

# Overcoming the Challenges of Energy Scarcity in Japan

The creation of fossil fuel import dependence

Natassjha Antunes Venhammar

EKHK18



**LUND**  
UNIVERSITY

Dependence on imported fossil fuels is a major issue in contemporary Japan, as this creates economic vulnerabilities and contributes to climate change. The reliance on imports has been increasing, despite efforts to diversify and conserve energy, and today imports supply over 90 percent of energy consumed in Japan. The aim of this study is to understand the context that contributed to the creation of this fossil fuel import dependence, and to examine how economic incentives and policy tools have been employed to mitigate the issue. This is done through a case study, using analytical tools such as thematic analysis and framing. It is argued that continued reliance on fossil fuel imports is due to a combination of; increasing consumption, absence of natural resource endowments, institutional structures, and alternative sources being considered unreliable or expensive.

# Table of Contents

1. Introduction .....	4
1.1 Research Question and Aim .....	5
1.2 Relevance .....	6
1.2.1 Economics of Global Warming .....	7
1.3 Delimitations .....	7
1.4 Structure .....	7
2. Background .....	8
2.1 Historical Overview .....	8
2.1.1 Industrialisation and Imperialism .....	8
2.1.2 Militarisation and the Second World War .....	9
2.1.3 Rebuilding the Economy .....	10
2.2 The Energy Sector in Japan .....	11
3. Previous Research .....	12
3.1 Incentive Policies, Hong Kong .....	12
3.2 Renewable Energy, Japan .....	13
3.3 Energy Security, EU .....	13
4. Theoretical Framework .....	14
4.1 Evolutionary Economic Theory .....	14
4.2 Energy Security .....	15
4.3 Factor Endowments .....	15
5. Methodology .....	16
5.1 Research Design .....	16
5.2 Data Collection .....	16
5.3 Analytical Framework .....	17
5.3.1 Framing .....	17
5.3.2 Constructivism and Subjectivity .....	17
5.4 Limitations .....	18
6. Analysis: Fossil Fuel and Import Dependence .....	19
6.1 Increasing Energy Demand .....	19
6.2 Natural Resource Endowments .....	21
6.3 Production and Trade Patterns .....	21

6.5 Institutional Structures .....	22
7. Analysis: Economic Incentives and Policy Tools .....	24
7.1 Policy instruments .....	24
7.2 Diversification .....	24
7.3 Alternatives to Fossil Fuels .....	25
7.3.1 Nuclear Power .....	26
7.3.2 Renewable Energy.....	26
6.4 Energy Efficiency.....	27
8. Discussion .....	29
9. Conclusion.....	30
References .....	31

# 1. Introduction

During the last century Japan has industrialised, and experienced economic growth at a rate that has made it widely recognised as a “miracle economy”. After experiencing defeat in the Second World War, Japan quickly rose to become one of the world’s largest economies, with an economic growth rate much higher than average (Heller, 1976, Kingston, 2013:3). This significant growth and development was accompanied by large increases in energy consumption, as is common when a nation industrialises. As Japan became one of the world’s leading economies, it also became the fifth largest energy consumer in the world, as of 2015 (Enerdata, 2016).

The nation has long relied extensively on imports of fossil fuels to supply a large share of its energy, therefore, the economy was severely affected by the oil crisis in the 1970s and a slowdown of Gross Domestic Product (GDP) growth can be seen in the years that saw disruptions in the international energy market (Kingston, 2013:15, The World Bank, 2017d). The main share of energy demands today are still satisfied through imports of fossil fuels, and Japan is one of the largest importers of energy, with net energy imports constituting 94 percent of total Japanese energy use in 2014 (The World Bank, 2017a). The reliance on international markets to supply the nation with energy creates vulnerabilities, both economic and diplomatic, and energy security is, therefore, an acute concern in contemporary Japan. Since the crisis in the 1970s there has been a clear focus on the issue of import dependence, and the need to manage the accompanying risks, in Japanese politics and government planning (Lesbriel, 2004).

With the technological level that Japan is already at, it can be questioned why other renewable energy sources than hydropower, such as wind and solar power, have not been developed more extensively. Much of the Japanese plan appears to rely on the use of nuclear power, which has proven to be an unstable and unsafe energy source. Through innovation and a restructuring of the energy sector it might be possible to find alternatives to the reliance on imported fossil fuels and unstable nuclear power. This development could be furthered by economic incentives and policy tools that specifically target the energy sector, promote the development of sustainable technologies and the use of renewable energy sources.

## 1.1 Research Question and Aim

The aim of this research is to understand the reasons behind Japanese dependency on imports of fossil fuels. Furthermore, the purpose of this research is to examine what is being done in Japan, through economic incentives and the use of policy tools, to counter this dependency and promote renewable energy sources. Therefore, a research question has been constructed as follows;

**Why has Japan remained dependent on energy from imported fossil fuels, and how have economic incentives and policy tools been used to counter this dependence?**

This question is highly relevant in Japan today, and encompasses many important topics such as self-sufficiency, global warming, energy security, economic independence and the debate on nuclear power. The high reliance on fossil fuels, which have to be imported, is currently a widely discussed issue in Japan as it is not economically safe to be reliant on an energy source that can only be supplied through the international market. The previous oil shocks have shown that the import of energy, specifically fossil fuels, makes Japan vulnerable. It is easy to understand why dependence on imported energy in the form of fossil fuels is a widely-discussed issue in Japan.

