precisely speaking, local administration service is currently carried out by public actors (mostly the local government) with taxation allocated by the central government. However, due to chromatic deficits in the government's accountancy, it is highly uncertain how long the services can be sustained in a current configuration (Fujioka, 2011; Kanno et al., 2004; Musha, 2009). Second, there is also uncertainty in for what local economies seek. Precisely speaking, local governments currently compete each other to obtain more budgets from the central government or to attract more business and residents to maximize their tax revenues. Yet, such zero-sum budget trading game is unsustainable when the economy is in permanent deflation. On the other hand, local administration service is simply an expansion of non-profitable activities originally carried out within families and by local communities. Thus some assert that the quality of service can be maintained without seeking for profits (K. Hirose, 2017; Kanno et al., 2004; Tominaga, 2001).

6. Sense of Ownership: How do people possess and use goods and services in 2030?	
Scenario A	The market of sharing economy grows to 11.5 trillion JPY. 60% of population is open to share transportation, house, energy, goods and skills
Scenario B	The market of sharing economy grows to 5.7 trillion JPY. 50% of young people are open to share transportation, house, energy, goods and skills.
Scenario C (Status Quo)	80% of people prefer private ownership for transportation, house, energy, goods and skills.
7. Local Economy: How is local economy managed in 2030?	
Scenario A	Local administration service is carried out by non-profit communal group in local level.
Scenario B	Local administration service is carried out by profit-seeking companies in local level.
Scenario C	Local administration service depends on their tax income. Local economies compete each others to attract private companies to settle in.
Status Quo	Local administration service depends on tax allocation from the central government.

Table 5-2-2. Driving Factors' Scenarios.

Combined these scenarios together, the thesis has made the Four-field Matrix as shown in *diagram 5-2-3*. The y-axis is about how energy is owned: whether privately or publicly. For example, most energy is currently owned as private commodity by utilities and IPPs, and consumers use them privately by paying bills. However, energy can be owned as public goods, as is currently done by Yoshino village in Nara prefecture and Itoshiro area in Gifu prefecture, where local citizens took initiatives to install small-scale hydro power plants on agricultural waterways as to serve city lightings (see *section 3-1-3* for more detail). The x-axis is about how energy is produced from local economy: whether they do so for profits or for non-profit purpose. For example, most local economies rely their energy on producers outside of the city and they import energy from them. In other words, they are not pursuing profits by producing energy. However, whether privately or not, local economies can also produce energy to seek for profits, as is done by Yusuhara City in Kochi prefecture (see *section 3-1-3* for more detail).

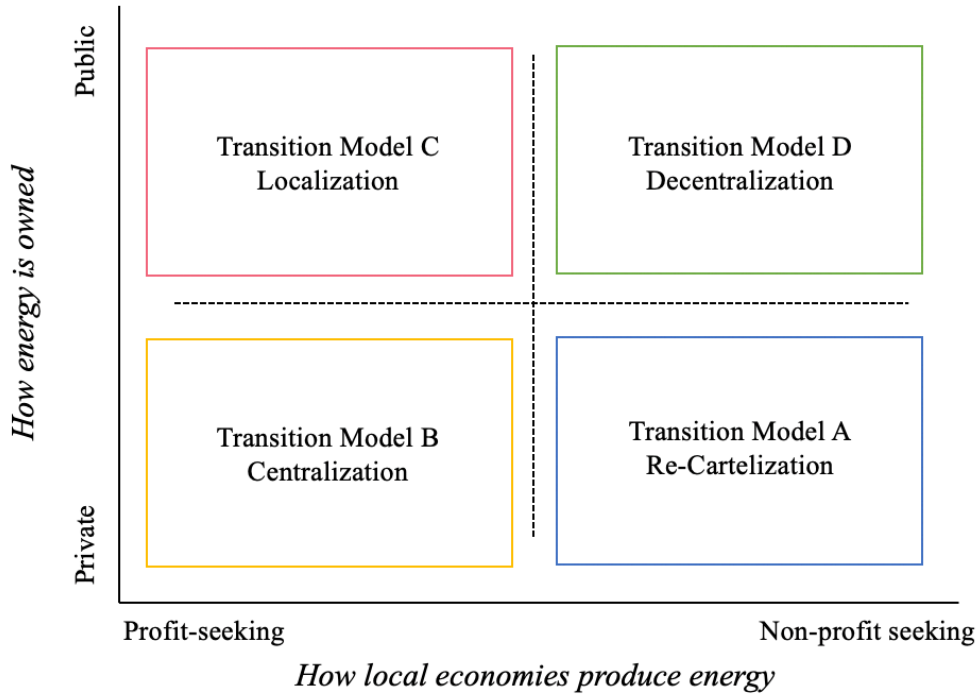

Diagram 5-2-3. Four Field Matrix

These two axes provide four fields and each field implies completely different energy systems (*Diagram 5-2-3*). The model A implies the energy system that is most close to status quo. In this model, local economies in Japan are not producing energy, and simply purchasing privately-owned energy from outside of the local area. In other words, energy production is centralized, and the producers can and must seek for economy of scale to serve for large quantity of demand. As a result, producers prefer fossil fuel and nuclear power as the major power generation technology.

The model B implies that energy is produced actively from local economies in seeking for profits. Thus, because a number of individuals and firms enter the energy market, the market is in harsh competition. This leads to an expansion of renewable energy capacity, a decrease of unit costs of energy and the need for responsive power source that can complement intermittent renewable energy. This will push out the baseload capacity such as nuclear and coals, and instead, gas companies enter the electricity industry as to compensate the absence of nuclear and coals and to play an important role of supply-demand balancing.

The model C implies that local companies produce energy for profit. But unlike model B, local energy companies have a strong aspect of social companies owned by communal actors. Therefore, in this model, the profits that the companies gain will be re-distributed to local economies. The electricity producers in this scenario has a strong tie with local business and community, and they offer highly localized and valuable service for their customers, rather than only seeking for cost competitiveness.

The model D implies that local producers generate energy for their own consumption, rather than for profits. In this model, the prosumers become the core actors: they sell energy only when they produce more than they need, and they purchase energy only when they produce less than they need. By doing so, most low-voltage needs are sufficed by consumers themselves and therefore the energy market is less competitive than the other models. In this model, the sharing has become a core function to reduce energy consumption. The sharing economy and market function as platform with real-time and real-place information that people can access and use service on demand. As a result, it induces an increase of average utilization rate per shared facility, reducing the need for new resource inputs to consumption ecosystem.

Chapter 6. Discussion and Findings

The last chapter revealed the four different energy systems from the result of CIM surveys. In this chapter, the thesis will interpret each energy system more closely with a deeper analysis of interactions among driving factors. Precisely speaking, the thesis attempts to interpret why the characteristics of scenario drivers (sense of ownership and local economy) have changed differently in each scenarios. This is done by incorporating the other driving factors as guidance for implication. That said, explaining all the driving factors takes so much space and may obscure the key points, so the thesis only discusses what is most important to characterize a scenario.

Please be noted that this thesis does not serve as feasibility assessment of each scenario or technological trajectories, but rather it is limited to presentation of plausible societal transition pathway as a product of interactions among driving factors.

6-1. Transition Scenario A: "Re-Cartelization"

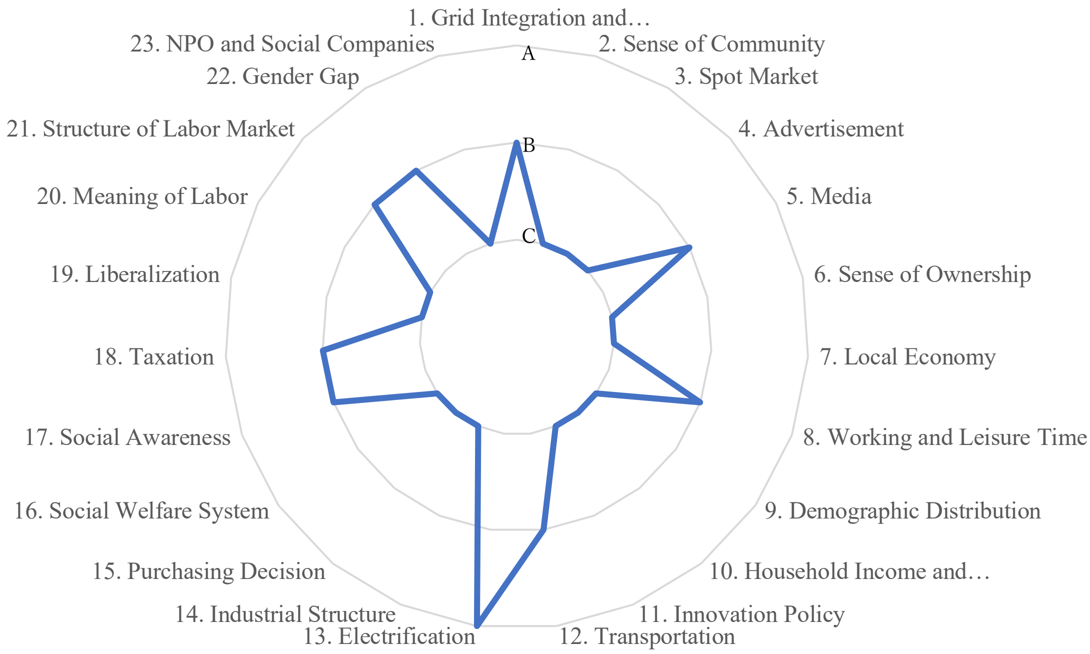

Diagram 6-1-1. Driving Factors in Scenario A.

The thesis interpreted how driving factors would look like in the scenario where local economies are merely a consumer of privately-owned energy (see *Diagram 6-1-1*). This will be further explained in the following sections. The axis (A, B, C) corresponds with scenarios of each driving factor as mentioned in *Appendix*. *Figure 6-1-2* below shows an implication of power configurations in scenario A. Please be noted that it is not a mathematically-derived prediction but is purely for an illustrative purpose to make the scenario less vague.

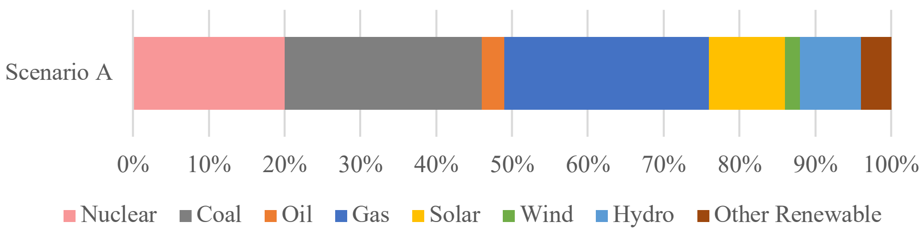

Figure 6-1-2. Implication of Power Configurations in Scenario A

6-1-1. Interpretation of energy system in Scenario A

The complete liberalization of electricity market in 2020 did not drastically change the utility-centered regime configuration: the industrial structure is retained as it was, and the domestic electricity grid is regionally and vertically integrated. Transmission companies, holding financial ties with formerly-regional monopoly firms, are discriminatory: renewable electricity producers, who could destabilize the utility-centered coordination, are disfavored. Furthermore, any power producers and retailers (including utilities) are still obliged to partake an decommission fees of NPPs and compensation for damage caused by the Fukushima nuclear disaster. Because of these factors, new electricity companies do not have price competitiveness with utility. As a result, new entries are de-facto strictly regulated.

The failure of liberalization also implies the state's monitoring and supervision did not ensure the fair competition in electricity market. More specifically, Electricity and Gas Market Surveillance Commission (EGMSC), the monitoring commission under METI to ensure energy trade after liberalization, acted fairly on paper but in reality, acknowledged the discrimination of transmission companies. They use the grid parity and transmission fees as good reasons to justify this: the commission allowed the transmission segment under regional monopoly to have dominant power to select market entry by charging transmission fees and intermittency penalty to the one they disfavor. METI also abolished FIT scheme once the renewable energy reached 20% of the power mix, under the reasoning to protect the grid parity.

Furthermore, the state nationalized all NPP decommission works and some of damage compensation for Fukushima. The large amount NPPs built during 70s and 80s started being in decommissioned phase during 2020s and the fee for decommissioning surpassed what utilities and the government estimated. More importantly, the capacity of nuclear waste site in Rokkasho Village was already saturated as predicted. These situations necessitated political interventions to create new decommission facilities and approve the extension of aging reactors.

By doing so, utilities could externalize (and socialize) the cost incurred by their own conduct. With a strong political support to render nuclear power less risky, utilities restarted their aging reactors. The overall utilization rate of NPPs throughout Japan reached 30%. As a result, utilities could become less exposed to the risk of oil price increase and, more importantly, desterilize their assets. As a result, nuclear energy consists 20% of Japan's power mix in 2030. Although domestic energy demand has shrunk due to economic and demographic deflation, an increase of electrification rate helps utilities to go business as usual. Furthermore, together with METI, the project to expand the electricity grid to South Korea and China is under operation. Although investing for new baseload capacity was no longer fruitful in the domestic market under permanent deflation, a large electricity demand from the rising economies in Asia once again justified for utilities to expand nuclear capacity.

That said, due to the rigorous FIT policy in 2010s, the renewable power, as planned by the 3rd Basic Energy Plan, grew to consist 20% of the country's power mix. Renewable energy has generally decreased its unit cost due to the proliferation of the technology and it is challenging the expensive utilities' products. However, the growth has hit the ceiling at this level due to the restart of nuclear power, the power which is more prioritized than renewable in the electricity market. The discriminatory transmission policy also guarantees certain level of protection for utilities. These are the special characteristic of this scenario that defies the force of market mechanism and curtails the energy system into the utility-centered coordination.

The vested-interest of utilities are so strong and widespread throughout the country, from politicians, financial corporations and various other industries and individual capitalists. The voice for the political intervention to improve the utilities' business is strong. Furthermore, through various media, the utilities advertise how safely NPPs are operated under tighter security measures revised after Fukushima, how cheap it produces electricity and how it contributes to the CO2 emission decrease. After nearly 20 years after Fukushima, citizens have also become more accepting toward nuclear energy. In a situation that average temperature of Japan has been almost constantly rising since 1990s, citizens have slowly become more accepting toward the nuclear energy as an economic and environmental policy.

Japan could not find its way to escape from the economic stagnation that has continued since 90s. Plus, due to aging society, the productive population has dropped to 57% and the average age of population reached 50 years old. In other words, the nation is suffered with low tax income and high tax expenditure for maintaining social welfare. Japan's government raised consumption tax from 10% to 15% and reduced pension payments. As a result, the relative poverty rate has increased to 20% and Japan's households averagely hold debts 150% of average income. The impact of economic deflation and aging population is particularly strong on local economies in rural areas: local industries suffer from shortage of productive labor, which, as a result, deteriorates the local tax income. Consequently, some local economies and citizens have become more accepting to invite new NPPs, for its accompanied subsidy and job creation capacity, increasing their tax base.

6-1-2. Analysis of interdependencies in the energy system and societal transition pathway

Diagram 6-1-3 explains the interdependencies in Energy System A: there are 3 characteristics. First, METI believes the utilities as a perfect actor to keep the traditional regime configuration. For this purpose, METI abolished FIT schemes to prevent new actors from entering to the market and tolerated the discrimination against new entries.

Second, thanks to political support to render NPPs free from cost of decommission works, utilities actively restart aging NPRs to maximize the utilization of their assets. Furthermore, the international grid project is also justified for expanding the NPPs capacity. NPPs also provide thousands of jobs for vendors, and consequently created employment opportunities and delivered tax incomes to impoverished rural area of Japan. Together with the aforementioned first point, industrial policy of METI and utilities formed an interdependency between bureaucrats, utilities, industries and local economy.

Third, consumers (households and business) have lack of options to choose electricity providers. Because of this, no matter whether actively or not, most consumers naturally have to contract with utilities. This shapes an interdependency between consumers and utilities: consumers need to depend on utilities for their energy consumption, on the other hand, utilities run their business based on the revenue delivered by consumers.

In sun, the regulative force successfully socializes the various costs that NPPs incur the utilities. The decrease of marginal costs of NPP serves the interest of lenders for the utilities (mostly business conglomerates and financial corporations). The normative force (grid parity) is defined by METI and transmission companies and it discriminates non-utility actors. The regime also employed cognitive rules to propagate the NPPs' safeness and cheapness, and how it is important for energy security. Consumers, lacking options to choose electricity providers, rely its energy consumption on utilities and therefore, are embedded in this regime, and reproduce this interdependency. The IPPs also have to rely on the transmission company's grid for their operation, thus they are also reproducing it. Thereby, the duality of structure is established.

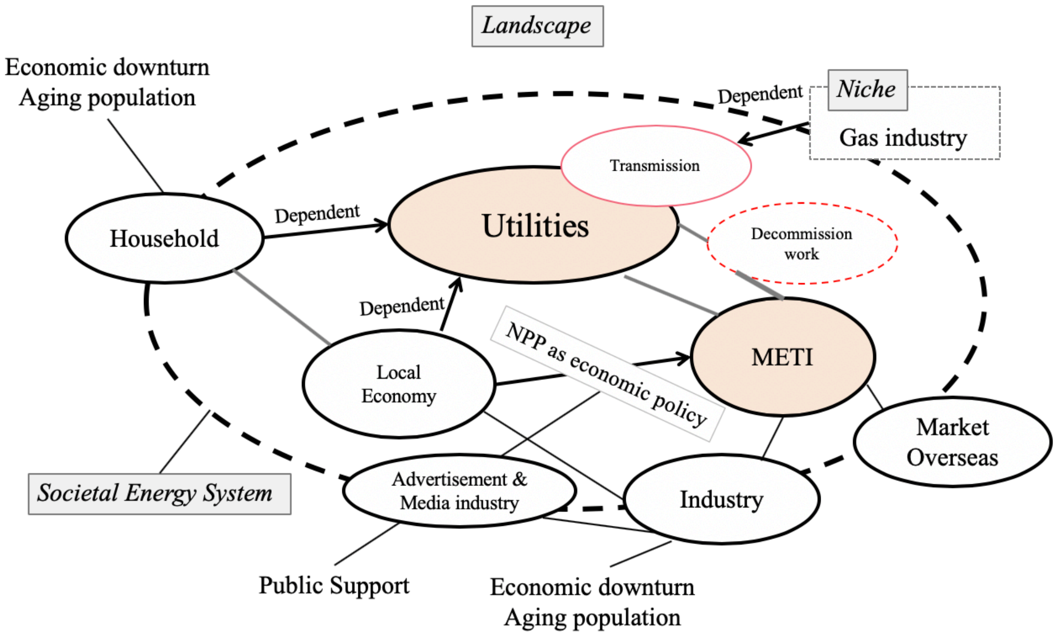

Diagram 6-1-3. Interdependency in Energy System A.

Based on the above-mentioned analysis, the thesis draws a societal transition pathway for energy system A (see *diagram 6-1-4*). ST-regime utilized an institutional change (de-regulation of electricity market) as a means to impose nuclear-related costs partly to tax payers (i.e. damage compensation for Fukushima and decommission fees). Neither the landscape or the niche failed to effectively destabilize the regime configuration, but rather, the regime insider utilized their adaptive capability to make best use of landscape change (i.e. an increase in oil price, issue of global warming and local economy's slump). As a result, it paved the way to restart NPPs and to expand its capacity.

Renewable energy producers, especially large-scale solar and wind power were seen as threat for the regime in that they could take utilities' share away. Plus, their intermittent electricity does not match with the regime's aim to expand baseload capacity. In the absence of landscape support to the niches, the force of the regime, the coalition of political and industrial interest groups, was so strong that niche actors could not open a window of opportunity to reconfigure the regime structure.

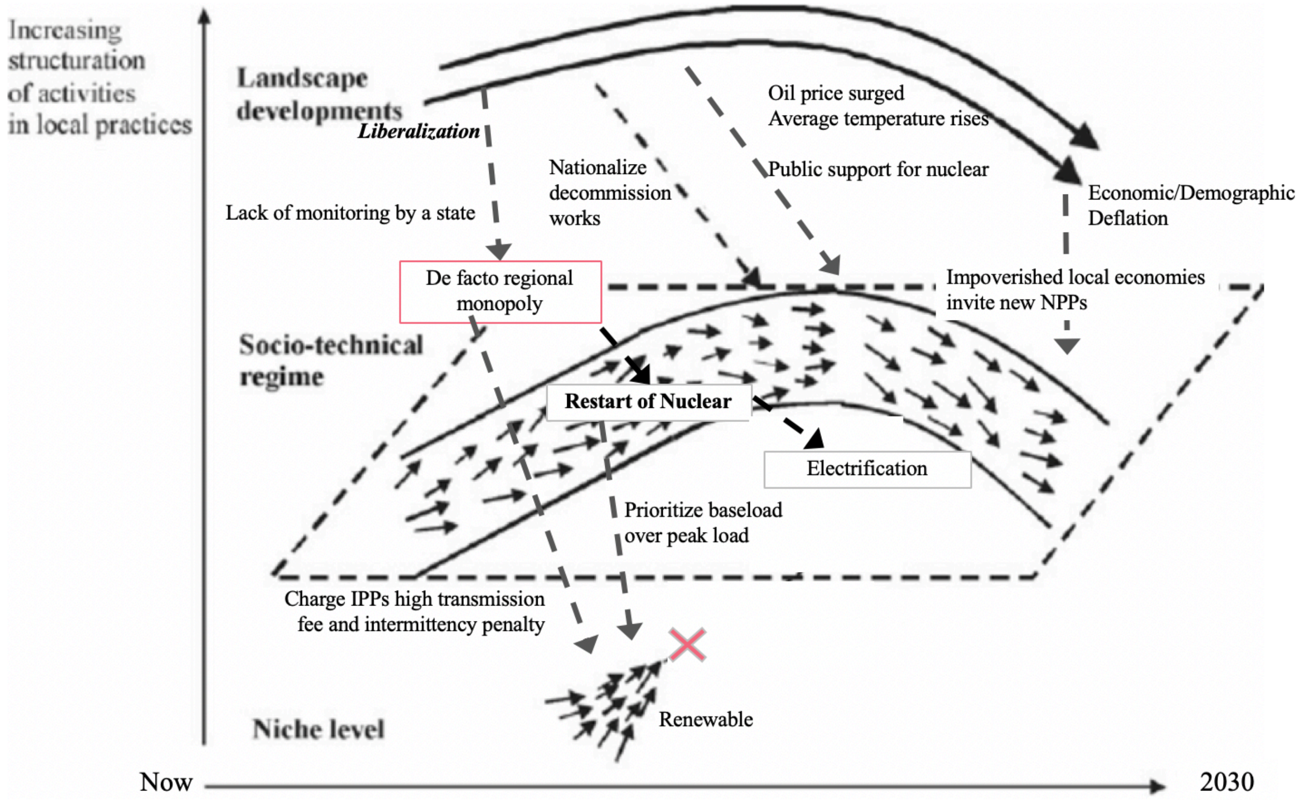

Diagram 6-1-4. Societal transition to energy system A.

6-2. Transition Scenario B: "Centralization"

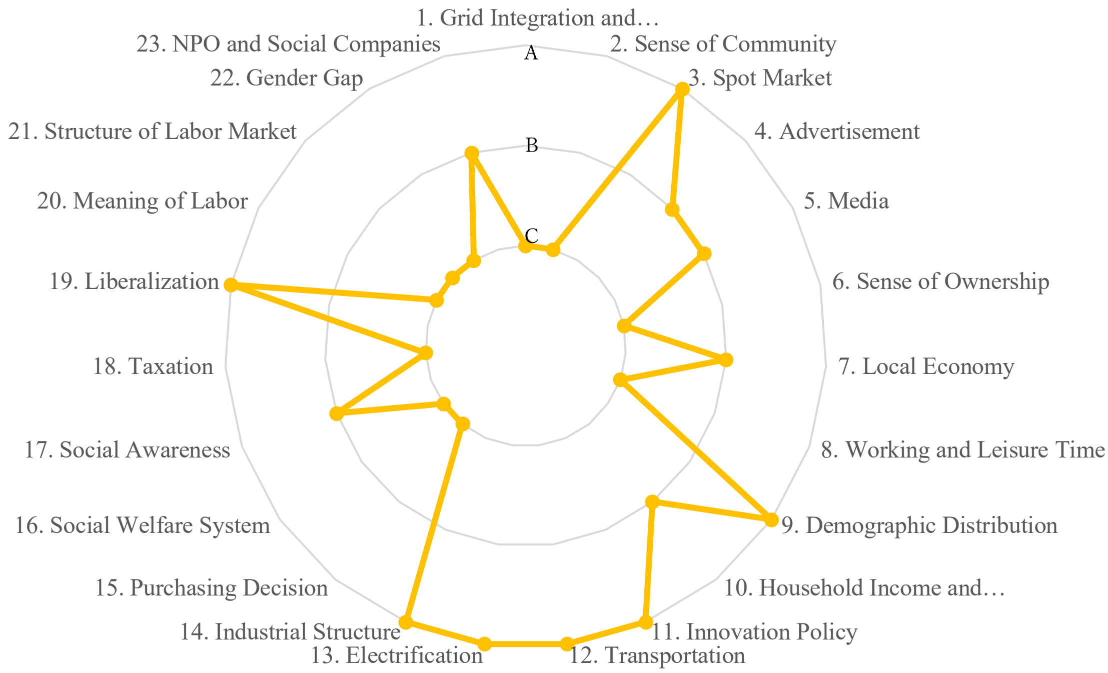

Diagram 6-2-1. Driving Factors in Scenario B.

The thesis interpreted how driving factors would look like in the scenario where energy is privately produced from local economies for profit-seeking purpose (see *Diagram 6-2-1*). This will be further explained in the following sections. The axis (A, B, C) corresponds with scenarios of each driving factor as mentioned in *Appendix*. *Figure 6-2-2* below shows an implication of power configurations in scenario B. Again, please be noted that it is not a mathematically-derived prediction but is purely for an illustrative purpose to make the scenario less vague.

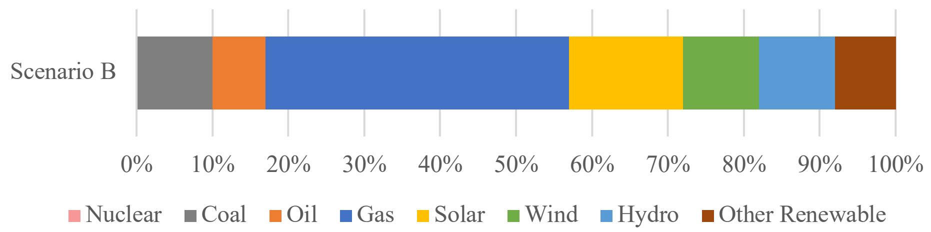

Figure 6-2-2. Implication of Power Configurations in Scenario B

6-2-1. Interpretation of energy system in Scenario B

The liberalization of electricity market in 2020 opened up a window of opportunity for new entries called Independent Power Producers (IPPs). The pursue of free market mechanism created harsh competitions in the electricity market. Many suppliers who could not provide energy cheaply could not gain customers, thus are disappeared from the market. In other words, those who can survive in the market are only the suppliers who own capitals large enough to realize economy of scale and reduce unit cost of production. As such, the energy market is reorganizing itself into oligopoly in order of cost competitiveness.

One of the most important IPPs in this energy system is a gas company. Gas companies own a huge number of customers and could easily take shares in electricity market by selling their customers with electricity and gas as a package deal. More importantly, they do not own the NPP. This marks a big cost advantage over the utilities that incur huge O&M and decommission costs derived from NPPs.

Another important IPP in this energy system is large-scale renewable energy suppliers, particularly solar farms, onshore and offshore wind farms power plants. These IPPs have successfully enter to the electricity market due to the following two reasons. First, the unit cost of generation has lowered to the level that is competitive with thermal power generations as they have achieved economic of scale.

Second, they can sell electricity with priority over other sources. This is because, unlike fossil fuel, renewable electricity cannot adjust their output by regulating input (unless it is accompanied with enough storage capacity). This delivers Merit-Order effect in the spot market and drags down the market price (as discussed in *section 2-1-1 and Appendix).*

For the transmission company, this intermittent nature of renewable energy is in conformity with the LNG power generation, the generation technology that can flexibly adjust its output. In other words, in the situation that sees the proliferation of renewable energy, the transmission company demands for responsive power generation such as gas and hydro power plants and lowers the needs for the inflexible capacity such as nuclear, coal and oils. Under this symbiosis, gas producers and renewable producers started taking a market share from utilities, and actively invest in renewable electricity.

This symbiosis between renewable and gas created a new large coalition group that pressurizes METI and politicians. Thus, unlike Scenario A, the market monitoring agency (EGMSC) does not let transmission companies discriminate IPPs over (former-) utilities. The share of traditional utilities (in retail segments) has fallen from 70% in 2017 to 40% in 2030. Correspondingly, the utilities' power to influence on policy-making has also weakened. As the market has become to appreciate flexible power generation, the traditional utilities in power generation segment has changed its focus of corporate strategy from nuclear, oil and coal to gas and large-scale hydropower.

The proliferation of renewable, together with the advent of free market, led the energy generation a sort of decentralized. Rural areas were especially favored as sites for large-scale wind and solar farms. However, these farms were often owned by the large capital outside of the local area. In other words, renewable energy in local area do not directly lead to the wealth of local economies but to the owner of those plants (only limited to the tax income derived from the plants). Plus, the local job creation capacity of renewable energy industry in this scenario is very limited. Because of this, the renewable producers are facing to the NIMBY issue, struggling to get a consent from local citizens for establishing renewable power plants, and limiting the growth of renewable energy (especially wind farms). As for the small-scale renewable producers (i.e. residential PV), they are also facing to an issue in the investment. The electricity market price has decreased so much that it made difficult for the small-scale producers to assure enough ROI or at least disincentivized them to make investments. Due to the low electricity bills, it is also more reasonable to purchase electricity from the market, rather than producing them for their own consumption.

In a situation that Japan is in the economic stagnation, the lower electricity bill is largely appreciated by the consumers. Correspondingly, electrification of energy demands including transportation has increased tremendously. On the other hand, it also reflects the situation that most consumers choose their energy provider solely based on the price: social and environmental factors are regarded as complementary.

6-2-2. Analysis of interdependencies in the energy system and societal transition pathway

Diagram 6-2-3 explains the interdependencies in Energy System B: there are 4 characteristics. First, an economic incentive is the core of institutional force for both production and consumption side: the fierce price competition is ruling the production side and the consumer's purchasing decision heavily relies on the electricity price. Eventually, the market price goes down and ROI decreases. Only those who have enough capitals to realize economic of scales (thus ensure a certain level of ROI) and who are expertized in large-scale business operation will dominate the market. The suppliers with cost advantages gains more customers and revenues, so they are able to invest for more large and efficient capacity. Thus, they can decrease unit costs and achieve more customers. In this sense, former utilities should have remained as the strongest actor because they own largest human, financial and resource capitals in the electricity market. However, they own cost-intensive assets, NPPs. This makes the utilities difficult to compete with deflating market prices while covering the cost.

Second, the empowered niche regime becomes the core institutional force to select a production method. The LNG power generation is a technology that can adjust their output quickly, while the nuclear, coal and oil facilities are much slower. In the situation that the market sees an surge of intermittent energy (renewable), the transmission company, who is in charge of grid parity, favors the responsive power generation methods. The gas companies utilized this opportunity to devour the share of those inflexible power sources and started actively investing on the renewable. As a result, the perfect synergy with intermittent renewable energy became a strong coalition of gas and renewable interest groups and strongly influence to policy making processes.

Third, much energy is produced from local areas but is owned by a few numbers of large private corporations. By that, it means that large private firms make contracts with local landowners to build large-scale solar and wind-farms, and they sell the generated energy to their customers. Therefore, the renewable industry does not bring much wealth to the economy, and its economic impact for local economies is limited. However, this sparks an NIMBY issue and limits the growth of renewable energy developed under the niche coalition.

Fourth, consumers are offered with a variety of options. Although a variety of providers are still limited due to oligopolistic feature of the market, the providers offer highly customized services to survive the market competition. However, due to the economic recession of Japan, most people choose their provider solely based on the price: social and environmental factors are regarded as complementary.

In sum, the market mechanism acts as a strong regulatory force and, under this rule, the successful energy producers compete (= reproduce the rule) each other. As these actors became more politically voice, the METI, politicians, and transmission companies have also become willing to reproduce it and abstain from the market turning in favor of traditional utilities' coalition. For keeping the grid parity, the transmission company now sets a normative rule that disfavors the entry of baseload energy. Consumers also have a strong normative rule that favors the decrease of the electricity price and thus the market competitions. Under these circumstances, the energy corporation with large capitals keeps winning the competition, centralizing the financial and political power and the energy as material resources. Thereby, the rules and resource (power) are reproducing in a different way from the traditional structure.

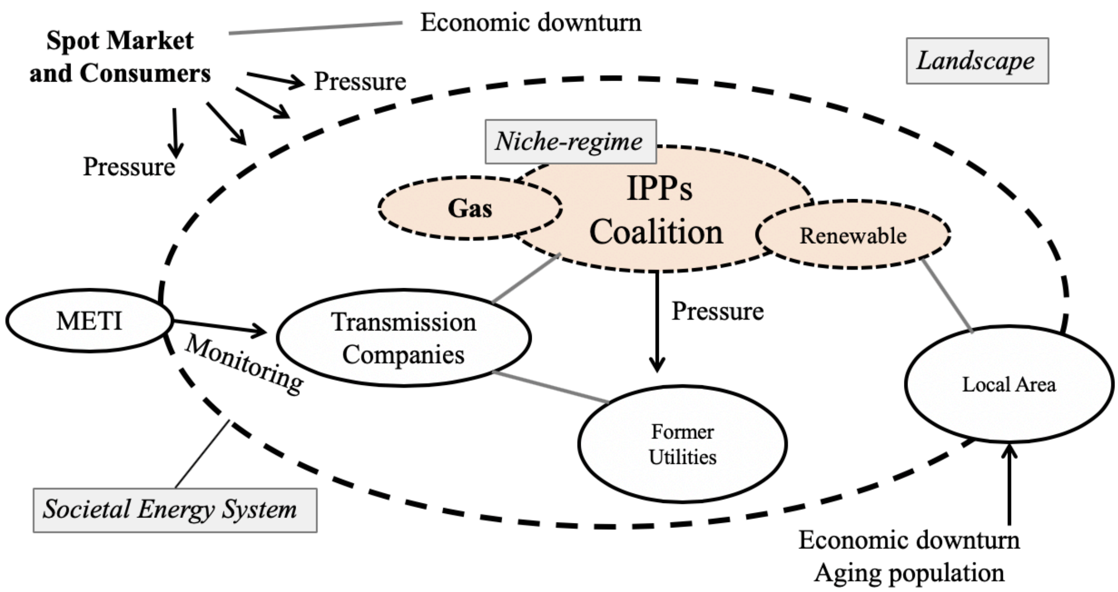

Diagram 6-2-3. Interdependency in Energy System B.

Based on these analyses, the thesis interpreted a societal transition model to energy system B (see *diagram 6-2-4*). Liberalization opened up a window of opportunities for certain niche actors (gas companies and large-scale renewable energy producers). Together with high pressure from landscape that calls to decrease electricity price, the niche actors press political actors to keep the electricity market free from the pervasive control of traditional utilities. As a result, electricity grid has transformed into a coexistence of large quantity of intermittent power and flexible power, and eventually pushes utilities' baseload capacity (nuclear and coal) out of the market.

The selection mechanism of free market also pushed out suppliers without cost advantages. Suppliers like small-scale renewable power producers cannot lower their unit production cost to the level that the market desires. Although renewable electricity is purchased with priority in the electricity market, the low profitability makes the producers hard to predict the return rate, thus discourage the investment. The market price is so low that it challenges the cost-effectiveness of installing PV for one's own consumption.

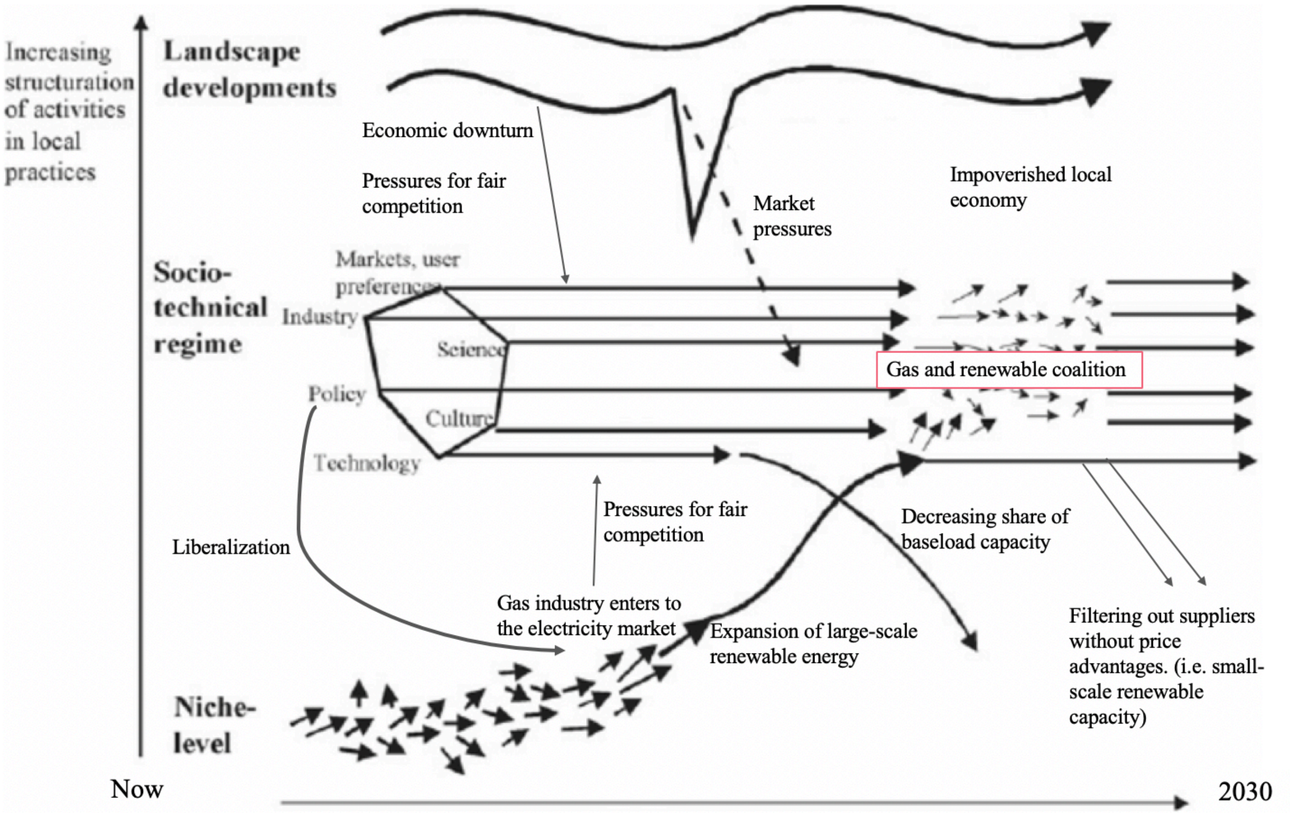

Diagram 6-2-4. Societal transition to energy system B.

6-3. Transition Scenario C: "Localization"

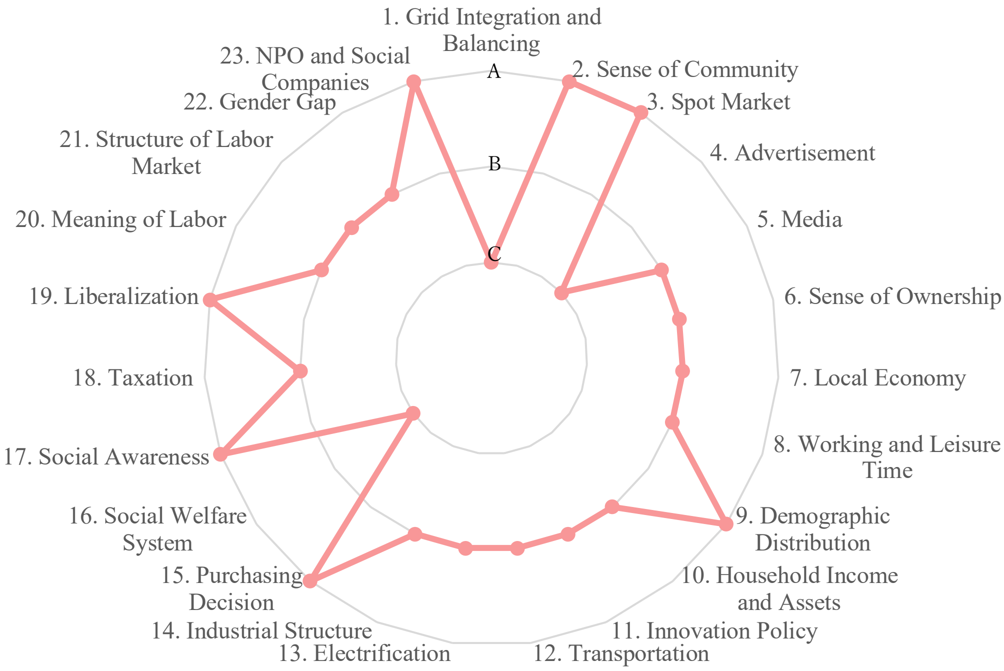

Diagram 6-3-1. Driving Factors in Scenario C.

The thesis interpreted how driving factors would look like in the scenario where local economies produce publicly-owned energy for profit-seeking purpose (see *Diagram 6-3-1*). This will be further explained in the following sections. The axis (A, B, C) corresponds with scenarios of each driving factor as mentioned in *Appendix*. *Figure 6-3-2* below shows an implication of power configurations in scenario C. Again, please be noted that it is not a mathematically-derived prediction but is purely for an illustrative purpose to make the scenario less vague.

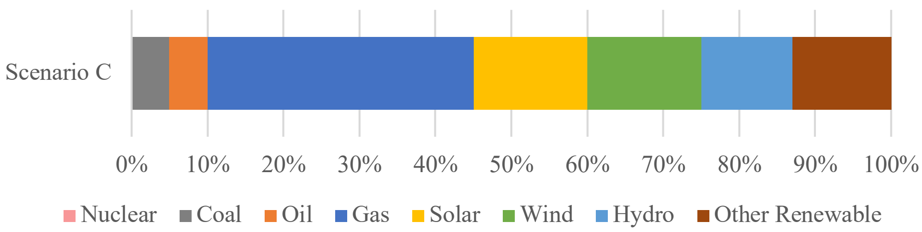

Figure 6-3-2. Implication of Power Configurations in Scenario C

6-3-1. Interpretation of energy system in Scenario C

The liberalization of electricity market in 2020 opened up a window of opportunity for new entries called Independent Power Producers (IPPs). The pursue of free market mechanism created fierce competitions in the electricity market. One of the most important IPPs in this scenario is a social company, the type of a profit-seeking company whose primary aim is to solve social issues.

The social companies in this scenario have following 3 characteristics; First, they are funded and owned by local citizens and community. For this reason, the local community strongly influences on the corporate strategy, and the profit of the companies will be re-distributed to them. Second, the social companies offer locally-oriented service. For example, the social companies offer investors with the coupons worth 110% of what they invested to the companies. Those coupons can only be used in local shops. This does not only lure local residents to be the investors but also incentivizes them to purchase goods from local business. The coupon, once it is used, can also be eventually exchanged to JPY, from their business yields. Third, utilizing their strong customer base, the social companies sell renewable electricity mainly to local residents.

On the other hand, a large gas company is also another important IPP. Because of social companies, the gas company's share in low-voltage segment is not as significant as model B. However, they still hold a large amount of industrial demand (high- and ultra-voltage). In the surge of renewable energy, transmission companies view the gas companies as an important actor for the grid parity. For this reason, like scenario B, a coalition of private gas companies and renewable producers put a pressure on the politicians, METI and former-utilities. However, unlike model B, the gas companies are simultaneously in competition with these social companies for the share of low-voltage segment.

The free market competition and the proliferation of renewable and gas-based electricity drags the electricity price down. Compared to private companies, the social companies own smaller capitals and deal with local-level smaller market, thus they cannot offer electricity as low as the large private companies do. Nevertheless, the social companies have become the main actor in this energy system. This implies that the social companies compete with value advantages rather than price competitiveness. As mentioned earlier, the social companies offer highly-localized service that brings benefits not only to the company itself, but also to local community and business. They focus on nurturing the locally-intertwined bond not only between a company and its consumers but also with local investors and non-energy related local industries.

For this reason, the public perceives the social benefits of locally-oriented energy system as a part of local economic policy. In other words, the consumers in this scenario consider social impacts as a factor to make a purchase decision. Furthermore, the citizens are well aware of security of supply in fear of another 3-11 and other major disasters. This incentivizes a decentralization of energy production as well as a growth of renewable energy more than scenario B, where the consumers heavily value on the electricity bills over the social problems and also where NIMBY issues constrain the renewable's development.

Because the spot price is low, the small-scale renewable has become an investment that contains high uncertainty in return. In addition, the social companies, working as a retailer in local areas, also prefer to purchase electricity from local residents only when they can make contract at low fixed-rate. If not, it will make sense for them to purchase from the spot market. This hinders a growth of small-scale renewable capacity.

6-3-2. Analysis of interdependencies in the energy system and societal transition pathway

Diagram 6-3-3 explains the interdependency in energy system C. There are 4 characteristics. First, social companies create interdependency at local level. They are funded by local citizens, community and business, and thus their profits are also an interest of these local investors. The companies use the available land and resources in their region to generate electricity, mostly through large-scale solar, wind and biomass power plants. By doing so, they have become an important niche regime in this scenario. Unlike model B, the renewable regime is not regionally and vertically integrated by a powerful private company but rather, it is a horizontal integration of locally-specialized companies.

Second, there is also another niche regime, the gas companies. Like model B, the proliferation of renewable energy straightens the necessity of responsive power sources. Gas companies, having strong customer-base and cost competitiveness over utilities' gas power plant, have become an important coalition in the energy market. However, unlike model B, local economies are more resistant to entries of private companies outside of the local areas due to strong supports for their social companies: the local citizens tend to reject the outsiders to build their renewable power plants in their region. As a result, it shapes a bipolar conflict between gas companies and renewable energy companies that are owned by citizens.

Third, although the two niche regimes have a reason to conflict with, they have something important in common: renewable and gas powers are interdependent each other. For this reason, they both agreed on keeping the market free from traditional utilities' influences and pressurizing the government to maintain the fair competition in the market.

Lastly, the economic stagnation and aging population are also extant in this scenario. However, local economies are circulating more than model A and B, because of the strong sense of community and business creation capacity of social companies. Although the service offered by local, social companies tend to be expensive, their service provides higher value and more importantly, their profits are re-distributed to the local economy. The public support and perception for this kind of economy is the nucleus of the interdependency in this scenario.

In sum, Scenario C is characterized by the coalition of renewable and gas companies like in Scenario B. However, the cognitive force from the citizens, who are aware of social and environmental problems in the energy system, plays a much significant role. There is also a new kind of normative rule among consumers that values on the energy's role to circulate local economy, rather than simply to suffice their need from centrally-produced cheap electricity. Under these circumstances, the social companies became an important actor in the energy market, and they reproduce this rule. The stakeholders of these companies hold energy, finance and strong political influences (resource and power) and reproduce this system.

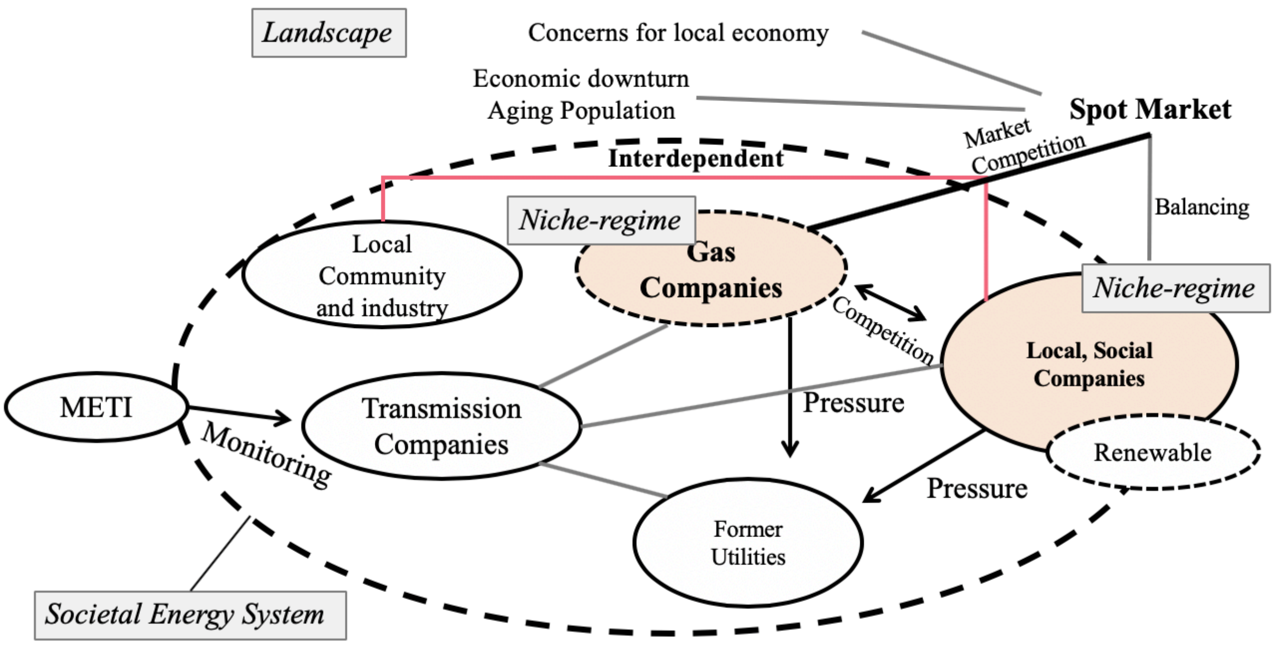

Diagram 6-3-3. Interdependency in Energy System C.