Furthermore, the second part of the research question intends to continue the argument of why this situation has arisen, to how Japan has attempted to mitigate these issues with the use of economic incentives and policy tools, and the effectiveness of these attempts. Nuclear power is the most widely proposed solution, however, the recent Fukushima incident demonstrates the considerable risks associated with nuclear power, especially in a zone that is as geologically unstable as Japan. One could question why such a country, previously quick to adapt and develop, is still reliant on fossil fuels, especially when the country itself does not have a lot of fossil fuel reserves. To sustain the ongoing industrialisation, urbanisation and trade in the East Asian region further increases in energy consumption are to be expected in the future (Thomson, et al., 2011:vii). Hence, it is essential to Japanese security that energy is accessible to meet the demands of the economy at a reasonable price (Lesbriel, 2004).

To clarify the research focus working questions will also be used to guide the collection of information; i) *how can innovation contribute to Japanese energy security?*; ii) *why does Japan remain dependent mainly on fossil fuels?*; iii) *what possibilities for the use of renewable energy sources exist in Japan?* and iv) *does Japan have an institutional and economic structure that facilitates innovation in the energy sector?*

## 1.2 Relevance

As more countries modernise and achieve the same level of wealth as the ‘developed’ nations, the strain on our environment will only continue to increase unless solutions can be found. Both to reduce the amount of energy required to sustain current standards and the current dependence on environmentally harmful energy sources (Komiya, 2014:28; von Weizsäcker, 2016:26). It is essential that solutions are developed to decouple economic growth from greenhouse gas emissions (von Weizsäcker, 2016:35). In its effort to reduce greenhouse gas emissions and mitigate global warming the Japanese government is focusing on technological solutions and improvements, and most nuclear power plants that closed after the Fukushima incident will be reopened (UNFCCC, 2015). Japan has also made significant advances in the field of energy efficiency, becoming one of the most energy efficient nations in the developed world, thus, offsetting increasing energy consumption to some degree (Honma & Hu, 2007).

Furthermore, oil consumption has been declining in the years 1994-2004 (Thomson et al., 2011:14), and in the decades since 1979 industrial sector energy consumption has not increased, despite a doubling of Japan’s GDP (Kingston, 2013:177). Looking at these measurements it appears that Japan is making significant progress with respect to environmental goals, however, there are some that argue that when measuring other indicators emissions have in fact increased (Kingston, 2013:178). Japan’s energy sector has a high reliance on oil, 48 percent in 2009 (Kingston, 2013:178), and very little progress has been made in the development and use of renewable energy in the 2000s (Kingston, 2013:184).

The Kyoto Protocol required Japan to reduce its emissions by 6 percent in the period from 2008 to 2012, compared to 1990 average levels. These goals were not achieved, and instead Japan experienced a 9 percent rise in CO<sub>2</sub> emissions (Kingston, 2013:178). Carbon dioxide emissions had previously increased by approximately 13.1 percent between 1990 and 2005, thus, the rise has been slowed, but still far from the targets that were set. The main source of these emissions was energy consumption. It has been calculated that in 2005 carbon dioxide emissions from energy consumption accounted for 92.6 percent of greenhouse gas emissions in Japan (Honma & Hu, 2007), and in 2010, 89 percent of Japanese greenhouse gas emissions emanated from the energy sector (Brömmelhörster et al., 2013:7-8). Since these calculations were made the Fukushima accident has further increased the reliance on fossil fuels, and it is therefore likely that the number is even higher today.

### **1.2.1 Economics of Global Warming**

If global warming causes a significant rise in sea levels, Japan would be one of the countries most affected, and a large share of resources would be at risk. A rise in temperatures would also cause more frequent tropical storms and flooding in Japanese coastal areas, which is where 24 percent of the Japanese population is located (Brömmelhörster et al., 2013:14-19). Therefore, the use of fossil fuels is not only a damaging economic practice from the perspective of import dependence, but also from the perspective of long term effects of CO2 emissions.

### **1.3 Delimitations**

This research focuses on Japanese imports of fossil fuels, and policies and incentives related to this topic. Japanese trade patterns and economic structures will only be studied in direct relation to the energy sector, fossil fuels and the import of fossil fuels. This will include research about alternative energy sources, so that the reason for high reliance on fossil fuels can be determined. The aim of this study is to create an understanding of the circumstances that created and sustained the reliance on imported fossil fuels, and explore how economic incentives and policy tools have been utilised to address this issue. Thus, no recommendations or suggestions will be made as to which solutions would be the most effective at solving the issue. Possible solutions will be discussed insofar as they are related to previous attempts to mitigate the risks of fossil fuel import dependence.

### **1.4 Structure**

In the next section some historical background on Japanese politics, trade and economy will be provided, to create the necessary foundation to explore the issues at hand. In the next section, Previous Research, studies that have dealt with similar issues or aspects of the current issue will be presented and discussed. This section will be followed by two sections explaining the theoretical framework and methodology that has inspired and facilitated this paper. Following the section on methodology is the main section of this study, providing the material and context to answer the research question. The answers will then be discussed, and finally summarised in the conclusion.

## **2. Background**

After years of seclusion and isolation from international markets Japan was forced to open the country once again at the end of the 19<sup>th</sup> century (Yamamoto & Yamaguchi, 2005).

Previously Japan had mainly been reliant on domestic coal for its energy supply, however, participation in the global market allowed Japan to access the global resource base and import natural resources. In the 1890s the Japanese population had surpassed 40 million and energy demands were increasing at a fast pace as the nation industrialised and modernised. In the following 50 years, from 1890 to 1940, the population increased to 70 million as Japan experienced rapid large-scale change (Totman, 2014:191, 203 & 235).

### **2.1 Historical Overview**

#### **2.1.1 Industrialisation and Imperialism**

In 1894, as a part of a new imperialist direction, Japan went to war with China to maintain control over the Korean peninsula and drive China away from the area. The war ended with China confirming Japanese power over Korea, and with Taiwan given over to Japanese rule (Totman, 2014:197-199). The main purpose of the Japanese expansion was to secure natural resources, however, international trade still provided the majority of the required resources. Japanese trade increased rapidly between 1883 and 1913, from a trade value of 174 million yen to 1.5 billion yen. During this period the trade composition changed as well, from exports of raw materials and imports of manufactured goods, to export of manufactured goods and import of raw materials (Totman, 2014:208). The main actors in the Japanese economy were the so called ‘zaibatsu’ – large conglomerates that were engaged in a variety of companies and sectors, such as shipping, manufacturing, mining and finance. These ‘zaibatsu’ were run by an industrial elite and has substantial influence in policymaking as they always strived to “maintain mutually advantageous relationships with government organs and leaders” (Totman, 2014:214).

At the passing of the century, in 1900, there was an increased cooperation with the European imperial powers and an alliance was made with Great Britain, the Anglo-Japanese alliance. Longstanding tensions with Russia over the areas of Korea and Manchuria escalated and culminated in the Russo-Japanese war in 1904-1905 (Totman, 2014:197-199). After a

settlement which was mediated by the US, Russia ceded some areas to Japan and Japanese primacy in Korea was recognized. Japanese rule in Korea was not uncontroversial, and there was resistance against Japan, eventually leading to the formal annexation of Korea by Japan in 1910 (Totman, 2014:197-199).

Because of the Anglo-Japanese alliance, when the Second World War started in 1914 Japan joined on Great Britain's side and declared war on Germany. This also suited Japan's current imperial ambitions as this allowed the expansion of Japanese power through the seizure of German assets in China and the Pacific. An attempt was also made to gain more land in the areas adjacent to those already controlled by Japan in the Manchuria-Siberia region. Japanese forces did not leave Siberia when the European forces had retreated, but stayed in the region until 1925 when military leaders were finally forced to return home without reaching the goal of expansion in Siberia-Manchuria (Totman, 2014:199).

### **2.1.2 Militarisation and the Second World War**

Relations with both China and the US were deteriorating rapidly in the 1930s, and the tensions between Japan and China escalated into war in 1937. During the Sino-Japanese war, the Second World War also broke out in Europe, and in 1940 Japan joined the Three-Power Pact of mutual assistance with Germany and Italy (Totman, 2014:200-201). Japan attempted to stop foreign supplies from reaching China by moving troops into French Indochina (Vietnam), which prompted the US to cut all exports of scrap iron and steel to Japan (Totman, 2014:201).

To gain access to natural resources in the north, a non-aggression pact was signed with the Soviet Union in 1941 (Totman, 2014:201-202). With these resources Japan managed to advance in Indochina, leading to both Britain and the US to freeze all Japanese assets and discontinue the export of oil to Japan (Totman, 2014:202). This oil embargo had a significant role in the following events as Japan, later that same year, attacked Pearl Harbor and occupied large parts of Southeast Asia. However, after being defeated by the US Navy in the Battle of Midway Japan gradually lost control of the Pacific (Lam, 2009:117). The war ended in 1945 with the bombs in Hiroshima and Nagasaki, and Japan lost all colonies (Totman, 2014:202). Japanese motivations for the attack on Pearl Harbor and occupation of Southeast Asia had a lot to do with the need to secure an energy supply, which was only amplified by the embargos

placed on oil exports to Japan. With the loss of the colonies in Siberia and Southeast Asia, Japan lost a large share of its natural resources, especially fossil fuel sources.

### **2.1.3 Rebuilding the Economy**

After the defeat, industrial growth decreased temporarily, and there was general confusion concerning leadership and future policy decisions. In the previous decade, a political elite had been the leading force, however, the leadership was increasingly shifting towards a commercial elite in decades following the war (Totman, 2014:192 & 237-238). This shift in power was in line with the new direction the nation was taking, setting goals of recovery, development and growth, instead of the previous aspirations to expand the Japanese empire geographically through military advances. A new model of economic development was created that became a sort of hybrid; a capitalist system with a planned economy that had the flexibility necessary to respond to market signals. The 'zaibatsu' corporations that were in power before the war changed from family-owned conglomerates to more bank-centered industrial groups, now called 'keiretsu' (Kingston, 2013:13).

With the Cold War and the Korean War, Japan became a valuable asset to the US and Japanese goods and services were in high demand. Trade with the US during the Korean War benefitted the Japanese economy significantly, and industrial production grew at an average rate of almost 30 percent from 1947 to 1952. Japanese autonomy was restored in 1952, and the high production growth continued throughout the decade and managed to bring Japan back to pre-war levels of production by 1955. Between 1955 and 1985 Japanese population growth increased rapidly and the nation experienced an economic boom, becoming one of the world's largest economies (Totman, 2014:238-239 & 241-242).

The high growth period after the Second World War saw a change in factor endowments from relatively labour-abundant production, that Japanese competitiveness had traditionally relied on, to a focus on capital intensive production. In the transition between these two types of economies Japan maintained a dualistic production structure, as firms were faced with different factor price ratios in the 1950s. Large firms were supported by the government and could engage in capital intensive ventures while smaller firms that did not have easy access to capital instead relied on labour. This also created a wage dichotomy, as employees in smaller firms earned less. Both types of firms coexisted within different sectors, and this dualism was also present in international trade. To nations that were less developed Japan exported capital

intensively, and to those that were more developed exports were focused on labour intensive products. In the early 1960s this dualism was weakened as wages in small firms increased but capital remained relatively inaccessible, hence, capital intensive exports became predominant (Heller, 1976). This change in factor endowments shifted Japanese trade patterns towards exports of high quality goods, instead of the previously prevalent export of manufactured low-quality goods that could be produced cheaply (Kingston, 2013:14).