Based on such understanding, the thesis interpreted a societal transition model to energy system C. Liberalization opened up a window of opportunities for two types of niche actors. One, few local communities with significant planning capacity initiated the local energy policy based on the locally-funded social companies, and they showed the potential of the business model. More local citizens and business became willing to invest for establishing a social company that generates and sells their electricity mainly to serve for local's interest. This created job opportunities in local area, indirect profits to local business, and return on investments. The second niche-regime is a gas company. Gas companies is highly needed as a balancer in the highly fluctuating electricity market, grows its presence in the energy market.

Unlike model B, even the suppliers without cost advantages are not necessarily pushed out from the market as long as it provides a social benefit corresponding to the cost. Therefore, the electricity market consists of a few numbers of private gas companies (plus weakening utilities) and many numbers of social local companies. That said, the small-scale renewable (i.e. residential PV) fails to provide neither cost advantages nor value advantages, so it has failed to grow its capacity in this scenario.

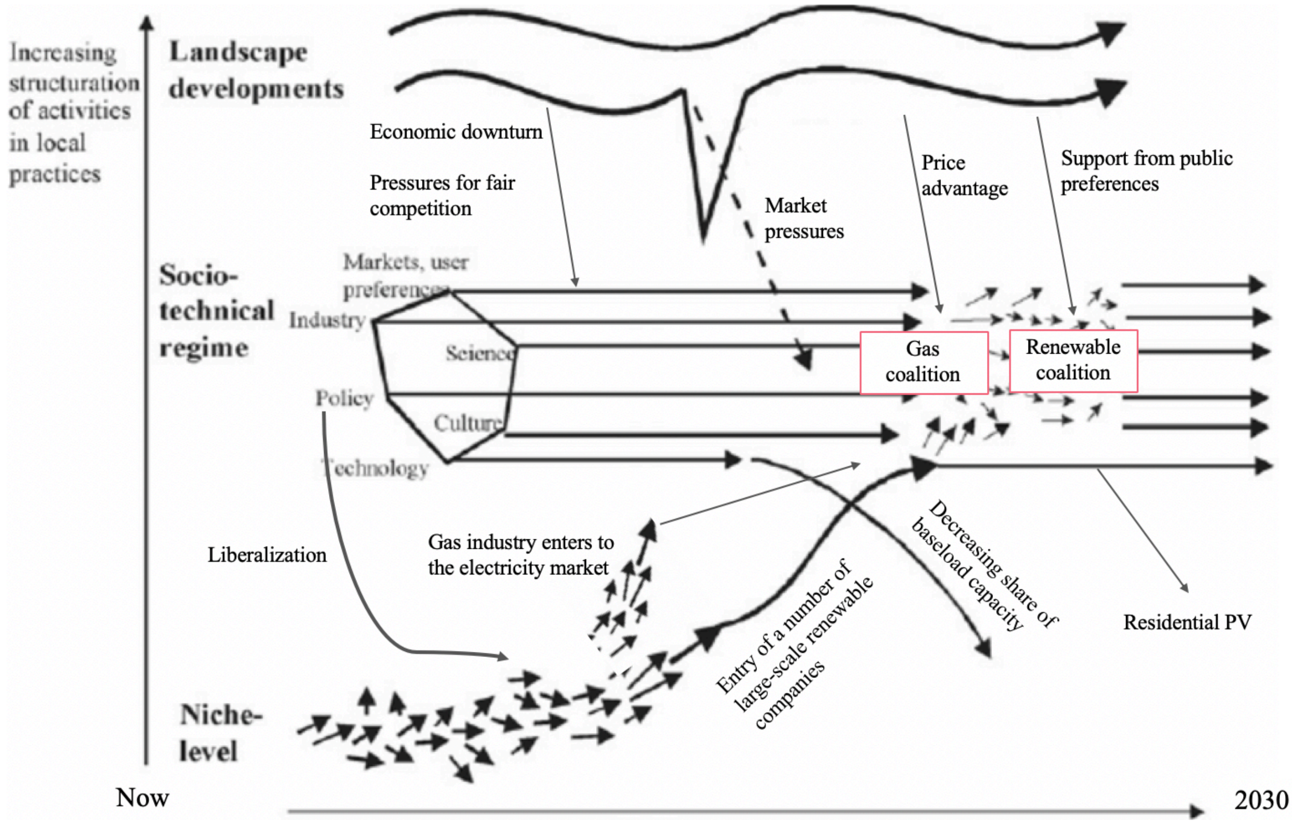

Diagram 6-3-4. Societal transition to energy system C.

6-4. Transition Scenario D: "Decentralization"

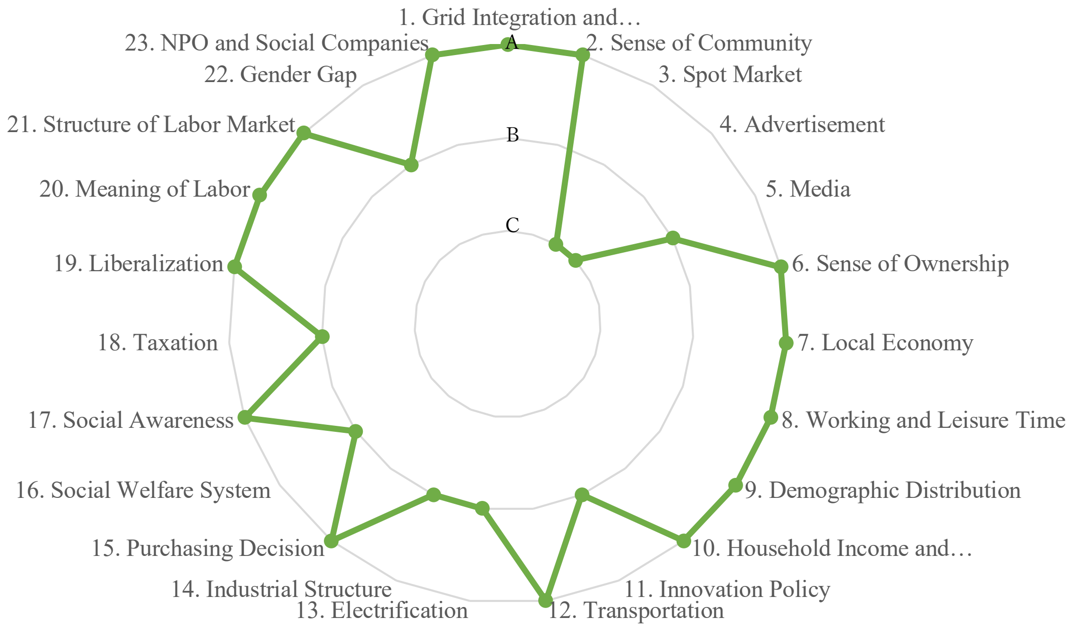

Diagram 6-4-1. Driving Factors in Scenario D.

The thesis interpreted how driving factors would look like in the scenario where local economies produce publicly-owned energy for non-profit seeking purpose (see *Diagram 6-4-1*). This will be further explained in the following sections. The axis (A, B, C) corresponds with scenarios of each driving factor as mentioned in *Appendix*. *Figure 6-4-2* below shows an implication of power configurations in scenario D. Again, please be noted that it is not a mathematically-derived prediction but is purely for an illustrative purpose to make the scenario less vague.

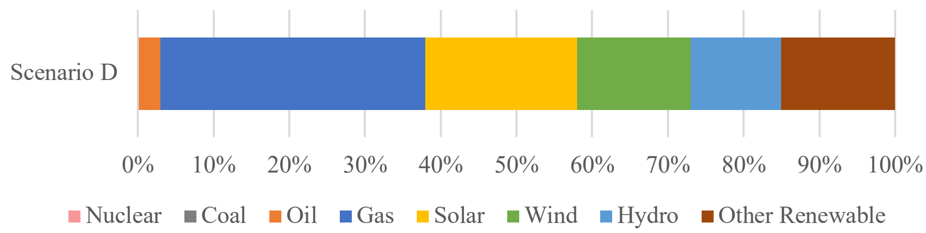

Figure 6-4-2. Implication of Power Configurations in Scenario D

6-4-1. Interpretation of energy system in Scenario D

The liberalization of electricity market in 2020 did not destabilize the basic configuration of the electricity industry: in early 2020s, the market was still dominated by the coalition of traditional utilities and METI. However, unlike model A, the economic stagnation and technological progress encouraged small-scale consumers (such as household and small business) to generate electricity on their own, rather than using high-cost private electricity.

The electricity industry in this scenario has the following 4 main characteristics. First, electricity provided by private companies is expensive due to lack of competition in the market. Like model A, a coalition of traditional utilities and METI dominated the electricity market after the liberalization. METI's support for utilities were especially effective in order to prevent IPPs from taking the market share as well as to hedge the economic risk of NPPs. More precisely, IPPs are charged high fee for using transmission lines, high penalty when their production exceeds/falls behind the contract amount, high fee for damage compensation for Fukushima, and fee for NPPs de-commission costs to support utilities. Thereby, IPPs became no longer cost competitive against utilities. These policies led to a general increase of electricity price and discouragement of market competitions.

Second, the high electricity bill encouraged small scale consumers such as household and small business owners to generate electricity for their own consumption. Meanwhile, PV installation costs in Japan were significantly decreased due to the expansion of PV market in the world. This incentivized citizens and small business to install PV and wind turbines for the sake of own consumption to keep the electricity bill low.

Third, the local-scale microgrid is established. The surge of small-scale renewable power plants made the grid highly fluctuating. The day-time electricity needs from households are low, but the production is high. This is because many house members leave the house for work and school during day time when the PVs produce electricity the most. This necessitates a balancing mechanism to integrate a number of decentralized power generators. The microgrid serves for this purpose.

Local citizens and business owners established non-profitable organizations (NPO) to establish the microgrid and manage the electricity transactions inside. These NPOs surely aim to produce some margin as to cover the operation costs and investment for expansion, modernization and maintenance of existing assets. However, these margins are not to serve for individual profit but for the public (local citizens' and investors') interests. They are also in charge of building large-scale renewable power plants (i.e. solar farms, wind farms, biomass power, small and middle-scale hydro) both for more electricity supply and for the grid parity.

Fourth, microgrid operators are also in charge of inter-grid electricity transactions. The fundamental problem of microgrids based on renewable energy is that the local weather affects to the electricity production of the microgrid: some regions are abundant in electricity someday and some regions are not. To address this issue, the microgrids, operated by local NPOs are horizontally connected for inter-regional electricity transaction. In 2030, this is done by utilizing the (former-) utilities' grids.

When the overall demand for electricity exceeds the overall supply at state-level (especially during night time), commercial power plants complement the shortage through spot market. This also implies that the commercial power plants need to respond flexibly to the demand change, thus the baseload capacity such as nuclear and coal power plants are pushed out from the market as they are not in conformity with grid structure. On the other hand, when the overall supply exceeds the overall demand at state-level (especially during night time), electricity storage (owned by prosumers and microgrids) and pumped-hydro (owned by utilities) will absorb the excess supply.

These features imply that the energy system in scenario D has 4 layers of electricity transaction: First, and most importantly, electricity is generated on the point of demand. Second, when the energy consumers cannot generate enough electricity, local microgrid (managed by non-profitable organization) provides an electricity at low price. Third, a local microgrid is connected with other microgrids, enabling inter-regional balancing. Fourth, the demand-supply balancing at national scale is done by the spot market. Unlike other models, the electricity transaction and balancing in this scenario is not integrated vertically at national-scale, due to presence of microgrids.

Unlike model C, the people's motivation for implementing renewable energy is not solely for economic interest but also motivated by a strong awareness toward social and environmental issues. Therefore, people regard energy as sharable resources that serves for their wellbeing, rather than as private property that serves for their economic profits. That said, receiving energy in this sharing system requires monetary compensation, and similarly, supplying excess electricity should also be compensated. This transaction is done though the microgrid operators. While the microgrid operators are also in need of raising some margin to operate and modernize the grids, these margins are not to serve for individual profits. this also implies that, unlike model C, local economy does not raise profits directly from energy.

Rather, local economy in scenario D is focused on satisfying their need by generating electricity on their own. Citizens and business, whose generators being connected each other, are satisfying their electricity needs on their own. In other words, whoever owns enough generation capacity is guaranteed to have sufficient energy to keep certain living standard regardless of their income. Eventually, it reduces the need for purchasing electricity from the large corporations outside of their economy. This reduces the outflow of finance from local economies. Furthermore, the security of supply is more guaranteed than any other scenarios in that, principally, the demand is sufficed at the point of demand.

6-4-2. Analysis of interdependencies in the energy system and societal transition pathway

Scenario D creates more complex interdependent structure than any other models, especially because no simple supplier-consumer or producer-user relationships can be drawn (*diagram 6-4-3*). First, individual prosumers are interdependent each other: when one person lacks electricity, she/he needs to depend on others. This creates an interdependency at intra-microgrid level. The microgrid is also interdependent on the other microgrids: when a microgrid lacks electricity, it needs to depend on the supply from other microgrids that are abundant on electricity. This creates an interdependency at inter-microgrids level. Finally, all of the microgrids are also dependent on commercial power plants: when supply from microgrid is lower than demand at national level, commercial power plants (more precisely, gas and hydro power) need to support them. Similarly, the electricity excess is, to some degree, stored at individual level (such as through battery and EV) and is distributed at intra- and inter-microgrid level (such as through transaction). It can also be stored using pumped-hydro whose capacity is largely available due to the absence of nuclear and coal power.

In this scenario, a coalition of prosumers, NPO, has become a niche regime that dominates the energy market. NPO plays a pivotal role to straighten the sense of community and maintain a sharing system in the local area. This sharing system, emerged naturally as the number of prosumers increased, straightens the connectivity among local citizens: from the vertical integrative structure between producers and consumers, to the horizontal integration among prosumers. Like model B and C, the surge of intermittent renewable energy challenges the baseload capacity of utilities as well as makes flexible power source such as hydro and gas relatively preferable options. However, unlike model B and C, not only flexible power source does the balancing work but microgrids and small-scale hydro also partake it. This makes gas and hydro power less necessary.

In sum, the public's social awareness (cognitive force) opened up a new movement to decentralize the traditional energy system. The new norm in this scenario is to produce energy for the producer's own consumption. The collection of prosumers started forming locally-oriented microgrids for their energy transaction and balancing. As the microgrid is being developed, the local grid operators, funded by citizens and local business, start making regulative rules (such as trade contracts). These regulative rules are to suffice the needs and wants of local residents and energy producers, and a profit margin for the microgrid operator is decided upon local consensus. The key normative force in this system is how energy serves the public welfare. Unlike scenario A, B and C, the key resource (i.e. financial resource, political power and human capitals) is neither centralized nor localized, but are largely decentralized at individual consumer level. In other words, the largest resource holder is a collection (or a coalition) of consumers in this scenario, and intra- and inter-locally dependent. Embedded in this new system, the citizens, local business and prosumers are e and they actively reproduce this structure.

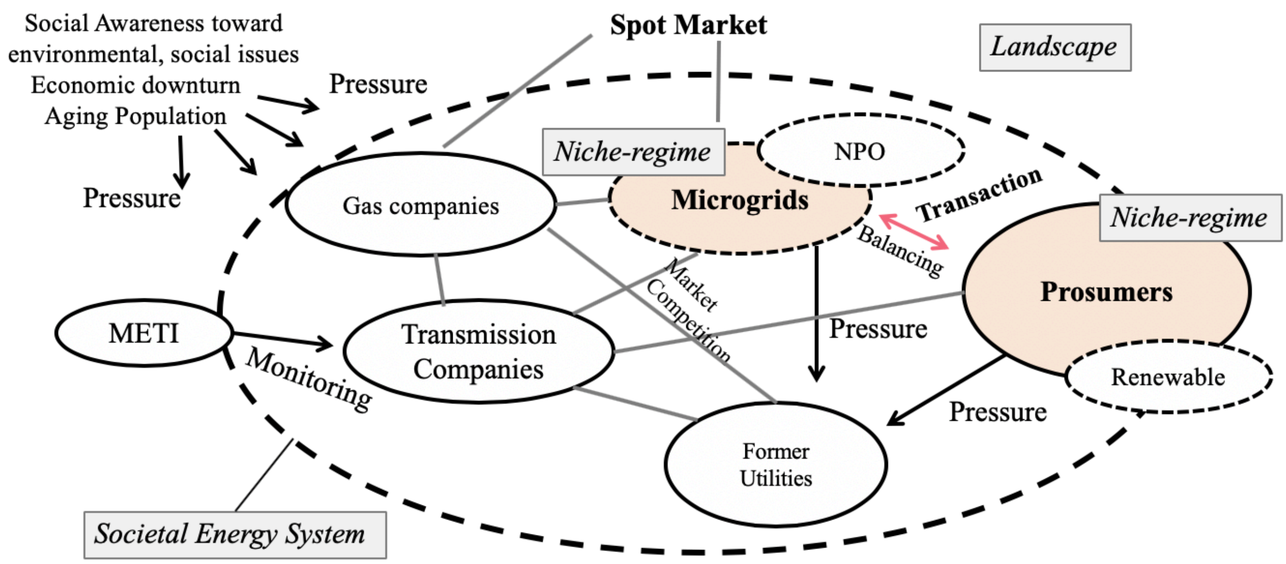

Diagram 6-4-3. Interdependencies in Energy System D.

Based on this understanding, the thesis made an interpretation about a societal transition model to energy system D (see *diagram 6-4-4*). Liberalization in 2020 did not encourage market competitions in the energy system and the electricity bill went higher. Together with the economic recession, aging population (especially in rural area of Japan) and the decreasing cost in installations of rooftop PVs, more people started building their own self-sustaining energy system, consisting of solar PV and small-scale batteries in EV. As more households and business started owning their own PVs, they started funding for local NPO to establish and manage microgrids. Conflated with the public's awareness of sustainability issues in the traditional energy system, a coalition of prosumers and microgrids stakeholders became a new niche regime.

The presence of the niche regime is strong throughout the country and pressurizes the traditional regime to de-configurate. The traditional regime, a conglomerate of former utilities and their stakeholders, has seen a tremendous loss in electricity share due to smaller market demands. Furthermore, the electricity market demands only for responsive power source such as hydropower and gas and pushes out the baseload capacities that utilities owned. In addition, unlike model B and C, the microgrids play a significant role in balancing supply and demand by themselves, thus in this scenario, the gas companies are not as needed as they are in model B and C.

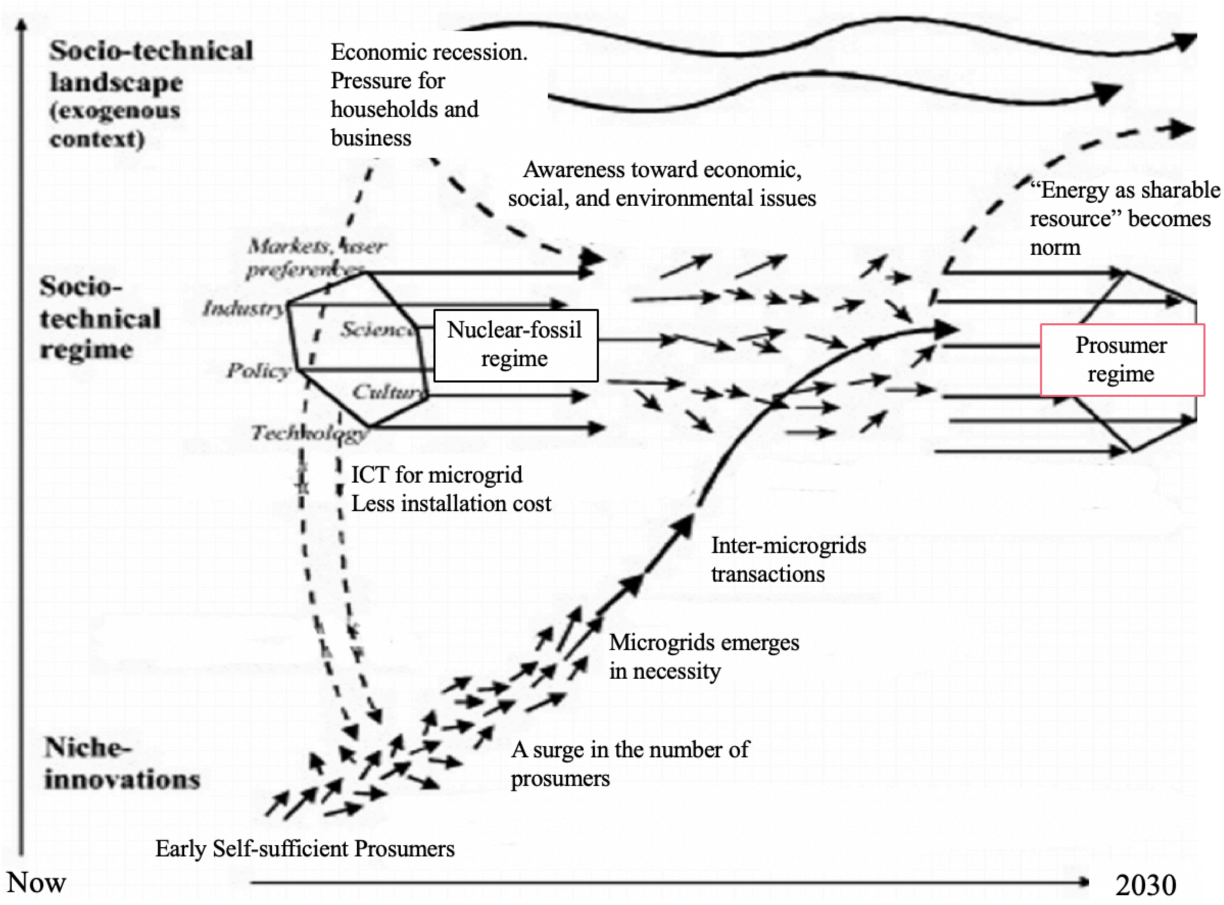

Diagram 6-4-4. Societal transition to energy system D

6-5. Research Question Revisited

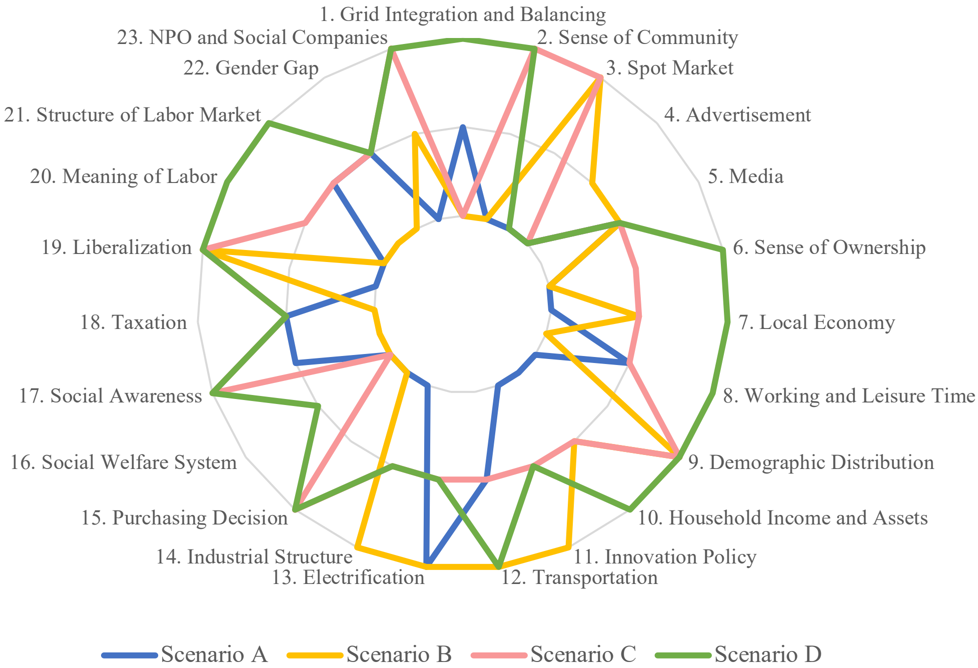

Diagram 6-5-1. Comparing Scenarios in terms of the changes in driving factors.

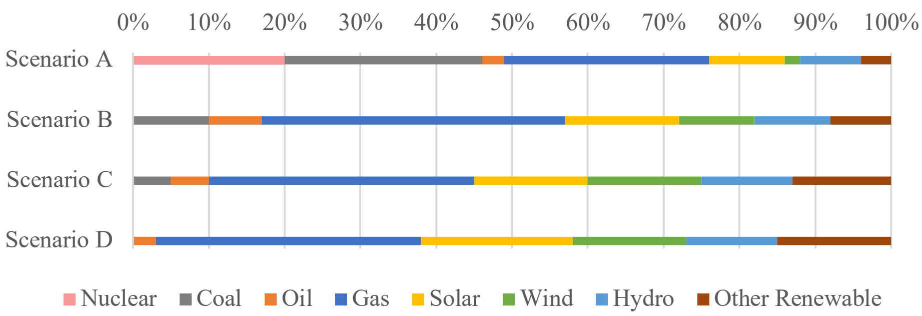

Figure 6-5-2. Implication of Power Configurations in Scenarios

There are two research questions that the thesis wanted to answer;

- Who will be the main system driver, how do they drive the system and why in 2030?
- To achieve sustainable development, what kind of transition management will be required in different scenario by 2030?

The above-mentioned discussion revealed some indicators that implies the answer for these questions.

Who will be the main system driver, how do they drive the system and why?

First, the thesis revealed that each scenario was a product of different actors becoming the main system drivers for different reasons and, depending on who will be the new niche regime and why, the scenarios differ tremendously as *Diagram 6-5-1 and figure 6-5-2* illustrates.

In scenario A, the energy system is dominated by the traditional regime (a coalition of incumbents). The interdependencies among bureaucratic actors, utilities and other industrial vendors created a strong path-dependency to keep the energy system status quo by externalizing (or socializing) economic, social and environmental costs. Due to the strong presence of protecting the utilities, the market is perverted as to utilize the assets owned by utilities (NPRs and coal power generation). The potential threat of renewable (particularly wind power) is discriminated. As a result, the base-load capacity is still utilized compared to the other scenarios (*figure 6-5-2*),

In scenario B, the energy system is dominated by the new coalition of gas companies and large-scale renewable energy companies. The key scenario driver in this model is the gas companies that pressurize the traditional regime configuration while encouraging the entry of renewable energy to raise a position of gas companies in the energy market. The key common feature in both scenario A and B is that energy is privatized by firms with plenty of capitals, centralizing the resources such as energy, money, labor and political power. However, unlike scenario A, the renewable energy (including wind power) is seen as favorable resource to straighten the new regime, thus is widely utilized. Yet still, since the business model does not directly contribute to the local economy, the renewable producers faces to the issue in acquiring local consents to build the plants. Plus, due to the harsh market competition the spot market price is so low that small-scale investors hesitate to invest for small-scale capacity (such as rooftop PV).

On the other hand, in model C and D, the energy system is much more decentralized. In scenario C, the core actor to shape the energy system is a coalition of social companies funded by local citizens and business, serving for the welfare of local community while seeking for profits. Utilities and gas companies are simply backups for balancing the supply and demand. Unlike scenario B, the renewable power is perceived as a resource that brings well beings to local economy. This breaks down the NIMBY issue from the renewable power producers, easing the capacity growth process. However, due to the competition between social companies and gas companies, the spot market price is so low that small-scale investors hesitate to invest for small-scale capacity, and social companies also hesitate to make a trade contract with higher price than they could otherwise purchase from the spot market.

The role of former utilities and gas companies are even more devalued in Scenario D where a local prosumers groups establish their own balancing mechanism. One thing in common to scenario C and

D is that the energy is produced locally for local consumers, in other words, the locally produced energy directly and indirectly benefits local economy. However, the difference exists in that the actor in the scenario D is a consumer itself. Rather than relying energy on purchase from someone else, they principally serve their consumption by themselves. Hence, the energy system in scenario D is more decentralized (or individualized) than that of scenario C. Because of this, the small-scale renewable is more developed than other scenarios, and the locally-oriented microgrids also actively develop the local energy potential for better grid parity, including small- and middle-scale hydro power.

Therefore, this research indicates the following two points; first, how consumers are involved with energy production greatly affect to the regime configuration and power mix. If they only perceive energy as something they purchase one-sidedly, the opportunities for local energy business will remain under investment. Instead, the production of energy will be greatly centralized, and the energy systems will have to rely on a few numbers of giant actors, leading to a centralization of not only energy, but also financial, political and human capitals. Second, how consumers value energy is also an important factor. If consumers value energy solely based on price, it incentivizes the producers to seek for economics of scale and externalizes the social cost and opportunity cost for local economy. If consumers value energy not only based on its price but also as a catalyst to realize social welfare, energy that is produced rather in an expensive manner but serves for social and environmental welfare, will also be valued.

Which scenario is more sustainable?

The research also implies the possibility for sustainable development in Japan's energy system. First of all, all the scenario except for A indicate a surge of large-scale renewable energy. In scenario B, gas companies see renewable energy as a way to devour the energy market while pushing utilities' baseload out. As for scenario C, large-scale renewable energy is seen as a way to reconstruct local economies. As a result, the renewable energy producers (together with gas companies) become a strong coalition to influence the country's energy policies. Scenario D also indicates the surge of renewable energy, not only with large capacity but also the ones with small capacity such as rooftop PVs, and energy is seen as a sharable resource to improve the consumer's wellbeing's.

On the other hand, the growth of renewable energy is limited in scenario A. This is because the utilities and METI politically curtailed the energy market (or even it can be described as re-cartelization with a return to the 1960s before the public opinion became an important factor in energy policy). Because nuclear energy only produces a fixed amount of output regardless of the output of renewable energy, it pushes out other powers from the market. In other words, the renewable electricity can only grow to the point that the transmission company demands them to stop operating. In this scenario, as the government's power mix plan aimed, the energy system is still heavily relied on oil and coal, causing economic, social and environmental sustainability issues, as discussed in Chapter 2.

That said, it does not mean that scenario B, C and D are all sustainable. For example, scenario B presupposes an intensive use of gas power, but Japan heavily relies LNG on imports. Considering that the gas price is corresponding to the price of oil, the power mix that largely relies on LNG contains an economic risk. Not to mention, LNG is also not environmentally sustainable as it is a depletable resource that produces CO2 when burnt. Furthermore, it is also skeptical whether the scenario is socially sustainable: the centralization of production implies the centralization of economic and social power in the energy system. Plus, the security of supply is hugely neglected. More people depend on a single entity, the more social damage is caused when the single entity malfunctions. More people depend on one energy source, the more social damage is caused when the energy source cannot be accessed.

The energy system in scenario C indeed develops more renewable energy than scenario B. Yet, it also sees the similar problem to scenario B in the point of the strong reliance on LNG, and weak ROI to disincentivize the investment for small-scale capacity. Plus, although local companies, as a producer and retailer, indeed provide locally-oriented service in the scenario C, they still rely on nationally-twined energy grid. Thus, like scenario B, here lies an issue of security of supply.

Scenario D is also not completely sustainable. First, unlike Scenario A and B, there is a weak presence of scale economy in the production of energy. Generally, the scale optimizes its resource use and minimizes the various costs extant in the value chain. Thus, the resource efficiency of scenario D is questionable. Furthermore, the proliferation of microgrids is also accompanied with the application of storage capacity such as batteries and the utilization of pumped-hydro. In this process, considerable amount of energy should be lost. Facilities such as PV and wind turbines require rare earth metals to produce (as mentioned in Chapter 2). The risk of resource depleting cast a shadow in environmental sustainability.

Despite that, scenario D is the scenario that utilizes the renewable energy the most: it overcomes the issue of cost disadvantages in small-scale power plants. It also ensures certain level of economic sustainability and supply security than other scenarios in a sense that whatever happens to the oil price, it does not affect to the prosumers nor the spot-market as much as in the other scenarios. It is also more socially sustainable as the resource (i.e. energy, financial capital and political power) is more diverse than the other scenarios. Not to mention, the environmental damage from CO_2 is also attenuated.

What kind of transition management will be required to realize different scenario?

This scenario research suggests several important factors in the transition management. First, nurturing new types of energy business and market preference should be included as a part of transition management. Electricity is a substitutable commodity that there is no much variance in the product's quality. If the quality of the product is standardized, the competition can purely be about its price. This incentivizes huge capital investment into scale effect, and the market competition easily converges toward lowering price and cost (and eventually deteriorate profitability) and utilizing energy-dense source such as fossil fuel. As discussed in above, this centralization of production can result into inflating the social and environmental costs.

To avoid this issue, the extra value must be added to electricity. This is what scenario C and D demonstrate. The niche regime in scenario C and D focus on providing social and environmental benefits over the price competitiveness. As long as the consumers perceive that the price fairly reflects the benefits, it is possible that they would prefer the expensive service and product. Of course, this is largely compatible with changing market preferences: if the consumers do not aware of the social costs of the current system nor social benefits of new regime, the expensive product and service does not compete in the market. When the market accepts the new service nurtured in the niche level, as pointed out by Rotmans and Loorbach (2010), it can become an emerging structure to break through the current regime configuration.

This leads to the second point; because a system is changing constantly, timing of intervention is crucial to maneuver a transition to a favorable pathway, thus a maneuverer has to be aware of plausible scenarios and prepare for the intervention (Rotmans and Loorbach, 2010).

On this matter, *diagram 6-5-3* explains a key turning point that diverges to different scenarios. The first turning point is whether liberalization incentivizes a price competition between incumbents and new actors. The scenarios suggest that this is largely dependent on the degree of public support for free market competition. Precisely speaking, if the economic stagnation (hence chronic income deflation) torments consumers so much that it creates a demand for cheaper electricity, and if the niche actors (gas companies and large-scale renewable producers) successfully captures this demand as an opportunity to enter the energy system, the transition moves to scenario B. However, if this movement is supported by citizen's participation fueled by social and environmental awareness, the consumers demand social benefits more than lower electricity bills. In this case, the transition can diverge into scenario C. Social awareness and citizens awareness also play an even more significant role in transitioning to scenario D. Scenario D is created when the utility's market curtailment induces a high electricity bill that torments the consumers to the point that self-production becomes more cost effective.

What this implies is that putting pressure on politicians and METI, the administrative organ in charge of monitoring the fair trade in energy industry, is a key point to intervene, if one wants to keep energy industry away from political power of the incumbents. Under the strong influence of utilities, the strict grid rule that protects an interest of utilities disincentivize the entry of profit-seeking niche actors. Furthermore, raising a social awareness in the issues of the current configuration should also be incorporated as a part of transition management. This is particularly important for realizing scenario C and D where citizens participants play essential roles in changing the regime structure. These scenarios demonstrate that public support and acceptance toward renewable energy created a niche regime and cultivated its internal momentum to break through the configuration. Therefore, these two premises, public support and resistance against political cartelization of energy industry, are essential in creating diversity and nurturing competitive service and product in niche regime, and to align new coalitions.

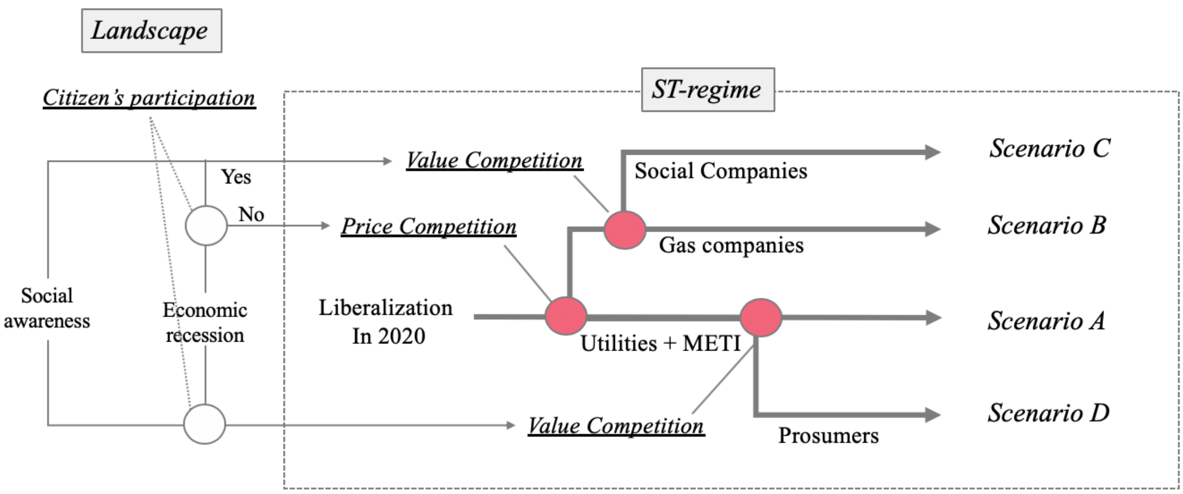

Diagram 6-5-3. The key points that transition managements should intervene.

Conclusion

As a starting point, the thesis addressed the problem in the Japan's energy transition pathway suggested by the 4^{th} and 5th Basic Energy Plan. It introduced frameworks to capture these issues in Chapter 1 and in Chapter 2, the thesis incorporated these frameworks to formulate specific problem statements in both sustainability and transitional issues in the current Japan's energy system. Based on the problematization, the thesis further produced specific research questions in Chapter 3 and introduced Scenario Planning as its research method in Chapter 4.

One of the contributions of this thesis is to demonstrate that a combination of MLP and CAS can be used as an analytical tool to look at historic transitions as well as to present models for plausible societal transition in the future. In Chapter 2, the thesis analyzed the historic change of Japan's energy system as a product of interactions between socio-technical landscape, socio-technical regime and niches. Simultaneously, the thesis also revealed an important structure of interdependencies created in the reproduction cycle of rules and resources (duality of structure) within the regime. Furthermore, through Scenario Planning, the thesis demonstrated four transitional model expressed by MLP and CAS. From these analyses, the thesis concludes that these two different models, MLP and CAS, can complement each other, and capable of analyzing historical societal transition as well as expressing models for future societal transitions.

Furthermore, the thesis also demonstrated that scenarios can contribute to the understanding of transition management. This is because the scenario analysis have high compatibility with the key feature of transition management that Rotmans and Loorbach (2010) articulated (see section 3-1-2). Scenario enabled us to capture the interaction of driving factors as to illustrate different types of system-internal, system-specific and system-external developments. As a result, the method helps us to implicate the plausible transitional pathways in each scenario and observe and recognize possible spillovers that may happen to the system. This can become an important insight for a development of adaptive management and anticipative management.

Limitations

The thesis made several attempts to reduce the involvement of the author's bias. In the process of making scenario, the thesis conducted a survey and asked professionals to quantitatively rate the impact of driving factors on a scale of 0 to 3. The results helped the thesis to create scenarios based on the judgement of someone who are expertise in this academic field, rather than creating them solely based on the author's point of view. The thesis also conducted a research as extensive as possible on problematization and on driving factors. Although this eventually took up a large space in this thesis, it was essential to articulate the interpretation of each scenarios as quality as possible.

Nevertheless, the research arguably involved author's bias to some degree. It is the author who made an interpretation of what kind of energy system is structured in each field of FFM depicted by driving factors. It is the author who construed the scenarios to lead to those energy systems. Although these interpretations are based on scientific process, it has to be mentioned that it is also not a completely objective process. Or, in my humble defense, it cannot be an utterly objective process unless technologies will come so far as to create scenarios in such manner.

Second, the limitation of this research also exists at the unpredictability in the future. Transition management is a goal-oriented thinking; thus ideally, it needs to take certain amount of uncertainty into account so that we can be prepared to flexibly adapt with the sudden societal changes. For this matter, the thesis attempted to capture driving factors as wholly as possible and how these factors may change in the future, rendering the energy system's uncertainty as a product of the changes in the interaction among these factors.

However, one can never be completely inclusive for uncertainty. For example, these scenarios were exclusive to the possibility of massive natural disaster which may cause another nuclear disaster, nor the possibility of great economic depression that may completely change the basic premises of scenarios that the thesis envisioned. In other words, these scenarios are limited only to suggest alternative pathways that Japan can take to realize relatively more sustainable systems, as an anti-thesis of status quo, in given premises that basic economic, societal and environmental conditions will not be drastically changed.

Finally, the thesis must admit that there is a lack of concreteness in scenarios. The thesis focused on capturing societal transition as a dynamic process (as explained by MLP), but it sacrificed concrete arguments for keeping the scenarios abstract. Of course, the thesis tried to avoid going a completely abstract approach to interpret scenarios. In fact, articulating key interdependency more or less characterized energy system in each scenario and contributed to demonstrate the macro-dynamics of societal transition process that could happen in MLP.

Nevertheless, for example, scenario D indicated an emergence of microgrid among prosumers, but to call such scenario feasible, it requires a lot more careful analysis in societal and technological developments to materialize such system (e.g. what kind of facilities and operations will be required to maintain the grid stability? Will the blockchain system be introduced to reduce the transaction costs?

What kind of vendors will take advantages? Will there be a need for electricity storages, if so, is the technological breakthrough necessary? Etc..). In other words, this thesis does not serve as feasibility assessment of each scenario or technological trajectories, but rather it is limited to presentation of plausible societal transition pathway as a product of interactions among driving factors.

Failure as lessons

To write this thesis, the author has spent nearly 8 months (and more if you include the time for choosing topics). In so doing, so many days were spent only to make mistakes, choose the wrong direction and overlook some important things that should have been considered. To let these failures not remain as failure, the thesis would like to explain what went wrong, hoping that the students in the future generation can learn from them, save some time and eventually write better thesis. Because these are not strictly a part of the thesis's argument, I would like to write in a subjective manner.

First of all, it would be wiser to render research questions as specific as possible, and to do so, an extensive pre-research is needed. I was initially planning to pick one or two specific local municipalities having "sustainable development" as their primary policy agenda, then analyze challenges and risks they are facing. Then, I realized that these municipalities were largely influenced by the state's policy. That is why I broadened my viewpoints from local municipalities to a state level. However, I now think that the initial plan could have gone well if I invested a little more time to specify what I wanted to look at. There should be an interesting topic and problem that I could focus on without taking larger contexts into consideration. Besides, I would not need to write 270 pages.

Second, I would advise you to be careful if you are to create scenarios in the contexts of academics. After 8 months of struggling, I am still fascinated by the idea of taking scenarios as a method to research societal transitions: as I discussed in Chapter 4, I believe that these two concepts are highly compatible, and that scenarios have a lot of potential to contribute to the study of transition management. However, as far as I concern, there is a lack of theory-based models to explain how scenario planning works. Although the method is considered as useful means of conducting strategies and is widely employed by practitioners, they are after all methods, not theory. Therefore, for those who plan to incorporate scenarios into their research, it is advised to invest enough time to explain what they are. On this matter, I personally found articles written by Chermack (2004) and Ramirez, Mukherjee, Vezzoli, and Kramer (2015) worth taking a glance.

Incidentally, it is also essential to develop scenarios with deep contemplation of external-validity. No matter how well you construct your scenarios, if they are at extreme variance with recent history, including the behavior of actors, time frame of processes, etc., then they cannot be regarded as valid/realistic, unless you can spell out a clear and plausible causal mechanism that causes and actors and processes to depart from their behavior up to now.

Third, it is highly recommended to take two months for conducting survey if you are planning to do a similar one to what I did in this research. My survey (CIM) takes roughly one to two hours to fill in, and it aimed highly expertise researchers (who are also tremendously busy) as its respondents. Therefore, I wrote personalized e-mails (for not giving them an impression of copy-paste letter) one and half month prior to the survey's deadline. Even so, the rate of reply agreeing to take part in the survey is not so high (probably around 30%) and the chance of having a filled-in survey back is lower (probably around 10%). Therefore, it is advisable to take enough time for collecting the survey and for expanding your personnel network to connect with your potential respondents.

Last but not least, it is desirable to prepare a solid scheme to manage your mental health. The long hour of sedentary work may increase your stress level and decrease your productivity, and the chronic isolation from the society may even be lethal for social animals like us. I found it important to occasionally take a few minutes walk outside, meet with my friends in library, go shopping, travel to sunny countries, or have some pints of beer before going to bed if you fancy.

Appendix – Driving Factors

0. Certain Factors

Population Decrease and Aging Society

The population of Japan reached its peak at 128 million in 2008 and started falling since then (see *figure A0-1*). The main point of concern is the decrease in the share of productive population (age 15-64). The productive population shared 67% of total population in 1980 but it dropped to 60% as of 2015 and it is expected to drop to 57% by 2030. What this indicates that the population which is the source of income for the nation is deflating while the population (elderly and youth) that depends their lives on social welfare system is inflating. This estimation is also based on the projection of immigration (see *figure A0-2*).

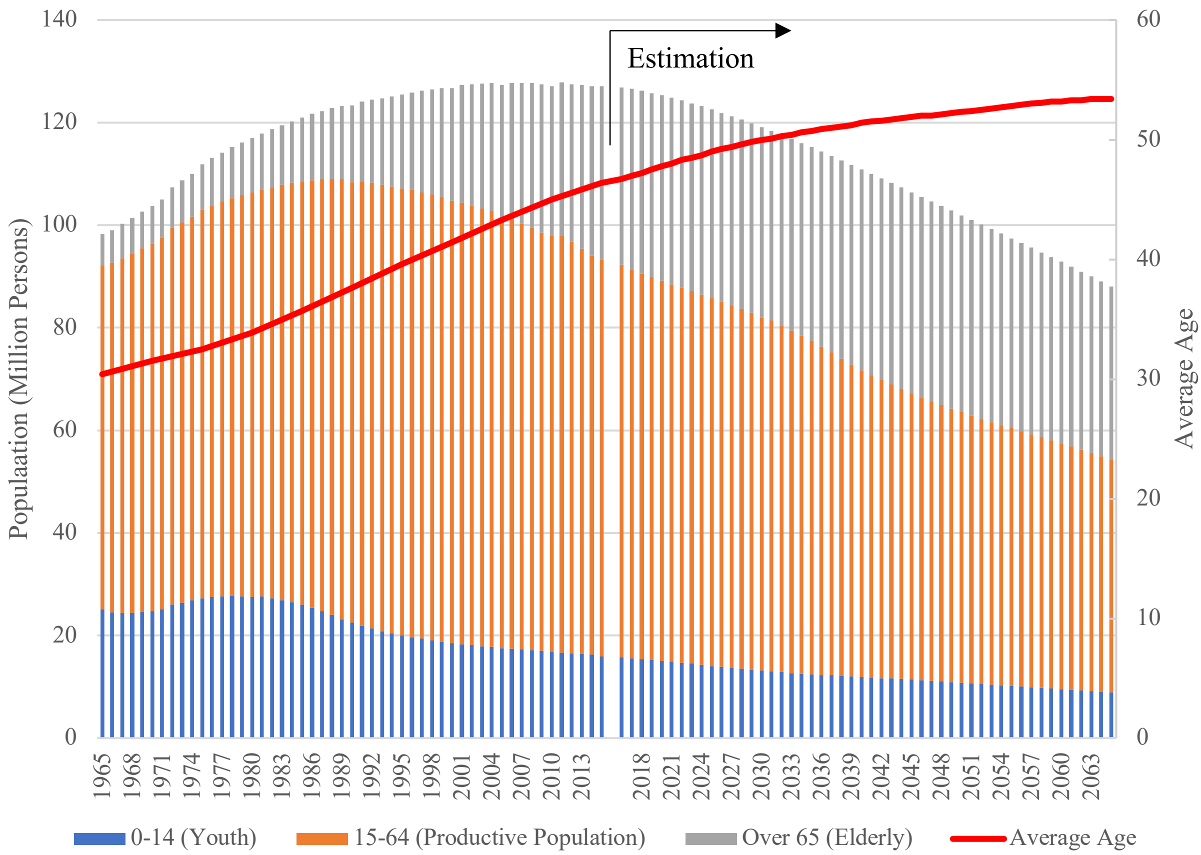

Figure A0-1. Population and Average Age of Japan (National Institute of Population and Social Security Research, 2019).