## **2.2 The Energy Sector in Japan**

In 1878 a lamp was switched on at the Institute of Technology in Tokyo, marking the first use of electricity in Japan (FEPC, n.d.). Some years later, in 1883, Tokyo Electric Light Company was founded and service to the public began in 1887. In 1890 Tokyo Electric Light Company supplied electricity to more than 5000 lamps in the Tokyo area. More power stations were built in Osaka by the newly founded Osaka Electric Light Company, and in Kyoto the first hydroelectric power station was planned in 1888. The installation of 19 generators in Kyoto was finished in 1897 and ten years later, in 1907, the first large-scale hydroelectric power station in Tokyo was built (Yamamoto & Yamaguchi, 2005). The use of hydropower increased and persisted during the 20<sup>th</sup> century, nevertheless, it only complemented the use of fossil fuels and did not surpass it. In the early years of electrification coal was the main fuel for electricity generation, but with technological advances oil gradually became more prominent (Totman, 2014:213).

After the First World War there was a restructuring of the Japanese energy sector, and 700 electric companies were dissolved and merged into five larger companies. The sector became completely state controlled during the Second World War, and all companies were integrated into one company that provided electricity to the entire nation through nine distributors. In an attempt to liberalise and democratise the economy after the war the energy sector was once again restructured, creating several privately owned and managed companies. These same General Electricity Companies remain today, supplying electricity to their specific region. Since the end of the 20<sup>th</sup> century there are also independent power producers, and the last decade has seen significant liberalisation of the sector (FEPC, n.d.).

### **3. Previous Research**

The question of import and fossil fuel dependence is highly relevant in Japan today, and is generally discussed in relation to topics such as sustainable development, climate change, energy security, energy scarcity and the risks of import reliance. On the national level, there is a large amount of research on national energy consumption and strategies that could solve the issues Japan currently faces. Especially in the wake of the Fukushima incident, many scholars focused their efforts on trying to find viable solutions to the energy problem in Japan. There is also a wide range of international material dealing with similar questions concerning other regions, as topics like climate change and energy scarcity are global issues, and a significant amount of research effort has been dedicated to finding economically viable alternatives to fossil fuels. These general trends are apparent from observing the academic material available. Three examples of these research trends are presented and discussed in the following sections.

#### **3.1 Incentive Policies, Hong Kong**

*A study of incentive policies for building-integrated photovoltaic technology in Hong Kong* by Aotian Song, Lin Lu, Zhizhao Liu and Man Sing Wong reviews the development of photovoltaic technology in five countries with leading positions in this industry, and propose incentive strategies that could be applied in Hong Kong. The authors aim to provide a foundation for the future creation of economic incentives and policies to promote and support photovoltaic technology and industry in Hong Kong, and possibly other nations that face the same issues of fossil fuel import dependence (Song et al., 2016).

The study appears to present economically practical and to-the-point conclusions concerning the most appropriate incentive methods, acknowledging aspects of photovoltaic development and use that are specific to Hong Kong. This research was published in 2016, making it a current and up-to-date account of the current state of photovoltaic technological capacity and spread, as well as the possibilities that exist presently to promote and support this sector. The possible effects that political interest or competing economic actors can have on economic incentives and policies are not discussed, as this is outside the scope of the research. This could, however, be an interesting continuation of the argument, to determine if the implementation of these economic incentives is feasible considering the political milieu.

### **3.2 Renewable Energy, Japan**

*Conditions for a 100% renewable energy supply system in Japan and South Korea* by Bent Sørensen examines the feasibility of an energy system that relies completely on a combination of renewable sources, and the possible advantages of a regional energy system. Through creating possible future scenarios and simulate the possibilities available in these, Sørensen comes to the conclusion that a complete reliance on renewables is a realistic alternative. Both technological feasibility and costs are taken into account, and a variety of possible scenarios are found. It is reasoned that it would be possible to establish a regional energy system between Japan and South Korea, allowing for energy interchange and coordinated management. Furthermore, the use of such a regional system would be beneficial to both nations, and better enable a nation fully reliant on renewables to manage intermittency of energy flows (Sørensen, 2017).

The conclusions presented in this study are encouraging with regards to the current dependence on fossil fuels imports, and the idea of cooperating in a regional energy system is intriguing. However, it can be argued that the path-dependency of a carbon society would stifle the development of such a system significantly. Sørensen makes a compelling argument though, and, with the right circumstances and context, the changes to the energy system proposed in this study could be possible, and would definitely benefit the nation.

### **3.3 Energy Security, EU**

*Rethinking EU Energy Security Considering Past Trends and Future Prospects*, by Mehdi P. Amineh and Wina H. J. Crijns-Graus, examines energy policy and security trends in the European Union (EU), and the possible threats to the supplies of fossil fuels. Sources and methods of data calculation are clearly presented in this study, and it is concluded that the EU will be influenced by the relations between energy producing nations. The emerging Asian economies are discussed, and argued to become a competing force to the EU concerning the access to energy supplies (Amineh & Crijns-Graus, 2014). This study is detailed, and has a much more qualitative direction as compared to the two presented in previous sections. The study engages in speculative arguments, and it is impossible to determine if predictions will be correct. However, the analysis takes the complexity of the situation into account, and the proposed future prospect appear to be logical given the data presented.

## **4. Theoretical Framework**

In the following section, theories and concepts that will aid and inspire this study are presented. The main theory discussed is evolutionary economic theory, although the concept of energy security touches upon ideas of political economic theory. Furthermore, the concept of factor endowments is presented briefly as a way to view the relation between natural resource endowments, economic structures and trade patterns. Theory is primarily used to assist the researcher in gaining an extensive comprehension of the phenomenon, and the research will not aim to test any theories.

### **4.1 Evolutionary Economic Theory**

The connotation of the word ‘evolutionary’ is that long-term progressive change, in this case economical change, is studied (Nelson & Winter, 1982:10). Evolutionary economic theory emphasizes the co-evolution of technology, industrial and firm structure, non-market institutions and public policies and programmes. Evolutionary economic theory puts forth the argument that the basic challenge for countries aiming to catch up with their economic development is to “learn to master new ways of doing things” (Nelson, 2008:15).

Furthermore, for successful innovation to take place physical and human capital is necessary, and to enable innovation to make use of these resources an institutional structure that facilitates this must be in place (Nelson, 2008).

Concerning the rationality of actors, evolutionary economic theory argues that since the economy is in a process of continuous change, and current situations cannot be completely understood by actors, bounded rationality can be assumed (Nelson, 2008). Actors are rational, but since they cannot completely comprehend economic developments as they happen, they will often act in accordance with previously established routines and behaviours. In fact, it is argued that most choices are made automatically, dictated by the routines of individuals and organisations (Nelson & Winter, 1982:134). It is also possible, however, that actors act in a way that is unexpected and new, thus creating innovation. Innovation is viewed as a form of creative destruction, facilitating economic progress through processes that are highly uncertain and will likely be disadvantageous for someone, while benefitting others (Nelson, 2008).

## **4.2 Energy Security**

The most basic presumption of the energy security concept is that energy, in the form of fossil fuels, is a strategic resource, and nations strive to ensure reliable supplies of this resource at reasonable prices for the foreseeable future (Fermann, 2014:23 & 31). Security of supply is a main concern of most import reliant countries since fossil fuel based energy will continue to rise in prices as availability declines and continued energy consumption growth causes increasing demand (Fermann, 2014:29). Furthermore, linkages are made between the Second World War and energy security by arguing that the need to secure access to strategic resources was an important incentive (Fermann, 2014:26-29).

The most common strategy to ensure security of supply is through control of foreign resources. Some degree of control can be achieved through for example investment, aid, diversification or coercion. Attention can also be turned to internal processes that limit dependence on foreign suppliers, bypassing the need for supply-security, such as energy substitution and conservation (Fermann, 2014:31-32). Markets are argued to be insufficient in ensuring energy supply, thus, the perspective of a political economy is deemed necessary to understand the concept of energy security. The argument is put forth that “[w]hen international energy-markets cease to supply predictable volumes of energy at acceptable prices, energy enters the domain of politics” (Fermann, 2014:26), and that energy transactions have inherently political aspects. Market actors do play a significant role, as they are able to affect energy related policy-making in many nations (Fermann, 2014:25-26)

## **4.3 Factor Endowments**

The concept of factor endowments can be useful in many contexts. Factor endowments can have indirect effects on the structure of an economy, and influence its economic performance, through their impact on the development of institutions (Engerman et al., 2002). With the concept of factor endowments geographical circumstances are taken into account. Factor endowments do not provide a complete explanation, however, as no one factor can explain economic development. But the concept can still provide insight into the dynamics of certain issues, especially when natural resource endowments are at the core of the discussion.

## **5. Methodology**

### **5.1 Research Design**

This research intends to identify the reasons for the longstanding dependence on imported fossil fuels, and explore related policies, through a single case study. The use of a case study design will allow for the creation of complex explanations to the phenomenon, which is what will be required to answer the research question (De Vaus, 2001:220-221). This research will primarily utilise qualitative research methods, however, some quantitative information will be required. Different sources may require different strategies, and some will require more than one approach. Therefore, the mixed method approach has advantages, since it allows for one method to fill the gaps left by another, and thus create a complete picture (Bryman, 2008:609-616).

As this research is a desk study using secondary sources, the main methodological focus is on the analysis and coding of data. The answer to the research question will consist of two main themes; explaining Japanese dependence on imported energy, and evaluating the effects of economic incentives and policy tools aimed at countering this dependence. Thus, the nature of the analytical process in this research will change depending on which part of the problem is being examined. Generally, a constructivist approach is adopted in this study, as the issue of fossil fuel import reliance is not believed to have one objective answer. Constructivism argues that phenomena and their meanings are constructed by social actors, and through a constructivist approach it is believed that a more complex explanation can be found (Bryman, 2008:710).

### **5.2 Data Collection**

Collection of data will be conducted mainly through the use of secondary sources such as previous research. Some official documents and databases will also be used. The collected data can be categorised and made accessible through ‘code and retrieve’ methods that operates based on categories created by the researcher. These categories are used to find and organise data in significant themes which can be analysed. This method is useful when the aim is to “understand complex narratives or processes” and “identify overall structures within each case” (Ritchie & Lewis, 2003:203).

## **5.3 Analytical Framework**

A thematic approach will be used to analyse the data and find patterns, this approach works well together with the code and retrieve method of data collection, since pieces of information can be labelled according to theme and then analysed in these groups (Byrne, 2016). Policy and evaluation analysis can be used for the latter part of the research question to understand the context, effectiveness and impact of economic incentives and policy tools (Ritchie & Lewis 2003:201). Through finding these patterns and associations within the data, and attempting to explain them, the research can move from descriptive to explanatory.

Explaining phenomenon is the main purpose of most qualitative research, and that is what this research aims to accomplish (Ritchie & Lewis, 2003:215).

### **5.3.1 Framing**

The concept of framing, or discourses, is essential in social constructivist analysis. Social constructivism questions and examines the social, political and cultural processes which shape the definitions of phenomena, and framing focuses on the way that meanings are assigned to different environmental phenomena, and what storylines are developed surrounding this (Hannigan, 2006:29 & 36). With an understanding of the frames that are present in the environmental and nuclear debates a more profound analysis of arguments and decisions becomes possible. Framing is often known as discourse, and discourse analysis has become a well-used method both in social constructivism and other schools (Hannigan, 2006:36-37).