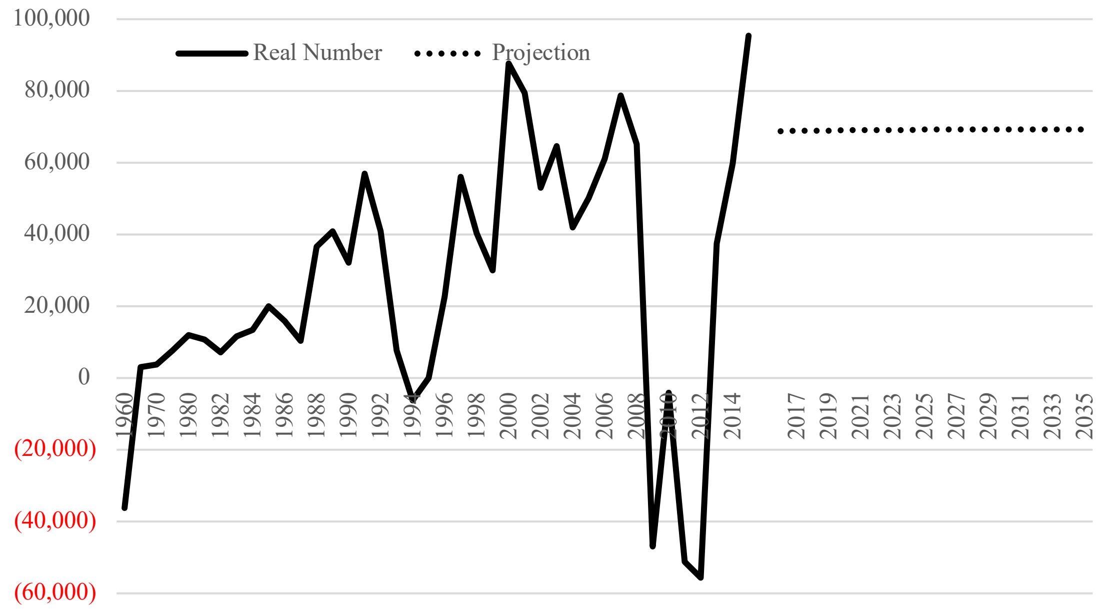

Figure A0-2. Inflow of Foreign Population minus Outflow of Japan's Population (National Institute of Population and Social Security Research, 2019)..

Earthquake

The east coast line of Japan is a convergent point of 4 continental plates; Pacific Plate, Eurasian Plate, North American Plate and Philippine Plate (see *diagram A0-3*). Because of this geography, 10% of the world's earthquakes with a magnitude 6 or more between 1500 and 2017 occurred in Japan (Berndt, 2018). Both the number and intensity of heavy earthquakes (the ones with more than 5 seismic intensity) has started a surge in Japan especially since 1980s, and between January 1st of 2010 and April 4th of 2019, 178 heavy earthquakes occurred (see *figure A0-4*). Almost all over Japan are facing to the high possibility of earthquakes with a seismic intensity 5 or more in next 30 years, and the risk of Nankai Through Earthquake (estimated magnitude 8 or 9 in Tokai Area) is also increasing to the possibility of 70%-80% in the next 30 years (Japan meteorological Agency, 2019b; The Headquarters for Eathquake Researach Promotion, 2018).

Diagram A0-5 shows the location of NPPs and seismic activities in Japan (Ishibashi, 2015, p. 4). Although NPPs are generally located in the west coast, where seismic activities are relatively moderate, those NPPs also have experienced some earthquakes happened in close proximity. Furthermore, "Japan's inland territory sits on a cluster of active faults (katsudansō), which have been created by earthqakes in the upper layers of the earth mantel and are themselves prone to so-called inland earthquakes" (Berndt, 2018, p.122), the fact which Ishibashi (2015) concerns the risk in storing spent nuclear fuel buried underground.

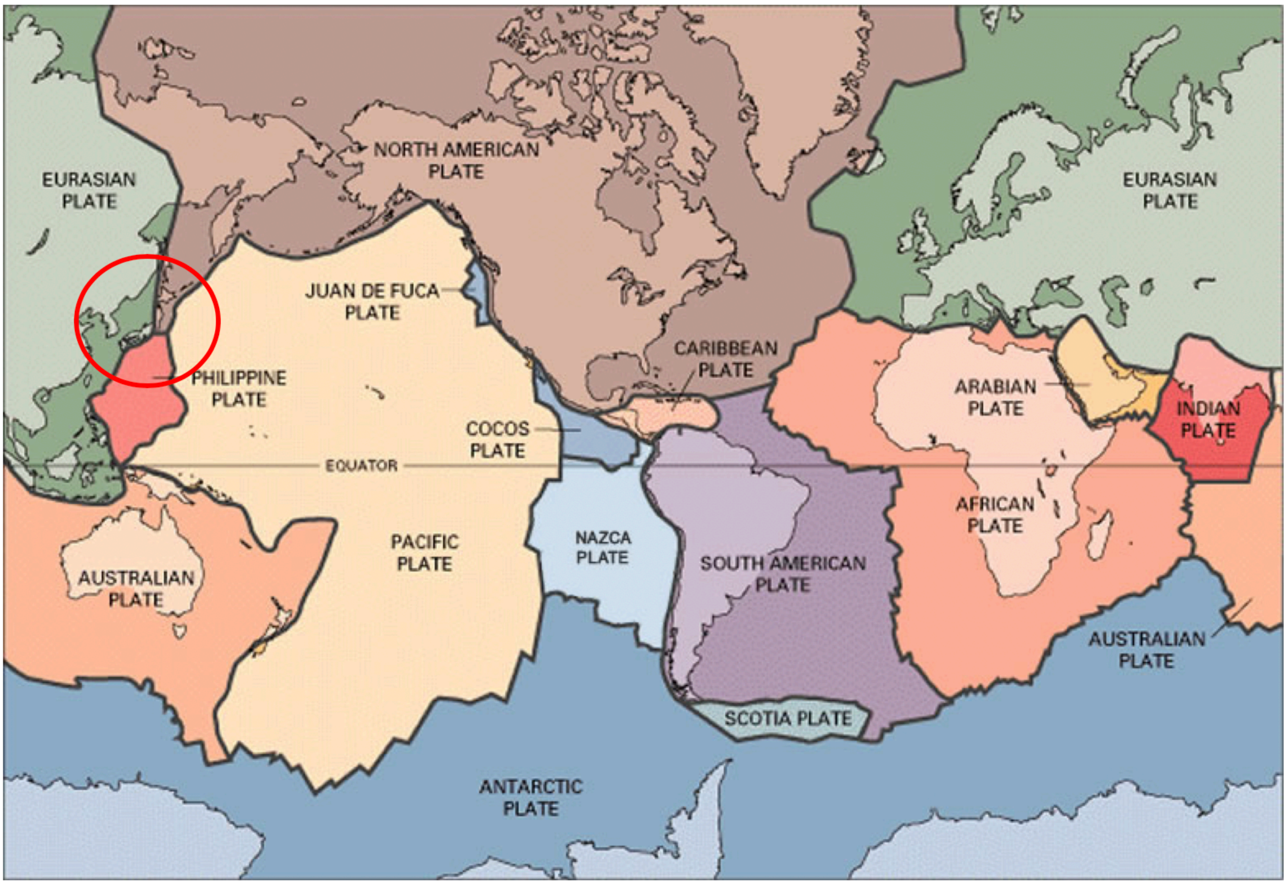

Diagram A0-3. Continental Plate Map (King, n.d.)

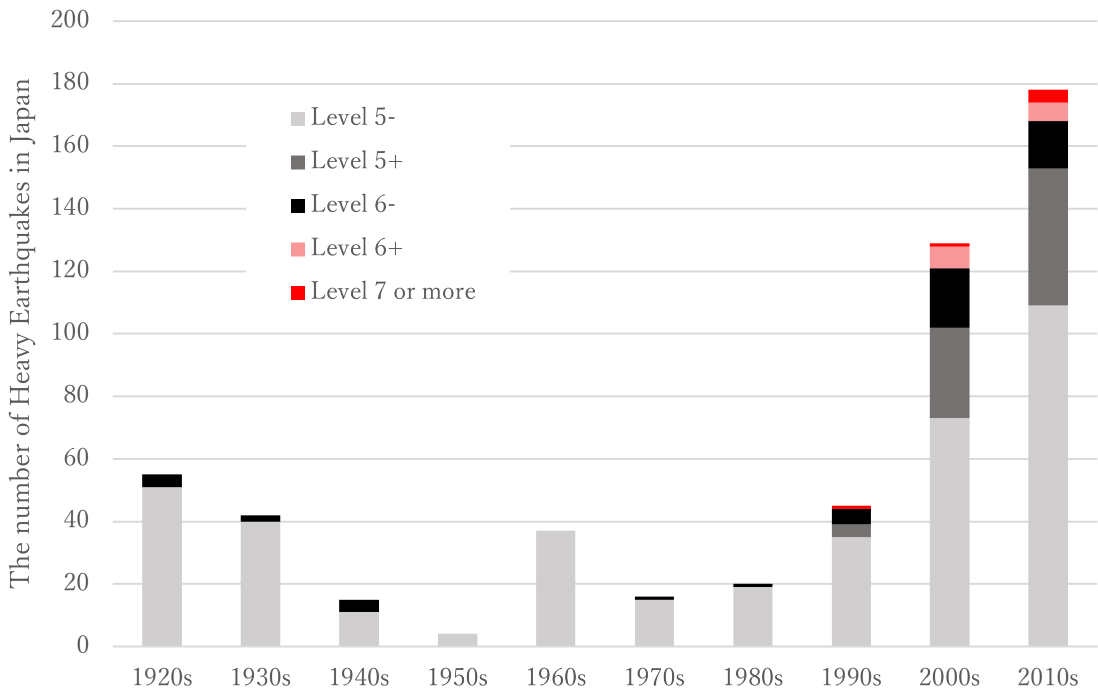

Figure A0-4. The number of earthquakes with high seismic intensity (Japan Meteorological Agency, 2019a).

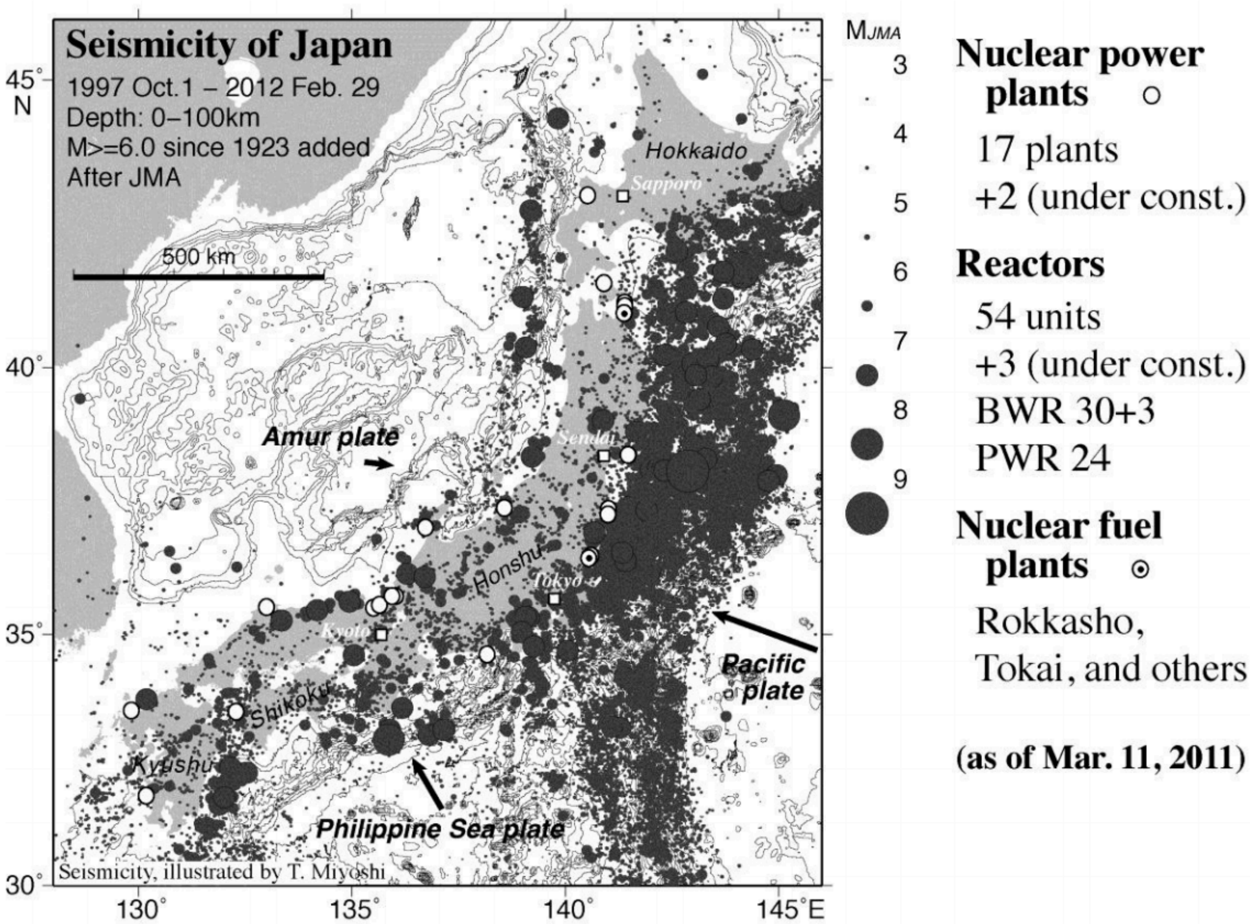

Diagram A0-5. Seismic Activities and Nuclear Power Plants in Japan (Ishibashi, 2015, p. 4).

1. Grid Integration and Balancing

Electricity grids in Japan has been regionally and vertically integrated. The vertical integration allowed a utility to monitor the whole grid easily, manage the grid parity unitarily, and expand supply capacity through economics of scale. Demand projection and supply adjustment were something that required highly-expertise operators who could oversee what is happening in the grid.

This region-specific development resulted into a constrain for inter-regional connectivity. Take Europe's grid for example, it shapes like a spider web where each region connects to various regions. However, as *diagram A1-1* illustrates, Japan's grid, especially for the east part, has limited interconnectivity with other regions. This is partly because of the geographical shape of Japanese archipelago, but also because the east part and west part manage their grids at different frequency (ANRE, 2017a). Furthermore, use of inter-regional transmission lines are strictly regulated on the "first-come first-served" rule where maximum output capacity has to be registered up to 10 years ahead and the capacity is largely occupied by "planned power generation" especially fossil fuel and nuclear, which inhibits renewable producers to utilize the grids (Wakiyama & Kuriyama, 2018).

Such poor connectivity barriers the inter-regional trade, setting a ceiling on the grid parity and the growth of renewable energy. For instance, Kyushu EPCO performed the output control from solar PV[33] during 13th and 14th of October, 2018. The reason behind was that their recent restarts of 4 nuclear power plants in their region provides base load, leaving smaller rooms for intermittent load such as solar and wind energy, they could not simply manage the demand-supply balance with their connection capacity (Solar Journal, 2018).

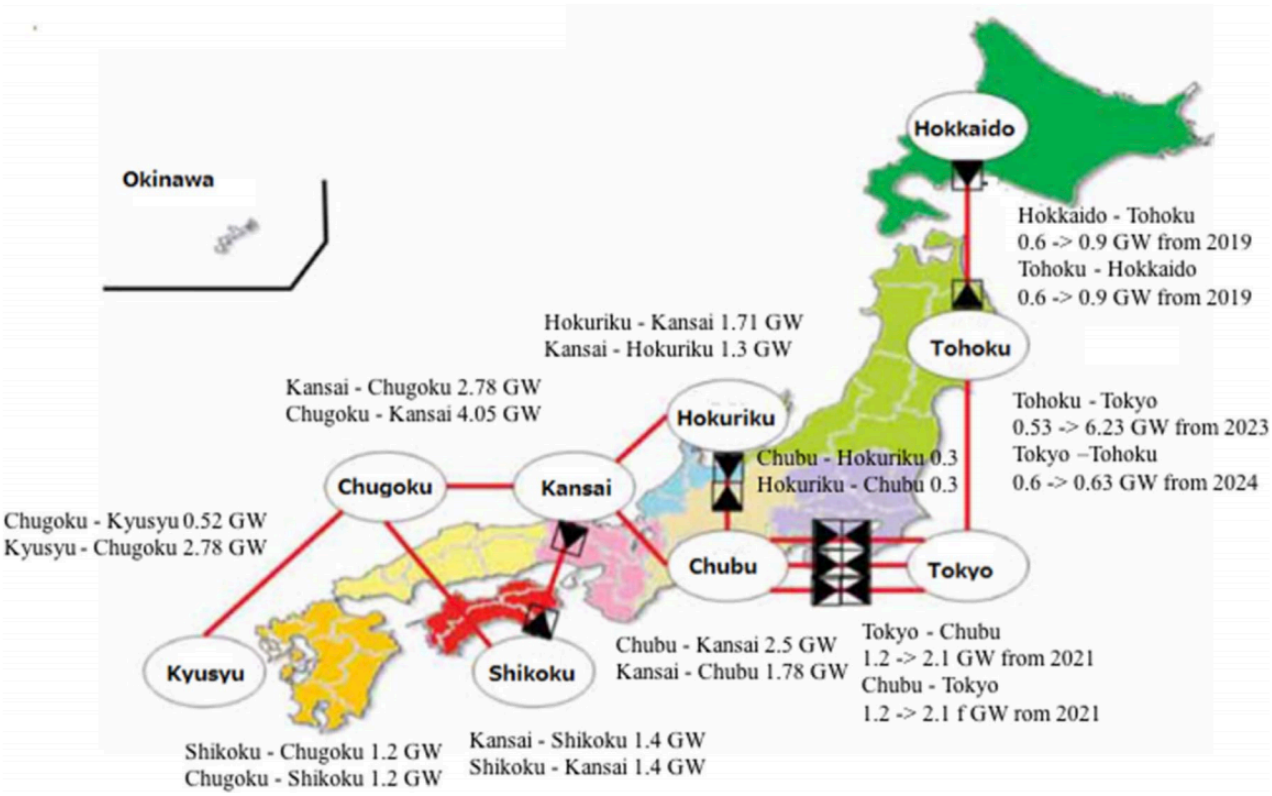

Diagram A1-1. Japan's National Trunk Line Connections (Wakiyama & Kuriyama, 2018, p. 305).

To approach this problem, mainly three options are actively discussed: a mere expansion of capacity in the current grid, international grid and micro grids. The first plan is already established by METI. Already, the three lines in the east Japan are expected to increase its capacity as the *diagram A1-1* shows (Wakiyama & Kuriyama, 2018). The second option is yet to be materialized, but slowly begin to move forward with an initiative of major energy companies from North-East Asia (softbank group from Japan, State grid corporation of China, Korea electric power corporation and Federal grid company from Russia) (Renewable Energy Institute, 2018).

[33] Kyushu EPCO rejected to purchase 320,000kW from solar PV on 13th October and 540,000kW on 14th October.

Another plan is the expansion of microgrid that provides, consumes and manages electricity in locally integrated energy network. Thanks to development of ICT, much of balancing operations now can be automated. As more weather information is stored as data and more accurately the weather is predicted, the intermittency of solar and wind power will be more accurately projected. Furthermore, the technology such as EV and battery has a potential not only to expand the tradability of electricity, but also to help the grid parity and secure a certain amount of energy supply at individual level (Taki, Sato, Maeda, & Mukai, 2018). Asmus (2017) predicts that a market value for grid-tied, commercial and industrial microgrids will increase by more than 10 times in 2026, largely led by its expansion of Asia Pacific (see *figure A1-2*).

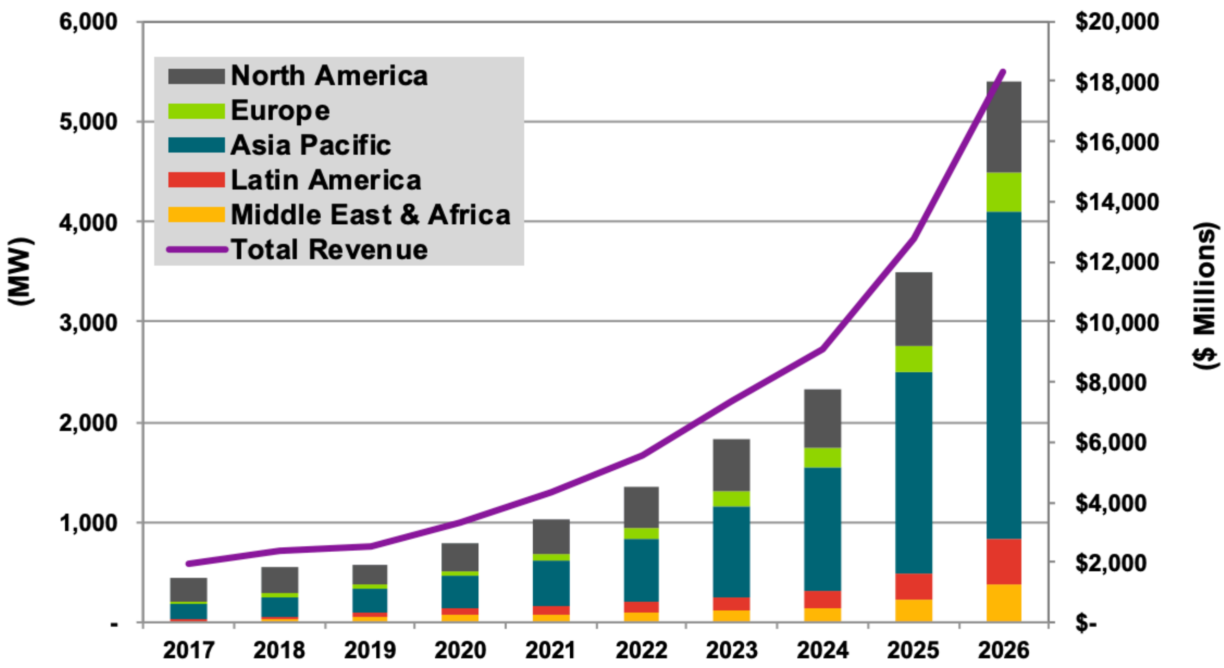

Figure A1-2. Grid-tied Commercial and Industrial Microgrids by Region, World Markets (Asmus, 2017, p. 11).

Scenario A: The grid parity is managed with microgrids.
Scenario B: The grid parity is managed with internationally connected grid.
Scenario C: The grid parity is managed in the expanded capacity of the current integration.

2. Sense of Community

People feel less connected to their local community. According to the survey conducted by Cabinet Office (2018b), to the question "how closely do you interact with your neighborhood", 52% answered that they are closely interacted with their neighbor in 1975 while the percentile declined to 42.3% in

1997. On the other hand, the respondents who answered, "no interactions" and "rarely interacted" increased from 1.8% and 11.8% in 1975 to 5.3% and 16.7% in 1997 (see *figure A2-1*). Furthermore, the Cabinet Office conducted similar survey between 2002 and 2018 with a slight change in wording of question. This time, they asked to respondents how closely they interact with their local community, and the proportion of respondents who claim to be closely engaged into their local community drops to 18.3% in 2018 while those who are not intimately but still have interactions with consist 49.4% in the same year. While the proportion of respondents in complete isolation from their local community has been stable at around 6-7%, people who rarely interact with their local community increases to 25.3% as of February 2018. Japan, the nation which is generally considered as a collective society, may be changing its basic nature.

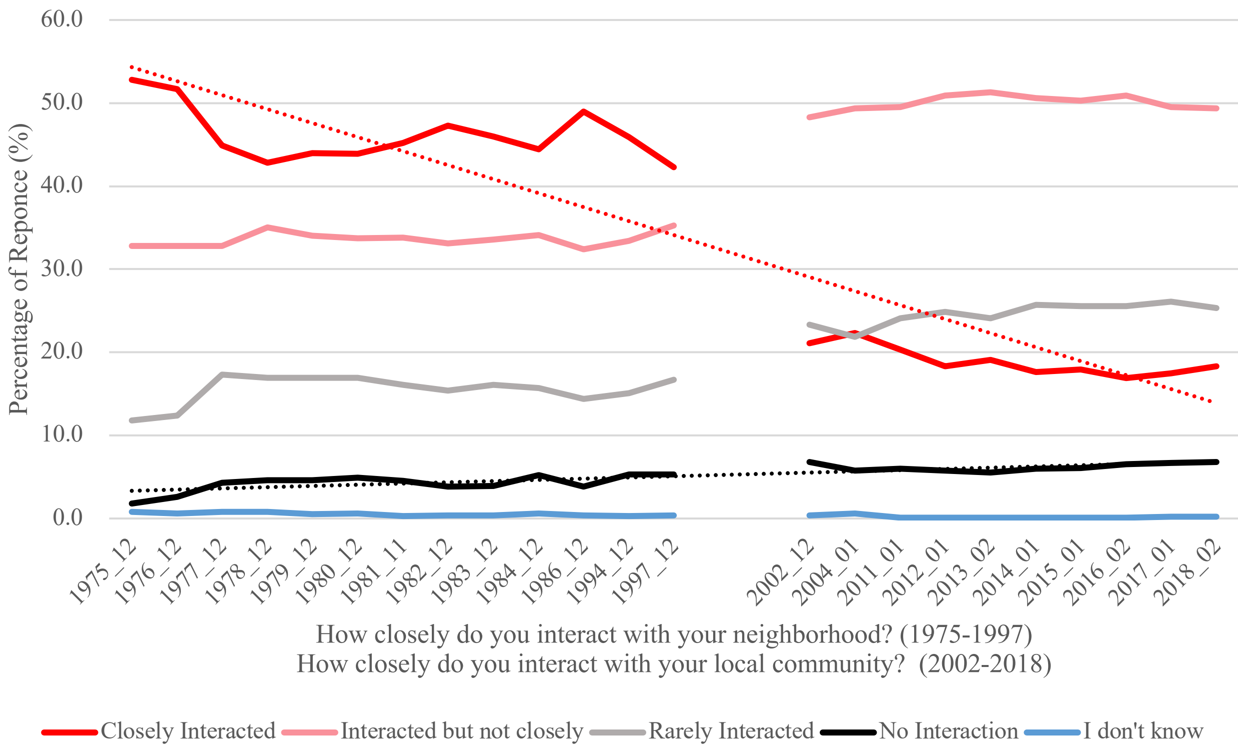

Figure A2-1. The interaction with local community (Cabinet Office, 2018b).

Breaking down the respondents who either claims to have no interactions or rare interactions with their local community, the survey also found that younger the respondents are, more likely they are isolated from the community. As of February 2018, 63% of respondents in range of 20-29 years old have either no or rare interactions with their local community while only 20% of respondents who are older than 70 answered so. That said, the age 20-29 is also the only generation who increased the social connection compared to 2002. The other generation are generally more inclined to social isolations compared to 2002 level.

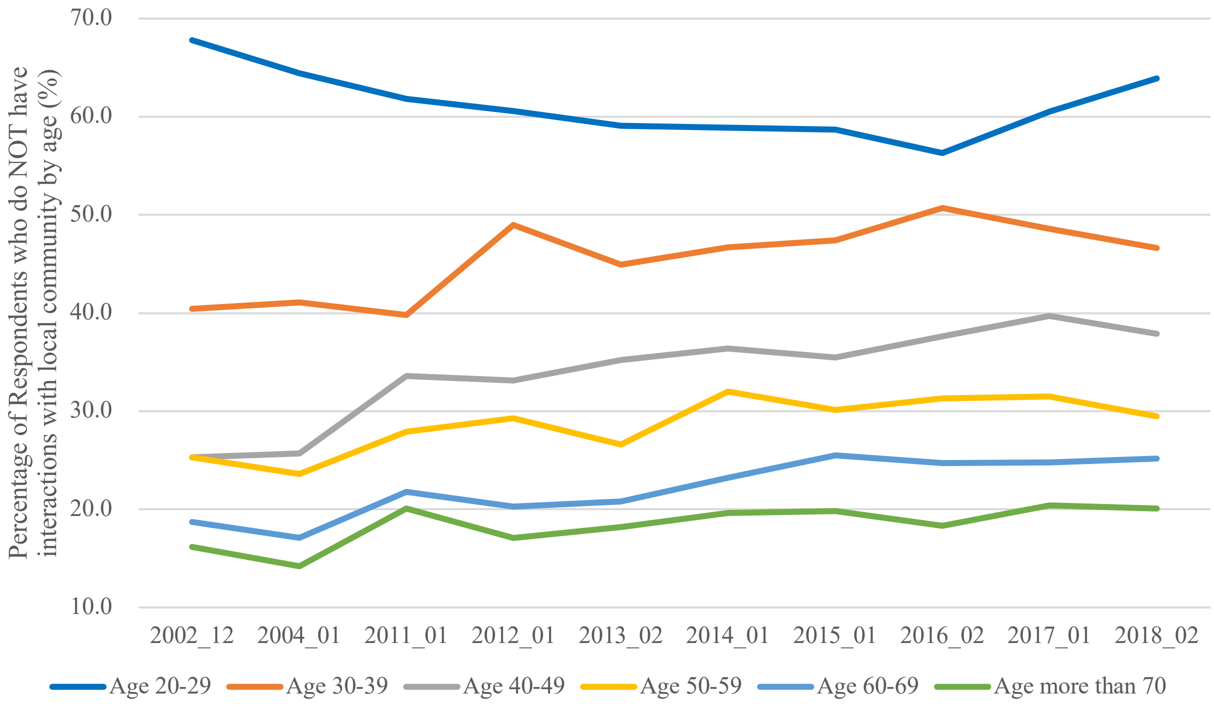

Figure A2-2. Percentage of respondents who do NOT have interactions with local community (Cabinet Office, 2018b).

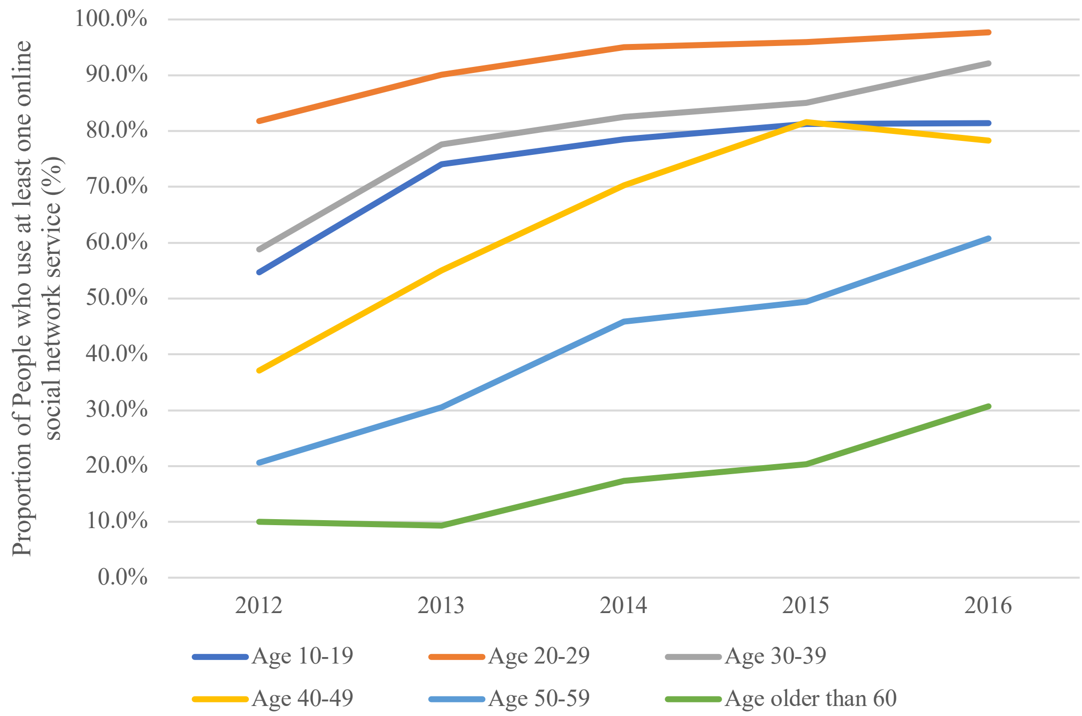

Figure A2-3. Percentage of respondents who use online social network service[34] (MIC2017b).

[34] The survey covers 6 different social network services (LINE, Facebook, Twitter, Mixi, Mobage and Gree). The number reflects the percentage of respondents who uses at least one from these

While the sense of community has been deflating in real life living-sphere, users of virtual community has increased its number. Virtual community transcends a matter of geographical proximity that traditional social interactions took for granted, and creates a new type of social ties where a distance no longer matters (Takhteyev, Gruzd, & Wellman, 2012). The more than 80% of age between 10-49 is using at least one social network services from LINE, Facebook, Twitter, Mixi, Mobage and Gree whereas 60% of the age 50-59 and 30% of those who are older than 60 years old use them (see *figure A2-3*)(MIC2017b).

Here the fundamental question lies at whether virtual community serves as an alternative social network that provides users a sense of community. Several research suggest that there is only a slight correspondence between its usage and feel of social isolation (Gil-Or, 2011; Manoucher, Dowran, & Haghighat, 2016; Ranaejy, Taghavi, & Goodarzi, 2016). However, Gil-Or (2011) claims that the most active users of Facebook is significantly concentrated within the study group with medium social engagement and people with either high or low social engagement are less inclined to use it. Furthermore, Takhteyev et al. (2012) claim that physical proximity still plays an important role even in virtual communication although technically users can reach globally (see *diagram A2-4*).

Scenario A: 50% of people are actively engaged in local community both through real-life and online network.
Scenario B: 20% of people are actively engaged in local community while 50% of them are actively engaged in inter-regional community through online network.
Scenario C: 10% of people are actively engaged in local community as well as inter-regional community.

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service.

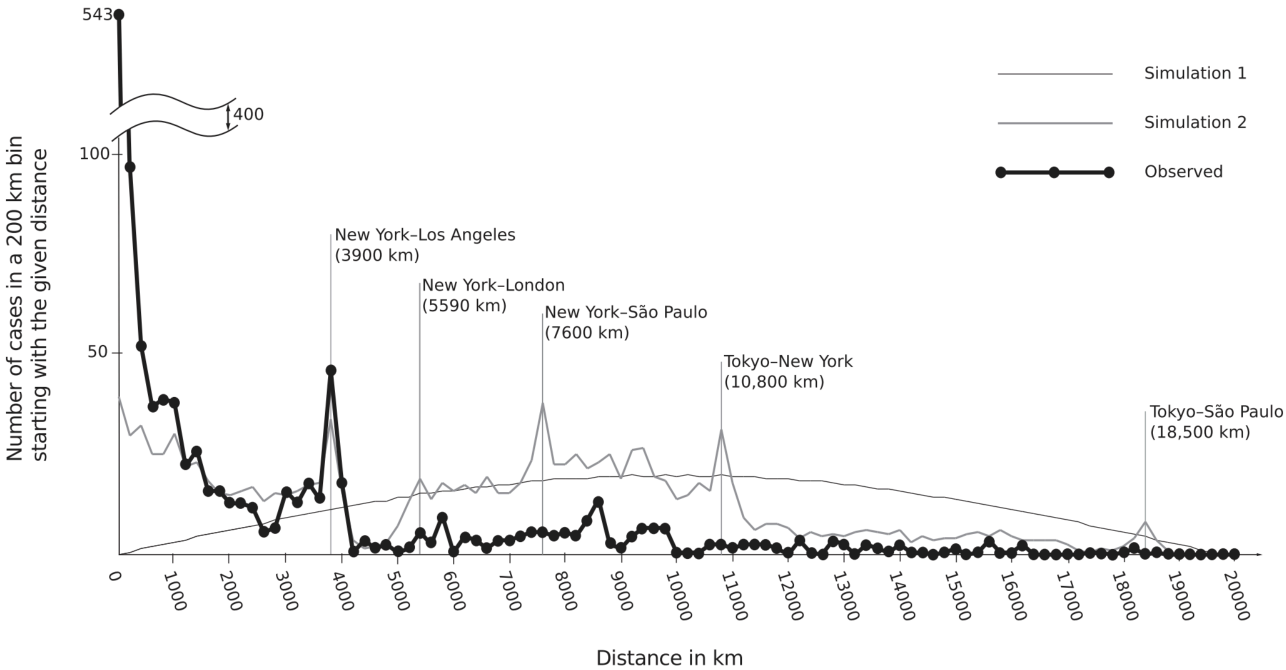

Figure A2-4. the distribution of distances between egos and their alters (Takhteyev et al., 2012)

3. Spot Market

JEPX, Japan's electricity spot market, has seen an upward trend since April 2016. While the transaction of JEPX only consisted 2% of total electricity sales volume as of April2016, it consists 32% as of November 2018 (see *figure A3-1*). However, most of this transaction are done by non-renewable energy (oil and gas). These features are unidentical with the wholesale market of the countries such as Germany, France or the United Kingdom, where "the total transactions being traded on the exchange market often account for at least 40% of the whole market, of which renewable energies make up for about 30% of the energy mix" (Maekawa et al., 2018, p. 2229).

The market with higher penetration rate of renewable energy tends to decrease the whole sale market price, and this phenomenon (called Merit-order Effect) has already been seen in the countries such as Germany and Spain; "As most renewables have low marginal costs or are supported without market integration, conventional plants with higher marginal costs are pushed out of the market in all hours when renewable electricity is available leading to a price decrease", which will affect to investment decisions (Winkler et al., 2016, p. 159). Maekawa et al. (2018) argue that the impact of renewable energy to the spot price is not as clear as in western countries because Japan's spot market is still largely based on supply from utilities and gas-fueled power plants of IPPs. However, they also acknowledge that it is highly likely that the same effect occurs to JEPX once the renewable energy gets proliferated[35].

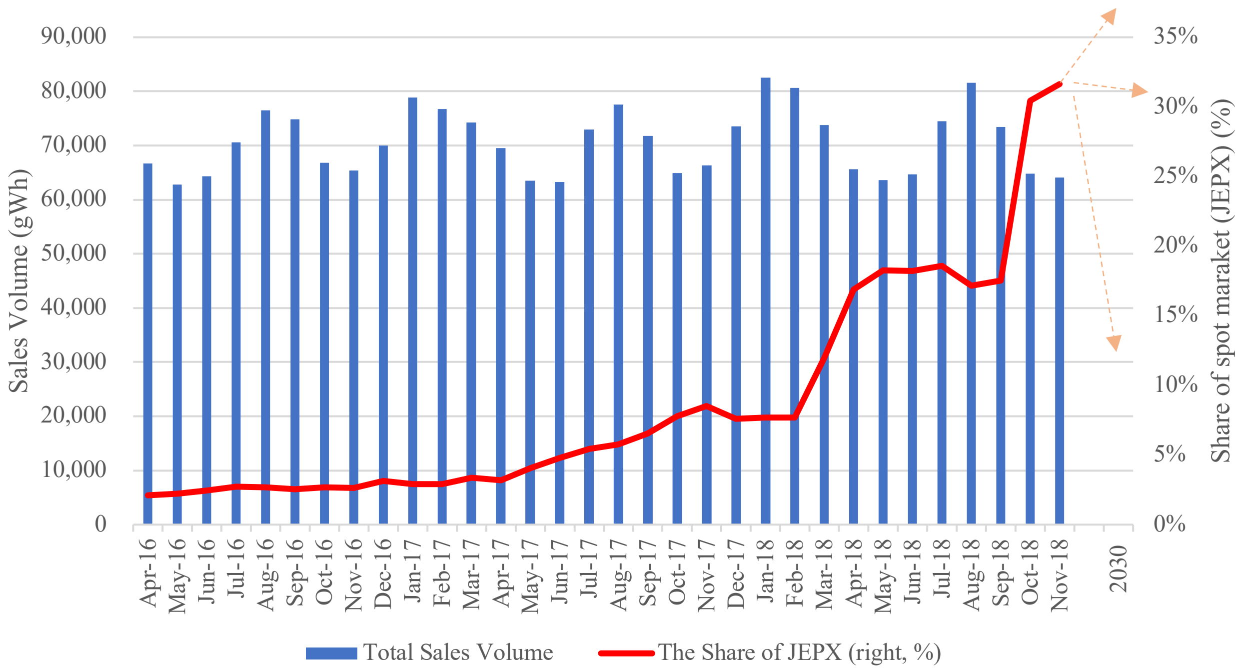

Figure A3-1. The share of spot market transaction (JEPX) in total sales volume of electricity (EGMSC, 2019; JEPX, 2019).

Scenario A: The share of transaction in spot market increases to around 70% (Scandinavia level)
Scenario B: The share of transaction in spot market stagnates around 30% (Germany level)
Scenario C: The share of transaction in sport market decreases to around 10% (U.S & U.K level)

[35] Incidentally, the spot market also needs a certain degree of governance. For example, a spot price has surged to a record high of 100.02JPY/kWh on 23th July, 2018, the day when the temperature of West Japan marked 39 degrees in Nagoya. It is a historical figure for Japan's spot market as the highest price had long been 60JPY/kWh in 2007, the time 9 years before full liberalization of retail market (Nakanishi, 2018). Nakanishi (2018) points out that such a sudden rise is a considerable damage and risk for new retailers; First, 100JPY/kWh is far more excessive for bidding capacity of most retailers. Second, if they are unable to purchase electricity on the market, they will need extra supply from utilities. In so doing, they needed to pay "imbalance fee" of 60.02-76.65JPY/kWh at that time, the amount which would still be big enough for them to have deficit (Nakanishi, 2018).

4. Advertisement – Who rules the advertisement?

The size of Japan's advertisement market is worth 8.2 trillion JPY as of 2016, and roughly 37% (3 trillion JPY) is from what is called traditional "big 4 media" (newspaper, magazine, TV and Radio) and TV particularly has been the dominant actor in the whole media market, consisting roughly 25% of total sales in the advertisement market. Although over the past 20 years, the sales volume of TV market has been almost unchanged at around 2 trillion JPY, its share has been gradually decreasing since the advent of internet advertisement market (*figure A4-1*).

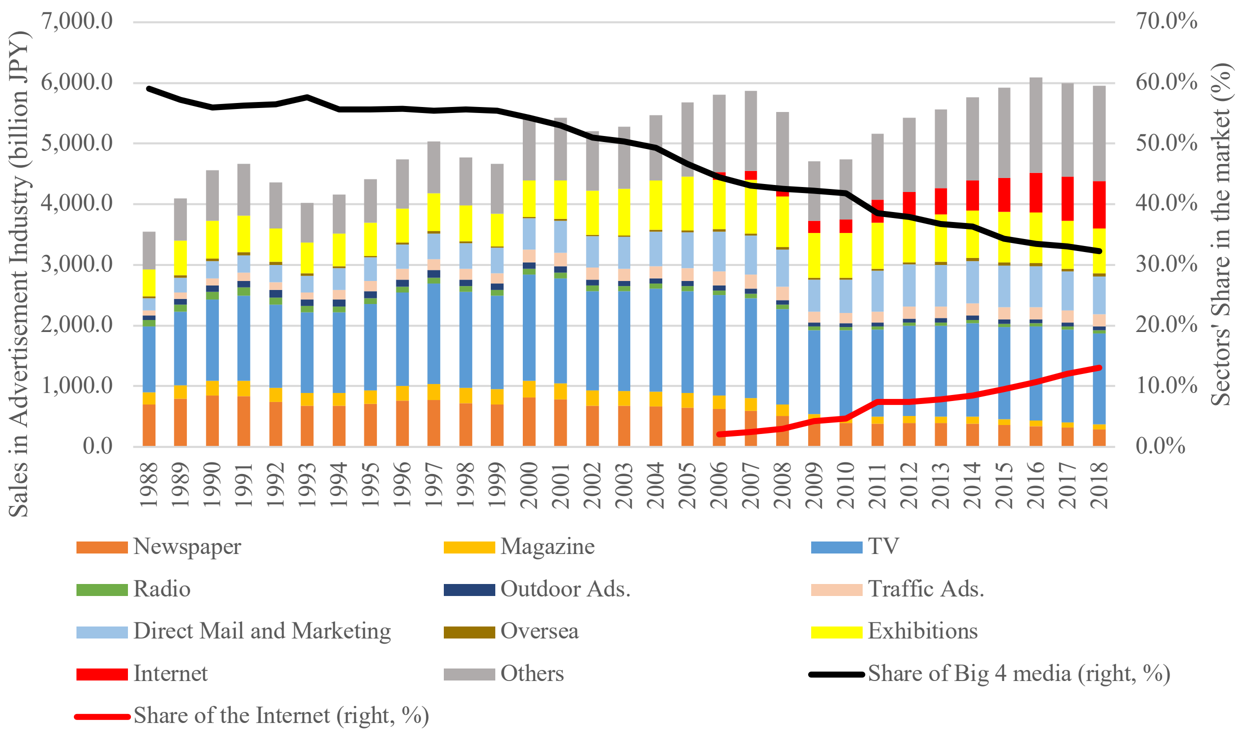

Figure A4-1. The size of advertisement market and share (METI, 2019a).

There are two major actors in the advertisement market in Japan; Dentsu Inc. and Hakuhodo Inc; the former consists 28.8% and the latter consists 15.2% share of the market as of 2016. They are particularly influential on the traditional media advertisement; Dentsu holds 42.4% of advertisements in Big 4 media (26.5% of newspaper, 29.9% of magazines, 33.7% of radio and 46.5% of TV) whereas Hakuhodo holds 27.7% (19% of newspaper, 26.6% of magazines, 28.2% of radio and 29.4% of TV). The presence of the two companies in internet advertisement is more moderate, although their share has increased to 40.9% where Hakuhodo holds 25.9% and Dentsu holds 15% (*figure A4-2*).

Advertisers orders those two mega-agencies to create ads and purchase slots in media, in other words, it is utterly on agencies' discretion for how it is delivered to audiences. However, since one agency naturally has several clients from the same industry due to this oligopolistic nature, the power they possess to propagate information is tremendous. As the thesis discussed in the *section 2-2-2*, it is criticized that they have become ambassadors of industrial groups and had a strict control over the information regarding nuclear power because not only utilities but also manufacturing and construction, politicians, bureaucracies are all important clients for them (Gaulène, 2016; Honma, 2016; Manabe, 2015).

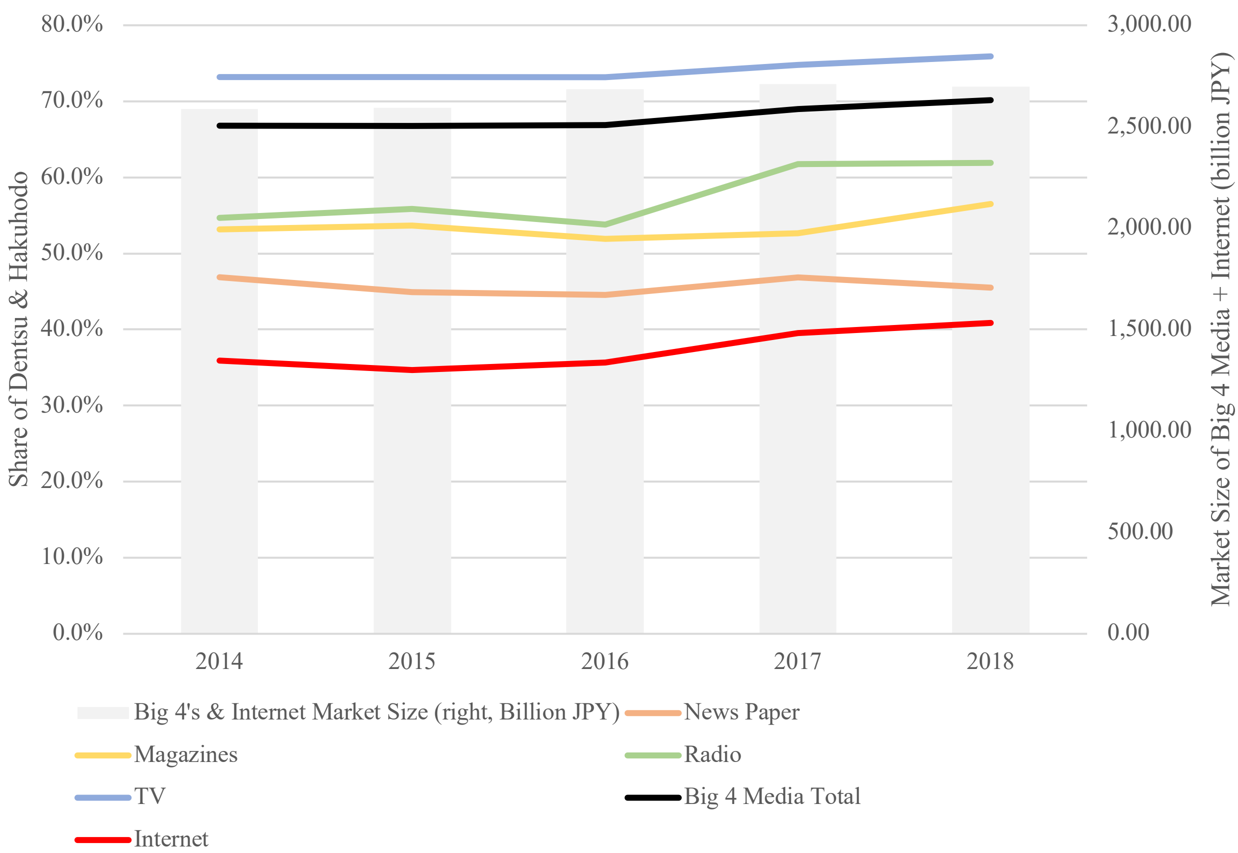

Figure A4-2. Advertisement Share of Dentsu and Hakuhodo in major media (Dentsu's and Hakuhodo's IR-reports; METI, 2019a).