### **5.3.2 Constructivism and Subjectivity**

Arguments cannot be definitively decided since they are based on subjective assumptions that are hard to prove beyond doubt. Indeed frames are subjectively constructed, even though facts are used both as a basis and in arguments they are shaped by the frame and certain facts are highlighted over others to further prove the validity of the framing. The idea of facts, universally valid truths, is fundamental to the whole concept of a discussion or an argument in the environmental debate. Facts usually are determined by science, it is science that determines the risks and problems that exist with environmental degradation and climate change, and it is science that tries to predict the most likely effects of our actions on nature and global climate. It can be argued however that science is also a discourse or frame. Science

is discovered and presented by scientists, and as a human creation of thought it is subject to human frames. The choices of the scientist are affected by the frame within which he or she operates, and these choices can affect the examination, presentation and significance of evidence in many ways. For example the frame within which the scientist operates affects the choice of topic, the method of collecting information, the way information is analysed, the choice of information to include or exclude and how information is presented. It can also be the case in environmental debates that a piece of information is framed as fact, when it is debatable (Yearly, 1996:101-121). The environmental debate and the environmental policies that come into existence as a result can be understood more profoundly with an awareness and knowledge of the concept of frames and discourses. In recent years of environmental discussions and decisions increased attention has been directed at the concept of sustainable development, which has been successfully framed as an “objective from which one apparently could not wish to diverge” (Yearly, 1996:133).

## **5.4 Limitations**

The availability of information is one of the factors that could become a challenge in this research. It will be necessary to clearly and continuously define the scope and limits of the research, so that information that is relevant can be separated from information that would only distract. The task of data reduction and categorizing will be essential in narrowing the research, and making sure that explanations do not become too wide and relative to have any use. The use of code and retrieve methods will assist with this, but it also has to be acknowledged that there is critique against these methods. It has been argued that these methods group data outside of their original context, and that it is important to revisit the original data constantly as part of the research process (Ritchie & Lewis, 2003:204).

Furthermore, the research can quite easily become too speculative as this topic has many relevant implications for the future. It is important that there is an awareness and conscious decision to avoid excessive speculation about the future of energy in Japan. There is a chance that the language will prove to be a barrier with some sources, as original documents may be in Japanese. However, previous research exists in English and many documents intended for international use will have been translated, therefore, sufficient information should be available in English.

## **6. Analysis: Fossil Fuel and Import Dependence**

This section aims to explore, and find answers to, why the dependence on imported fossil fuels was created and has been sustained to the current day. The analysis of this issue must first attempt to explain the need for imports, and then why fossil fuels became, and remains today, the dominating energy source in Japan, despite the need to import these fuels and the risks this brings.

### **6.1 Increasing Energy Demand**

Since the advent of electricity use in Japan, in 1878, energy consumption has increased rapidly, especially after the First World War when widespread electrification took place. By the mid-1930s the Japanese society had one of the world's highest rates of electrification with 89 percent of households having access to electricity for basic needs, such as lighting (Totman, 2014:213). This rise in electricity consumption was mainly sustained through energy derived from fossil fuels such as coal and petroleum, since the majority of Japanese forests had been cut down already in the 17<sup>th</sup> century (Totman, 2014:171-174). Thus, to sustain the rise in electricity consumption the use of fossil resources increased rapidly. Hydroelectric plants were also built early in the 20<sup>th</sup> century to complement the fossil fuel resources, as these were not sufficient to meet the energy demand (Totman, 2014:213). In the 1920s there were protests against the coal mining in Japan, due to the severe pollutions that resulted from this production (Totman, 2014:222). Nevertheless, coal mining continued for many years, perhaps because major economic actors such as the 'zaibatsu' conglomerates benefitted from increases in output of mining and manufacturing that followed the rapid industrialisation (Totman, 2014:225). The industrialisation and development of new technologies enabled economic growth, and environmentally harmful practices were therefore sustained and supported for many years despite protests (Springer, 2016:29).

In the decades before the Second World War many industries producing energy in different forms were established (Totman, 2014:209). After the Second World War, however, increases in domestic energy output were mainly consequences of technological development to extract more from already existing fossil fuel sources. The issue of energy supply became pressing as it was determined that Japan did not possess sufficient domestic resources to sustain its own

electricity consumption (Figure 1; Totman, 2014:240). As a result, imports of fossil fuels increased rapidly in the 1960s, and energy imports as a percentage of energy use eventually converged with the percentage of fossil fuels consumption (Figure 2). Thus, essentially all fossil fuels were supplied by the international market.