Scenario A: The internet consists 50% of the ads. market, and agencies are diverse.
Scenario B: The internet consists 50% of the ads. market, and mega-agencies are dominant.
Scenario C: The traditional media consists 50% of the ads. market, and mega-agencies are dominant.

5. Media – Through which media people consume information?

According to the research done by MIC (2017), from 2012 to 2016, Japanese people averagely spend

300 minutes on media in a weekday (*figure A5-1*). As of 2016, watching both real-time and recorded programs of TV are the dominant media consumption activities, consisting 59.4% of total time spent for media and the internet consists 31.8% as the second most enjoyed media. While the average time spent for media has been almost unchanged from around 300 minutes a weekday during 2012 and 2016, people are surely changing their preferences on media; the share of TV falls from 66.2 in 2012 to 59.4% in 2016 while that of the internet increases from 23.5% to 31.8%. Although the TV is more preferred as older the respondents are, all generations but 60s have showed a roughly 10% change in media preferences to some degree in this period (MIC, 2017).

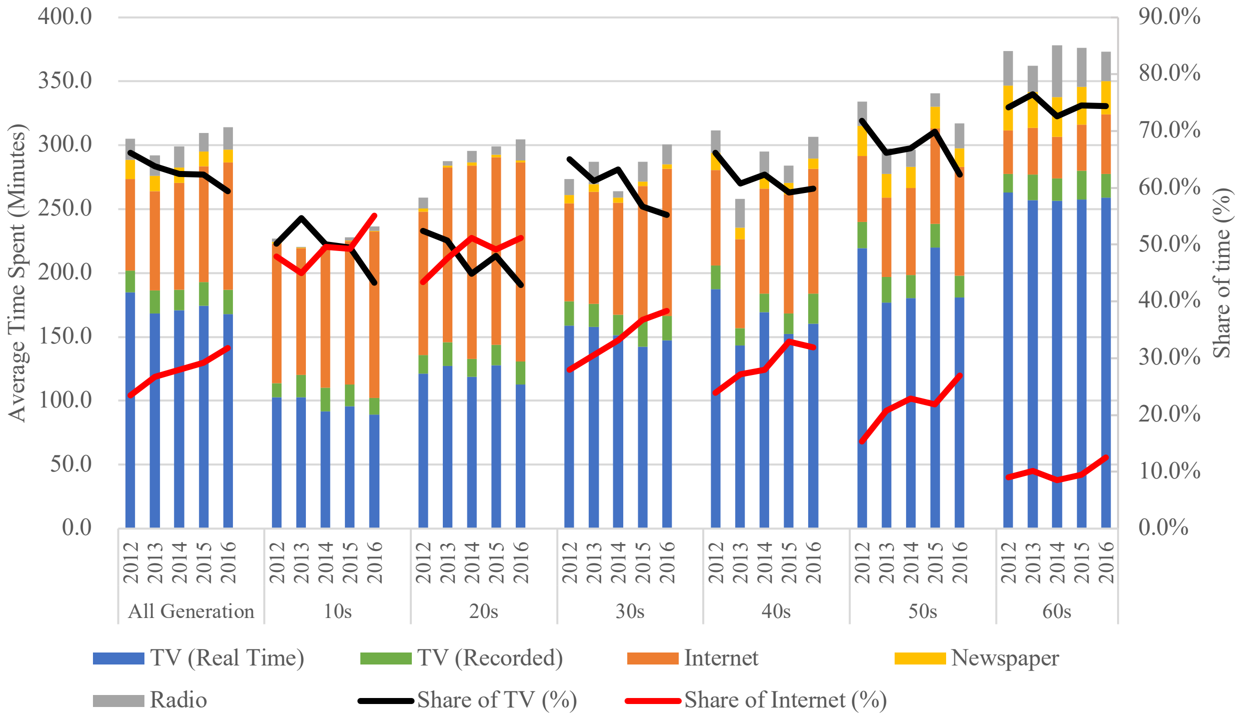

Figure A5-1. Average Time Spent for Media by Generation in a weekday (MIC, 2017b).

The same research also reveals the rate for those who use the media regardless of the time they spend (see *figure A5-2*). The internet is used almost as popularly as, or more popularly than TV except for 50s and 60s. That said, still 68.5% of 50s and 40% of 60s people get in touch with the internet although they do not use as lengthy as the other generations do. Newspaper on the other hand, has showed the most severe decline in popularity during this period; while it was averagely used by 40% of respondents in 2012, it has shrunk to 28.5% in 2016, becoming one of the most unpopular media in 10s and 20s along with the radio. Interestingly, newspaper is still the second most popular medium for 60s but the rate of usage in this generation has also declined by 10% (MIC, 2017).

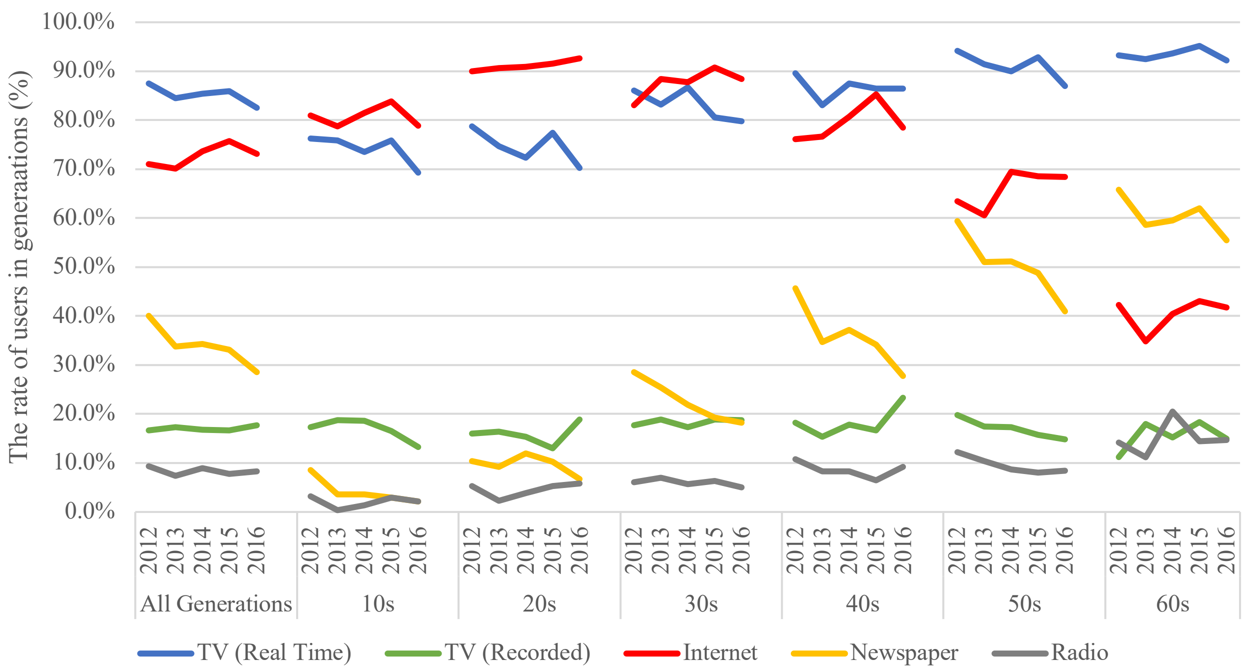

Figure A5-2. The rate of those who use the media in a weekday (MIC, 2017b).

The importance of through which media people consume information lies on the fact that the traditional media has oligopolistic industry structure as the thesis discussed in *section 2-2-2*. By laws that de fact inhibits any new entries to broadcasting network, such oligopolistic structure is tightly protected. They are also embedded in the custom so called “Kisha Club”, the regular convention that politicians and bureaucrats provide information exclusive to this club. Terrestrial TV broadcasting, newspaper and radio companies are vertically integrated with 6 key stations, and all of them, except for NHK, depend on the oligopolistic advertisement industry as their income source. By this structure, electric utilities have been major clients for all key stations. On the other hand, the internet is free from such influence (Asahi Shimbun, 2012; Au & Kawai, 2012; FreedomHouse, 2007; Honma, 2016; Yamaoka, 2011).

Scenario A: More than 60% of the time spent by all generation for media is on the internet (The internet replaces the current TV position).

Scenario B: 70% of total time spent by 10s and 20s for media is on the internet while the other generation remain at the similar level (generational dichotomy of information source)

Scenario C: More than 50% of total time spent by all generations for media is on tranditional media (TV, newspaper and radio)

6. Sense of Ownership

According to Nomura Research Institute (2018), more Japanese people feel comfortable with using goods owned by someone else through renting or leasing. According to their survey results (see *figure A6-1*), this change in the sense of ownership is largely driven by the cognition change of middle-aged people while younger people, especially those less than 30 years old, have generally more open to such usage. The proportion of those who feel comfort in sharing goods with others significantly drops as respondents get older than 60 years old. Overall, Nomura Research Institution (2018) concludes that this figure suggests the interest of public has moved its weight from owning goods to using goods although recently the change is as not as drastic as it was before 2012.

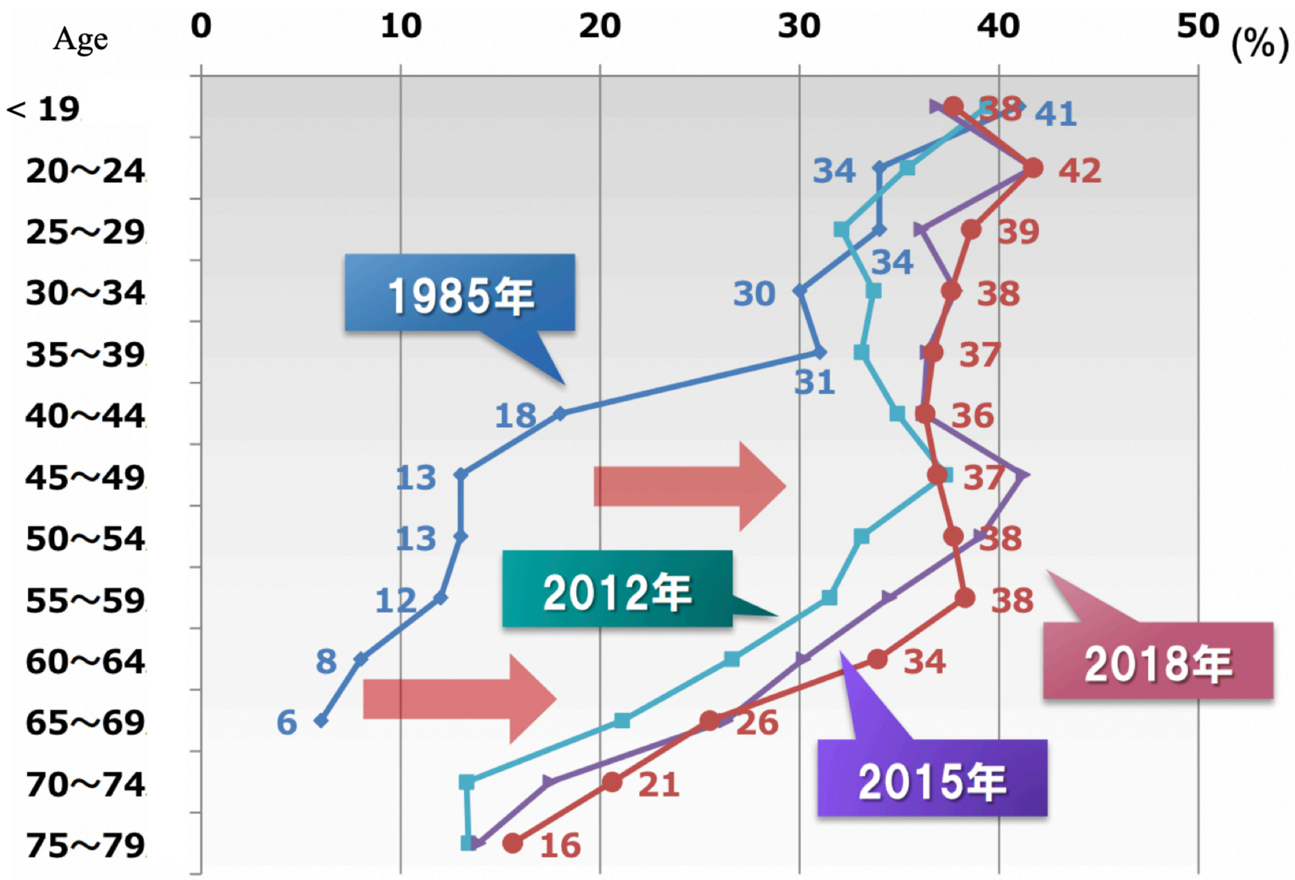

Figure A6-1. The percentage of who answer as “I do NOT hesitate to rent or lease goods” (Nomura Research Institute, 2018, p. 42).

Such movement advanced with the evolve of ICT, as Pouri and Hilty (2018) explains; “The penetration of Information and Communication Technology (ICT) into everyday life pushed the narrow boundaries of conventional sharing activities and created scalable sharing economies. People are becoming increasingly interested in the shared use of goods instead of buying and owning them” (p. 4453). This is because “sharing” enables people to save the costs of owning while still satisfying the functional needs (and sometimes even more convenient and more socially beneficial). Although sharing is the idea as old as mankind, time and place constrained information sharing, restricting the growth of traditional sharing economy. However, the ICT transcends such physical limitations, allowing sharable resource to be well coordinated and allowed more people to access to the information about the resource and the resource itself (Pouri & Hilty, 2018).

Pouri and Hilty (2018) argue that sharing economy has a great potential in sustainability;

> The increased level of real-time and real-place information generated and distributed via online platforms enables intensified access to existing resources and, as a consequence, induces an increase of their average utilization. This is normally expected to decrease, or at least balance, the need for new resource inputs to consumption ecosystems. In so doing, the sharing economy would be viewed as a potential stimulus to reduce the ecological footprint of consumption and as an effective approach to sustainability and sustainable development. […] The most important enabling impacts (Level 2) of the sharing economy occur as changes with patterns of production and consumption. From a resource-efficiency perspective, the optimization effect in shared consumption reduces the need for new products and resources. The contribution of the sharing economy to more sustainable consumption patterns can be compelling, as sharing eases off the flow of material resources by enabling their shared use—which itself is enabled by sharing a immaterial type of resource, namely information. (p. 4468)

The research done by Intercom Research Incorporation (2019) argues that sharing economy will be largely introduced in the area of transportation, space (sharing space), money, skills and goods and prospect that the market size of sharing economy in Japan increases from 1.8 trillion JPY to 5.7 trillion JPY in 2030 if the current development pace is kept. Furthermore, if the current growth-restriction issues are solved, the growth can reach to 11.5 trillion JPY, which is about the same market size to that of Japan's electric component manufacturing industries.

Scenario A: The market of sharing economy grows to 11.5 trillion JPY. 60% of population is open to share transportation, house, energy, goods and skills.
Scenario B: The market of sharing economy grows to 5.7 trillion JPY. 50% of young people are open to share transportation, house, energy, goods and skills.
Scenario C: 80% of people prefer private ownership for transporation, house, energy, goods and skills.

7. Local Economy

As is discussed in *Appendix 9*, the demographic distribution of productive population is largely aggregated to metropolitan areas, most notably Tokyo. Correspondingly, there is a huge economic dichotomy between metropolitan area and local area (see *figure A7-1*). On the other hand, those who need to depend their lives on national pensions (social welfare for those older than 65, *see Appendix 16 for more detail*) are concentrated in lower GDP areas, with an exception of Okinawa. Thus, the local economy is highly dependent on some kinds of re-distribution systems.

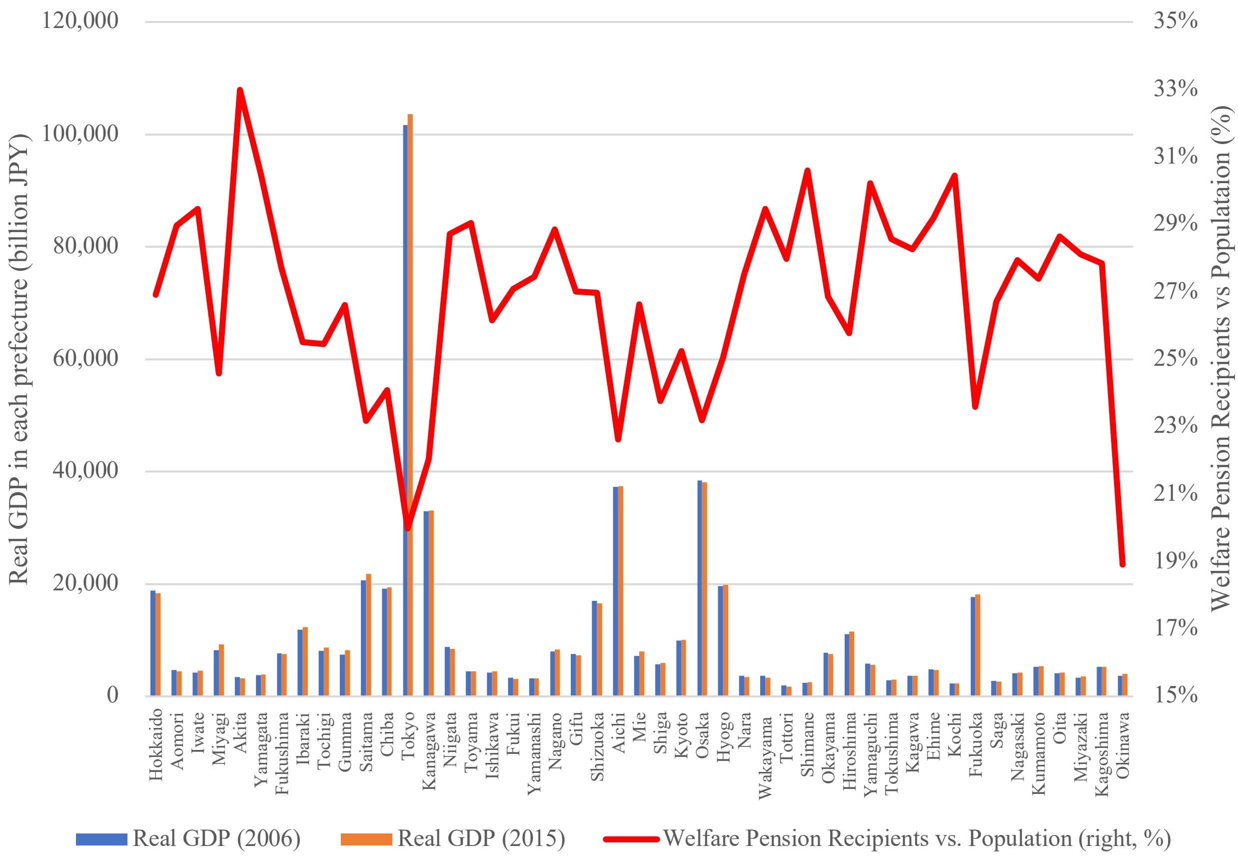

Figure A7-1. Real GDP in each prefecture (Cabinet Office, 2018a).

Current Model

Local economies depend their finance on mainly two sources; tax and pubic works. Japanese citizens are obliged to pay two kinds of tax: national tax (i.e. sales tax, income tax, corporate tax etc.) and local tax (i.e. residential tax, business tax, real-estate tax etc.). All of those tax, once goes to the national treasury, then MOF annually writes a draft for budget allocations and politicians give the final decision.

Local municipalities are dependent on the budgets allocated by the central government. According to the budget plan reported by Ministry of Internal Affairs and Communication (MIC) (2018a), Japan's total tax income in 2018 was expected to be 98.5 trillion JPY, where national tax consists of 59.1 trillion JPY (60%) and local tax consists of 39.4 trillion JPY (40%). However, the total expected expenditure on that year was 184.6 trillion JPY where the nation spends 97.7 trillion JPY and the local spends 86.9 trillion JPY. When you look at the money flow in detail, as illustrated in *Figure A7-2*, you will see that the central government compensates 16 trillion JPY as "tax allocation to local government (Chiho Kofukin)" and 8.4 trillion JPY as other grants to the local financial budgets. As a result, the local finance consequently gets to have 62.1 trillion JPY, which is roughly equivalent to 62% of the total tax revenue. You can also restate this as that local governments rely 39% of its budget on the central government[36].

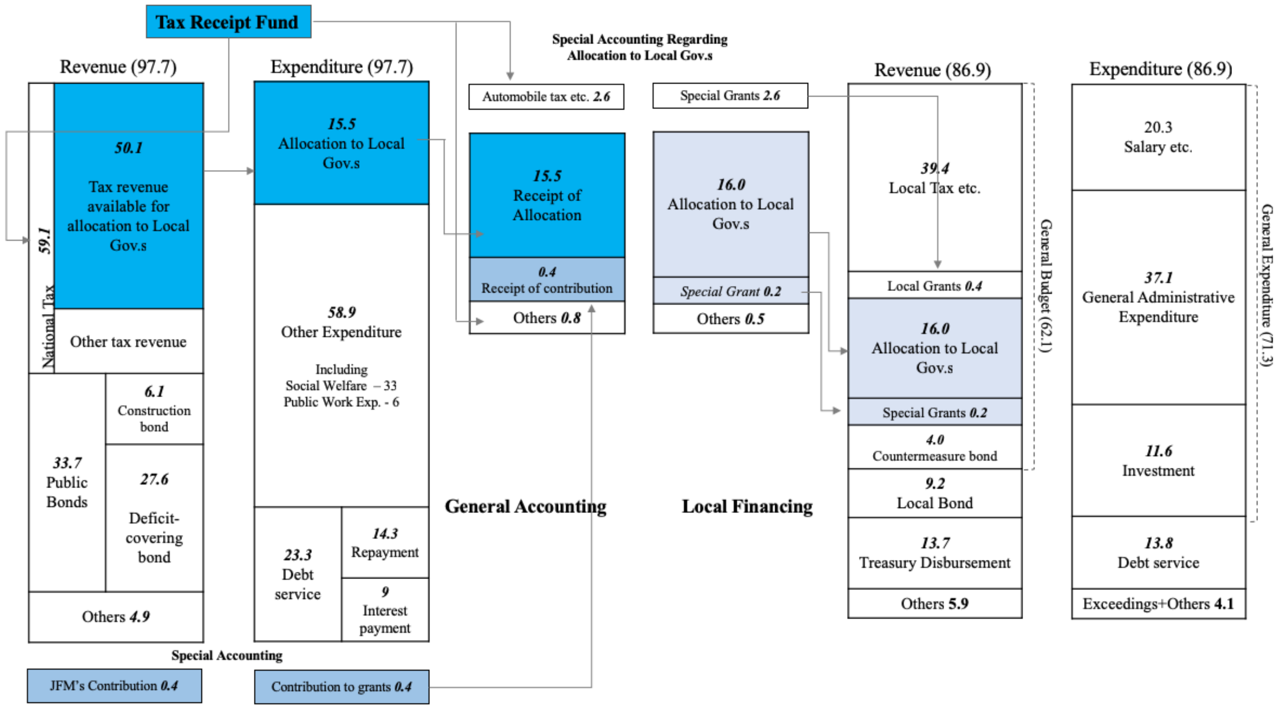

Figure A7-2. The relationship between the national budget and local budgets (trillion JPY) (MIC, 2018a)[37].

Fujioka (2011) argues that this scheme casts the uncertainty in budgeting for local municipalities. Even

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[36] As a side-note, you might notice that there are still other 24.8 trillion JPY of deficit in local finance. Among them, 13.7 trillion JPY was provided by the central government as "national treasury disbursement", the item which is used for the administrative service designated by the nation, such as compulsory education. Furthermore, 9.2 trillion JPY is covered by the local government bonds, in the same way as which the central government covers 33.3 trillion JPY as the national bonds.

[37] 1) The number is approximated for the sake of simplicity. 2)JFM = Japan Finance Organization for Municipality

though the central government determines the annual budget prior to the fiscal year, the exact amount of local allocations are determined in the middle of the year, forcing the local governments to submit "skeletal budget (Kokkaku Yosan)" for next year based on assumption of how much they will have been granted for the year (Fujioka, 2011).

The local municipality relies not only on the allocation from the central government but also on the economic effect created by the public works (i.e. road construction)[38]. Since the late 80s when the Japanese economy collapsed, the government put efforts to create jobs in local area through public projects, compensating the lost jobs that caused by the retreat of Japanese manufacturers and factories (Kanno et al., 2004; Musha, 2009). This relationship is clearly illustrated in *figure A7-3*. Although the expenditure for public works in 2018 is not as eminent as during 90s, but still nearly 8 trillion JPY supports the certain amount of employments in local economy.

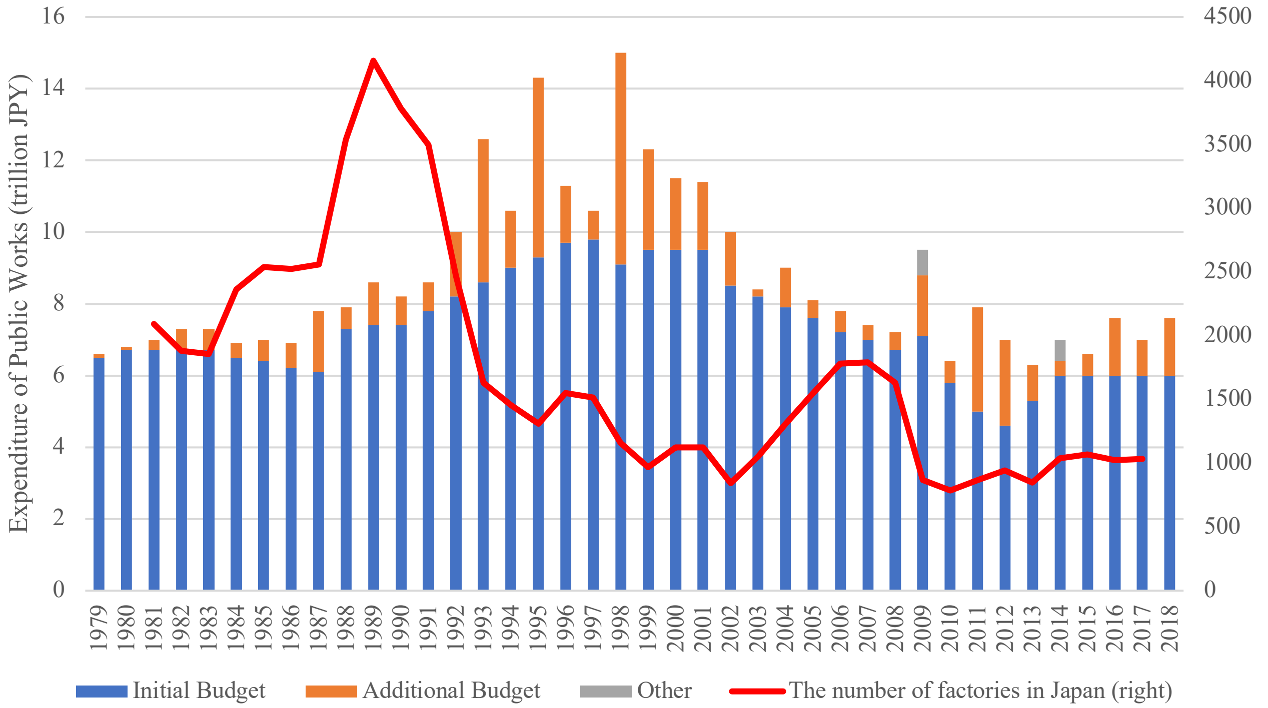

Figure A7-3. The change in the expenditure for public works and the number of factories in Japan (METI,2019b; MLIT, 2018, p. 12)

To address this issue, the competition among local economies is intensified to attract large manufacturing business that create a large amount of jobs. However. except for few cases (such as Osaka and Fukuoka), it is generally difficult as most local economies fail to satisfy companies' needs (N. Hirose, 2008). Besides, in a situation that more and more companies are focusing on foreign

[38] This expenditure is accounted in the item named "Other Expenditure" in the general accountings in *Figure A7-2*.

productions for cheaper costs, such competition cannot create co-development of local economies, but rather, merely encourages a zero-sum game of one deflating pie.

Alternative Model?

It has been a focus for local economy on how to secure allocated tax as well as how to attract public works or wishfully private companies. On the other hand, Kanno et al. (2004) proposs a development model that is not entirely based on the amount of profits or zero-sum budget trading game, but rather a model that can be sustained regardless of economic performance. The key roles are non-profit activities in private sector. They propose to enhance a self-sufficiency of a local economy as well as co-operation of neighboring local economies. In so doing, they alter 1) the part of profit-seeking activities that drain their capital to other municipalities into a cycle of non-profit activities completed in a local economy, and also alter 2) the part of current non-profit activities of government administration into private non-profit activities (see *diagram A7-4*).

As for the first point, re-discovery and development of local resource plays a fundamental role, as Kanno et al (2004) argue. Of course, not all the profit-seeking activities can be altered into locally cycled non-profit activities, but the fields such as energy or foods are essentially rooted in local economic activities and are the cores of local culture. In other words, when those commodities are one-sidedly provided by a centralized power source (large power plants) located in outside of local economies, the local economy simply loses their business opportunities. That being said, a complete self-sufficient energy cycle is not only hard to be achieved but also even harmful to their activities. Thus, the co-operation among neighboring economies are essential (Kanno et al., 2004).

As for the second point, the role of government and that of families are fundamentally overlapped. The government merely expands the traditional non-profitable service of family and local community to reach those who do not even know each other. Thus in other words, the non-profit service at local level can also be realized by creating ideal co-operation system at intra/inter local level (Kanno et al., 2004; Tominaga, 2001). That being said, a complete cycle of administration service within one local economy is hard to be met and it can even deteriorate the situation. Thus, the co-operation among neighboring economies are also essential (Kanno et al., 2004).

Scenario A: Local administration service is carried out by non-profit communal group in local level.
Scenario B: Local administration service is carried out by profit-seeking companies in local level.
Scenario C: Local administration service depends on their tax income. Local economies compete each others to attract private companies to settle in.

Status Quo: Local administration service depends on tax allocation from the central government.

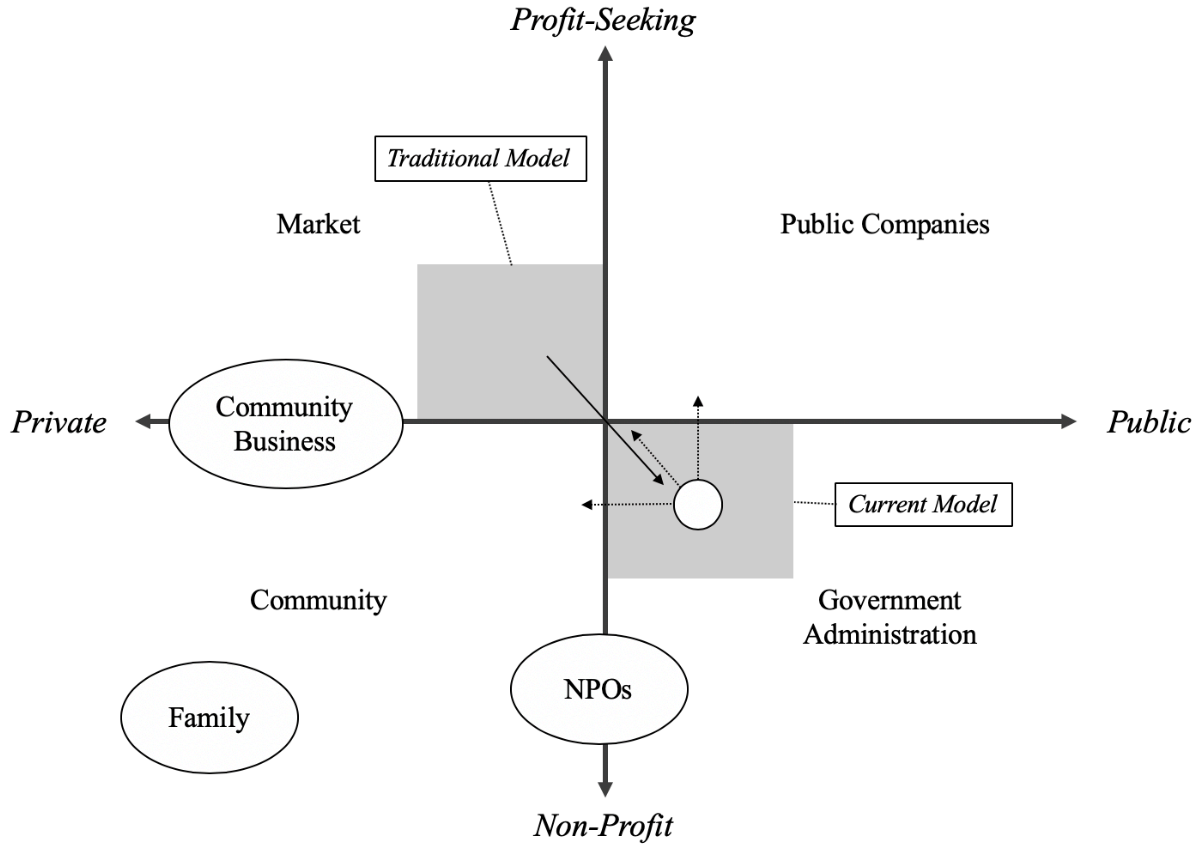

Diagram A7-4. "Sharing" that covers "private" and "public" (diagram based on Kanno et al., 2004).

8. Working Time and Leisure Time

Average working hour has been declining since 1990; averagely, workers spend 172 hours a month for working whereas it has declined to 143 hours as of 2017. However, as you can see from the *figure A8-1*, average working hour of regular employees are almost unchanged. This implies that the decline is mainly driven by the increase of non-regular employees (i.e. part-time, temporary, dispatched workers) since early 90s. *Figure A8-1* also shows that the working hour of non-regular employees are much shorter than that of regular employees and furthermore, they have reduced their average working hours from 98 hours in 1993 to 85 hours in 2018. The share of such non-regular employees, once it was 20% in 1994 has increased to 37% as of 2018. Thus the average working hour in Japan has declined.

However, *figure A8-1* only shows a working time for paid workers, excluding working time spent for house work or nursing/caring for house members. *Figure A8-2* shows how workers spent their day (average of weekdays and weekends). Not surprisingly, non-regular workers have more time to spend for non-paid activities than regular employees who tend to work roughly 200 minutes longer than non-regular workers. However, non-regular workers spend 70 minutes longer for the housework and 10 minutes longer for shopping. Considering that the figure also includes weekends (where regular workers can normally take work-off), the weight of housework that non-regular employees carry on weekdays are presumed to be much heavier.

What this indicates is that the decrease of working time (as *figure A8-2* shows) does not equal to the increase of leisure time as they include the non-paid working (i.e childcare, nursing, housework), work-related activities such as commuting and necessary life activities (i.e. personal cares, meal, sleep). Both non-regular and regular workers rarely spend their time for volunteering or social life.

Scenario A: Average monthly working time decreases to 100 hours. The workers possess average 6 hours of leisure time a day (time excluding paid/non-paid work and other necessary time such as meal and sleep), of which 2 hours are spent for activities such as learning, social life, volunteering.
Scenario B: Average monthly working time remains at 140 hours. The workers possess 4 hours of leisure time a day, most of which is spent for either consuming media or hobby.
Scenario C: Average monthly working time increases to 160 hours. The workers possess 2 hours of leisure time a day, most of which is spent for either consuming media or hobby.

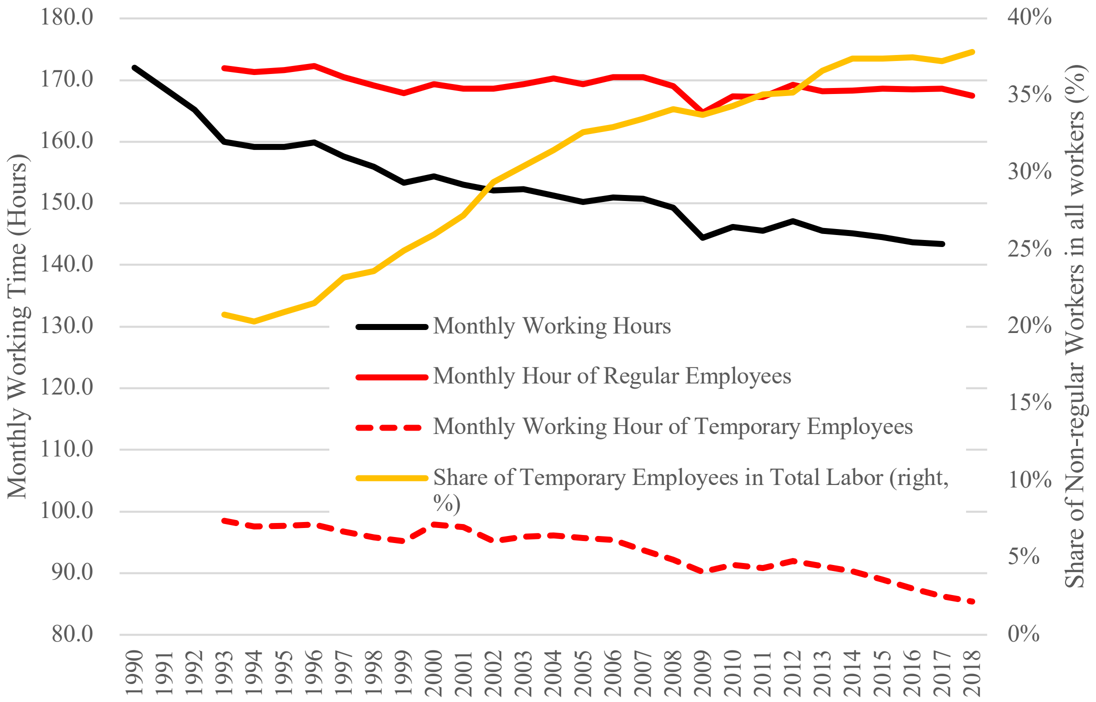

Figure A8-1. Change in Monthly Working Hours (MHLW, 2019; The Japan Institute for Labour Policy and Training, 2019)[39].

[39] The figure is based on "Monthly Statistical Study of Labor" published by MHLW, the report that was found in January 2019 as having methodological fraud since 2004 report. However, the thesis uses a corrected version of data.

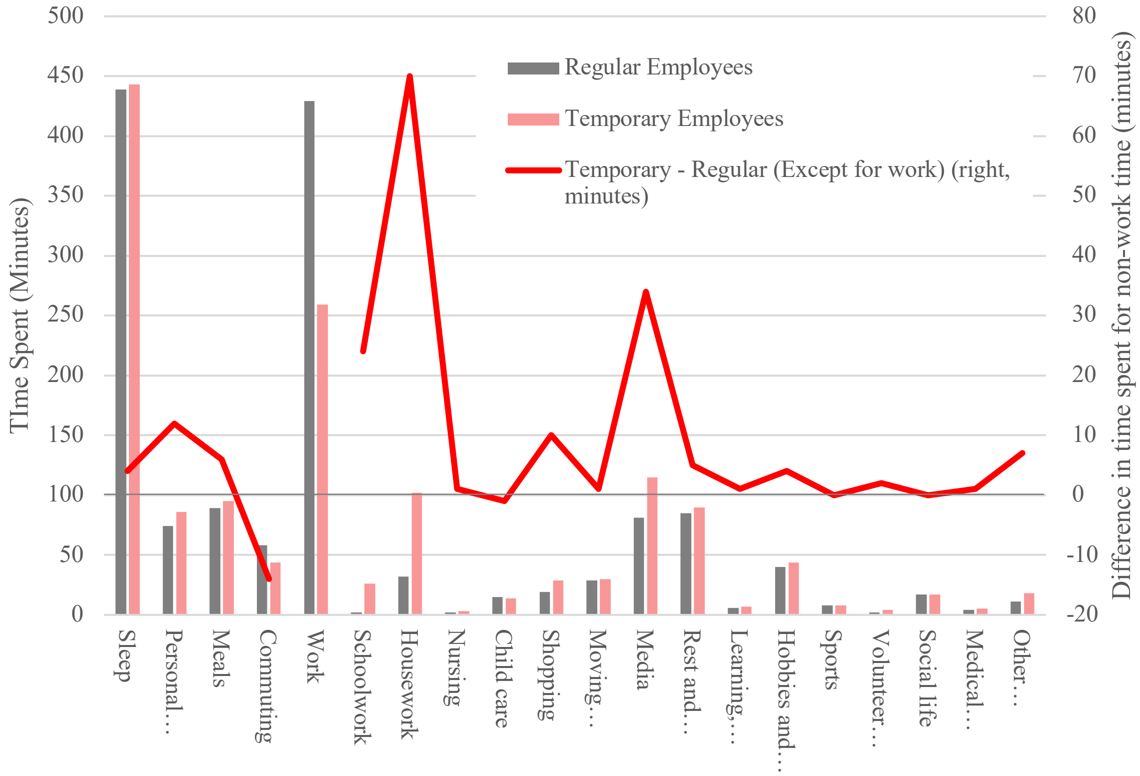

Figure A8-2. How workers spend their time (average weekday and weekends) as of 2016 (MIC, 2016).

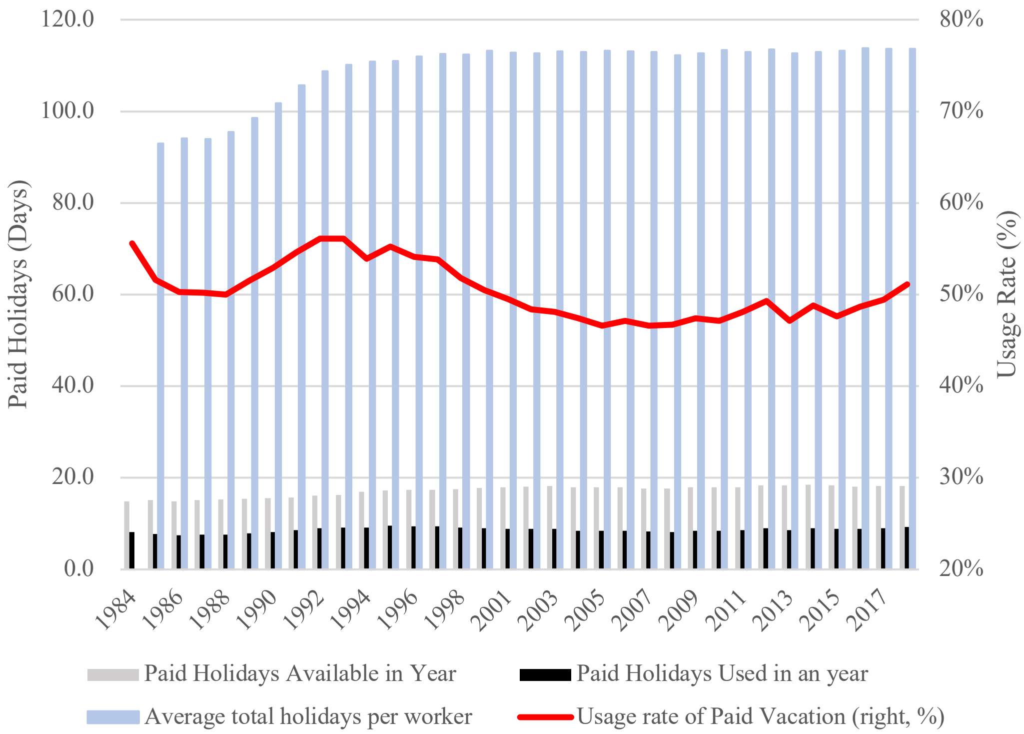

Figure A8-3. Holidays of Workers (The Japan Institute for Labour Policy and Training, 2019).

9. Demographic Distribution − Agglomeration of Population

The population in Japan has started decline after the peak in 2008 at 128.1 million, is now roughly 126 million as of 2017. It is also estimated to fall to 119 million in 2030 and 97 million in 2055. Also, elderly (over 65 years old) who live on national pension consists 27% as of 2017 while it is expected to expand to 31% in 2030 and 38% in 2055 (MIC, 2018b).

Yet, the effect of aging depopulation is not equally distributed throughout the country. There are total 7 prefectures that experienced a population increase. 6 of them are the result of surplus in social increase (in-migrants outnumbers emigrants) over natural decrease (death rate outpaces birth rate), and the remained 1 is Okinawa prefecture, the only prefecture that a natural increase outpaced the social decrease (MIC, 2018b). Other prefectures are experiencing the population decrease.

As *the figure 9-1 and 9-2 illustrate*, as of 2017, the number of in-migrants to Tokyo and its nearby area from the other prefectures outnumber that of emigrants from the same areas to the other prefectures. Furthermore, the most of the in-migrants to Tokyo and its nearby area are 20-39 years old as *figure A9-2* illustrates. Therefore, the rural areas are experiencing not only general depopulation, but also the social depopulation of productive young people.

Scenario A: Non-metropolitan areas achieve a 5% increase in productive population.
Scenario B: Metropolitan areas other than Tokyo achieve a 5% increase in productive population.
Scenario C: Tokyo area achieves a 5% increase in productive population.

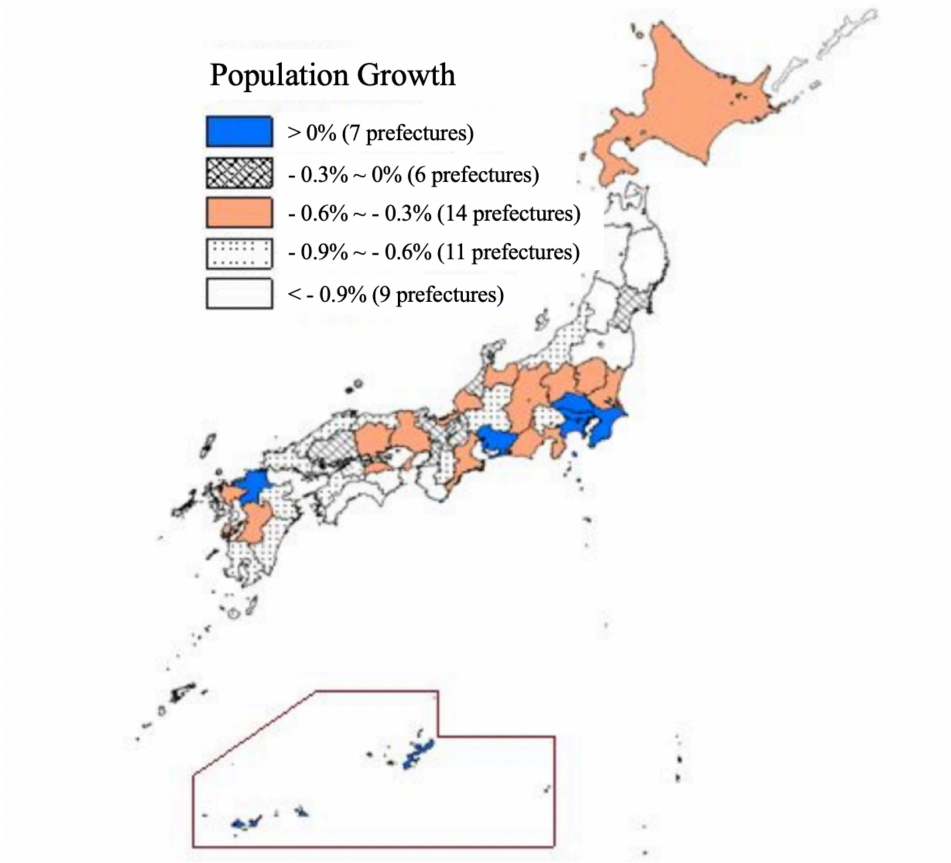

Figure A9-1. Population Growth by Prefecture as of 2017 (MIC, 2018b).