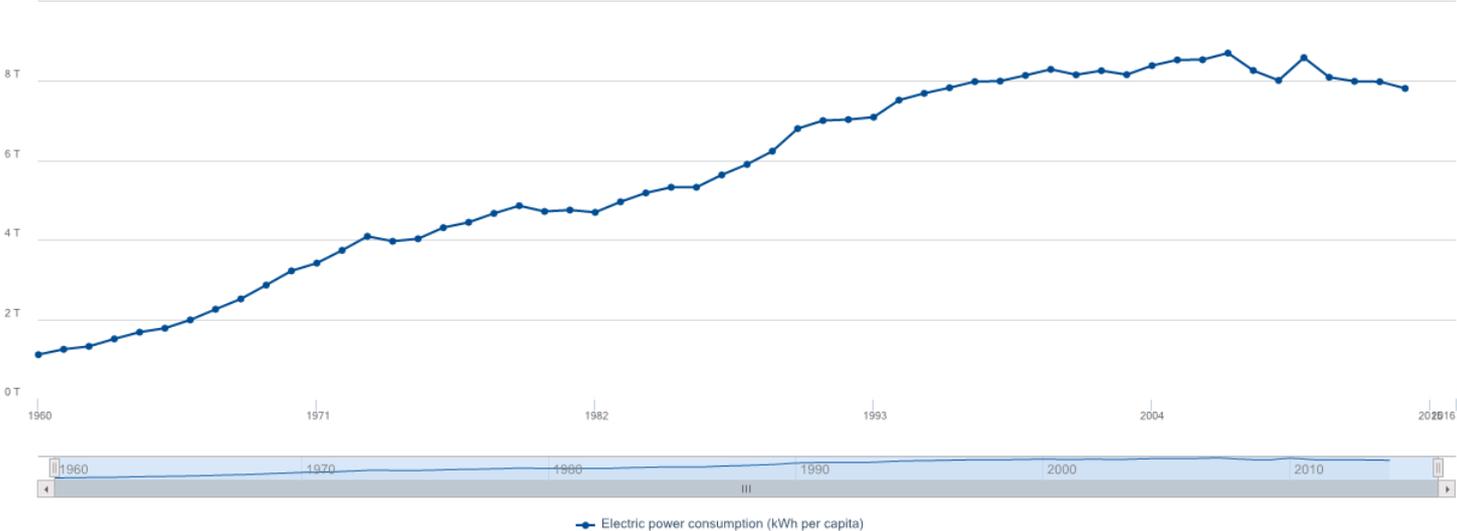


Figure 1: Electric power consumption, 1960-2014 (The World Bank, 2017e)

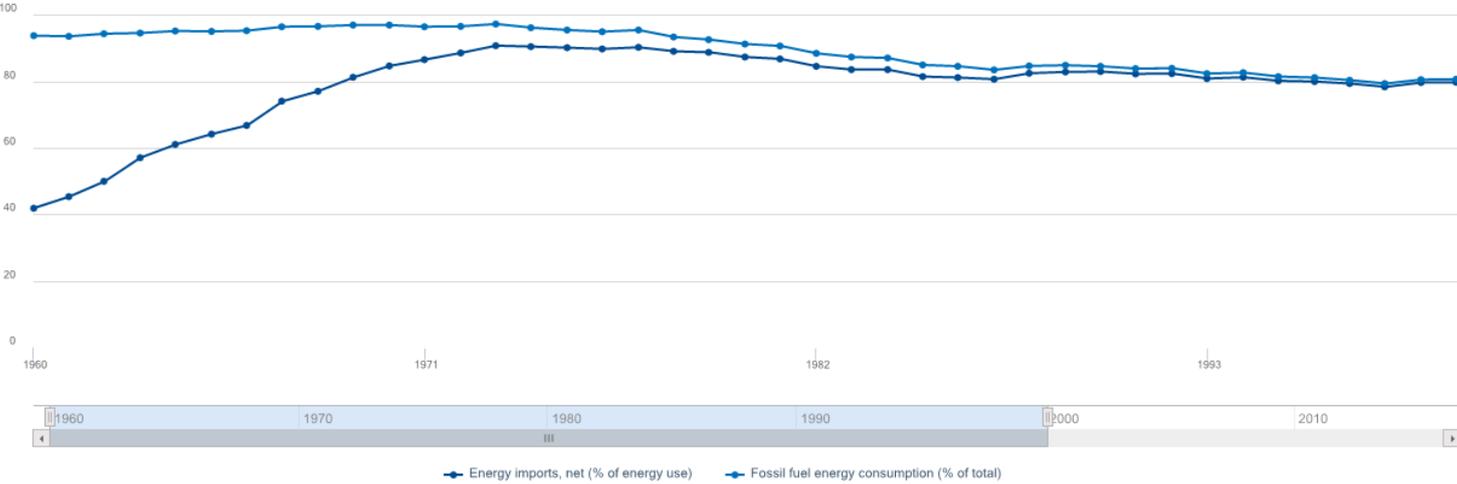


Figure 2: Japanese energy imports + fossil fuel consumption, 1960-2000 (The World Bank, 2017a+c)

Towards the end of the 20<sup>th</sup> century there was an increasing awareness as to the detrimental effects of fossil fuels consumption on the environment and climate, and attempts were made to reduce the consumption of these goods. However, in 2009 Japan was still reliant on oil to satisfy 48 percent of energy demand and coal, which has even higher emissions of CO<sub>2</sub>, supplied almost 30 percent (Kingston, 2013:178).

## **6.2 Natural Resource Endowments**

Energy scarcity has long been a problem for Japan, since it lacks the required natural resource endowments to sustain the growing energy needs of its population. As mentioned, a large share of Japanese forests had been cut down by the 17<sup>th</sup> century, and coal findings became the new main energy source (Totman, 2014:171-174). However, due to Japan's relatively young geological age, much of the domestic coal is bituminous (soft) and does not generate the intense heat that anthracite (hard) coal does. Thus, all industrial needs could not be met with this domestic supply of coal, and up until 1913 soft coal was mainly exported and hard coal imported (Totman, 2014:212-213). There were great regional differences in natural resource endowment, and natural resources of oil and gas were also sparse, located mainly along the coast of the Sea of Japan (Totman, 2014:212-213). The few places that possessed these resources became major producers in the industrial sector, suffering from issues with pollution and high emission rates from production (Honma & Hu, 2007).

A large share of domestic production of fossil fuels in the first half of the 20<sup>th</sup> century came from Karafuto, an area north of Japan that was lost to Russia after defeat in the Second World War (Totman, 2014:213). The acquisition of land for the purpose of extracting fossil fuels was a major incentive for Japan's military goals leading up to the Second World War (Lam, 2009:117). With the defeat in the war Japan lost all its colonies, and in the process also lost a significant amount of natural resource endowments that had been located in areas such as Manchuria. It could be argued that, hypothetically, if Japan had retained these areas there would be a lesser need for imports today.