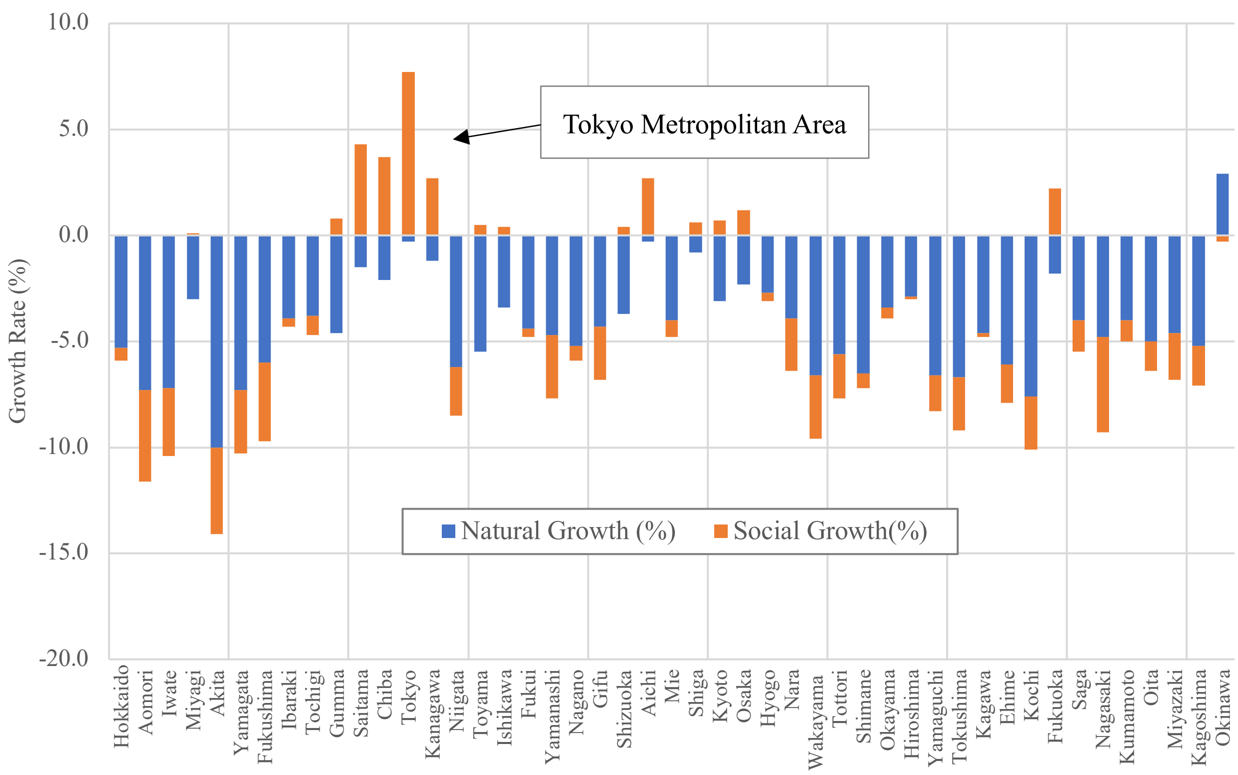

Figure A9-2. The drivers of population decrease as of 2017 (MIC, 2018b).

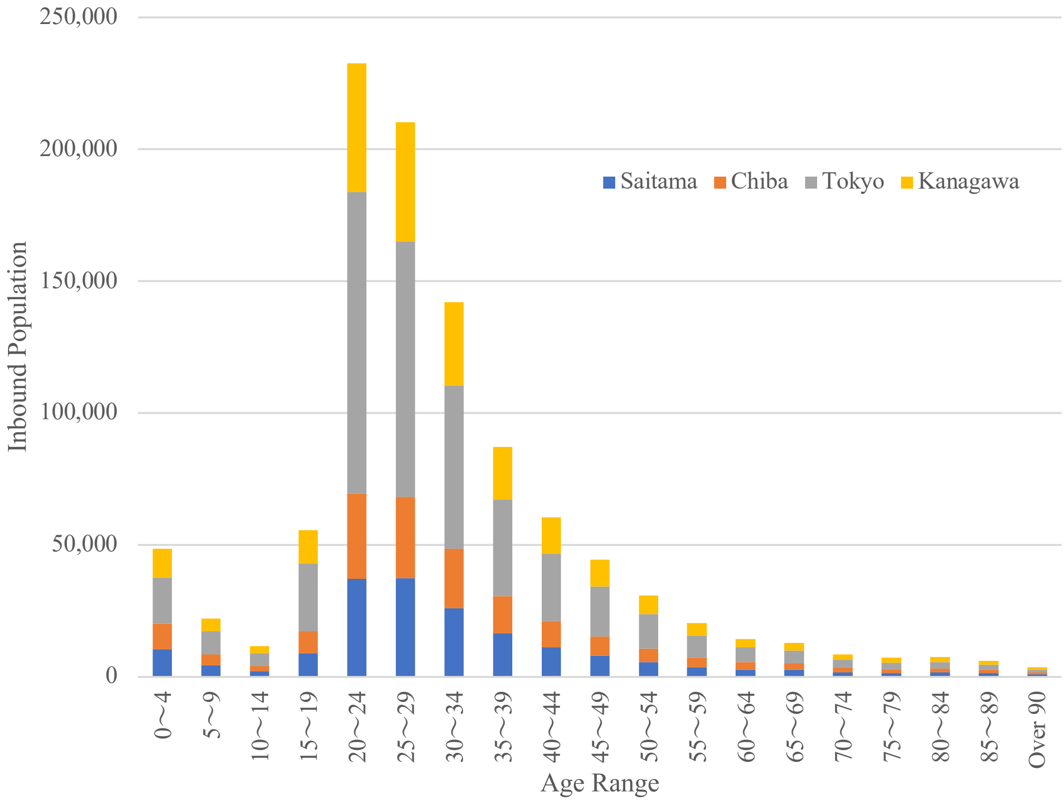

Figure A9-3. In-migrants to Tokyo Metropolitan Area by age range as of 2016 (MIC, 2018b).

10. Household Income and Assets

Average household's income in Japan peaked at 6.64 million JPY in 1994 and has been decreased by 18% since then, reaching to 5.6 million JPY in 2016. Correspondingly, average equivalent disposable income (household's disposable income divided by a root of household members), peaked at 3.4 million JPY in 1996 and decreased by 17% to 2.9 million JPY in 2016. Consequently, a Japan's relative poverty line (the half of median of equivalent disposable income) has decreased from 1.3 million JPY in 1997 to 1.06 million JPY in 2015. The share of household with income under this relative poverty line increased from 13.5% to 15.7% as of 2015 (see *figure A10-1*, MHLW, 2017).

For this matter, Berndt (2018) argues that an expansion of non-regular employment since 90s led to the deflation of working income and as a result, income inequality has risen. This point is also supported by statistics (see *figure A10-2*); as more non-regular employees enter to a labor market in 1990s, the unit labor cost started decreasing and the poverty rate has started increasing.

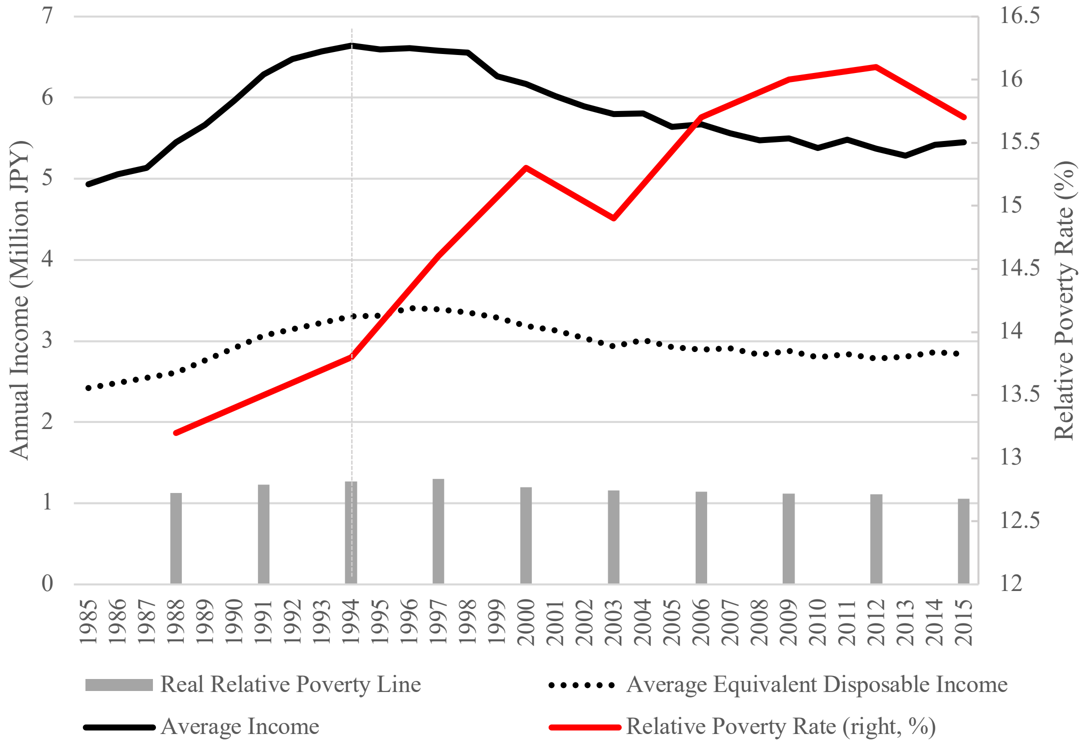

Figure A10-1. Household's Annual Income and Relative Poverty in Japan (MHLW, 2017a).

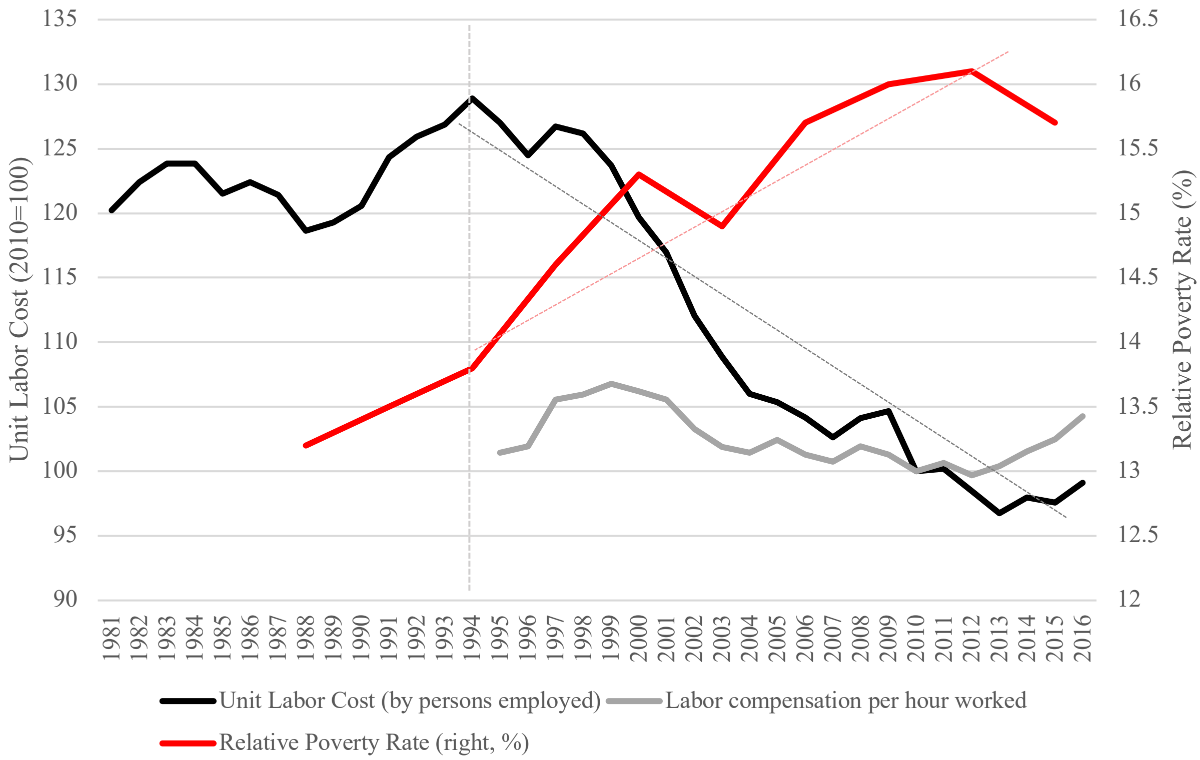

Figure A10-2. Decrease in Unit Labor Cost and Increase in Relative Poverty Rate (MHLW, 2017a; OECD, 2019).

The deflation of income correspondingly affects to assets of employee households. Saving rate of private households (% of disposable income), once 13% in 1990, shrank to approx. 2% as of 2016, and the debt of those households has steadily risen (Berndt, 2018; MIC, 2018c). As a result, median liabilities of the employee household with 2 persons or more has exceed their median saving by more than 5 million JPY, which corresponds to approx. 103% of annual income (see *figure A10-3*). Simultaneously, the number of households with financial assets has been downward since 1995, and more holders claim that their assets value have decreased or remained the same compared to the previous year's (see *figure A10-4*). As Berndt (2018) points out, this indicates that "systemic compensation for falling working income cannot be sought in gainsharing or participating in asset value increases and receiving additional income from dividends through common stock ownership" (p.52).

Scenario A: Relative poverty rate decreases to 13% and savings exceed liabilities.
Scenario B: Relative poverty rate remains as 15% but net debt expands as 200% of average income.
Scenario C: Relative poverty rate increases to 20%.

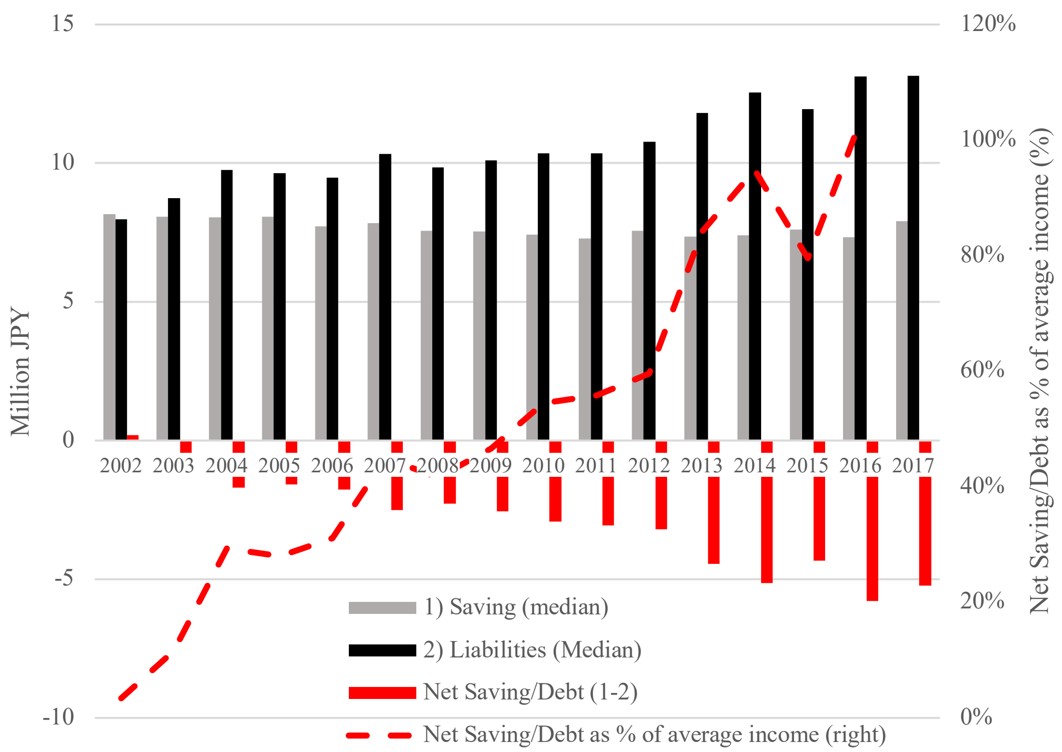

Figure A10-3. Median savings and liabilities of employee households with 2 persons or more (MHLW, 2017a; MIC, 2018c).

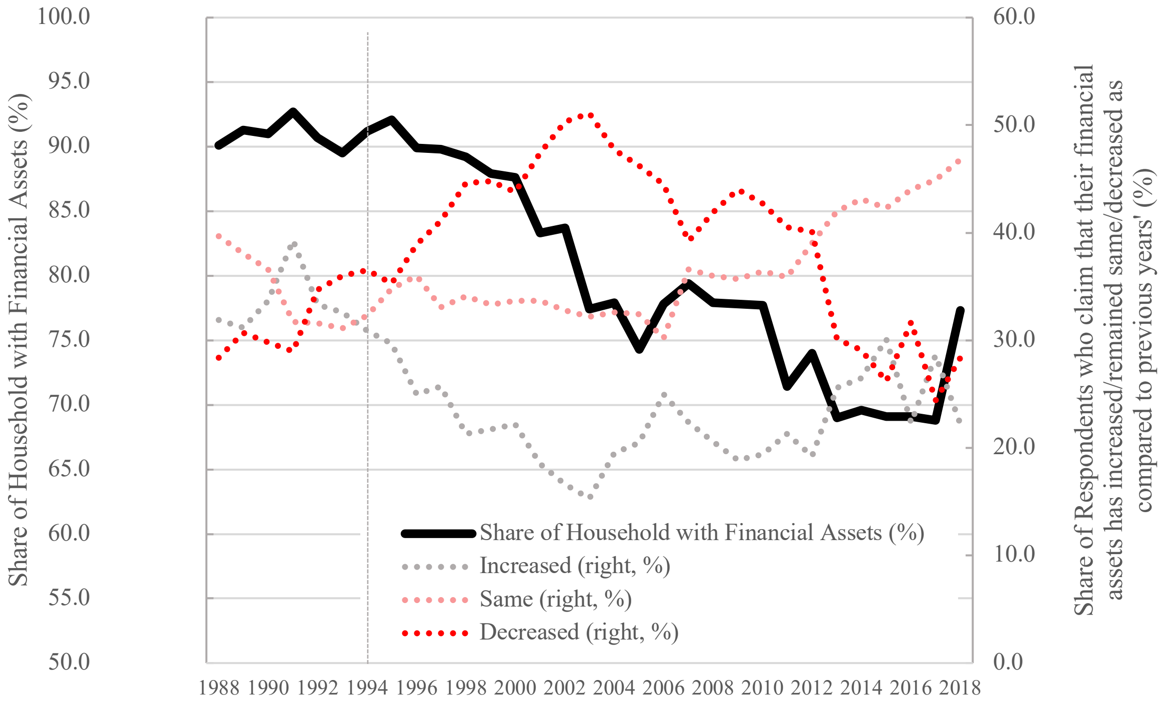

Figure 10-4. Household with Financial Assets and their yields (Central Council of Financial Service Information, 2018).

11. Innovation Policy

Japan is one of the world's largest investor in science and innovation; the share of R&D expenditure in GDP has been more than 3% since 2002, the amount which is roughly 5 times larger than the OECD average. However, despite of such intensive investment, Japan's R&D has little contribution to the productivity growth as the Japan's growth rate of GDP per hour worked is quite identical to what OECD average is (see *figure A11-1*). The crucial point here is that productivity can be met by increasing product value or, minimizing cost. In Japan's case, the productivity growth has been led by minimizing cost since late 90s, which clearly indicates difference from OECD's growth where GDP per hour worked is correspondent with labor cost (see *figure A11-2*).

Thus it is questionable whether capital expenditure simply equates to innovation and a rise in product value. Several scholars point out the characteristics of Japan's innovation policy as the root for this failure. Japan has traditionally leaned upon R&D by private sector and state's support on the domestic industry (see *figure A11-3*) (Koen, 2005; OECD, 2017). Indeed, even in light of energy industry, nuclear technology has been developed, improved and disseminated in strong corporative tie between states and utilities, and solar PV has been promoted as METI provided intensive R&D subsidy to encourage domestic industry. Such R&D efforts are largely put into effective operations and "fueling huge capital investment into scale effect which results in even more competitive convergence towards lowering price and cost and a deteriorating profitability" (Berndt, 2018, p. 93; Porter, Takeuchi, & Sakakibara, 2000). Thus, the propensity for such R&D activity is to create innovations as add-ons to protect/straighten their price competitiveness in the current business model and is not meant to deliver radical innovations.

Therefore, the fundamental problem lies on innovation policy. When you look at the other developed countries on the other hand, the United States has placed small startup companies as a prominent driver for innovation and the university and academic/scientific institutions has been playing a leading role in Germany, as Koen (2005) argues. These entities are neither necessarily funded by companies or entitled to serve for the current industry, thus may bring a structural change in the industry.

Scenario A: Public/Private funding to academics and venture become a major R&D expenditure (innovation for industrial change).
Scenario B: Private Companies fund to venture companies becomes a major R&D expenditure. (Diversifying business departments)
Scenario C: Private funding to own R&D projects keeps being a major R&D expenditure. (Innovation for cost-cutting)

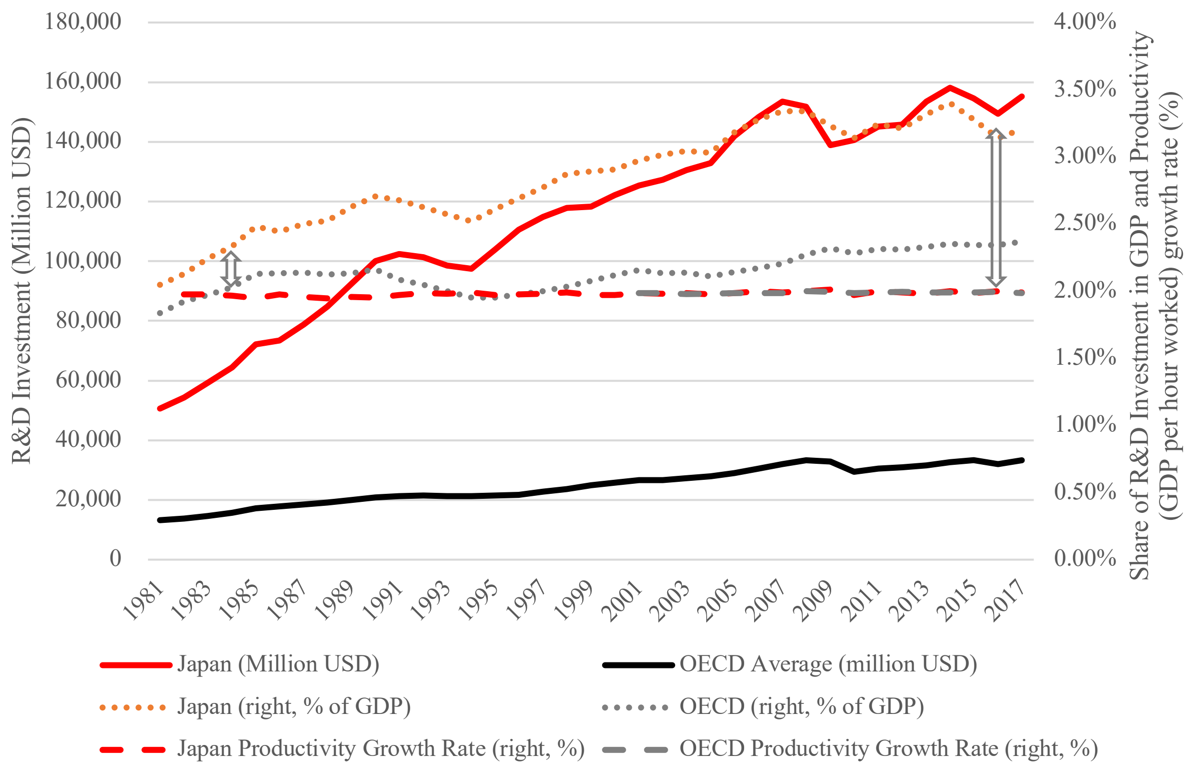

Figure A11-1. R&D investment and productivity (OECD Stat, 2019).

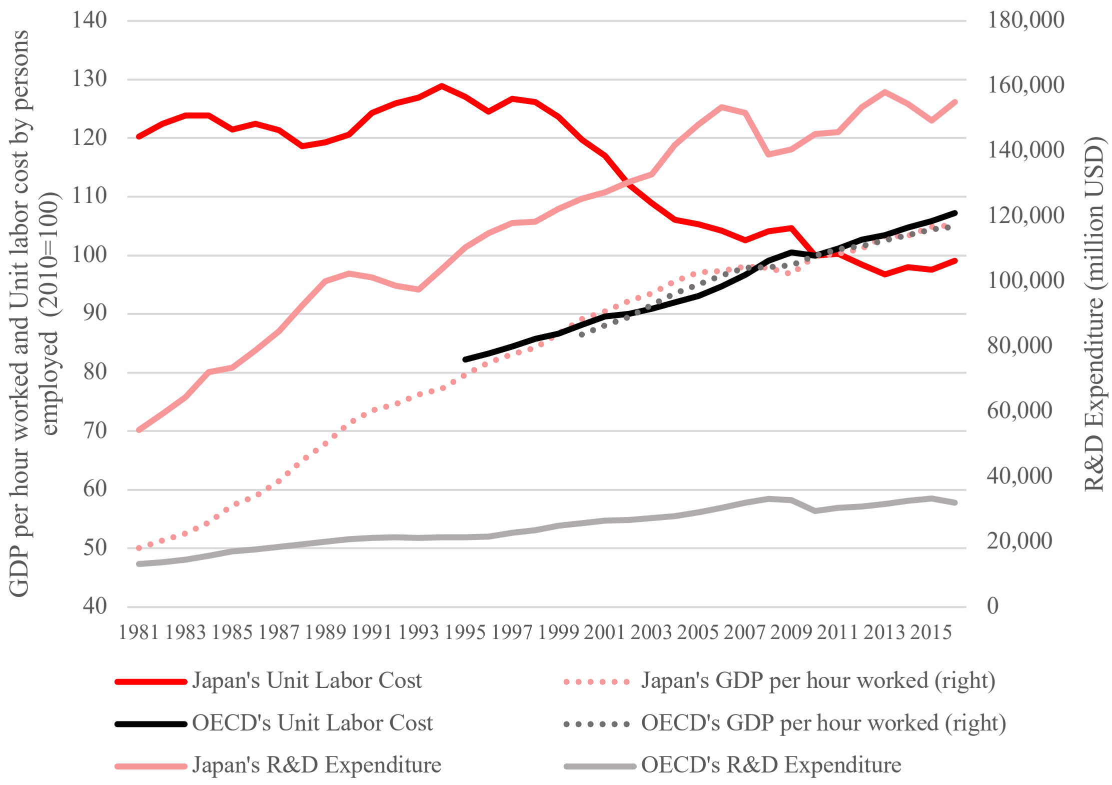

Figure A11-2. Is R&D for adding value? (OECD Stat, 2019; OECD, 2019).

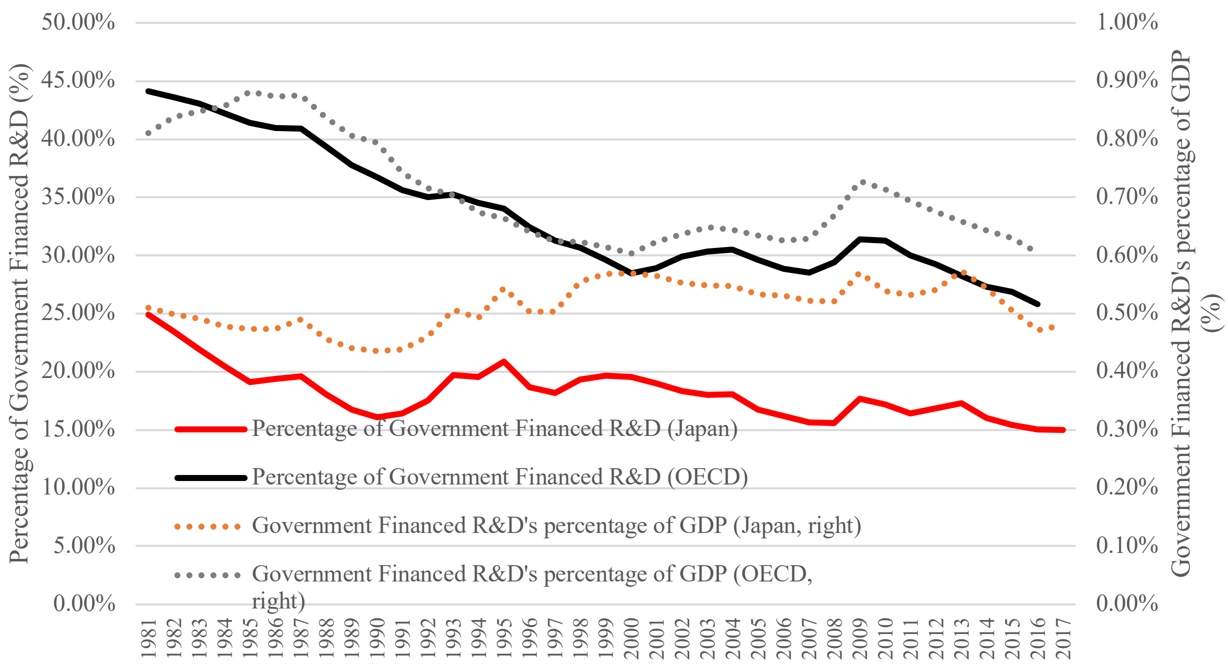

Figure A11-3. Percentage of Government Financed R&D (OECD Stat, 2019).

12. Transportation

Transportation sector comprises 23.4% of final energy consumption in Japan as of 2016. 40% of consumption in the sector comes from freight transportation and the 60% comes from passenger transportation in the same year (see *figure A12-1*). The consumption was steadily upward except during the oil shocks in the late 70s, until it gradually started decreasing since 2000s because of improving energy efficiency and shrinking transportation demand.

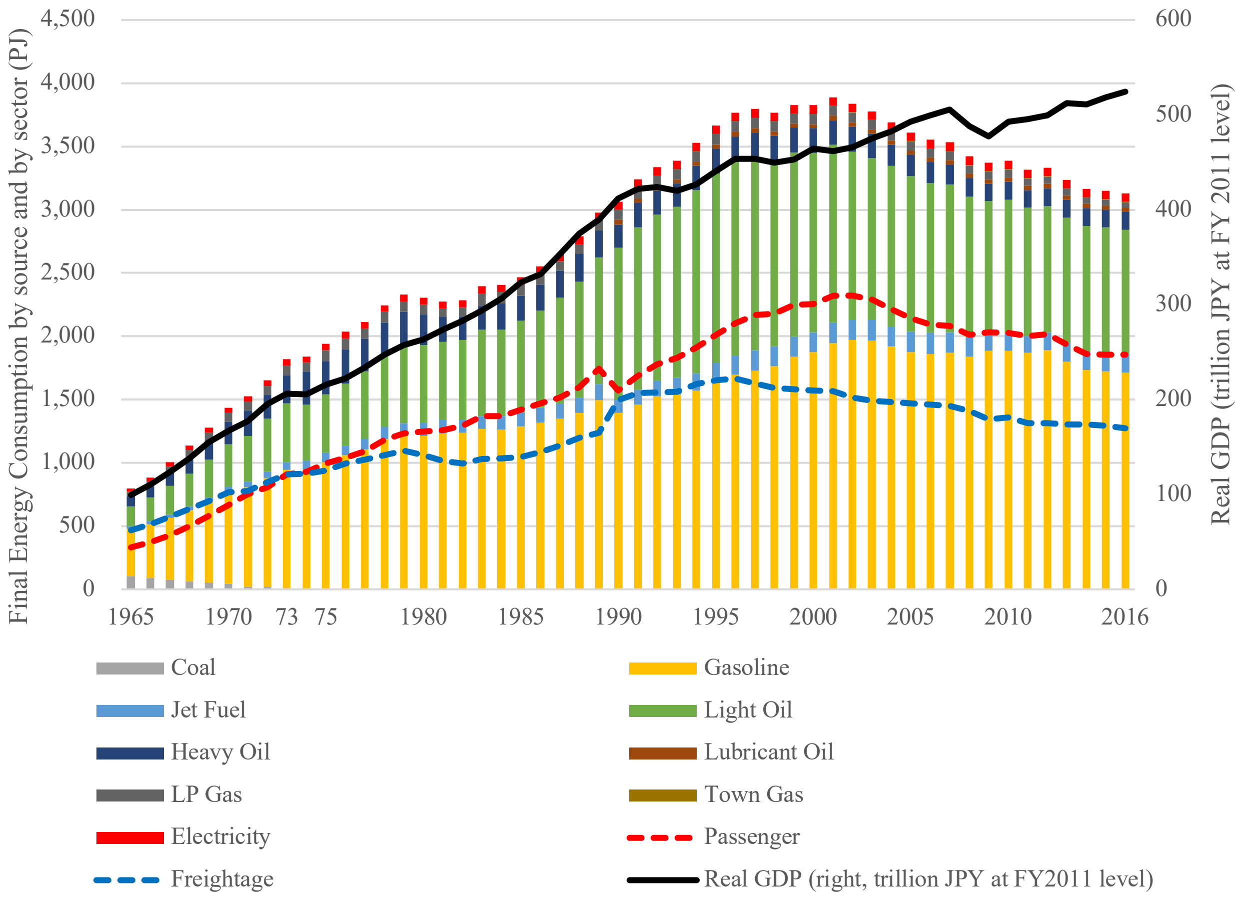

Figure A12-1. Final Energy Consumption by source and by sector (ANRE, 2018a).

When you look at the consumption by vehicle types, as illustrated by *figure A12-2 and 12-3*, approximately 82% of the consumption is derived from automobiles in passenger transportation sector, and the public transportation such as bus, train, ship and airplane only accounts 16%. Similarly, in freight transportation sector, 89% comes from tracks (41% from personal tracks and 48% from business tracks). The public transportation such as trains, ships and airplanes only accounts 10%. Furthermore, the transportation is tremendously fossil-reliant industry where 97% and 99.8% of energy consumed is derived from some sort of petroleum fuel in passenger and freight transportation respectively.

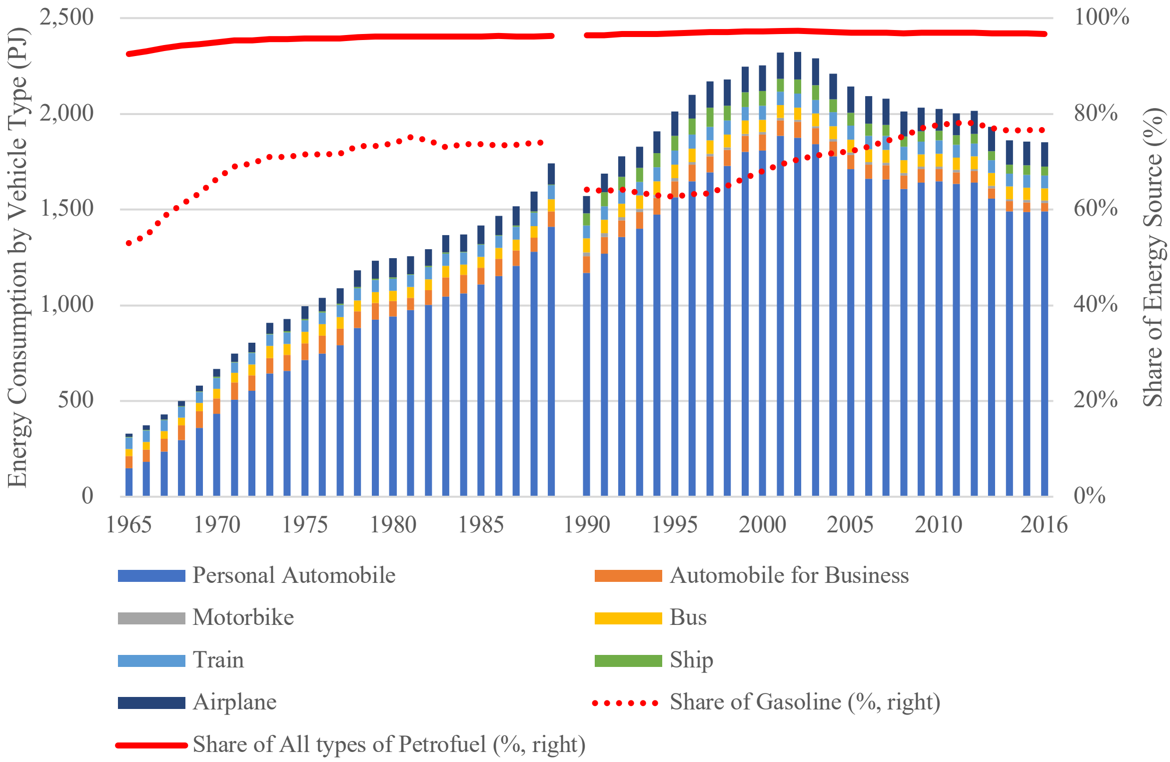

Figure A12-2. Energy Consumption for Passenger Transport by Vehicle Type and by Source (ANRE, 2018a)[40].

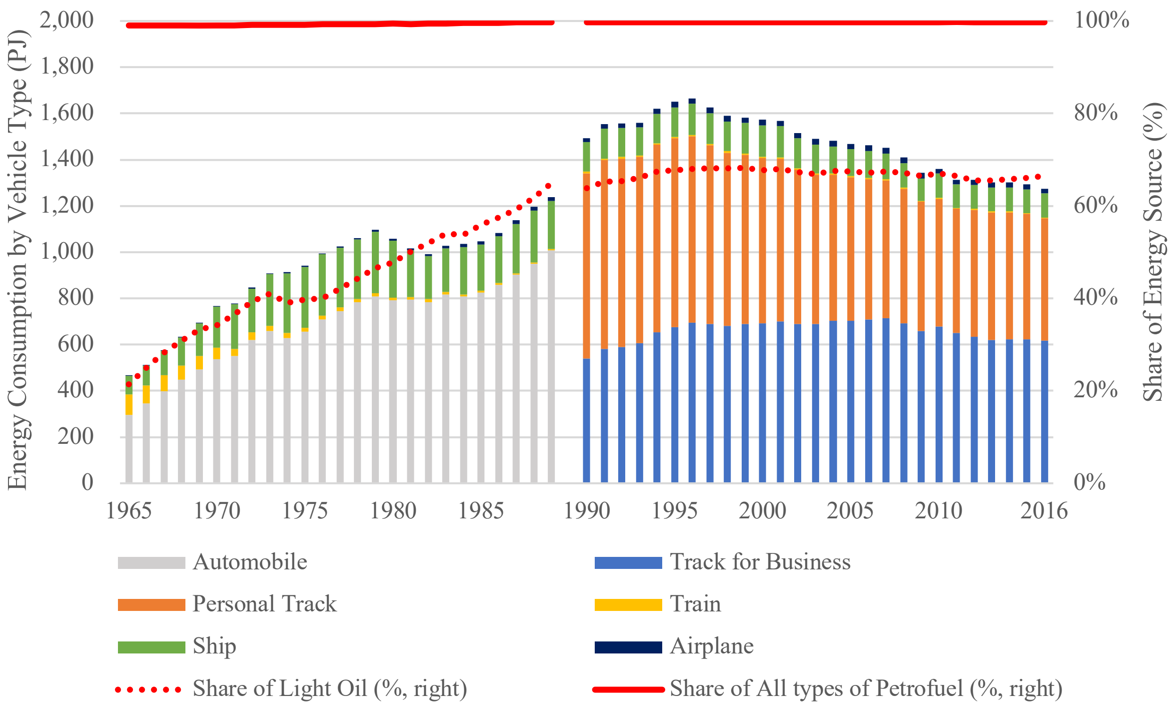

Figure A12-3. Energy Consumption for Freight Transport by Vehicle Type (ANRE, 2018a) [41].

40 The calculation method was changed since 1990.

41 The calculation method was changed since 1990 and the item "automobile" has been further differentiated between

The fact that majority of energy consumption in this sector is derived from small engines that ordinary citizens use, indicates the great potential in EV, the vehicle which can fuel itself with electricity, and electricity is the energy which can be generated from renewable energy source. However, as you can see from *figure A12-4*, EV still only consists 0.11% in Japan whereas the number of HV, the car which uses both electricity and gasoline surged since 2009 when tax exemption/subsidy scheme for eco-friendly cars legislated. Yet still, Japan is the fifth-largest EV market and domestic manufacturers such as Nissan and Panasonic are putting an investment effort (IEA, 2018). IEA (2018) provides outlooks for EV market in Japan by 2030; In new policy scenario (NPS), battery-powered EV (BEV) has to consist roughly 5% of light-duty vehicles (LDV) and Plug-in HEV for 15%. While in EV30 scenario, the target for BEV is more ambitious so as to consist roughly 20% of total LDV whereas Plug-in HEV consists 10%(see *figure 12-5*).

Scenario A: EV and Plug-in HEV consists 20% and 10% of light-duty vehicles respectively.
Scenario B: EV and Plug-in HEV consists 5% and 15% of light-duty vehicles respectively.
Status Quo: EV and HV consists 0.1% and 9% of light-duty vehicles respectively.

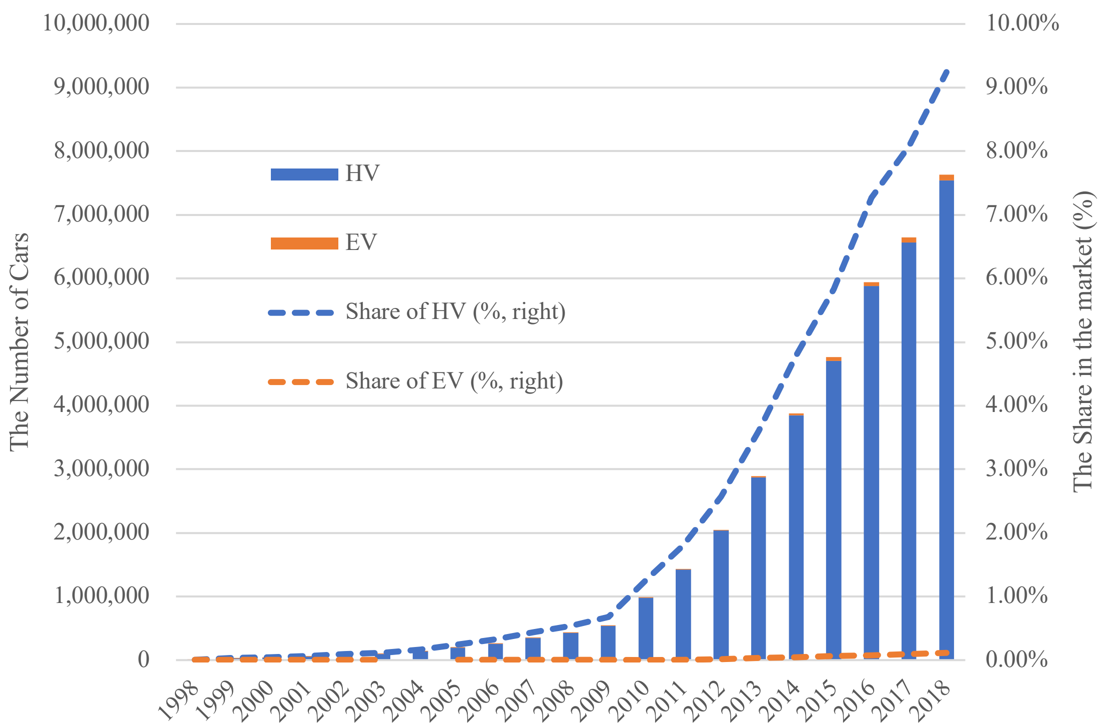

Figure A12-4. The number of EV and HV and their share in the market (MLIT, 2019a).

Personal tracks and business tracks.

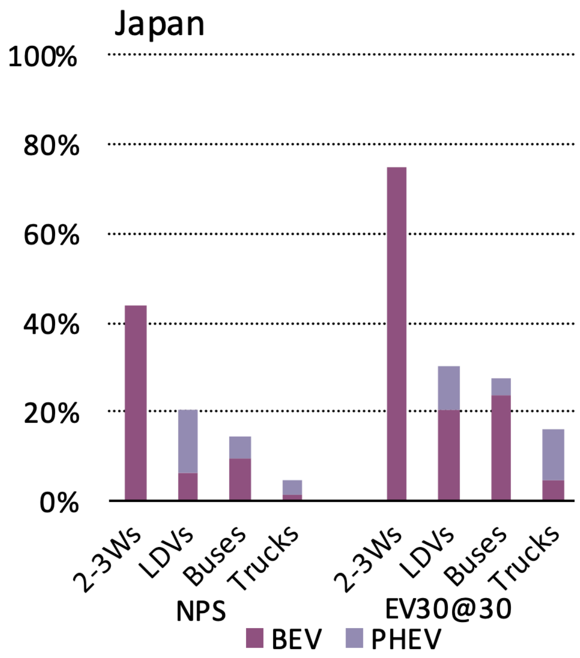

Figure A12-5. EV market share by type and scenario in Japan (IEA, 2018, p. 80).

13. Electrification

As *Figure A13-1* illustrates, electrification rate in Japan has been constantly upward since 1970s due to dissemination of electric home appliances. Electricity now accounts 25.7% of final energy consumption in Japan and 50.6% of that in households and office. Although electrification rate has more than doubled in the household and office sector since 1965, that of manufacturing sector has only increased by 19% including renewable energy that accounts 0.5% of total. The dominant energy source in manufacturing sector is still oil (34.2%) but since the oil shock in 70s, it has been replaced by the use of coal, having increased from 0.8% in 1973 to 7.3% in 2016. Meanwhile, electrification is hardly seen in transportation sector where gasoline and light oil are predominant, consisting 54.8% and 31.4% of total consumption in the sector respectively (ANRE, 2018a).

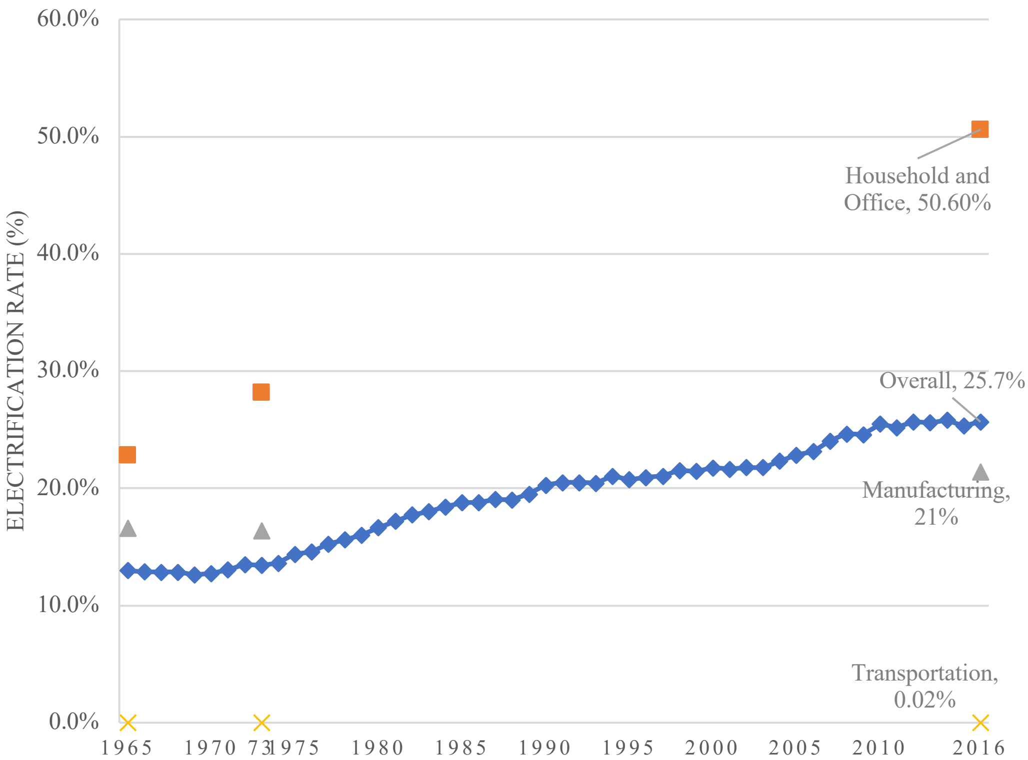

Figure A13-1. Electrification Rate by Sectors (ANRE, 2018a).

Electrification can become a powerful driver in decarbonization scenarios when it is in tandem with low-carbon emission technology (i.e. renewable, nuclear, CCS) and further improvements on energy efficiency (Oshiro, Kainuma, & Masui, 2017). However, as you can see from *figure A13-2*, not all energy demand requires electricity. Approximately 64% of the demand in household can be obtained from other types of energy source. Because electricity requires multiple energy conversion process and loss of electricity is inevitable, electrification without optimization of generation and end-use sectors may, on the other hand, turns out to be counterproductive.

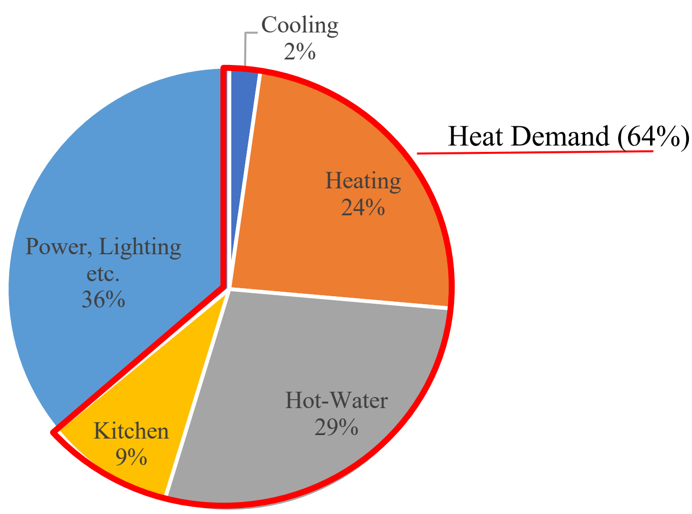

Figure A13-2. Consumption of households by energy demand (ANRE, 2018a).

Scenario A: Electricity comprises 40% of final energy consumption (Oshiro et al. (2017)'s Scenario, current Norway level)
Scenario B: Electricity comprises 25% of final energy consumption (current Japan level)
Scenario C: Electricity comprises 20% of final energy consumption (current EU-28 level)

14. Industrial Structure

Since 1960s, Japan's industries have grown in unique corporate ties called Shitauke Kozou (Subcontractor Structure). This structure has two distinctive features. First, a large company (a parent company) organized middle- and small-sized companies into a pyramid-shape hierarchy. Inside of this hierarchy, a parent company outsources certain process to middle-sized companies and the middle-sized companies, again, outsource some of their process to smaller companies, and so on. Second, these outsourcing contracts generally assume long-term period. As a result, an individual company is specialized in a specific area of a production line, yet are firmly organized each other, achieving high level of efficient division of labor system (Araki, 2008). On the other hand, this structure lets middle or small subcontractors to focus only on the production for a parent-company and neglect other business opportunities, creating significant reliance on the large company; as of 1981, roughly 70% of middle or small sized companies in Japan were in this subcontractor system (Araki, 2008).

However, the premises to support this system have slowly started breaking apart since late-80s. Those premises were 1) the steady growth of Japanese economy, 2) subcontractors are subjugated to an ordering company and 3) the domestically concluded cycle of production. Japanese economy started entering to a chronic deflation since late 80s and, with acceleration of globalization, the outsourcing activity has done internationally. These contributed to the malfunction of traditional subcontractor structure of Japan (Araki, 2008; Kanno et al., 2004).

The large companies faced to the need of cost-cutting since 90s as to secure a price advantage in the market competition with emerging economies such as China and South Korea. Subcontractors were required either to cut their production costs to satisfy their parent companies or else lose them. The result is as shown in *figure A14-1*, the gap in ROA started varying significantly by company sizes; large companies maintained at 3.5% since 90s, while that of middle and small size companies dropped to around 2% and 0% respectively. Correspondingly, the foreign production rate surged since late 80s (METI,2018a; Ministry of Finance, 2018a). As a result, subcontractors reliance on their biggest client has slowly been reduced, but as *table 14-2* illustrates, still 40% of subcontracting companies rely more than 50% of their income on one client as of 2015 (Tokyo Shoko Research, 2016). Araki (2008) asserts, it is a prime concern for middle and small companies to shift their parent-reliant business model to the one which to create their own markets by themselves. (Araki, 2008).

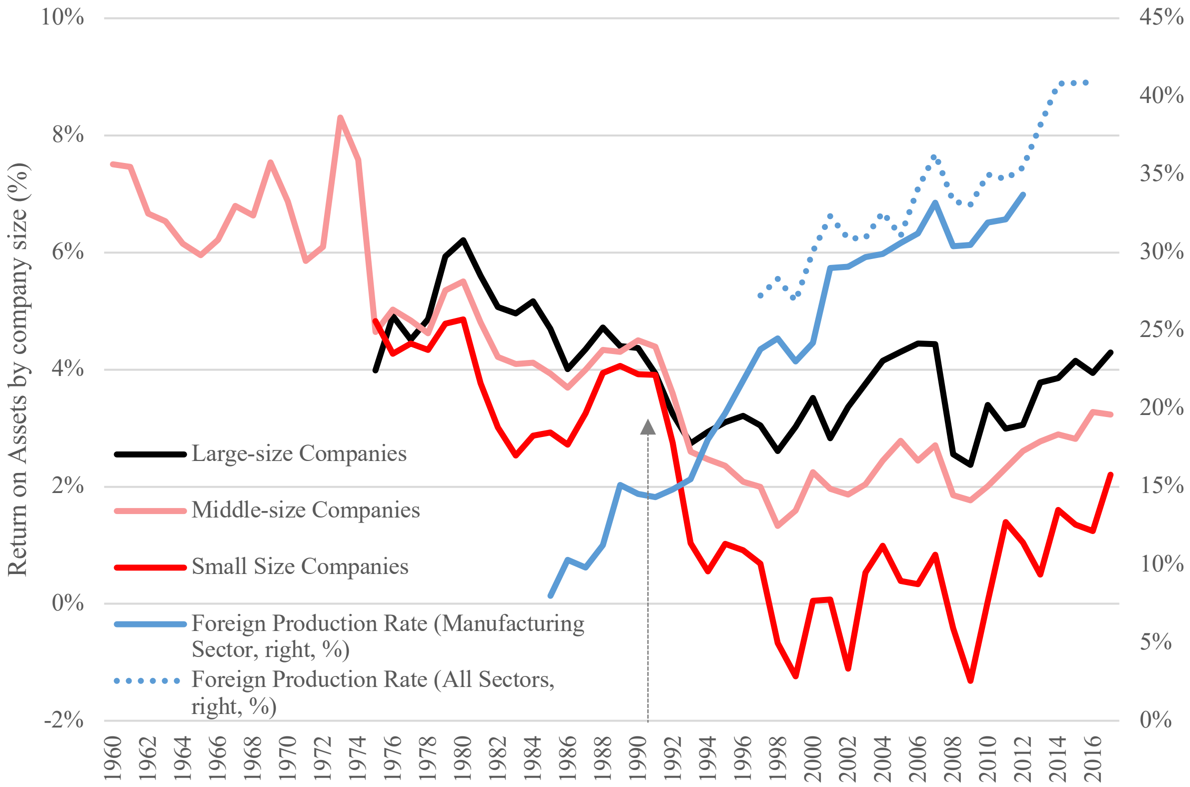

Figure A14-1. ROA in all industry except for financial sectors, by company size[42] (METI,2018a; Ministry of Finance, 2018a).

Another issue in Japan's industrial structure is its low metabolism. Generally, inefficient business will be pushed out from the market through the competition with the emergence of efficient business which bring "creative destruction" to the incumbent and as a result, a country's productivity increases (Schumpeter, 1943, p. 81). When you look at firm entry rate and exit rate of Japan[43](see *figure A14-3 and A14-4*), both numbers are historically very low compared to major western economies; the entry rate was only 5.6% as of 2016, whereas it was 14.6% and 12.7% in UK and France respectively.

[42] Large companies are those with assets more than 100 million JPY, middle-sized companies are those with assets from 10 million to 100 million JPY, small companies are those with assets less than 10 million JPY. Foreign Production Rate = Foreign Department Sales/HQ's sales.

[43] Entry Rate is the number of firms that establish during a year, divided by the total number of firms operated during previous year. Exit Rate is the number of firms that dismiss during a year, divided by the total number firm that operated in the same year.

Similarly, the exit rate was only 3.5% as of 2016, whereas it was 11.6% and 9.6% in the UK and France respectively. This indicates the stagnation of productivity in economy, of the job creation capacity, and of structural change in the industry although these rates are not only factors to determine the metabolism of economy.

Scenario A: Only 10% of small and medium companies rely more than 50% of their income on a single client. Firm entry rate increases to 15%.
Scenario B: 40% of small and medium companies rely more than 50% of their income on a single client. Firm entry rate increases to 15%.
Scenario C: 40% of small and medium companies rely more than 50% of their income on a single client. Firm entry rate remains at 4%.

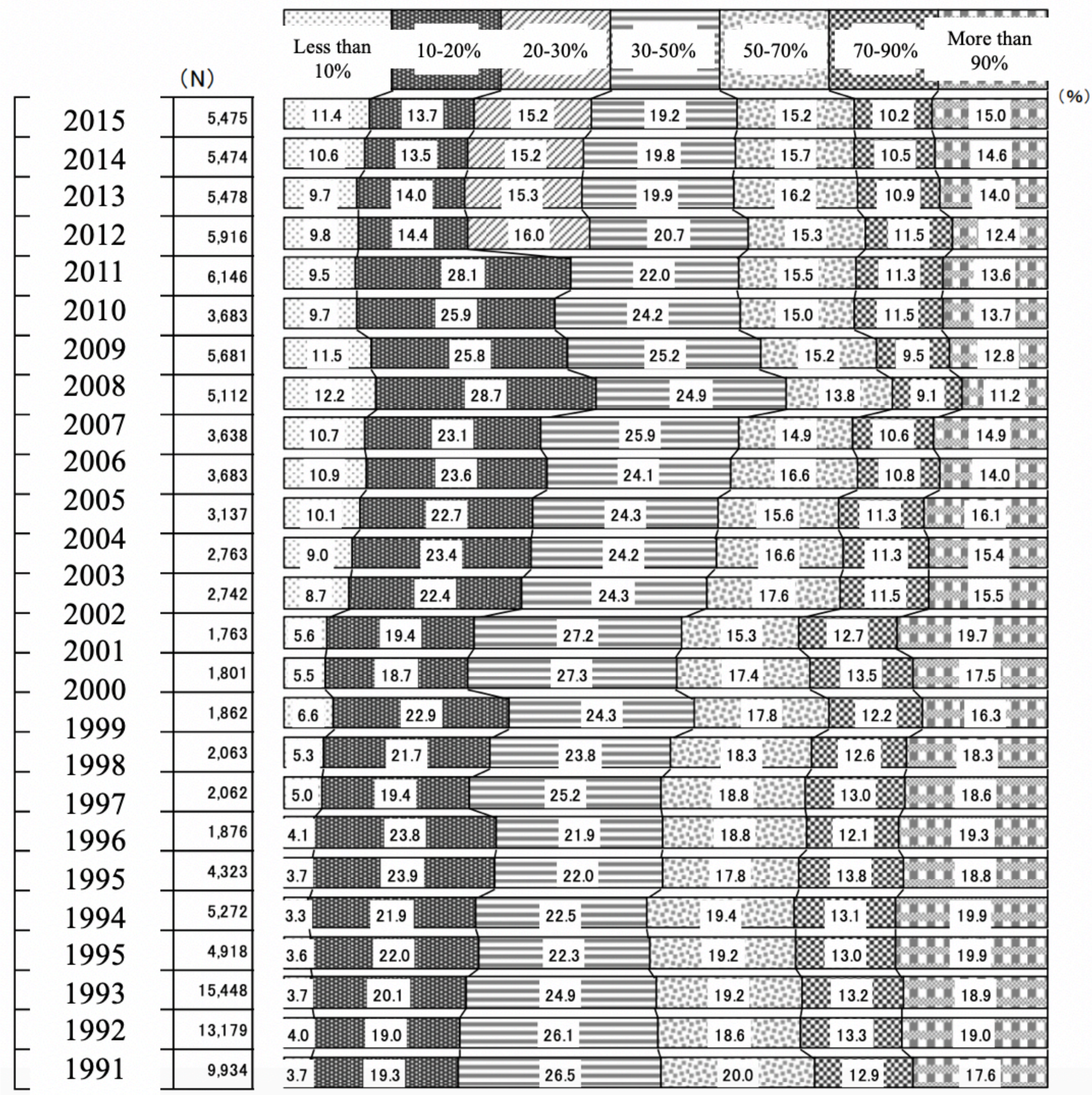

Figure A14-2. Subcontractors' reliance on their biggest client (Tokyo Shoko Research, 2016, p. 26).

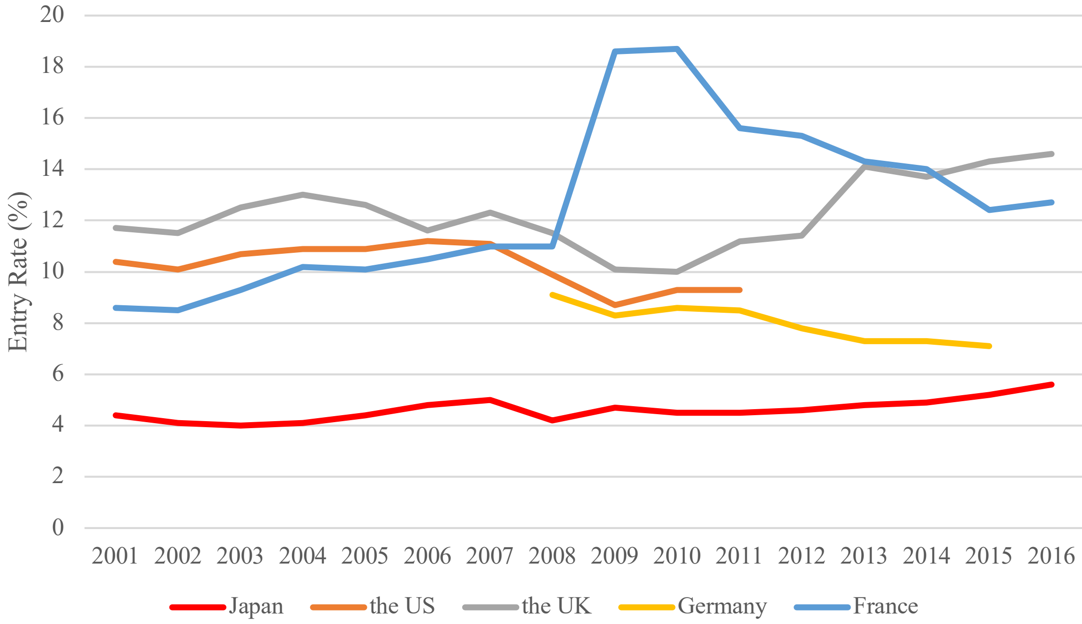

Figure A14-3. Entry Rate by country (SMEA, 2018).

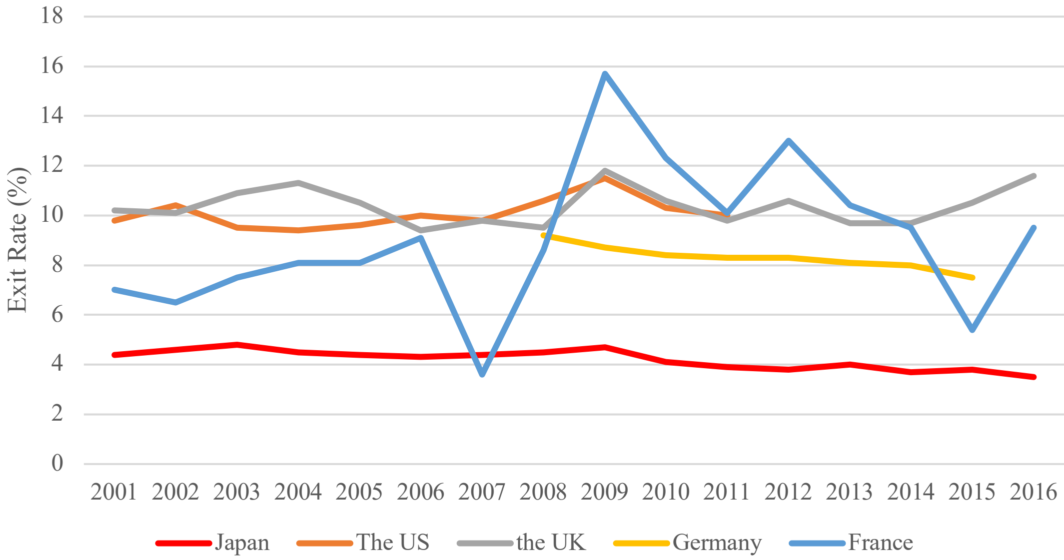

Figure A14-4. Exit Rate by country (SMEA, 2018).

15. Purchasing Decision – What do consumers value?

According to the survey done by Consumer Affair Agency (2017), consumers consider price, functionality and safeness as crucial factors when making a purchase decision. On the other hand, environmental impacts of products or CSR of suppliers are not actively considered (see *figure A15-1*). While roughly 90% of consumer value price and functionality of goods/service, only 36% and 18% value the potential of environmental and social impacts. However, this does not seem to mean that the consumers are totally blind of potential that a single purchase decision could result in environmental impact. As *figure A15-2* illustrates, 50% of people try to have the environmental impacts in mind when purchasing decision. Incidentally, these numbers have been almost unchanged since 2012 (Consumer Affair Agency, 2017).

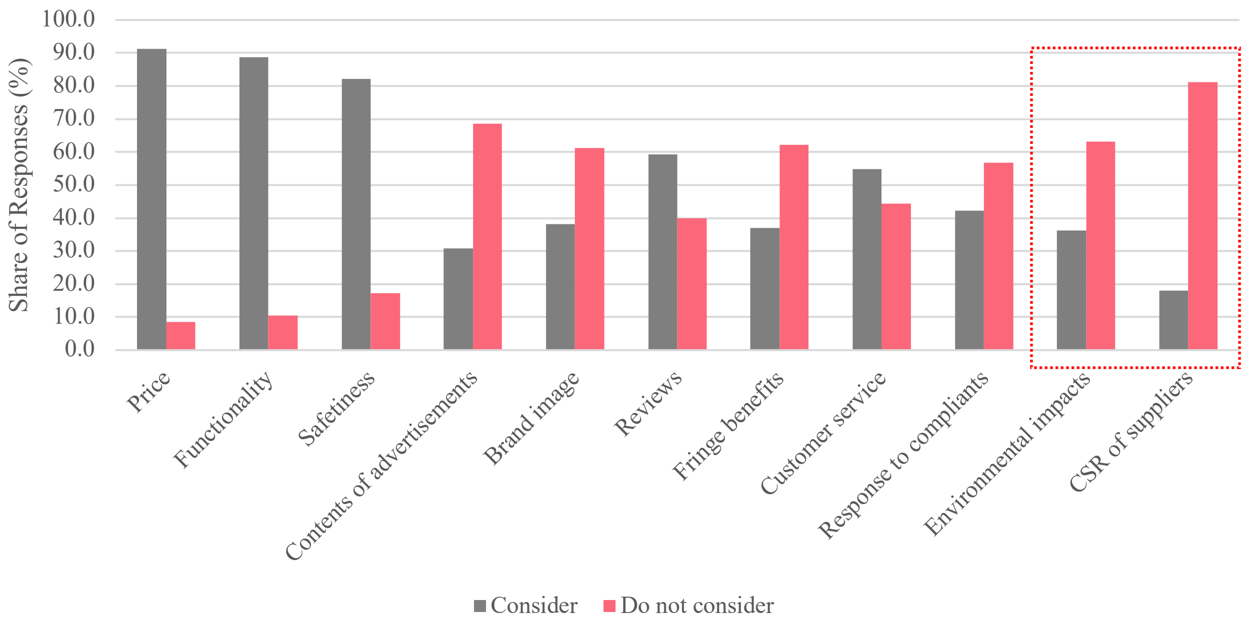

Figure A15-1. Factors that consumers care when making a purchase decision as of 2017 (Consumer Affair Agency, 2017).

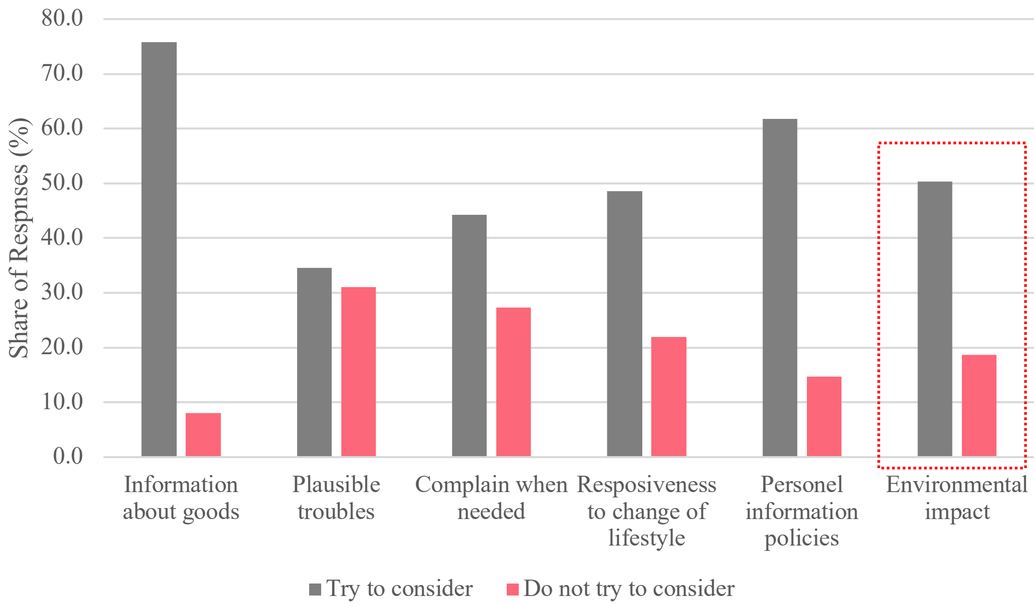

Figure A15-2. Factors that consumers try to consider when making a purchase decision as of 2017 (Consumer Affair Agency, 2017).

Kaneko, Komatsu, Nishitani, and Fuji (2011) conducted a survey to 2,155 people about the relationship between price and environmental factors and they found that the majority of respondents would prefer eco-friendly products only when their price is competitive with a market standard. However, less than 10% of respondents would purchase them if they are relatively more expensive and roughly 15% do not consider environmental factors at all (see *figure 15-3*). They also found that the share of respondents who would purchase eco-friendly but expensive products will roughly double from 9.2% to 17.4% when detailed information regarding carbon footprints of the products is given. Therefore, consumer's economic situation, social awareness and accessibility to information take a crucial role for their purchasing decision.

Scenario A: 50% of consumers value social and environmental impacts, and purchase the eco- and social-friendly goods even when they are more expensive than usual.

Scenario B: 50% of consumers value social and environmental impacts but they purchase eco- and social-friendly goods only when their price is competitive to a market standard.

Scenario C: 20% of consumers value social and environmental impacts and they purchase eco- and social-friendly goods only when their price is competitive to a market standard.

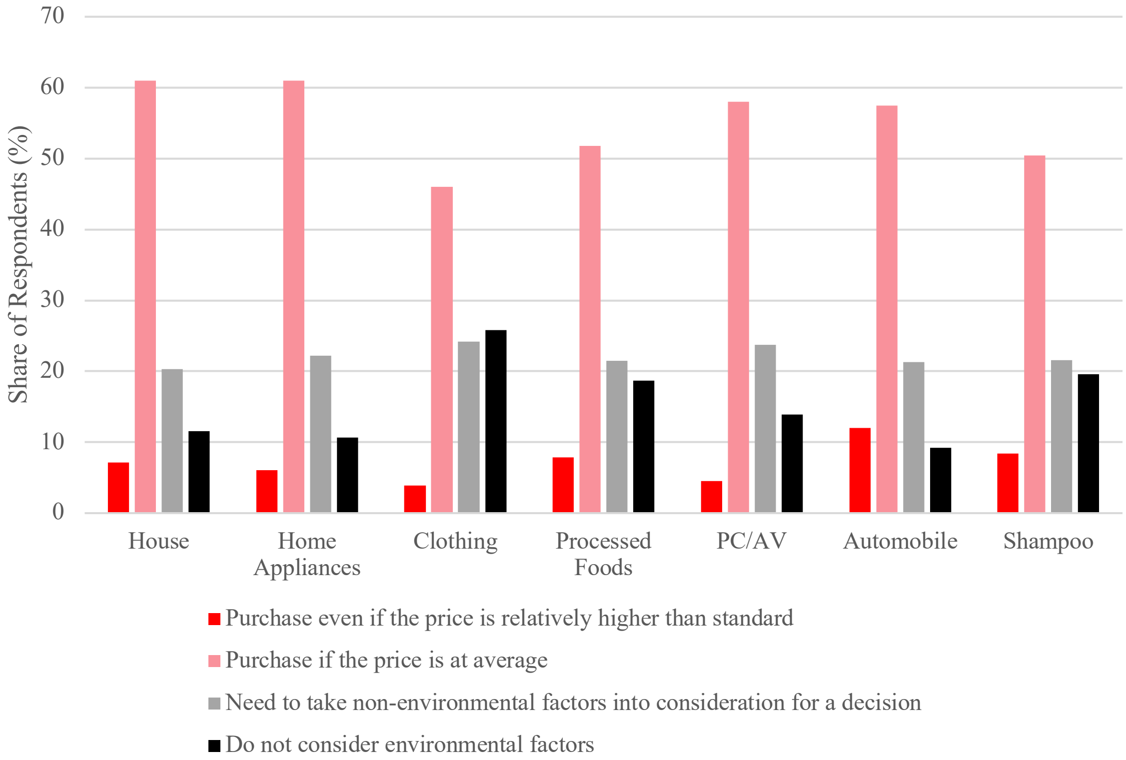

Figure A15-3. Consumer's decision making in relation with environmental impact and price (Kaneko et al., 2011).

16. Social Welfare System

Figure A16-1 represents the historical change in the welfare rate as well as the number of households and persons that are covered by social welfare system. The number has surged since late 90s, and as of 2018, 2.1 million persons and 1.6 million households receive social welfare, which in other words, 16.9% of population depend their life on the system. These social welfare does not only cover for those who are retired (older than 65), but also for those who receive income lower than the level they can sustain their lives. Thus, as discussed in *Appendix 11 "Innovation Policy"*, the decrease in a unit cost of labor also is also attributable to this system. However, as shown in *figure A16-2*, the majority of social welfare expenditure is for pensions and medical cost.

In aging society where productive population declines and the recipient population increases, the burden rate (burden vs. income) also increases. As of 2016, each person supports this system with 47% of its income, and this amount is equivalent to 22% of GDP. Furthermore, according to Inagaki (2010)'s simulation, the current public pension system should result in a considerable increase in the number of low-income elderlies as *figure A16-3* shows.

So in alternatives, Inagaki (2010) proposes several plans. First, all elderly receive the same amount of pension benefits while ignoring the past premiums (Plan A in *figure A16-3*). In this way, the number of poor elderlies will considerably decrease by 2030 while not stretching budget so much. Yet, the problem lies at the unfairness that those who paid extra money as premium will not have their returns. Plan C, on the other hand, is the plan that adopts uniform pension to all elderly while keeping premiums. This greatly enriches elderly, but it stretches a budget plan. He also proposes an alternative plan that suggests that a pension benefits for the elderly with low pensions and low incomes implemented only for the late-stage elderly (older than 75). The premiums benefits are not paid during early-stage elderly. However, this proposal provides no measures on low-pension and low-income early stage elderly. Furthermore, though this scheme does not incur as much additional cost as Plan A, it still follows the current welfare system, thus the burden of productive generation will still be worsened as the population ages.

Meanwhile the idea of adapting basic income (BI) is also discussed (Sudo, 2016; Yano, 2009). The basic income is the notion that the government provides fixed amount of cash (generally around 50 thousand JPY each) to their all citizens. BI is claimed to have merits of expanding disposable income thus inducing consumption, relieving the risk for losing income thus encouraging people to work in diverse ways and improving work-life balance, and making the grant process easier than the current system thus cutting administration cost. However, the implementation of basic income is based on the abolition of current welfare system. For those who have been paying pension premiums for half of their lives will also receive the same amount of money to those who haven't (Sudo, 2016; Yano, 2009). Thus, it should evoke the sense of unfairness.

Scenario A: Basic Income is implemented, and the current pension funds and low-income support scheme are abolished. Social welfare expenditure accounts 40% of GDP.
Scenario B: All elderly (older than 65) will receive the same amount of pensions, regardless of how much premiums they have paid in the past (Basic income only for elderly). The social welfare expenditure accounts 30% of GDP.
Scenario C: The current scheme goes on. There will be a large income disparity among elderlies. The social welfare expenditure accounts 30% of GDP.

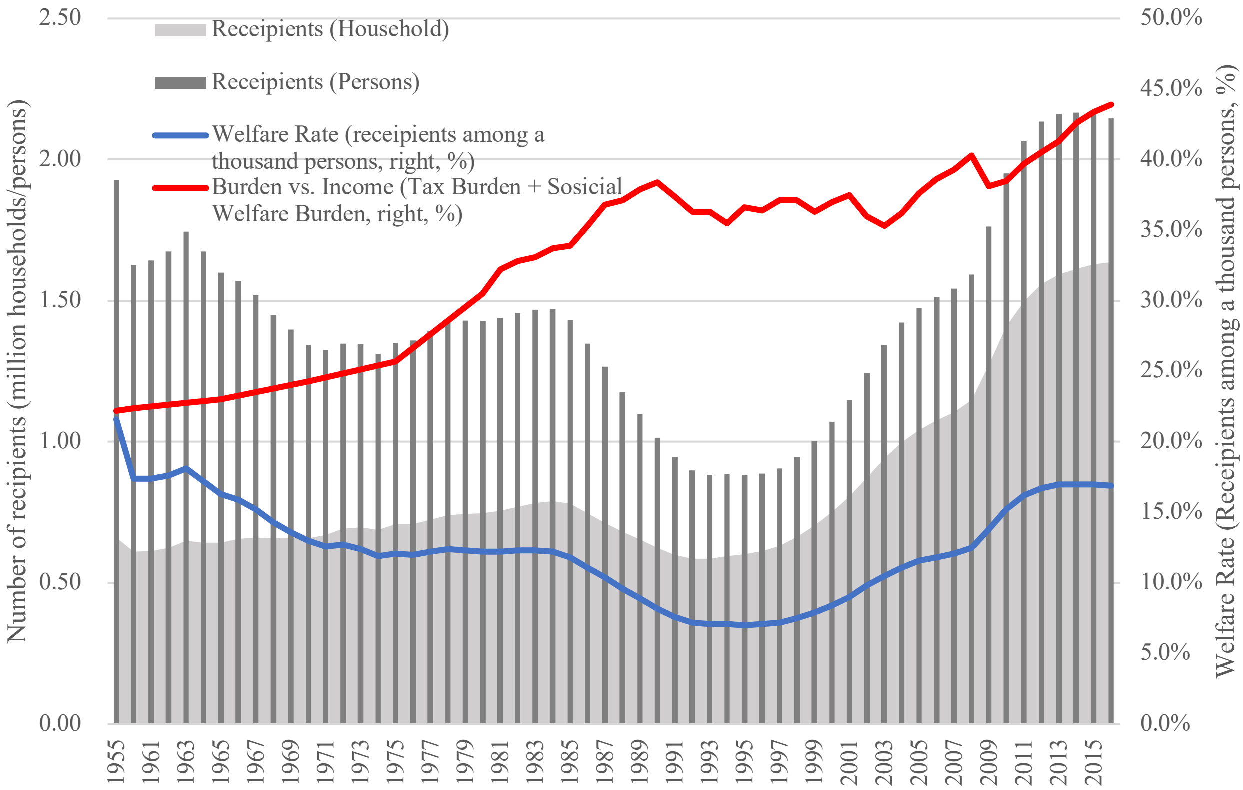

Figure A16-1. Recipients of social welfare in Japan (Ministry of Finance, 2019a; MHLW, 2018; NIPSSR, 2017).

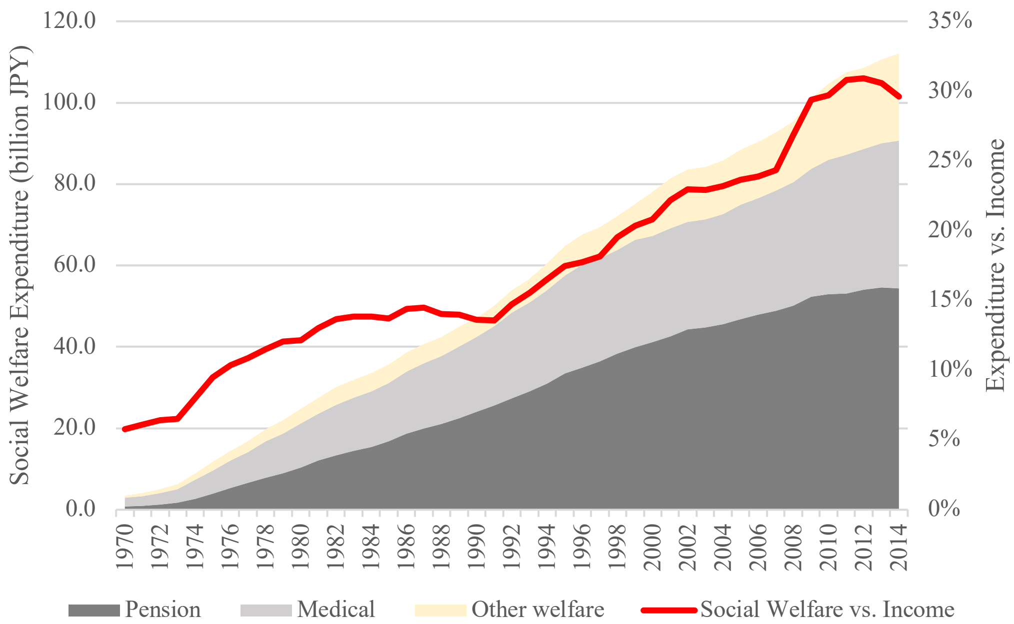

Figure A16-2. Expenditure for Social Welfare (NIPSSR, 2017).

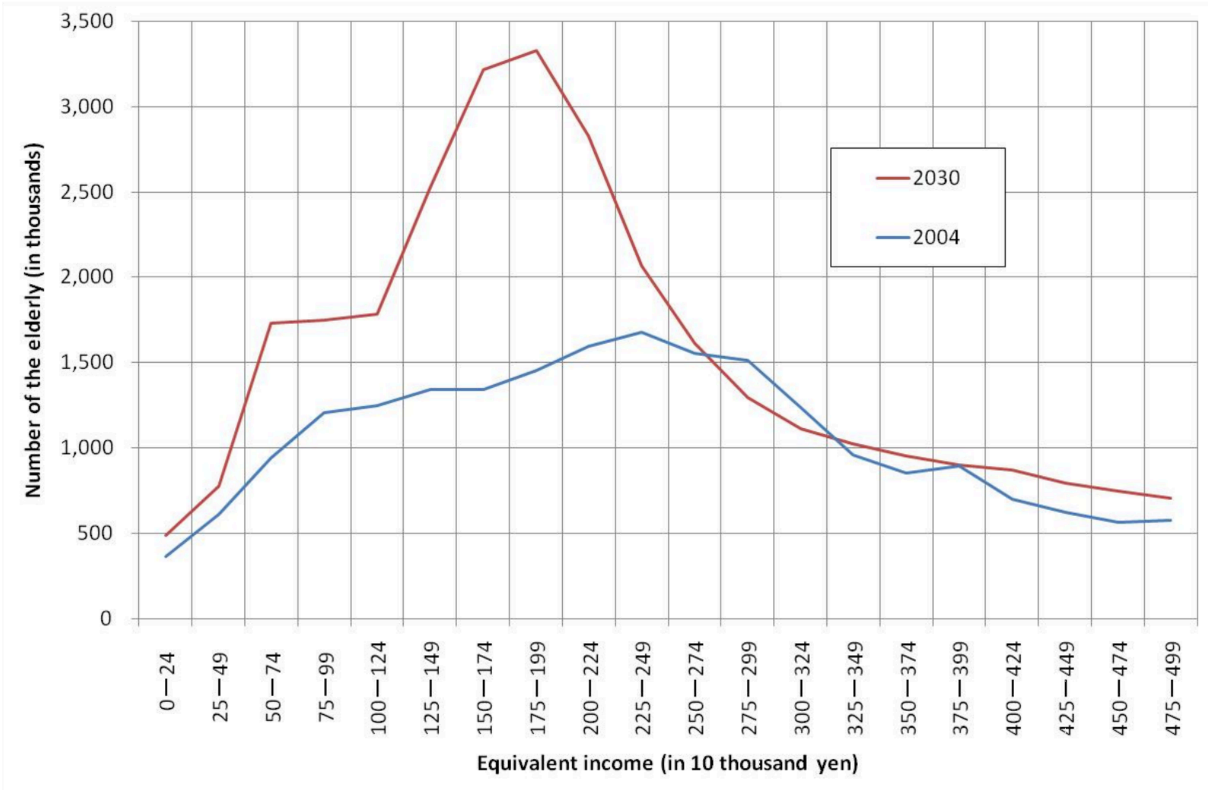

Figure A16-3. The number of elderly by equivalent income by 2030 (Inagaki, 2010, p. 9).

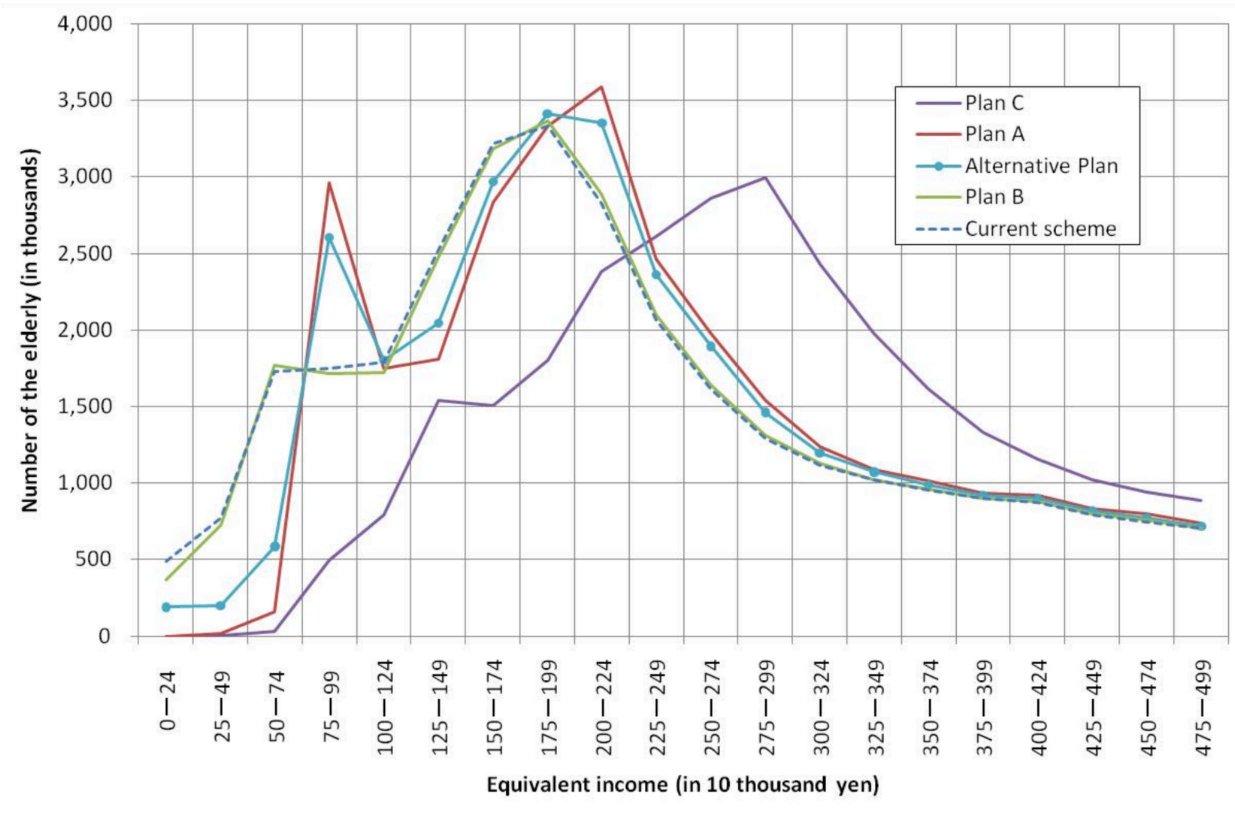

Figure A16-4. Inagaki (2010)'s simulations and proposals (Inagaki, 2010, p. 11).

17. Social Awareness toward Environment

National Institute of Environmental Study (NIES) conducted a national-wide survey in 2016 about environmental awareness among Japanese citizens. According to the result, the vast majority of Japanese citizens (94.1%) think that the climate change is happening and that they have already been experiencing its impact (76.7%). For the matter of causality, roughly 10% thinks that a climate change is a natural phenomenon whereas 42.2% thinks it is a result of mixture of natural phenomenon and human activities. On the other hand, 36.7% considers that climate change is mostly induced by human whereas 10.1% considers it solely responsible of human behavior (see *figure A17-1*). Thus, most of them are aware of climate change (94.1%) and its urgency (76.7%) as well as the role of human activities (89%) although there is a dissension on to what degree human activities cause climate change. There is only 0.5% who doubted the presence of climate change.

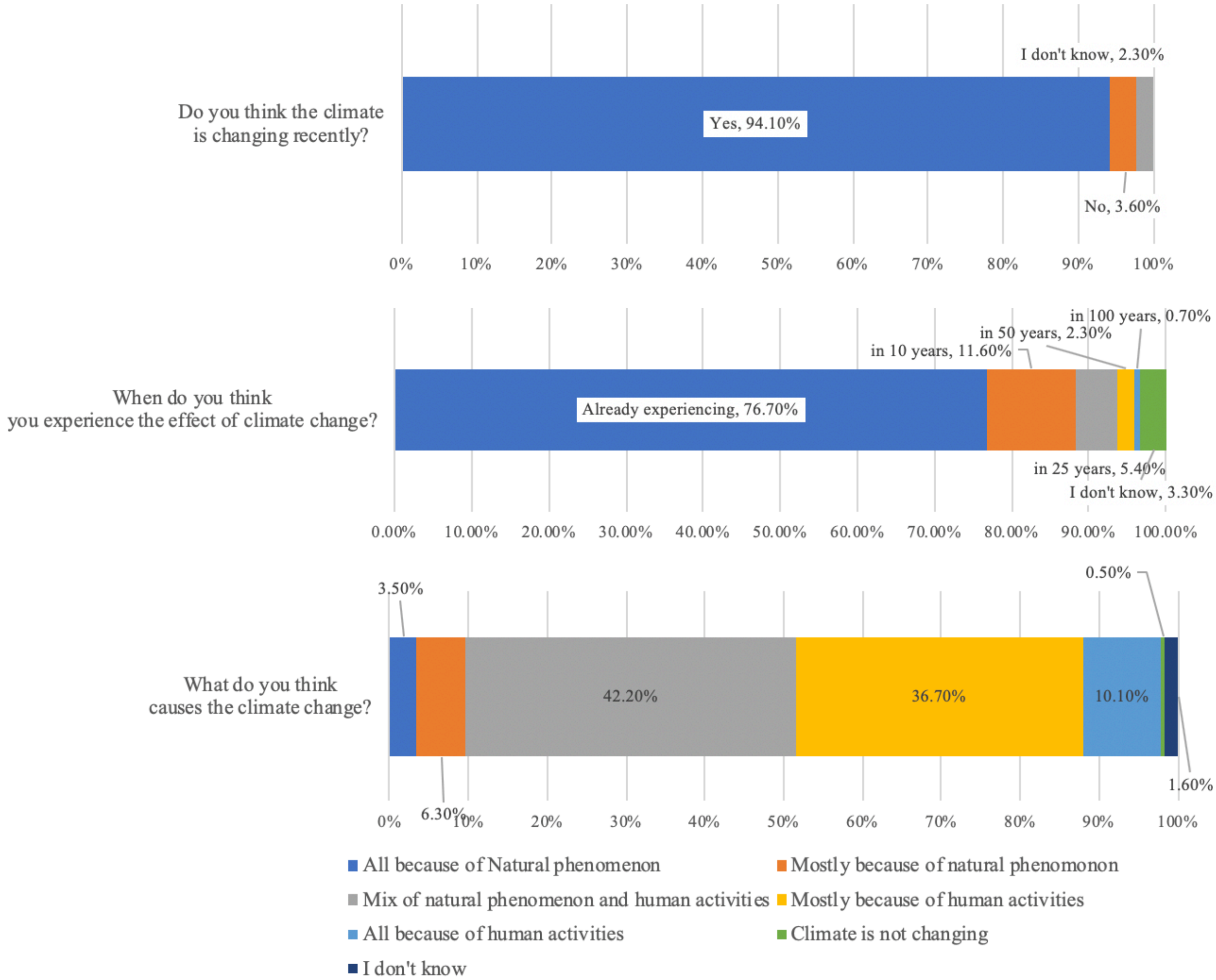

Figure A17-1. Is climate change happening? How serious is it? What causes it? (NIES, 2016).

As for actions, roughly 70% of them think that Japan and respondents themselves should take more robust actions to mitigate the issue. However, when the topic comes to their own responsibility, the respondents become less opinionated; 24.6% deny their responsibility for climate change and 28% neither agree nor disagree, although still 46% acknowledge the responsibility. On this matter, respondents showed similar perceptions toward people around them as well. Furthermore, they also tend to think that the people around them are more passive toward actions for climate changes; while roughly 20% of respondents think that people around them either perceive the importance of actions or have already taken actions for climate change, roughly 50% denied so.

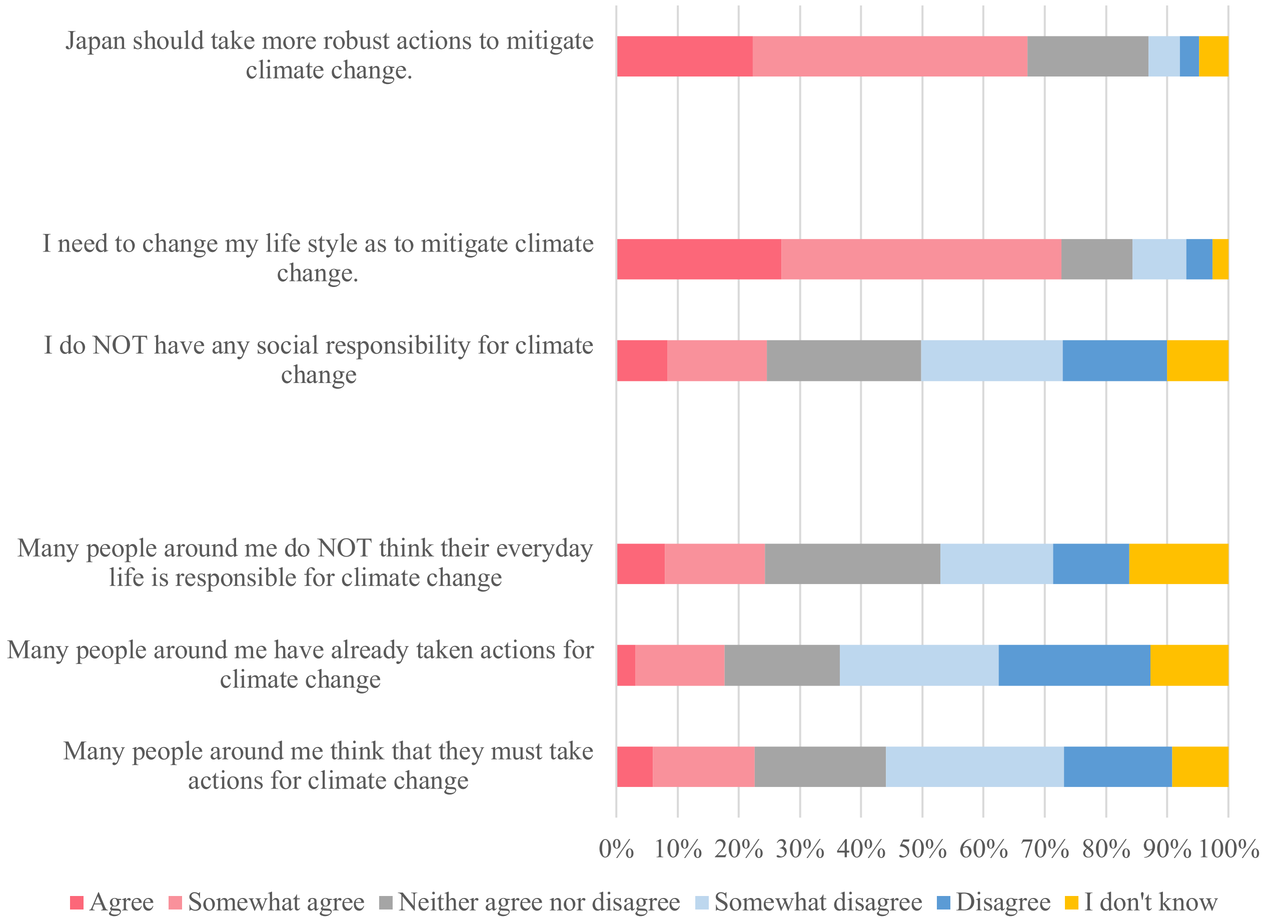

Figure A17-2. Public perception of responsibility (NIES, 2016).

Overall, it is safe to say that the lay public is cognizant of environmental problem and an importance of taking actions. Still, the question lies on how serious they think the problem is. The survey done by Cabinet Office (2018) reveals that people who think that the environmental condition is getting worse drops from 43.5% in December 1998 to 9.1% as of February 2018 whereas people who believe that it is getting better has slightly, but certainly increased from 7.4% to 9.1% (see *figure A17-3*). In other words, Japanese public has become less pessimistic, if not more optimistic, about environmental issues over the past 30 years. However, the amount of Japan's GHG emission as of 2017 is almost identical as 1998, only decreasing from 1,348 million tons to 1,294 million tons of CO2 equivalent. At this pace, the global temperature is expected to rise by 3-4 degree compared to the one of pre-industrial era, which is not something we can take as the natural environment getting better but worse. This leads to the discussion of in what scope and of seriousness Japanese public will perceive the problem (Cabinet Office, 2018c; Climate Tracker, 2019; Ministry of Environment, 2017).

Scenario A: 90% of the public is aware of 2-degree target and of the urgency to achieve it.
Scenario B: 90% of the public is aware of climate change but not of urgency to achieve 2-degree target.
Scenario C: 50% of the public doubts the climate change as humanly induced phenomena.

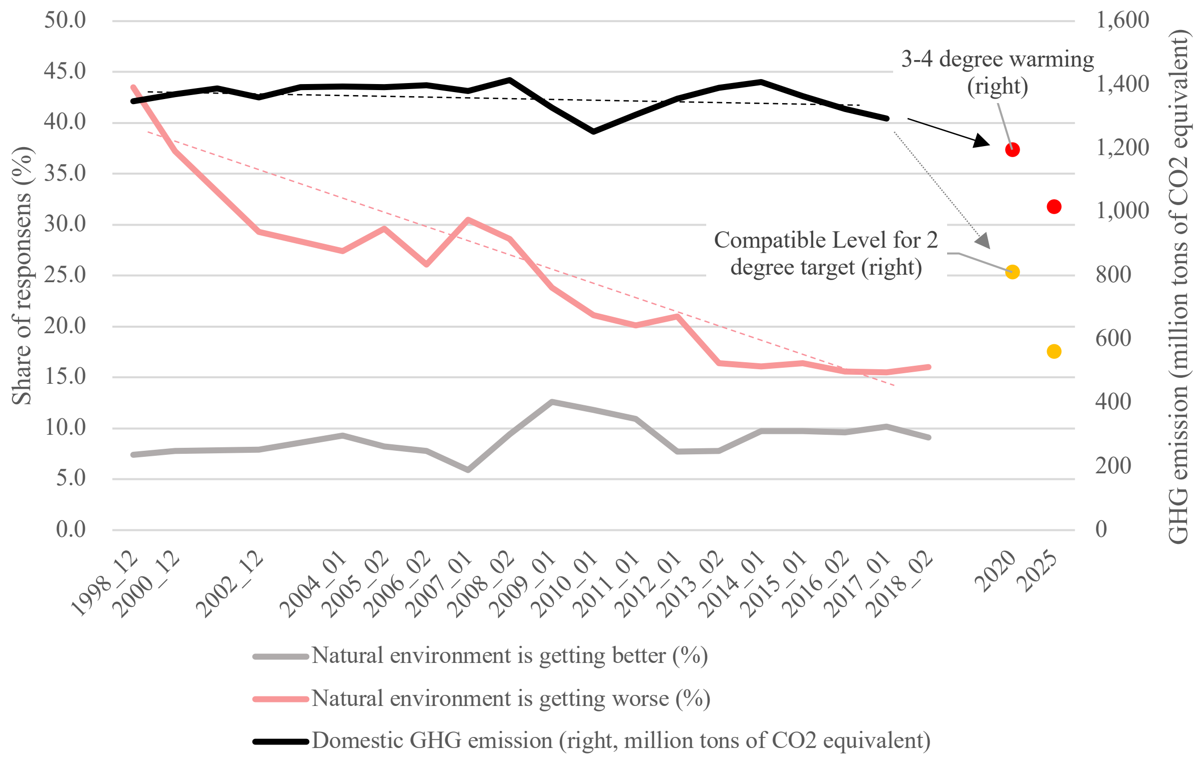

Figure A17-3. Public perception of the situation and the GHG emission (Cabinet Office, 2018c; Climate Tracker, 2019; Ministry of Environment, 2017).

18. Taxation

In Japan, the amount of tax/stamp income reached its peak in 1990 but it fluctuated since then. As of 2018, it amounts 59 trillion JPY whereas approximately 100 trillion JPY is required for total budget (*figure A18-1*). Japanese government has been compensating the gap by issuing government bonds since 1965. The yearly issued amount has surged especially since 2000s as to support enlarging social welfare cost and invest in public works, aiming to create jobs in local area (see *Appendix 7 for detail*)

(Fujioka, 2011; Ministry of Finance, 2018b).

In 2018, the government newly issued 33.6 trillion JPY as to cover the income deficit. In the same year, the cost regarding the bond servicing (such as interest payment) is roughly 23 trillion JPY. Thus, the servicing itself absorbs 23% of general accounting and 36% of tax/stamp revenue. As of 2018, the Japanese government holds a debt stock of 976 trillion JPY, the amount which is roughly equivalent to 156% of the country's GDP (see *figure A19-2*). In a situation that the cost of social welfare and infrastructure maintenance is expected to increase greatly, the government needs to find a way of solution not only to reduce the debt stock but also to cover up the bond serving cost that eats up more than two-thirds of its yearly income.

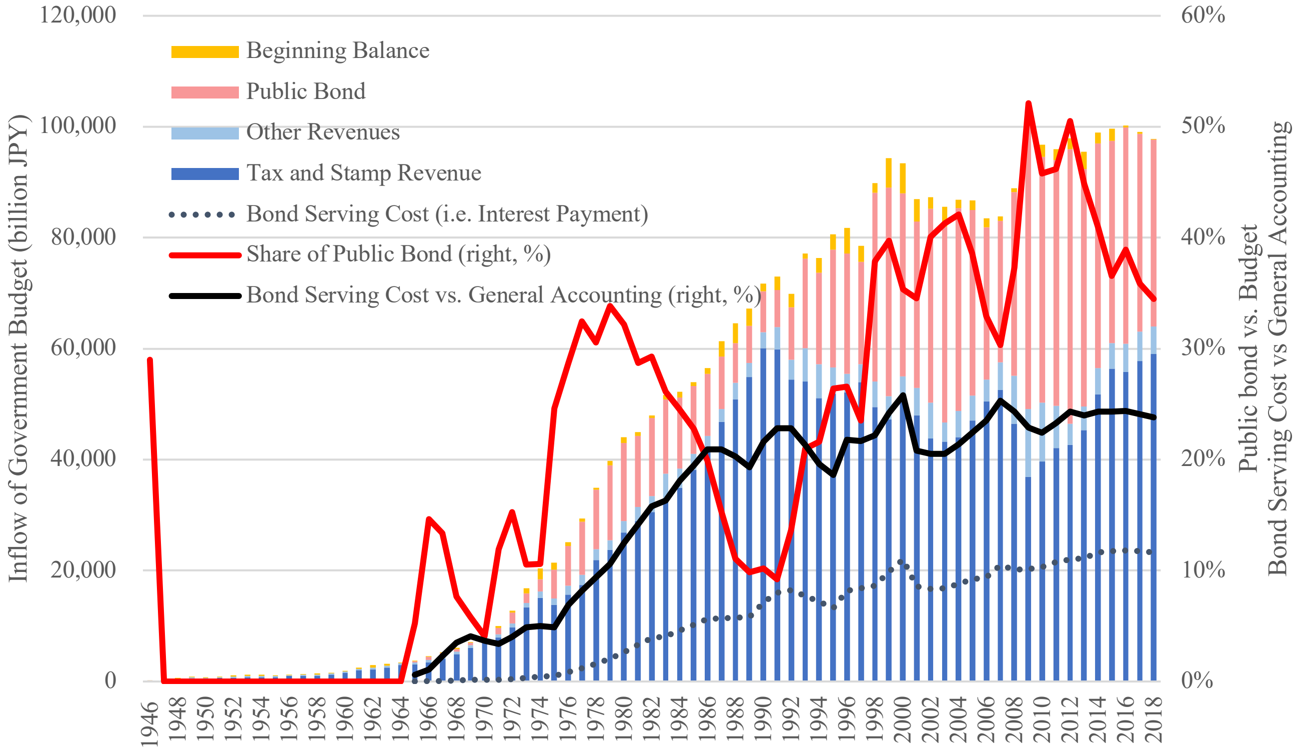

Figure A18-1. The flow of the government budget (Ministry of Finance, 2018b, 2019b).

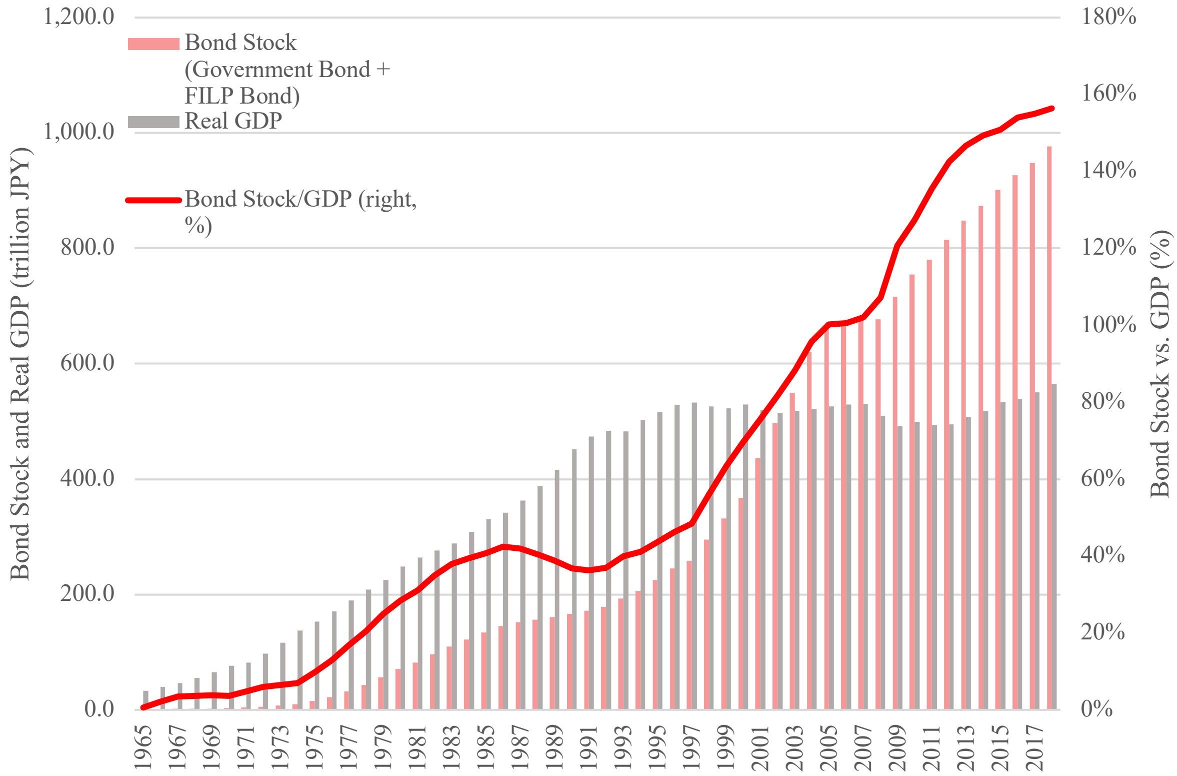

Figure A18-2. The stock of public bonds (Ministry of Finance, 2018b, 2019b).

One point of concern is on whom the government will impose tax. *Figure A18-3* illustrates the historical change of Japan's tax income by tax source and *figure A18-4* shows a change in tax rate. As you can see, until late 80s, corporations were the main tax payer, consisting around 35-40% of tax income, while the others are mostly carried by income tax. However, as the government started deducting corporate tax rate since 1986, the significance of corporate tax has correspondingly decreased. Instead, as the consumption tax was introduced in 1989 and its tax rate has raised several times in the past 30 years, it has started taking an important role; as of 2016, the consumption tax consists 31% of all tax income. The rate for consumption tax is expected to raise to 10% (Ministry of Finance, 2019c; National Tax Agency, 2018).

Unlike corporate tax which imposes tax based on their capital size, the consumption tax applies to all people all the time, from those with lowest income to those with highest. As discussed in *Appendix 10*, in the situation that the median income, and unit cost of labor is decreasing and that the relative poverty rate is increasing, raising consumption tax could result in a stall of consumption especially for lower income household (Noguchi, 2018).

To address this issue, Japan's communist party suggests the raise in the income tax rate for those who have higher salary (Nomura, 2017). As you can see from *diagram A18-5*, Japan adapts a progressive taxation system on income; 45% is the highest rate which is applied the annual income more than 40 million JPY (Ministry of Finance, 2019c). However, according to Nomura (2007)'s analysis, the increase in tax revenue would only be 2.5 trillion JPY even if the government imposes 90% of tax to the income larger than 18.00 million JPY. This is because higher the taxable income group, fewer people are applicable. On the other hand, when consumption tax is raised by 1%, the expected yields are 2.5 trillion JPY, the same level to the aforementioned case.

Scenario A: Consumption tax increases to 10%, while corporate tax increases to 40%.
Scenario B: Consumption tax increases to 10%, while corporate tax stagnates at 30%.
Scenario C: Consumption tax increases to 15% while corporate tax decreases to 20%.

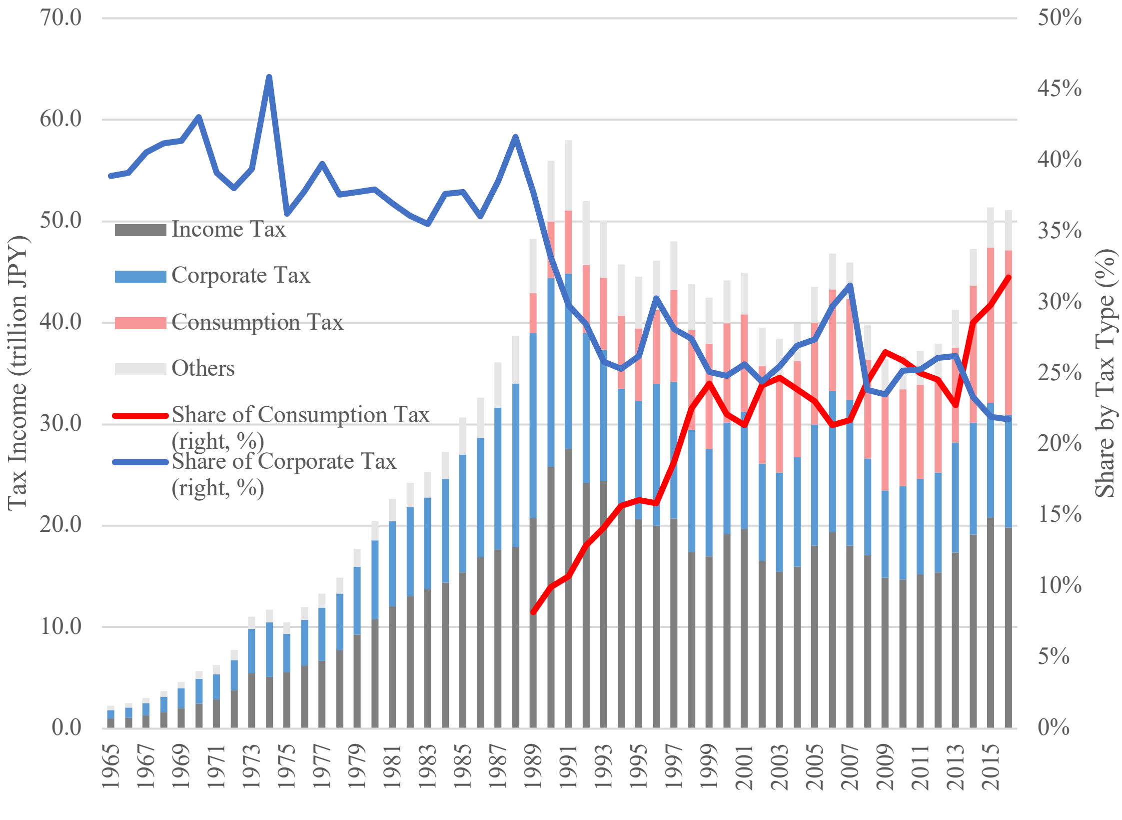

Figure A18-3. Tax Income by Source (National Tax Agency, 2018).

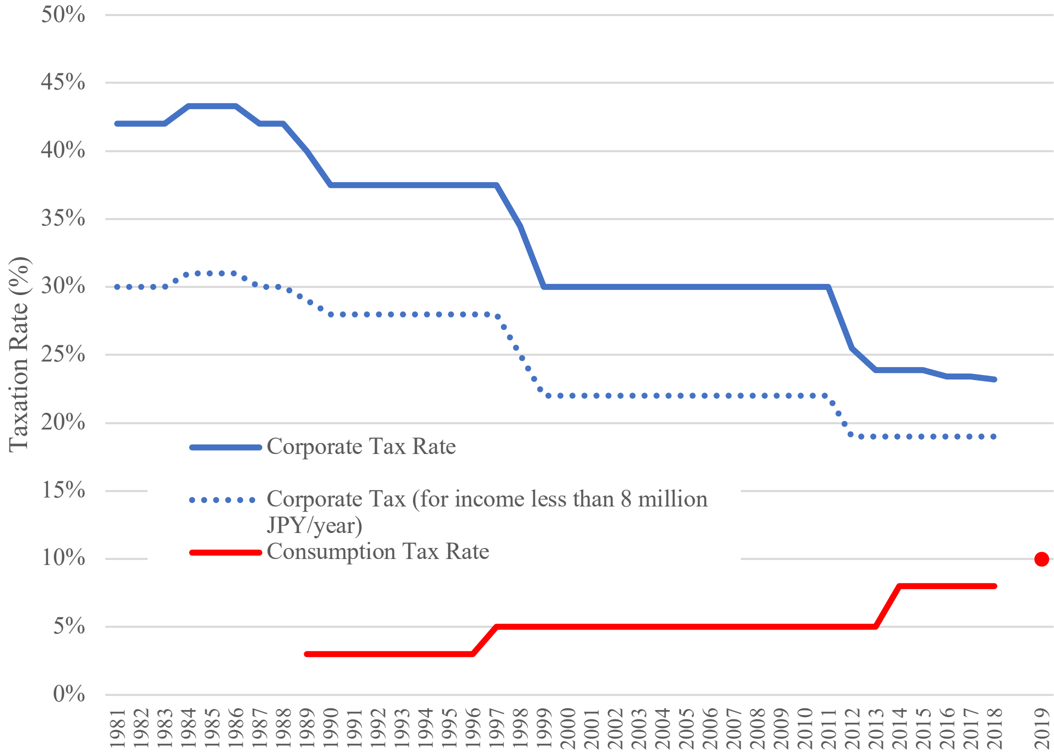

Figure A18-4. Rate Change of Corporate and Consumption Tax (Ministry of Finance, 2019c).

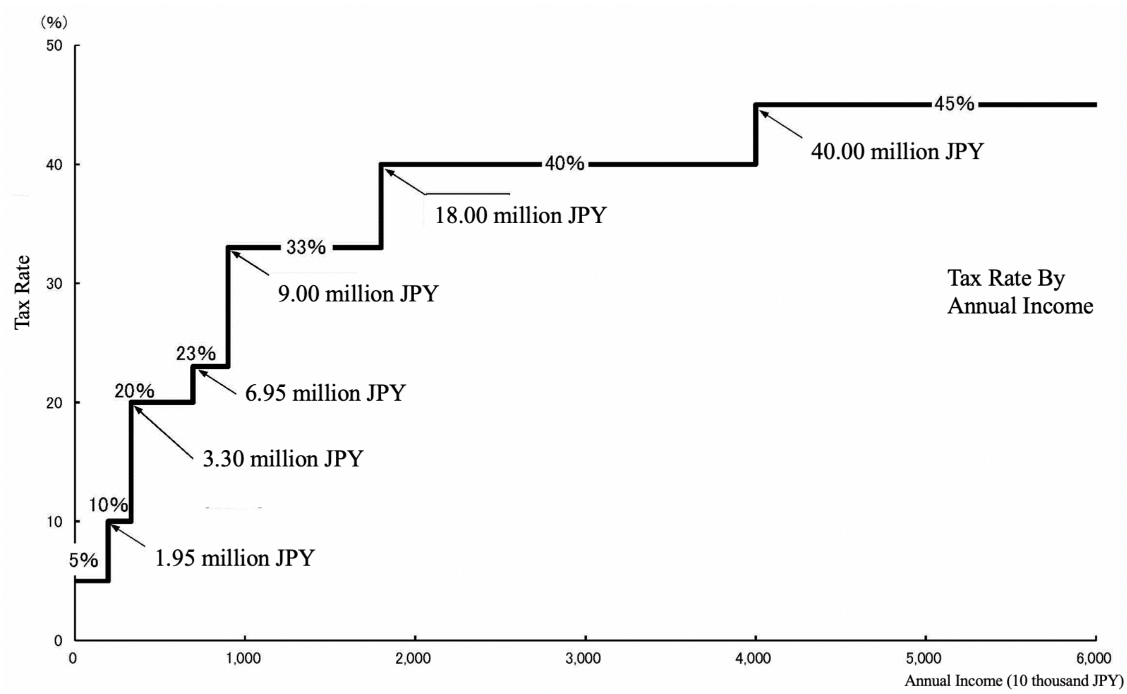

Diagram A18-5. Income Tax Rate (Translated by the author, Ministry of Finance, 2019c).

19. Liberalization

More than half of the countries have introduced a reform process in their power sectors since 1980s, the reforms which are strongly encouraged by the World Banks, IMF and other international financial institutions (Erdogdu, 2014). Although the underlying motivation of liberalization varies country to country, developed countries tend to liberalize in hope of overcoming inefficiency inherent in a regulated market (Weight, 2009). Generally, the cost-benefit studies show a significant potential in market liberalization. However the reforms have to be properly implemented to evade the market failure such that California Crisis (2000-2002) showed (Weight, 2009). But, how a reform process is delivered is largely dependent on a situation of the country's political economy, especially on how strong an incumbent industrial group has been for past three decades, and on liberalistic political ideology (Erdogdu, 2014).

In Japan, the retail market segment for ultra-high voltage users was the first target of liberalization that came in effect March 2000. In 2005, a retail segment for small and medium scale factories and buildings were liberalized for the new entries so called Power Producers and Suppliers (PPS). Finally, in 2016, the one for low-voltage was liberalized, which marks the complete liberalization of retail segment (Berndt, 2018). Now in Japan, the transmission is the last remained segment that is still regionally monopolized by utility. Yet this will also be liberalized by March 2020.

On this matter, there are mainly four types in electricity market reform; accounting separation, legal separation, function separation and ownership separation (see *diagram A19-1*). Japan has already adopted accounting separation since 2003, which disembodied an accountancy of transmission sectors from those of the other two sectors. Yet, the sector is still under the authority of the same company, and it lacks transparency and neutrality. Thus, the Abe Administration legislated to conduct a legal separation aiming to be in effect by April 2020. This time, the restructure will be implemented as to place a transmission sector as a different company while still being owned by a holding company (Fujiwara, 2016). However, because a transmission company would not be independent, nor be expected to be neutral, the structure is considered as less transparent than function separation and ownership separation.

Fujiwara (2016) argues that one of positive economic aspects of legal separation (and accounting separation) is the economy of vertical integration; 9 utilities in Japan optimized the cost of operation by 19-29% thanks to a vertically integrated system, the economy which is expected to be still viable even after a legal separation. Furthermore, although the restructure puts more pressure on competition among generation and distribution sectors, the transmission sector would still be operated as a regional monopoly whose price is still under supervision of the government. This enables to impose a transmission company a significant responsibility for social services (Fujiwara, 2016).

However, this casts an uncertainty on how much a new transmission company is loyal to its holding company and how strongly it discriminates new companies. Indeed, some scholars criticize that new entries have been charged tremendously high fee for using transmission lines and, in addition, they are also charged significant amount of imbalance fee (48JPY/kWh, three times of standard cost price as of 2008-2016), a compensation for any gap between actual electricity supply and demand over 3% that a transmission sector cannot balance within 30 minutes. This is applicable not only in case of shortage but also in case of surplus. As a result, an imbalance fee amounted national average of 14.3JPY/kWh as of 2016 (Berndt, 2018; Yamaguchi, 2007).

On the other hand, even if the liberalization is successfully carried out without discrimination, how it brings a change in market structure is another matter. There is a case like UK, that electricity market has been oligopolistic by 6 giant companies that provide both electricity and gas after the liberalization since 1999 although it has started being diverse since early 2010s (*figure A19-2*).

Scenario A: A transmission company becomes a neutral actor, and market have diverse actors.
Scenario B: A transmission company becomes a neutral actor, but only large capitals dominate the market.
Scenario C: A transmission company becomes discriminative against new entries..

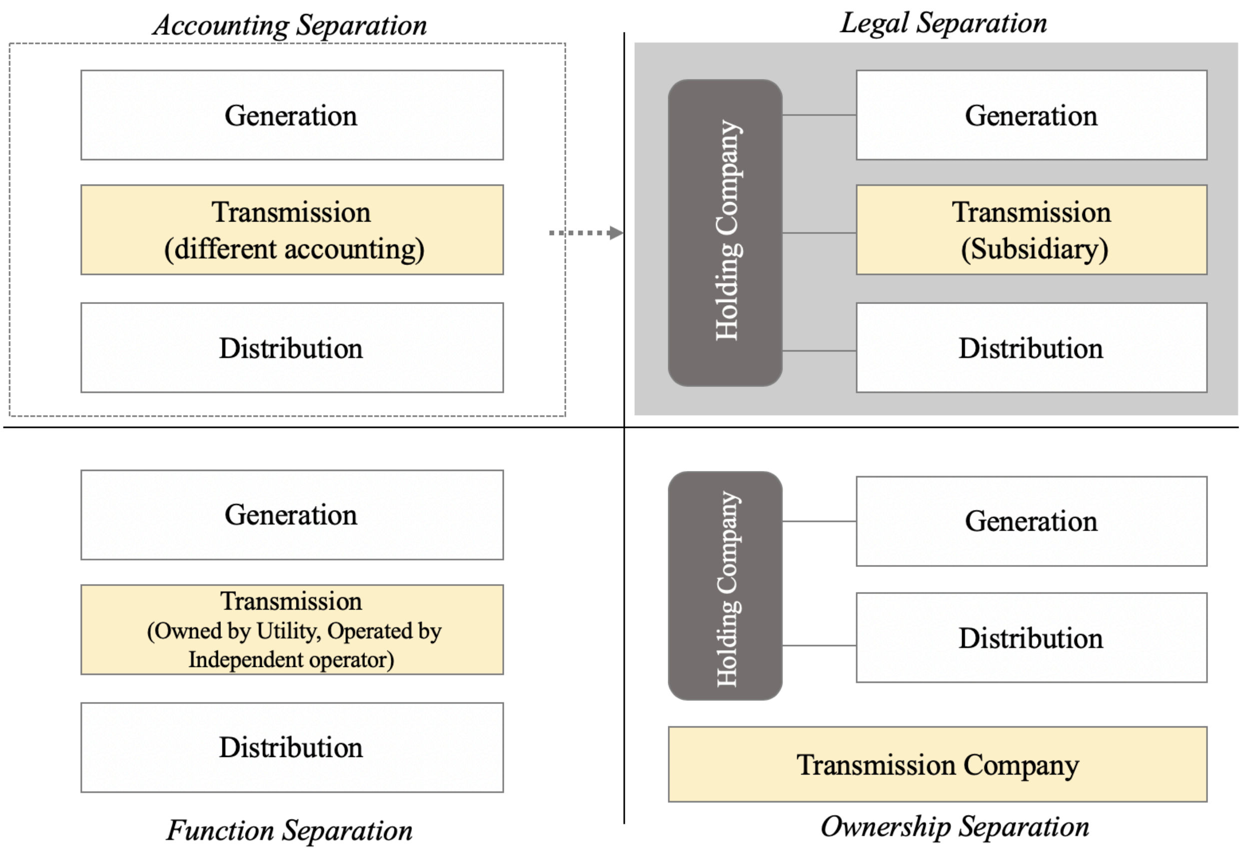

Diagram A19-1. Types of Electricity Market Reforms (Translated by the author, Nakanishi, 2018, p. 13).

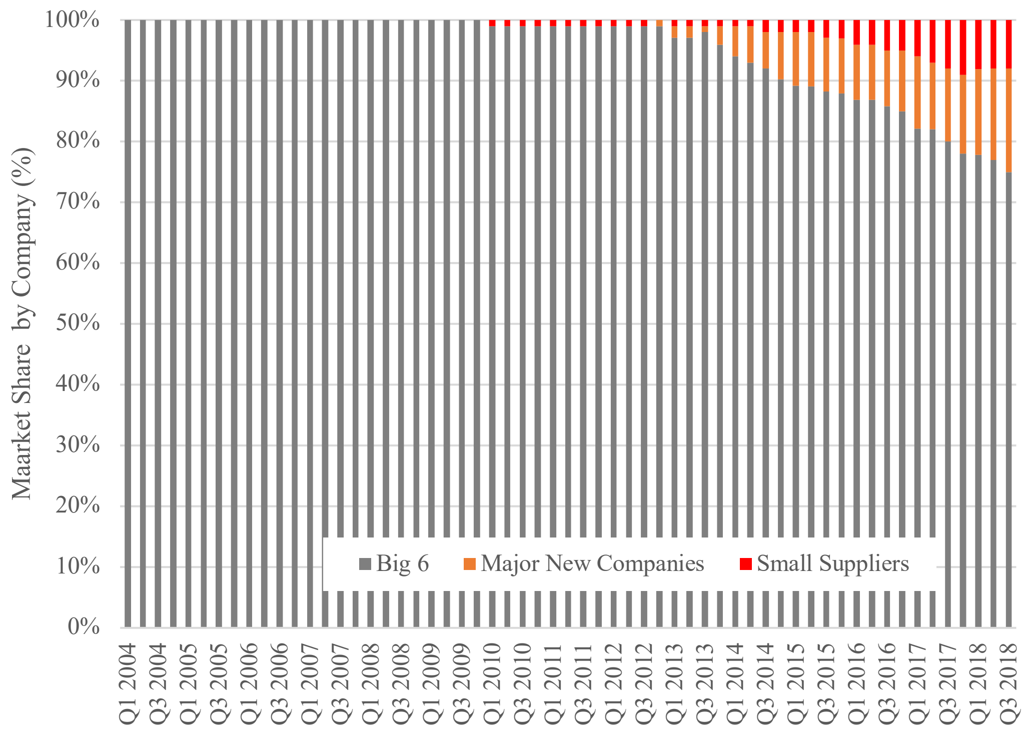

Figure A19-2. Electricity supply market share by companies[44] (Office of Gas and Electricity Markets, 2019).

20. Meaning of labor − Why people work?

The motivation for work has been gradually changing in Japan. As of 2018, 40% of new employees start working with an envision to realize more fun lives and 30% of them started working for money (see *figure A20-1*). On the other hand, 10% of them want to test their ability through work and roughly the same proportion of them mind contribution to the society when working (see *figure A20-1*) (Japan Productivity Center, 2018). When you look at the historical change, joy for lives has always been one of major motivation and social contribution, on the other hand, has been a minor one for newly employed people. However, both indicators have surged since 2000s although the motivation for social contribution started decreasing since 2012 from the peak of 15%. On the other hand, the share of people who expect their jobs to test their ability was once the biggest motivation in 1976 but it has shrunken drastically to approx. 10% as of 2018. It is the only indicator which has dropped from 1971 to 2018.

But what do people mean by "fun life"? Cabinet Office (2018d) conducts a survey, asking random respondents when they feel satisfaction in everyday life and finds out that roughly 30% of people feel satisfaction through work (*figure A20-2*). While the people who associate work with satisfaction has slightly decreased since 1992, the share of those who feel satisfaction in other indicators have increased. Family has been a strong factor over the years, but it has further increased by 14%. Hobby and social activities with friends were once less important for their satisfaction in 1992, now overwhelm a work factor by roughly 10%. Those who feel satisfied from learning and social contribution have also increased by 40% and 150% respectively, although they are still minor factors compared to the others.

Does this affect to the meaning of labor? As shown in *figure A20-3*, household consumption index has been on a downward trend since early 90s. Nevertheless, more people feel satisfaction while less people feel dissatisfaction in their life compared to the level before early 90s. During this period, people have started valuing more on the richness of the heart while de-valuing the richness in materials in their lives. In addition, during the same period of time, more people have started caring about social

[44] Big 6 consist of British Gas, EDF, E.ON, npower, Scottish Power and SSE. Major new companies consist of Co-operative Energy, First Utility, OVO Energy, Utilita, Utility Warehouse, Green Star Energy, Bulb, Octopus Energy.

contribution in their everyday lives, and more people started being aware of contributing to the society through their work (see *figure A20-4*). It is plausible that more people will find a meaning in a job, not as to earn money and satisfy their material wants, but as a means to satisfy the richness of their heart.

Scenario A: 50% of workers value an aspect of social contribution as their motivation for work. Only 20% feel satisfaction from money and material abundance.

Scenario B: 50% of workers value an aspect of securing a time with family and friends as their motivation for work. Only 20% feel satisfaction from money and material abundance.

Scenario C: 50% of workers value an aspect of higher income level as their motivation for work. 50% feel satisfaction from money and material abundance.

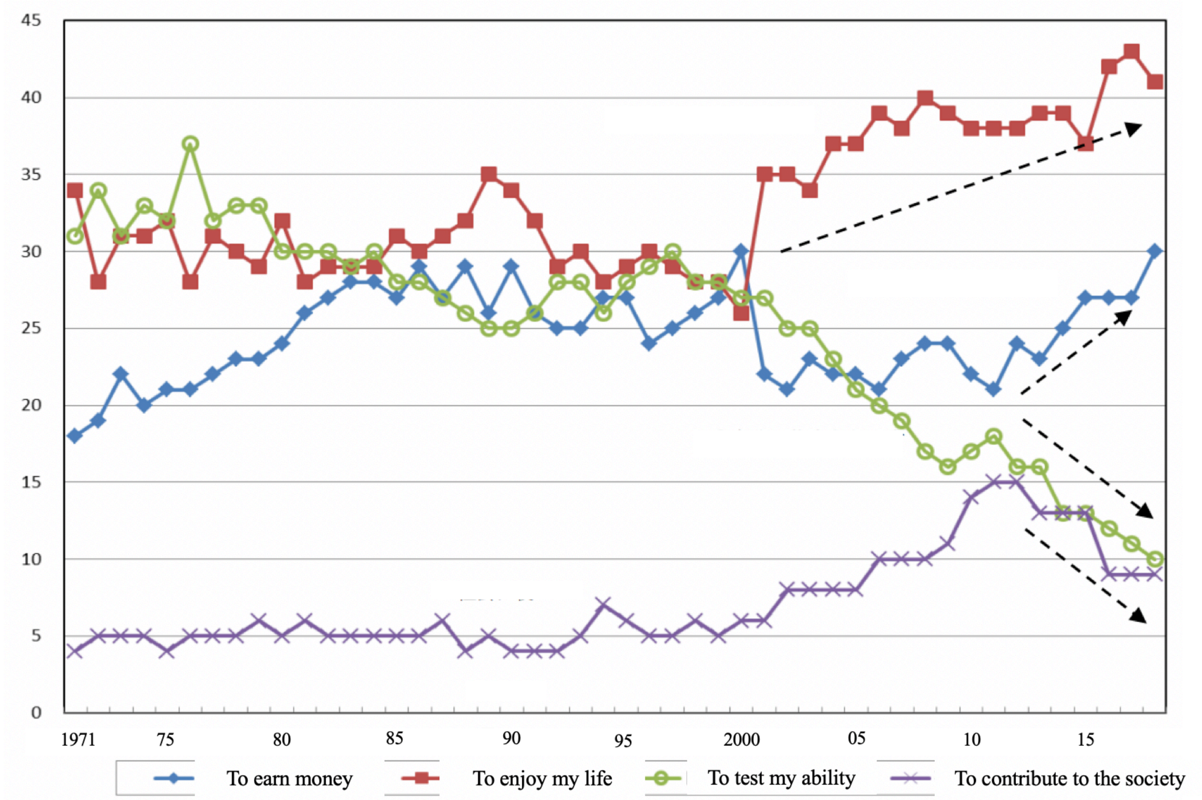

Figure A20-1. New Employees' Motivation for Work (Translated by the author) (Japan Productivity Center, 2018, p. 2).

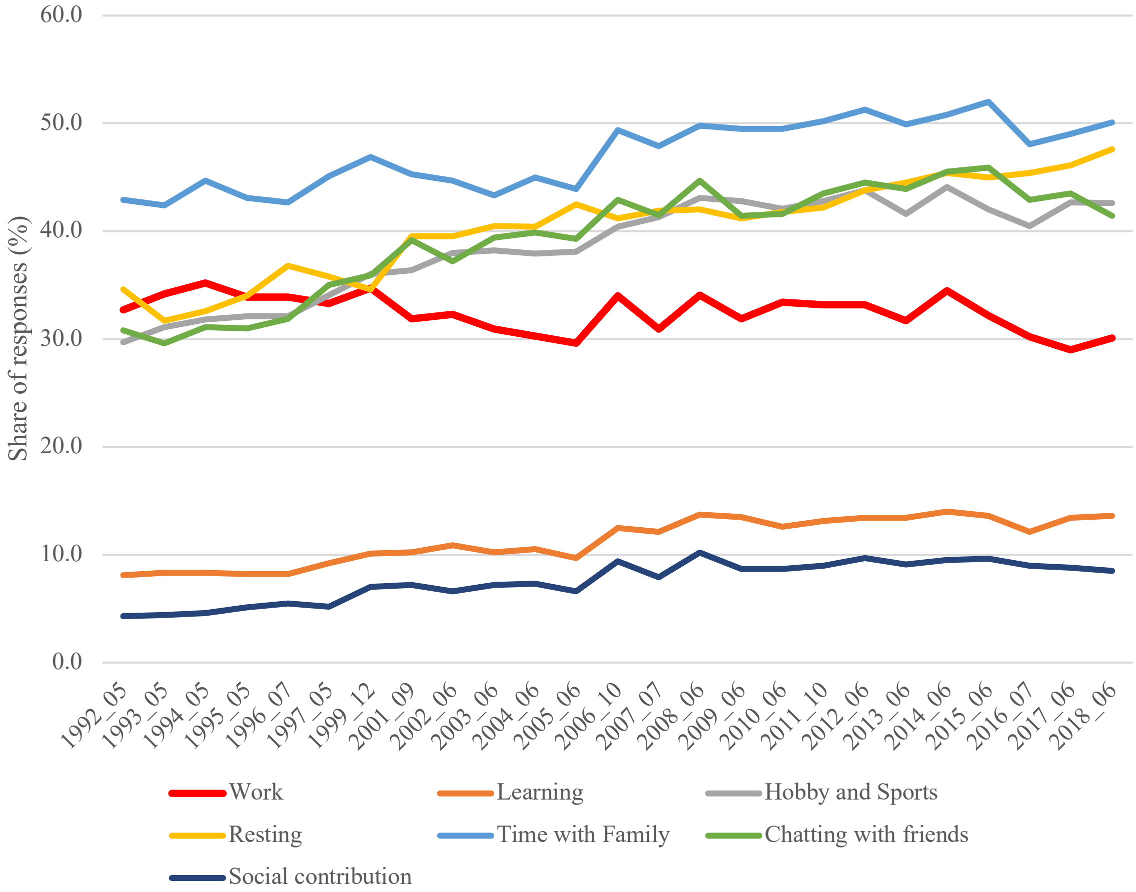

Figure A20-2. When do you feel satisfaction? (Cabinet Office, 2018d)

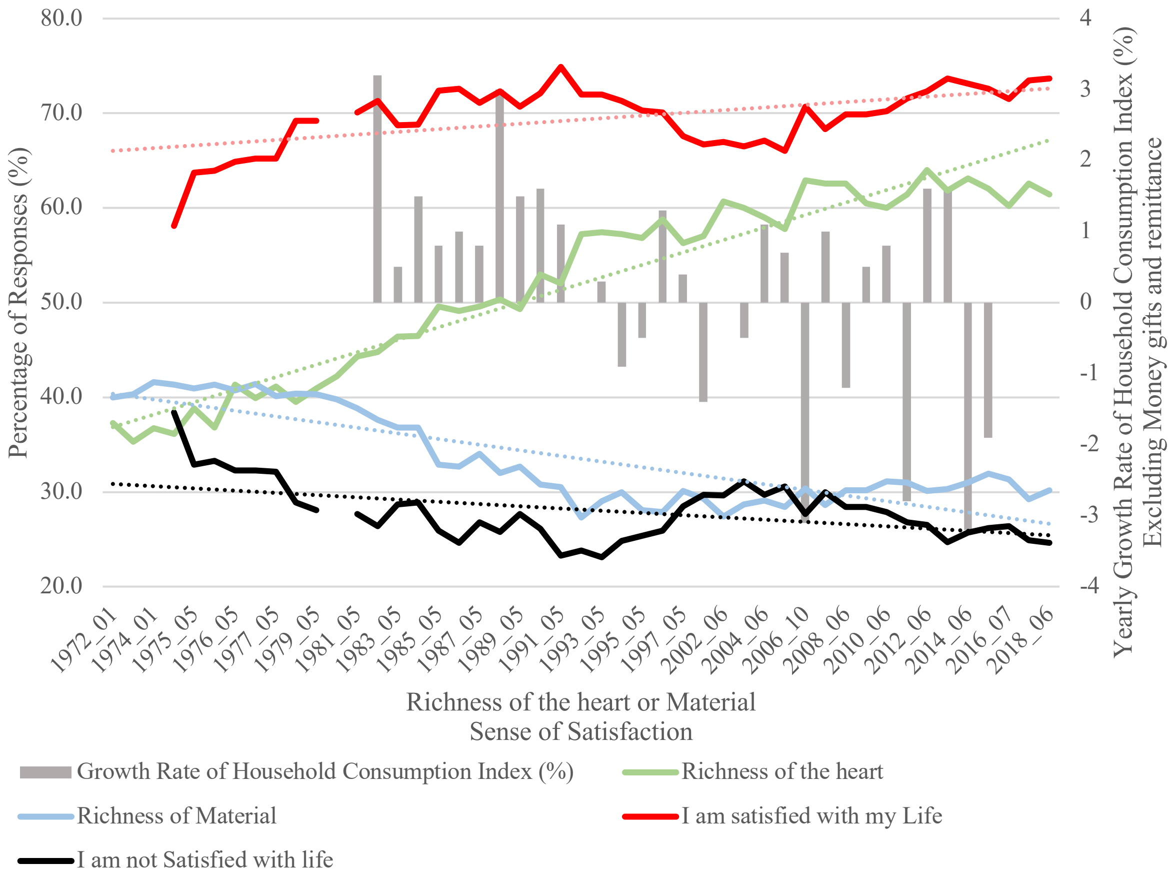

Figure A20-3. Value in life, Sense of Satisfaction. How does the income matter to people? (Cabinet Office, 2018d; MIC, 2018c)

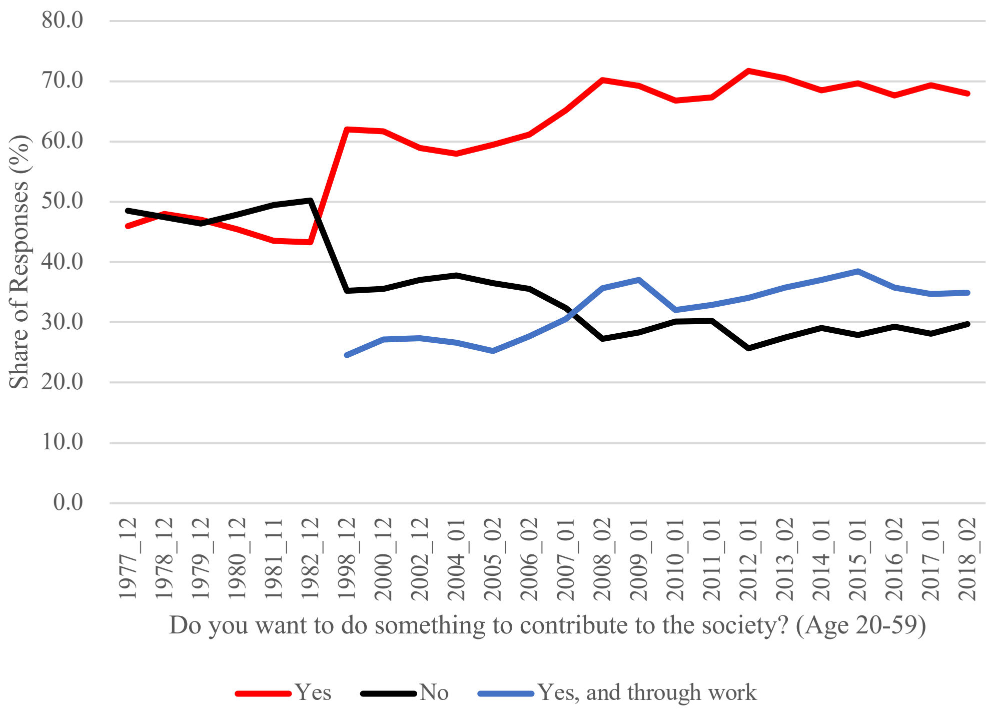

Figure A20-4. Do you want to do something to contribute to the society? (Cabinet Office, 2018d)

21. Structure of Labor Market

Hamaaki, Hori, Maeda, and Murata (2012) argue that most scholar regard the following three components as key distinguish feature in so called Japanese-style employment system, the long-standing administrative custom that Japanese companies have incorporated; 1) seniority wages, 2) lifetime employment, 3) enterprise labor union. In Japan, companies traditionally employ newly graduated students as regular employees (called Shinsotsu, age 22-24) at low cost and train them firm-specific skills and knowledge until they reach to the retirement age. As they incrementally learn those skills and knowledge throughout their life stages, the firms will gradually promote/raise salary as they get older. On the other hand, because it is an implicit consensus over the industry and country that an employee spend their life time with the same company, and because each employee receives firm-specific knowledge and skills, people rarely change their jobs. Thus the labor market of Japan is closed and largely relied on the intra-company flow (such as promotion and department transfer). Naturally, a labor union is rarely formed at industry level but a firm-specific level whose members will face to fight their own boss while paying loyalty. (Taniuchi, 1998)

Deeply rooted in the collectivist culture of Japan, this peculiar relationship was functioning based on mutual-trust between employers and employees; employees pay loyalty to the company and the company, instead, guarantees stability of salary, welfare, promotion. As a result, the system nurtured generalists who can handle all company-related affairs, which also results in relatively small wage difference within a company due to absence of vertical specialization. Such management system was also thought to be economically viable and contributed to the economic growth (Hamaaki et al., 2012; Sato, 1997; Taniuchi, 1998).

However, more people started from the bottom line of salary means more people will end up sitting at higher positions in the same company in several decades. This necessitates a company to hire far more people to maintain both employer's motivation for promotion and life-time employment. It was possible when companies could simply seek for scale of economies to supply for people with lack of the basic necessities in post-WW2 and when a labor cost of Japan was much cheaper than western countries'. However, such model was already meeting its systematic limit during 80s (Sato, 1997), and during early 90s when the bubble economy collapsed, Japan started employing neoliberalist Anglo-Saxon employment model that encourages the inflow and outflow of human capital based on their performance. At the same time, foreign investors have been straightening their presence on Japan's economy and they have become the biggest shareholders in Japan as of 2017 (see *figure A21-1*). They are generally less silent than Japanese investors and unaware of Japan's corporate culture, forcing an inevitable compliance to global standard to serve shareholder's interest. (Berndt, 2018; Japan Exchange Group, 2017).

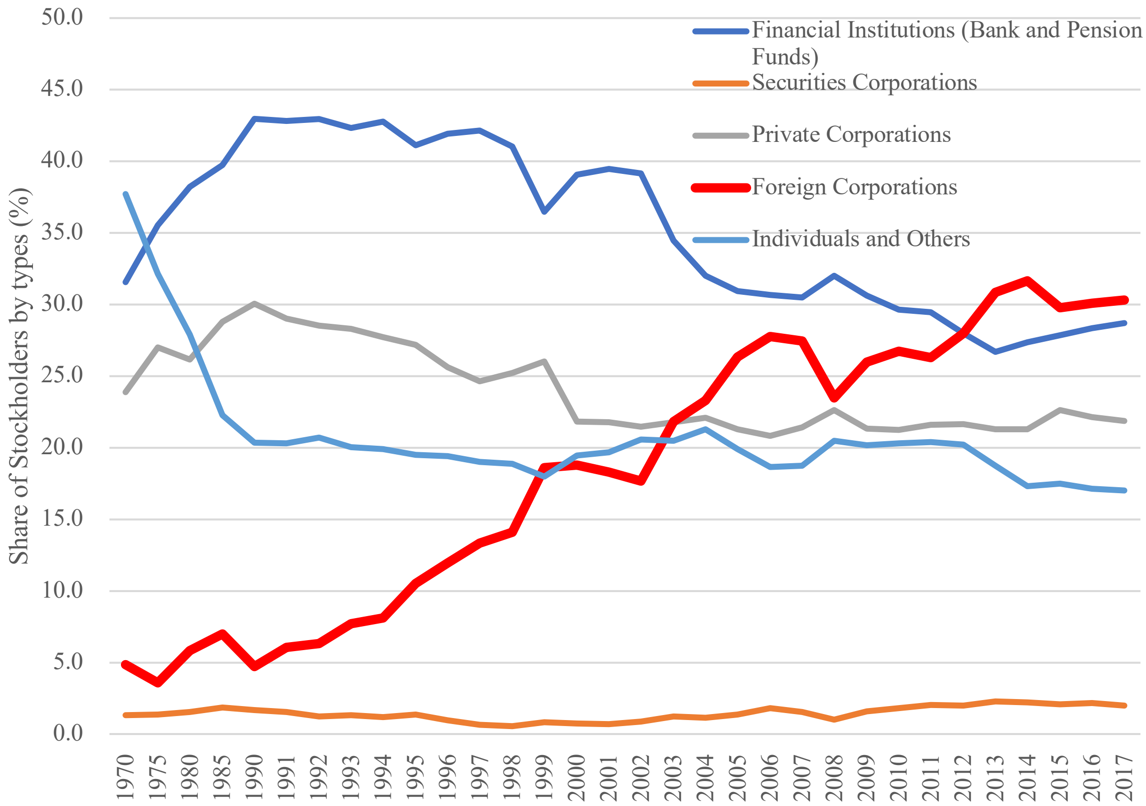

Figure A21-1. Stockholders of Japanese Corporations (Japan Exchange Group, 2017).

One of Japan's remodeling scheme was to further acceptance of using non-regular employment. As you can see from *figure A21-2*, the share of non-regular employees has increased and at the same time, unit labor cost by employees started declining. Meanwhile, the GDP per hour worked has been constantly increasing around 2%. This indicates that Japan has achieved a higher productivity (GDP/hour worked) by decreasing the cost of production. As *figure A21-3* shows, the companies, especially manufacturing industry has successfully oppress the cost of labor; "by reducing their core workforce and enlarging peripheral workforce has exceeded the previous trend by far: 32% of all working persons and 40% of all employed persons are more or less excluded from long-term job security, comprehensive fringe benefits, access to internal career building and regularly rises in working income" (Berndt, 2018, p. 83). It clearly results into a psychological distress as *figure A21-4* shows.

Now there are mainly two problems in this transition of employment customs in Japan. First, although Japan has adapted more performance-oriented HR system since 90s, life-time employment tradition is still alive; the company still expects employers to pay loyalty while they are no longer treated as family-like as before (Hamaaki et al., 2012). This causes a lower job mobility in regular employment market, while vitalizing that of non-regular employees (see *figure A21-5*). Furthermore, because the companies adopted non-regular employees as a means for cost-cutting, not only "same labor same income" principle is hardly achieved but also the income disparity between regular and non-regular employees have been enlarging (Nagase, 2018). The fact that Japan traditionally lacks a labor union at industry level makes this problem more difficult to solve because you will essentially need to have an industrial consent to define the industrial standard of "same work same income" principle. Unfortunately, Japan's labor union participation rate has almost constantly decreased from 23.8% in 1990 to 17.1% as of 2017 (see *figure A21-6*).

Scenario A: Non-regular employment consists 60% of total workers. Both regular and non-regular employees are under "same-job same-salary" principle and both frequently change their jobs according to their lifestyle.

Scenario B: Non-regular employment consists 40% of total workers. They are simply used as low-cost, easy-to-fire labor. Only non-regular employees change their jobs frequently.

Scenario C: Non-regular employment consists 60% of total workers. They are simply used as low-cost, easy-to-fire labor. Both regular and non-regular employees do not change their jobs frequently.

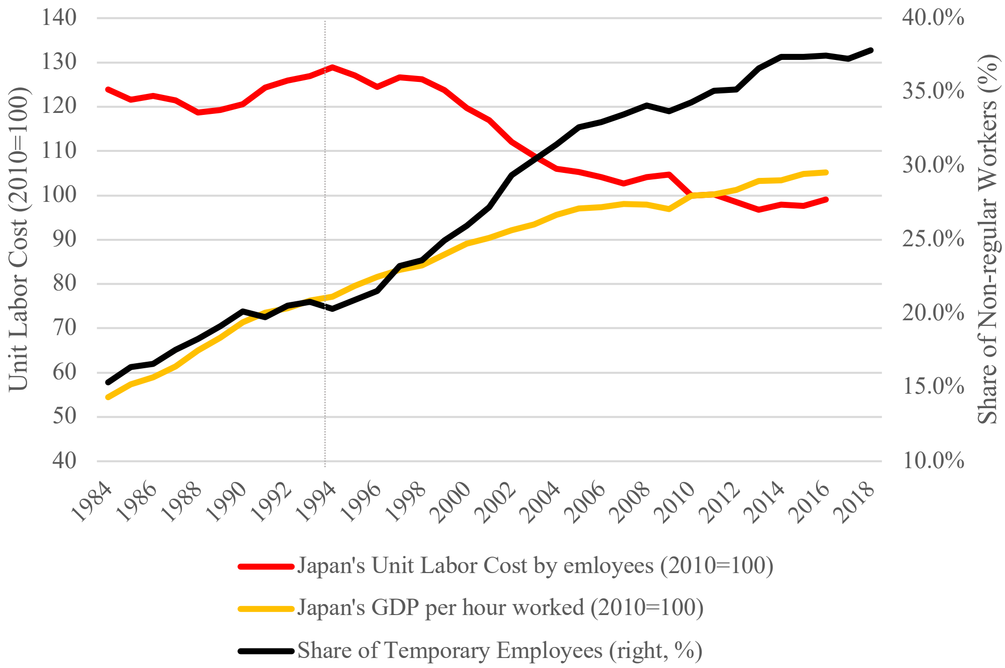

Figure A21-2. Unit Labor Cost and Share of non-regular employees (OECD, 2019; The Japan Institute for Labour Policy and Training, 2019).

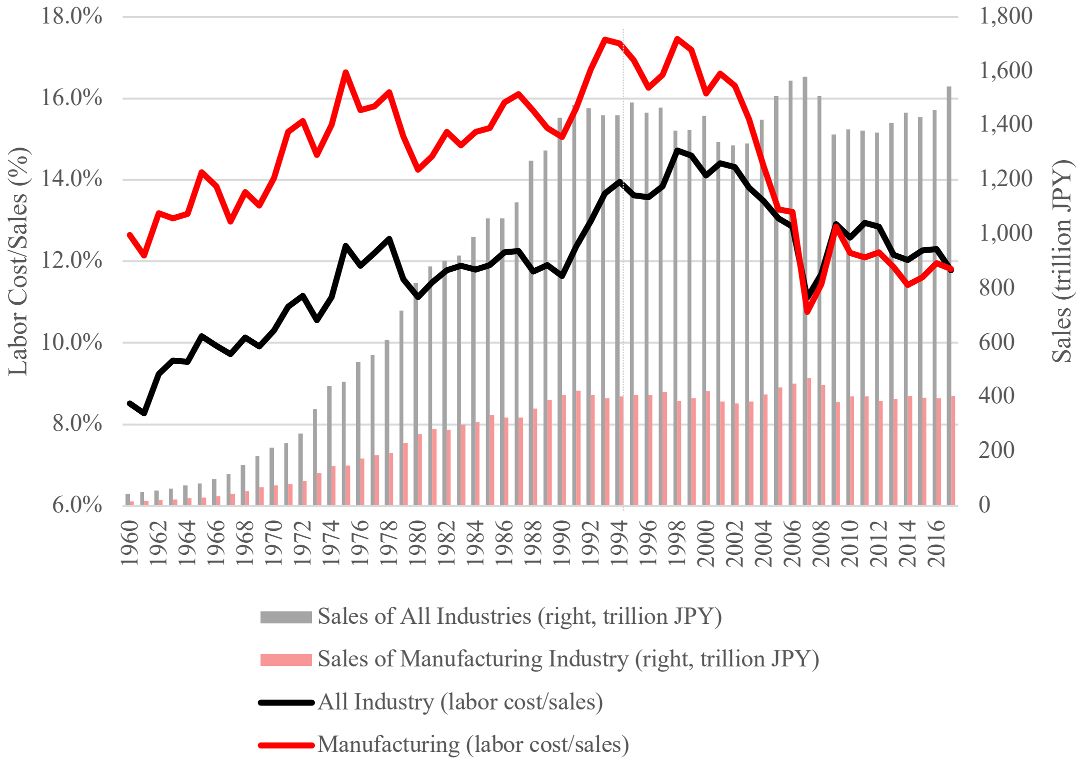

Figure A21-3. Weight of labor cost in sales (Ministry of Finance, 2018a).

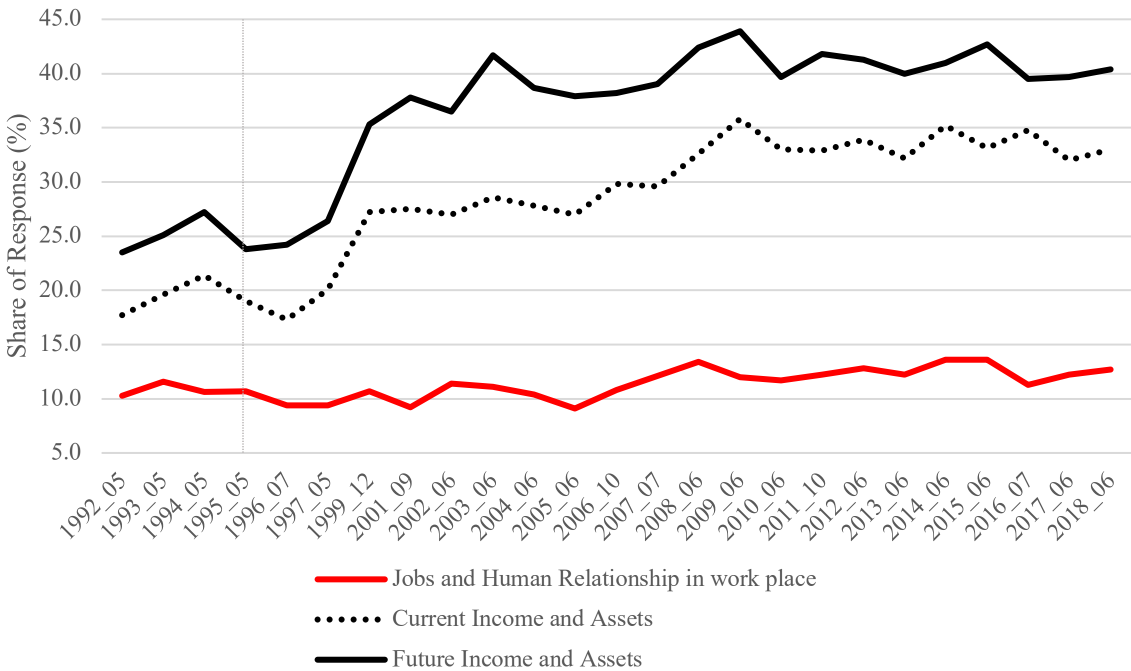

Figure A21-4. Matters that cause distress (Cabinet Office, 2018d).

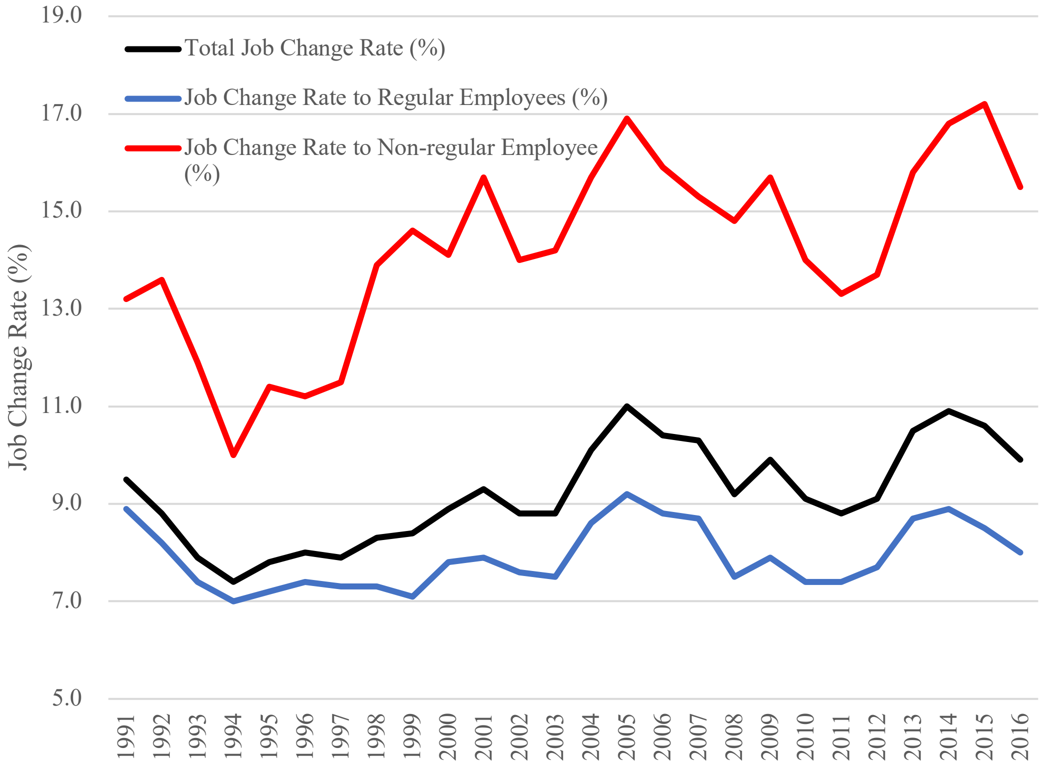

Figure A21-5. Job Change Rate (Ministry of Health Labor and Welfare (MHLW), 2017b).

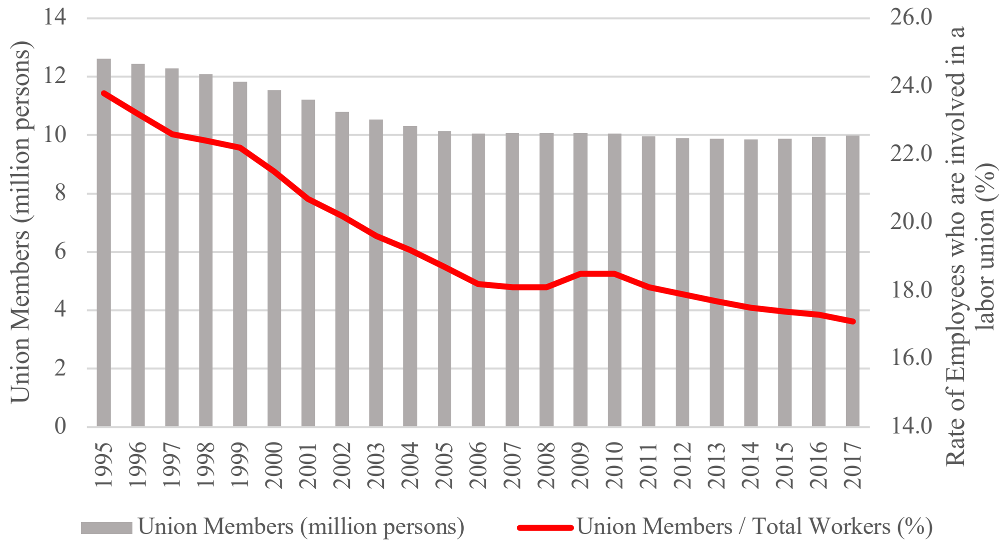

Figure A21-6. Labor Union Participation Rate (The Japan Institute for Labour Policy and Training, 2019).

22. Gender Gap

In terms of opportunities for education, Japan does not have a huge gender gap; as of 2016, almost 100% of population (both male and female) go to high school while 52.5% of male and 57.5% of female enroll to university (either 4-year university or 2-year). Nevertheless, percentage of women among researchers is only 15.3% in 2016, which is the lowest number in OECD country whose average is 33.4% (Cabinet Office, 2017). Although the share is slowly but constantly increasing in past 2 decades, it does not indicate that such increase is equally affecting to all disciplines. As you can see from *figure A22-1 and A22-2*, the share of female researchers is considerably low in the most fields, and only pharmacy and nursing fields show the gender equality.

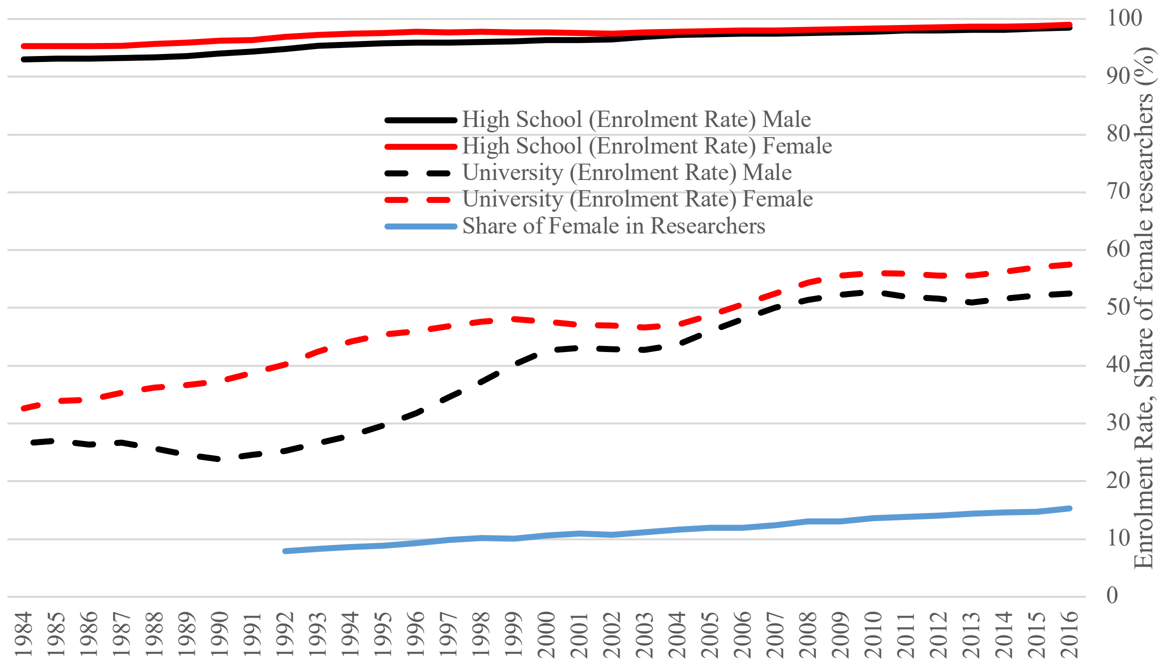

Figure A22-1. Gender Gaps in Education and Research (Cabinet Office, 2017; MEXT, 2017).

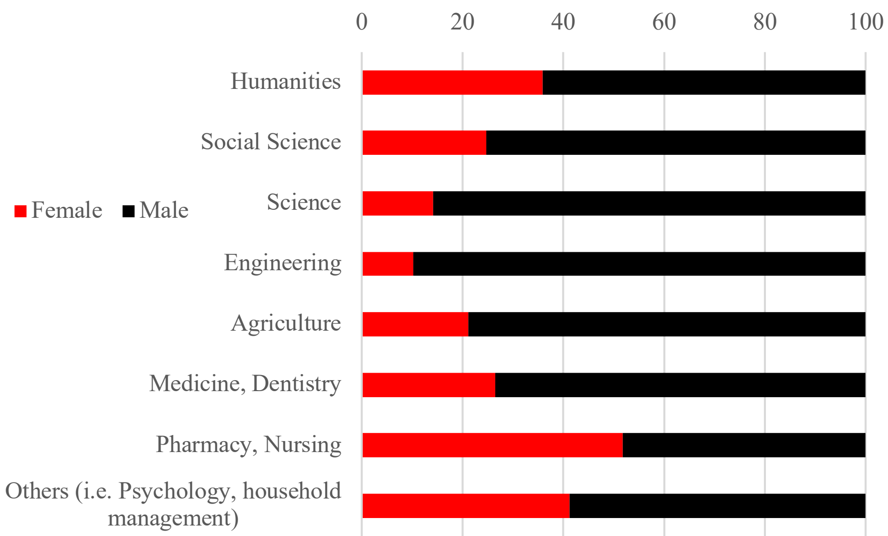

Figure A22-2. Percentage of Male and Female Researchers by Field . (Cabinet Office, 2017)

Gender gap also exists in income. As *figure A22-3* illustrates, there is a difference of 89 thousand JPY in monthly income between male and female as of 2016. Although *figure A22-3* also tells us that the income disparity has been slowly narrowing down since 1964, the reality is not as optimistic as it looks when we see the issue beyond the average income. *Figure A22-4* shows three trends. First, generally, the total number of employees has increased from 39.3 million persons in 1984 to 56 million persons in 2016. This increase is mostly met by an increase of non-regular employment (i.e. part-time, dispatched worker) as the number of regular employees in 2016 is almost at the similar level to 1984. Secondly, employment rate in productive female population has risen from 53.1% in 1986 to 66% in 2016, while that of male has been fluctuating at around 80%. This indicates that more women have started being involved to wage labor. Finally, there is a huge disparity in employment types by gender and this gap has been widened since 1984; 92.8% of male employees and 71% of female employees were regular workers in 1984. However, as of 2018, 80% of male employees and 44% of female employees are working as regular workers. Thus, the gap in regular employment type between genders has widened by 36.9% and this gap was filled by more female workers being employed as non-regular.

What this indicates is that there is still a strong tendency in Japanese society that regular workforce is carried by men. Although the employment rate in female has increased, it does not necessarily mean that social status of women has been empowered. This is also explained by *figure A22-5*: women shares majority in the low income range while men dominates all income groups larger than 2.5 million JPY, and the share of women constantly decreases as higher the income group is.

To address this issue, social awareness toward gender equality plays an essential role. The Cabinet Office (2017) conducts a survey asking respondents how they think about the concept of “men should work in the society while women should do a house work” (see *figure A22-6*). The result reveals that such traditional concept has been gradually fading away from the society; 70% of female and 75% of male agreed to the concept in 1979 while in the survey of 2016, 37% of female and 44.7% of male showed an appreciation to the concept. However, in other words, this result also tells us that roughly 40% of citizens of Japan, regardless of their gender, still support the idea that a gender determines their way of lives. Another striking discovery is that female respondents and male respondents historically share this cognition to some degree although female has less tendency to support the idea by roughly 5-10%.

The different research done by Cabinet Office (2018c) asked whether respondents satisfy or dissatisfy the condition for women to play an active role in the society (*figure A22-7*). As a result, more people in general have feeling dissatisfaction and similarly, less people feel satisfaction regarding the condition, although the number started slightly falling down since 2015. Women historically feel stronger sense of dissatisfaction whereas, interestingly, they also feel more satisfaction than men.

Scenario A: Employment rate of women (Age 15-64) increases to 80%. 50% of both male and female employees are working as regular employees. Average income becomes equal.

Scenario B: Employment rate of women (Age 15-64) increases to 80%. 40% of female employees and 80% of male employees are working as regular employees. Women's average income is 20% less than that of men.

Scenario C: Employment rate for women (Age 15-64) decreases to 60%. 40% of female employees and 80% of male employees are working as regular employees. Women's average income is 30% less than that of men.

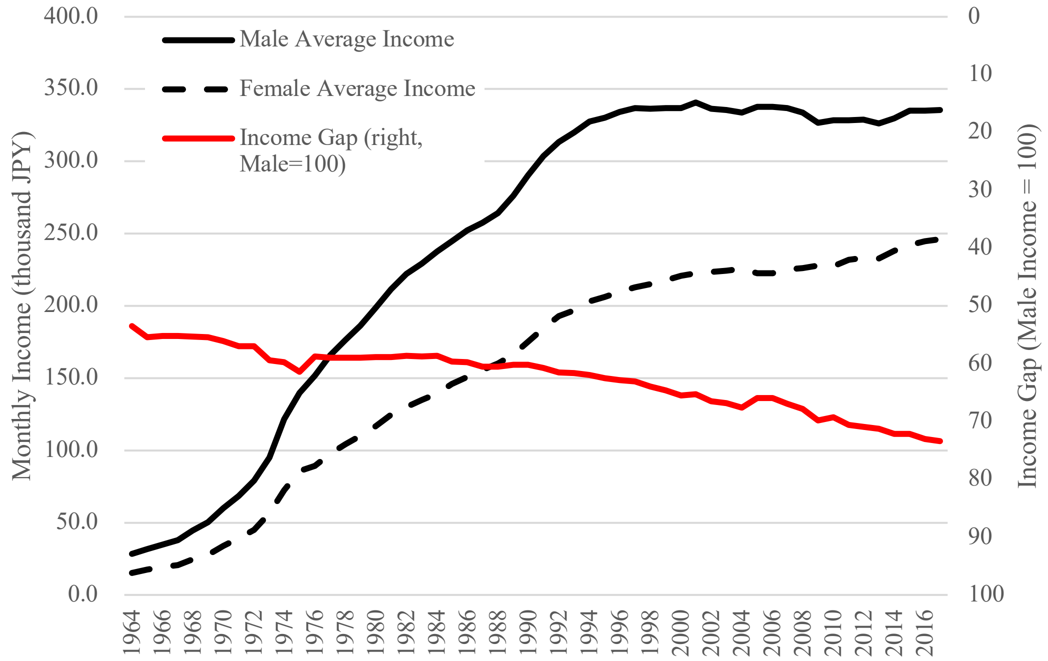

Figure A22-3. Gender gaps in average Income (The Japan Institute for Labour Policy and Training, 2019).

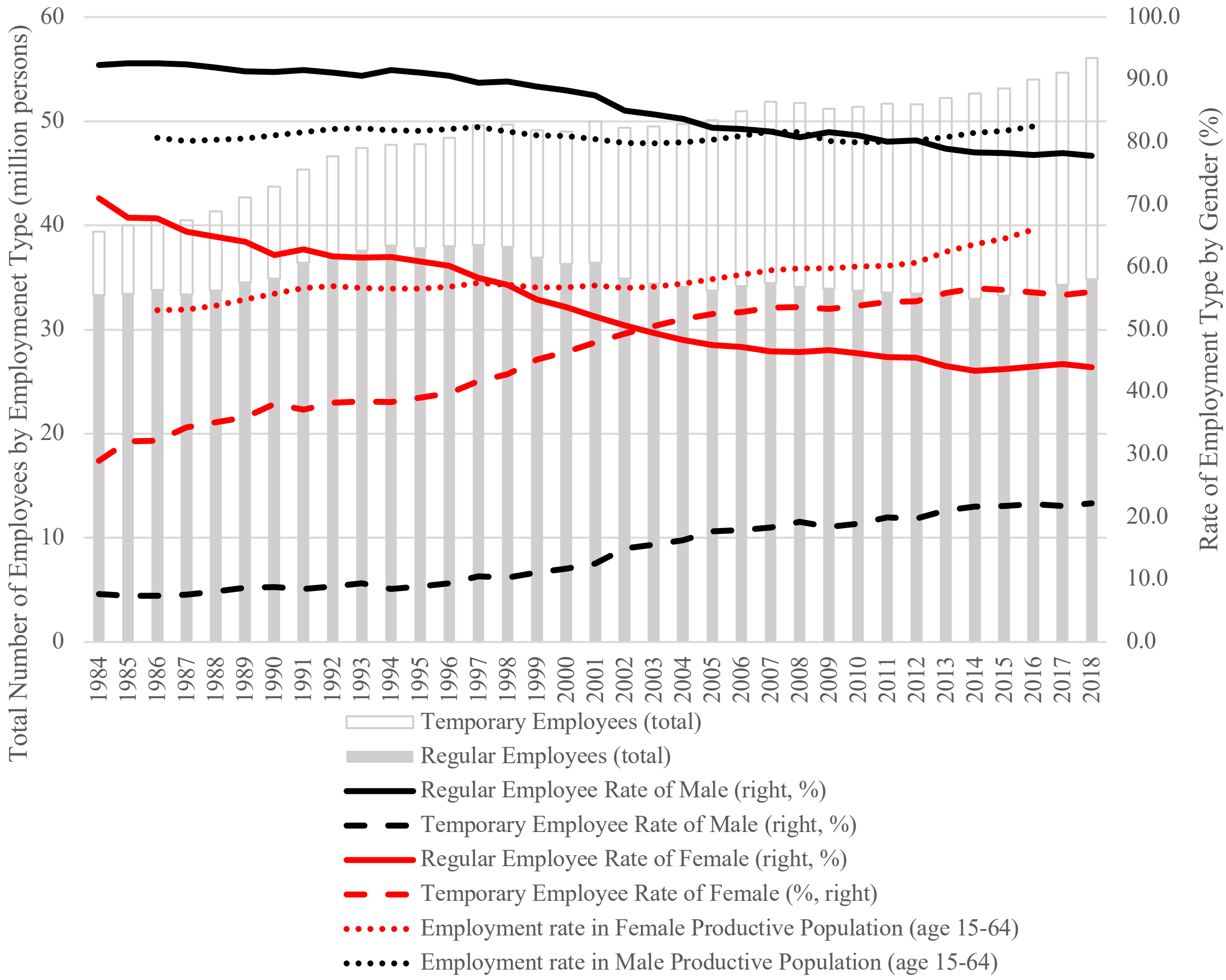

Figure A22-4. Difference of Employment Type by Gender (Cabinet Office, 2017; The Japan Institute for Labour Policy and Training, 2019).

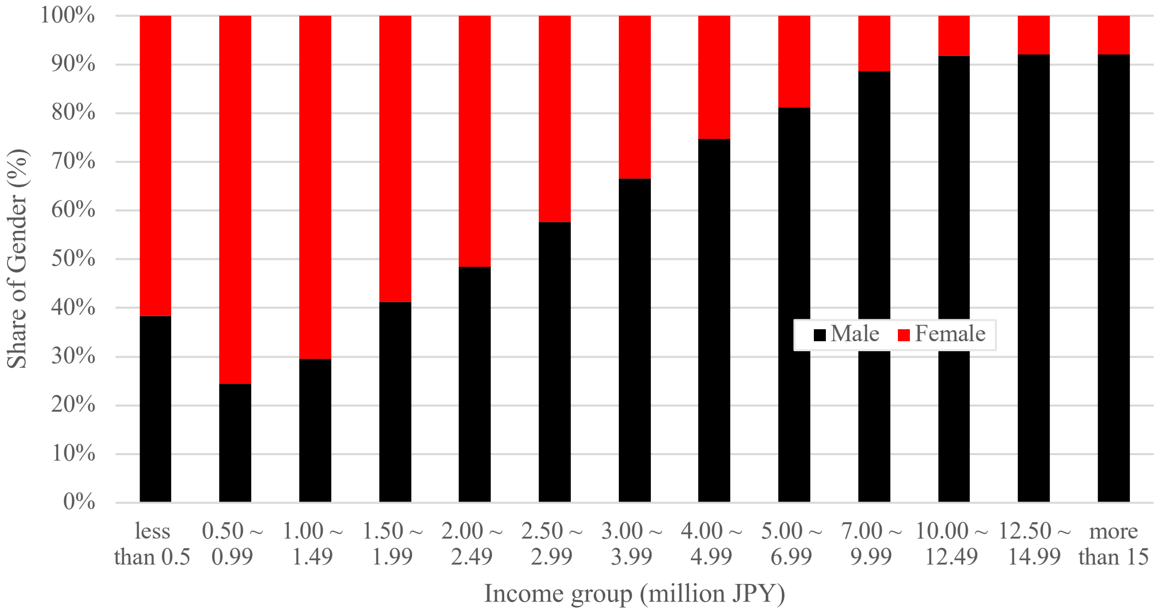

Figure A22-5. Share of gender by income group as of 2017 (MIC, 2017a).

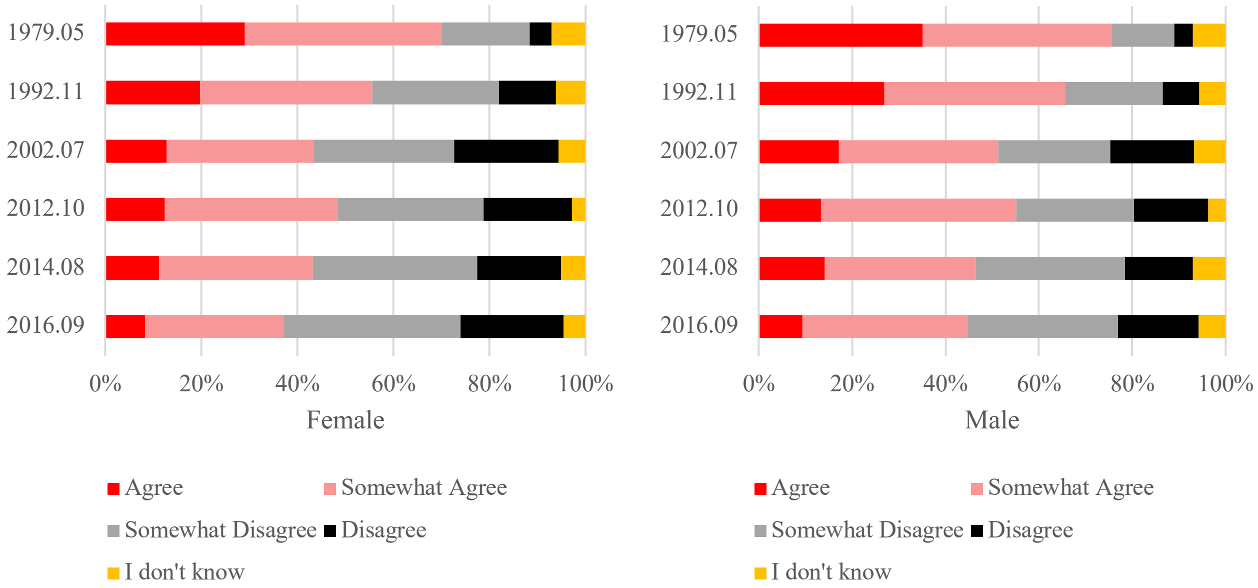

Figure A22-6. “Do you agree with the concept that men should work in the society while women should do a house work?” (Cabinet Office, 2017).

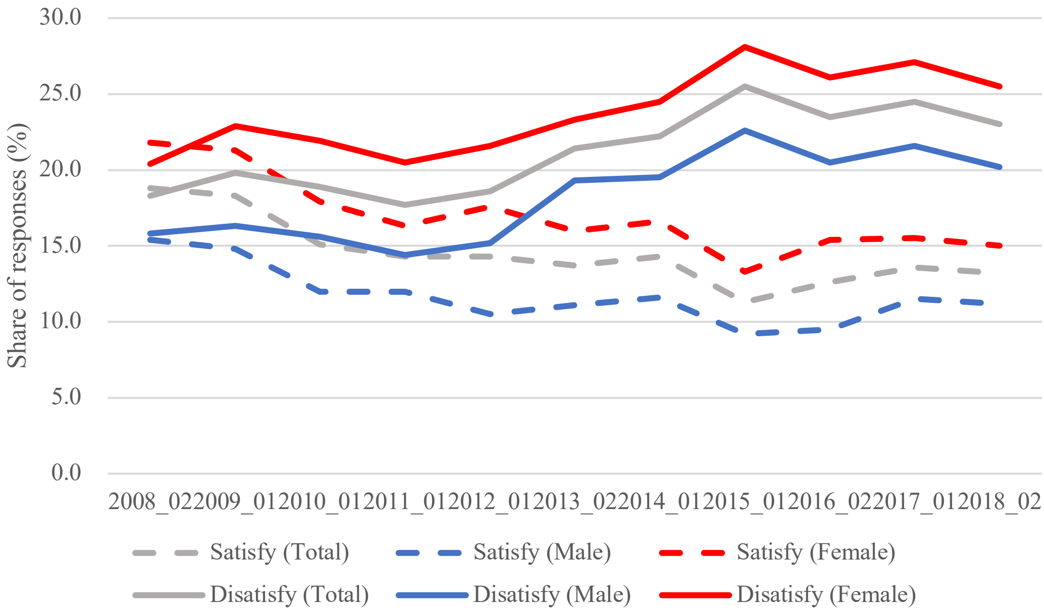

Figure A22-7. Condition for women to play an active role in the society (Cabinet Office, 2018c).

23. NPO and Social Enterprises – Who is responsible for social activities?

In 1998, Act on Promotion of Specified Non-profit Activities (as known as NPO law) has passed in Japan, enabling citizen-driven social activities to be more organized. Since then, as *figure A23-1* illustrates, the number of certified and accredited NPOs has constantly increased to 52,714 as of February 2018 (Cabinet Office, 2019). More than half of them are engaged in health or medical related activities and promotion and almost half of them are involved with social education, community/city development and managerial advice for other NPOs (see *table A23-2*).

NPO's activities are largely dependent on citizen's voluntarily works; an organization averagely has 14.1 people (median 5 people) with salary, among which only 6.7 people (median 2 people) dedicate to the organizational activities in full-time whereas they average employ 275 people (median 20 people) non-paid workers (*table A23-4*). Hence, as *figure A23-3* shows, securing and training of human resource is the biggest concern and challenge of NPOs. Furthermore, *Figure A23-3* also indicates that 60% of NPOs see a diversity in fund source as their challenge. According to Cabinet Office (2015), 52% of funds are derived from individuals whereas 23.1% and 18.9% are from private banks and government-affiliated banks (*figure A23-5*). Furthermore, Baba (2009) points out that majority of NPOs are basing on small income (less than 5 million JPY) and has a single income source that tends to be a fee from membership or a donation. Although it is true that bigger the income scale, bigger the cost their project incurs, still, the bigger NPOs tend to be more stably exceed the break-even points.

From the argument above, Baba (2009) argues that one of the reason why NPO struggles in funding is because NPO does not have an objective indicator of performance such as profit margin, rather, its performance evaluation is largely based on subjective judgement. This discourages large investors to input funds to smaller scale NPOs.

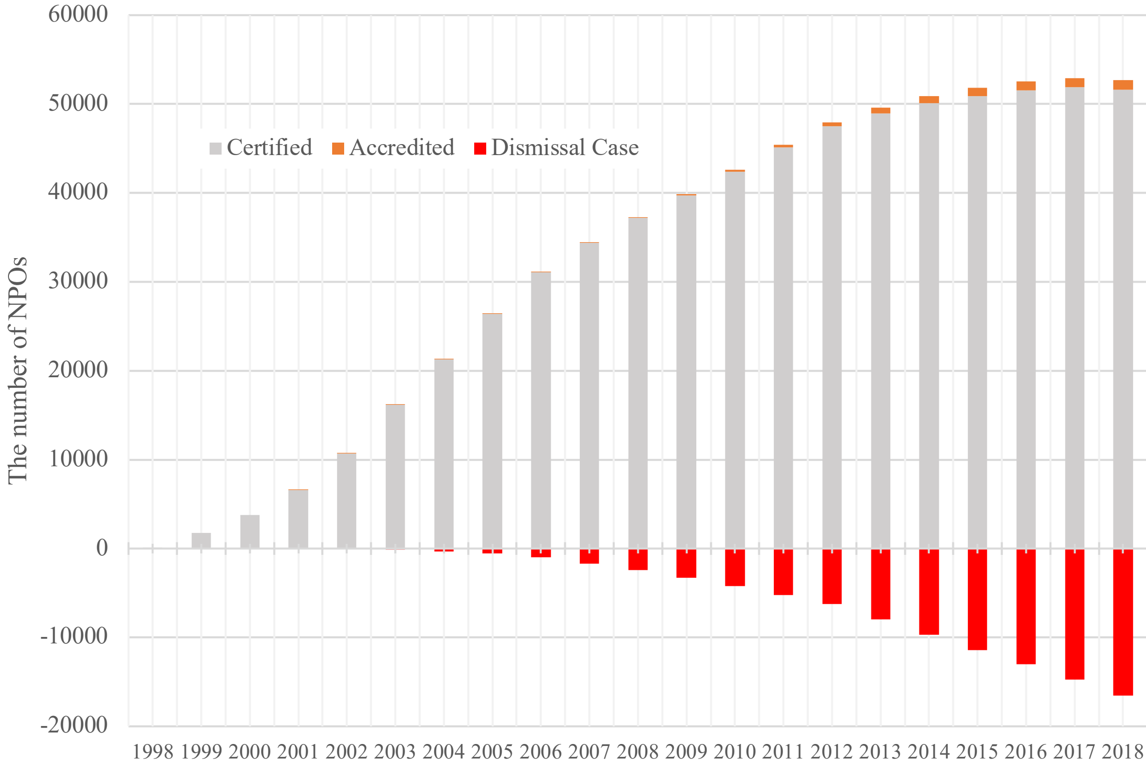

Figure A23-1. the number of certified or accredited NPOs in Japan.

Category	Content of Activity	Number	Share
1	Health or Medical Related Activities and Promotion	30469	59%
2	Social Education	25182	49%
3	Community/City Development	23099	45%
4	Promotion of Tourism	3299	6%
5	Development of Agricultural/Fishing Village and Remote Village	2697	5%
6	Promotion of Academics, Culture, Art and Sports	18225	35%
7	Environmental Protection	13818	27%
8	Disaster Relief	4445	9%
9	Local Safety Protection	6350	12%
10	Protection of Human Rights and Promotion of Peace	8724	17%
11	International Co-operation	10089	20%
12	Gender Equality	4805	9%
13	Children's health and development	23670	46%
14	Promotion of ICT-based society	5879	11%
15	Promotion of Science and Technology	3160	6%
16	Economic Development	9161	18%

17	Development of Vocational Ability and Job Opportunity	13329	26%
18	Consumer Protection	3110	6%
19	Advice and Managerial Help for NPOs	23990	46%
20	Administrative help for NPOs	245	0%

Table A23-2. Content of Activities as of February 2018[45].

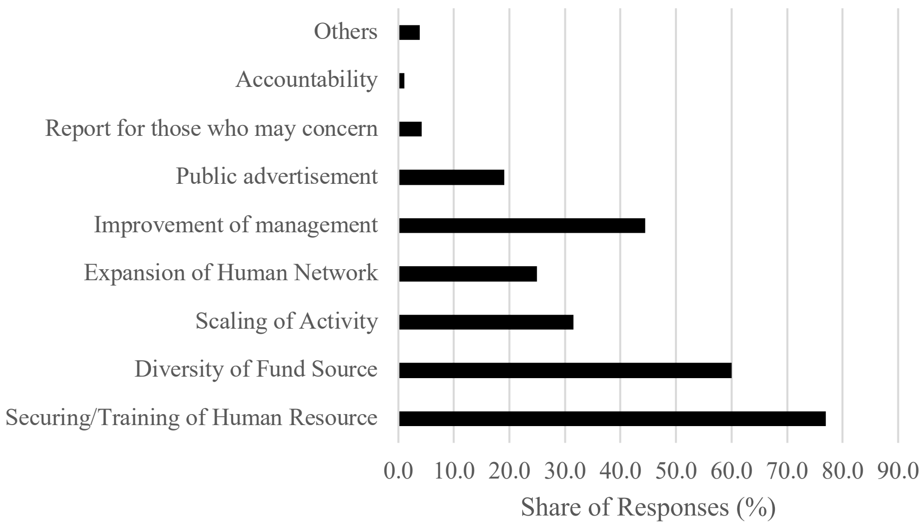

Figure A23-3. Share of NPO who face to specific challenges as of 2015 (Cabinet Office, 2016).

	Number of Staffs		Number of Staffs with Salary		Number of Full-time Staffs with Salary		Number of Non-paid Staffs	
	Median	Mean	Median	Mean	Median	Mean	Median	Mean
Total	7	16.1	5	14.1	2	6.7	20	275.6
Neither accredited nor provisionally accredited	7	15.6	5.5	13.9	2	6.9	15	182.0
Accredited or provisionally accredited	6	17.5	5	14.4	2	6.4	41	524.1

Table A23-4. Workers in NPO (Cabinet Office, 2016).

45 Some NPOs are engaged in multiple activities.

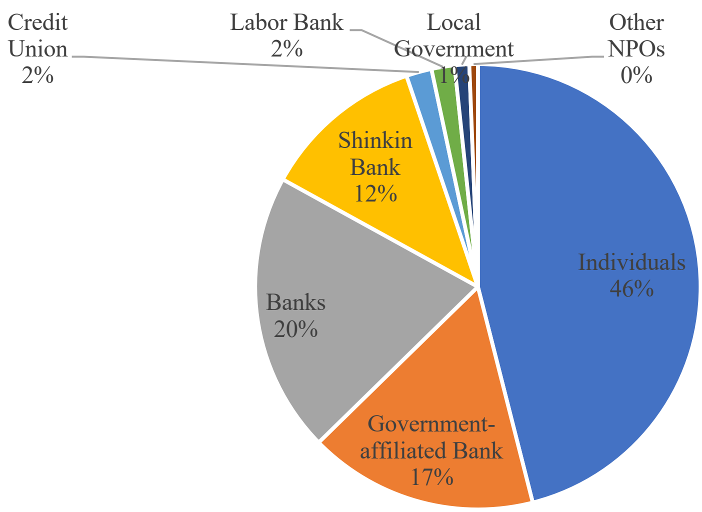

Figure A23-5. Source of Funds for NPO (Cabinet Office, 2016).

On the other hand, what is called "social enterprise" is a profit-seeking organization but simultaneously its primary aim is to solve social issues. The survey done by a Japanese think tank "Mitsubishi UFJ Research & Consulting" defined social companies based on three axis; non-profit organization (organizational type), having private market as their main income source, and seeking for social contribution as the purpose of business rather than for profit (see *diagram A23-6*) (Mitsubishi UFJ Research and Consulting, 2015). According to this definition, the survey reveals that there are roughly 205,000 social enterprises (11.8% of all companies) in Japan, consisting 16 trillion JPY (3.3%) of total added-values as of 2015. In the same year, the paid workers who are engaged in social companies are approximately 5.7 million persons, consisting 10.3% of total labor.

Because social enterprises enter to a private market and aim to raise some profits from it, they can have solid business model based on profit gaining and provide objective financial indicators, which makes them much easier to leverage finances compared to NPOs. That being said, they still encounter several obstacles in fundraising; first, social companies contain low risk due to smaller business scale but also contain high risk in long-term management. Second, because most social issues cannot be solved in short-term, their business will inevitably become long-run, which makes investors difficult to evaluate returns. Third, it is dependent on subsidy especially in early stages, which casts uncertainty in the business's sustainability (Hayami, 2015; Koseki, 2017).

In sum, for both NPO and Social Companies, fundraising is especially important. Currently, both (especially NPOs) are dependent on governmental subsidies, and they have hardship in raising funds from banks or credit unions as their social missions inevitably require long-term efforts, which casts higher uncertainty in investment compared to profit-seeking organizations. However, on these days, there are new way of civil funding such as cloud funding, which is claimed to be very compatible to their business model (Hayami, 2015).

Scenario A: Social Enterprises and NPOs consists 30% of all companies in Japan, most of which is funded by citizens and local government.
Scenario B: Social Enterprises and NPOs consists 10% of all companies in Japan, most of which is funded by private banks.
Scenario C: Social Enterprises and NPOs consists 5% of all companies in Japan, most of which is funded by private banks.

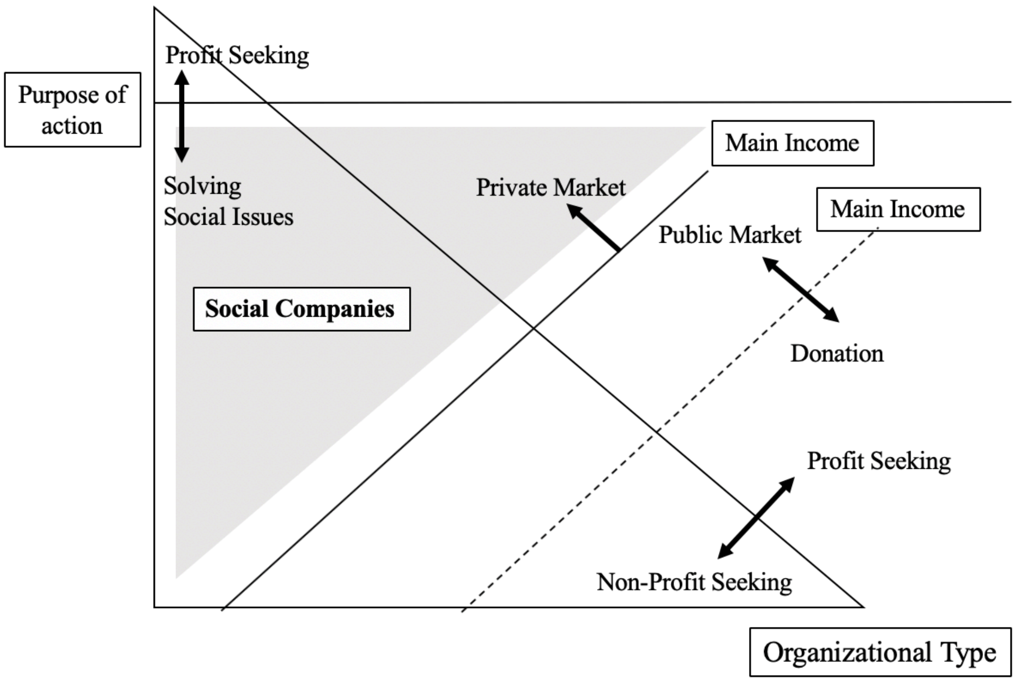

Diagram A23-6. Social Companies

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