## **6.3 Production and Trade Patterns**

With the opening of Japan by the US in 1854 after many years of seclusion extensive industrialisation and modernisation took place, and Japan became an actor in the global market (Yamamoto & Yamaguchi, 2005; Totman, 2014:235). As mentioned above, bituminous coal was exported and anthracite coal imported up until the First World War, however, this balance shifted once the war started. Domestic coal was increasingly used for domestic production, and imports increased as well due to the industrial production necessary in wartimes. This trend continued after the First World War as Japan both industrialised, and became increasingly militarised and engaged in wars and conflicts in the region, such as the attempt to conquer more land in Siberia (Totman, 2014:212-213).

There was intense pressure from the government to increase domestic production, and in 1940 the domestic coal output had increased to 56,313,000 metric tons, as compared to 208,142 metric tons in 1874. The demand for other fossil fuels was also growing in this period, to power motor vehicles, ships, airplanes and other new technologies. Between 1917 and 1937 the number of motor vehicle registrations had increased from 3,856 to 128,735. Only a relatively minor part of this demand could be satisfied by domestic resources, thus, in 1932 almost 80 percent of fossil fuel needs were met by imports. And a large share of domestic resources was located in areas such as Karafuto that, as a consequence of the defeat in the Second World War, do not belong to Japan anymore (Totman, 2014:212-213).

Since Japan was lacking in natural resource endowments, its comparative advantage in trade was to be found first in labour abundance and then in access to capital (Heller, 1979). It can be argued, however, that another significant factor endowment in Japan's case is human capital, both in the form of technological capacity and entrepreneurial skill. In the shift from labour-abundance, perhaps the economy instead benefitted from an increased endowment of skilled labour, as rising education levels followed modernisation. By the early 1970s Japan was an economic superpower, however, a major vulnerability was still the dependence on oil imports. This dependence could create awkward diplomatic situations, for example having to adopt a more sympathetic attitude towards the Arab countries even though the US was supporting Israel during the early 1970s, to avoid increasing oil prices and embargoes (Lam, 2009:117).

Most significantly, however, were the economic vulnerabilities as Japan became acutely aware of with the oil shocks in 1974 and 1979-1980 when oil prices increased rapidly. Between the years 1973 and 1990 there was a slowdown of GDP growth to an average of 3 percent, as compared to the average of 8.4 percent in the 1960s (Kingston, 2013:15). The GDP growth rate continued to be stagnant throughout the 1990s, which are generally referred to as the 'lost decade', and even though Japan remains one of the world's leading economies this trend in GDP growth has persisted (Kingston, 2013:23; Totman, 2014:238).

## **6.5 Institutional Structures**

Since the emergence of air-conditioning most buildings are constructed in a way that favour this technology, instead of allowing air to flow naturally through the house. Thus it can be hard, or impossible, for the individual to affect the patterns of consumption as they are merely

carriers of a practice that is considered normal. There has been attempts to change the standard of what is considered normal, for example in 2005 the Ministry of Environment in Japan made a successful attempt to decrease the use of air-conditioning in the summer months, by changing the standard workplace clothing. Air-conditioners were not to be set to less than 28C in government buildings, and employees grew accustomed to wear more light and casual clothing instead of formal suits (Evans, McMeekin & Southerton, 2012).

This experience illustrates that patterns of consumption are often based in routines, and that the institutional structure often determined individual behaviour. As the environments that people live and work in are built in ways that provide a certain set of conditions, it is only to be expected that those conditions become the standard of comfort. Houses built for air-conditioning that lack proper natural ventilation condition the life of the homeowner so that the standard of energy consumption to regulate temperature is inherent to the property (Shove 2003). These practices are not only embedded in society and considered normal, they are also further hindered from change by carbon lock-in (Söderholm et al. 2011).

The concept of routines, in evolutionary economics, can provide a significant contribution to the explanation of continued increases in energy consumption. For example, despite attempt at promoting an environmentally friendly way of life, emissions in the residential sector have increased by 40 percent since 1990 (Kingston, 2013:178). Unsustainable routines can be created and sustained as social and behavioural patterns, causing an individual to automatically make unsustainable choices (Nelson & Winter, 1982:134). Very often it may also be outside the individual's control to affect these situations, for example concerning the workplace or the structure of buildings.

## **7. Analysis: Economic Incentives and Policy Tools**

### **7.1 Policy instruments**

Changes in the electricity sector can improve the current environmental situation and the technology to make these changes exist. Yet a large share of the world's electricity is still generated from unsustainable sources such as coal and oil. To facilitate a change in the electricity sector the use of certain policy instruments may be useful, such as; command and control, market-based instruments, information disclosure and collaboration with consumers. The possible advantages and disadvantages of these instruments have to be considered, and the use of one does not exclude the use of another. Instead it appears that a combination is to be recommended, mixing top down and bottom up approaches and making use of both government, market and civil society (Bell 2012:283-293). The most distinctly top down approach is command and control, which entails government regulation, for example concerning the use of best available technology (Prakash & Kollman 2004). However, it has been argued that command and control is not enough to create incentives for regular citizens to choose sustainably, for example by using electricity from renewable sources. This is also a question of information disclosure, since a sustainable choice cannot be made by the consumer without sufficient knowledge of the functioning of the electricity sector and its companies (Bell 2012). Regulation and market incentives can come a long way, however, without information and consumer involvement a significant change appears unlikely in the near future.

### **7.2 Diversification**

The main share of energy imports was supplied by the Middle East in 1973, hence, when prices of oil suddenly rose due to conflicts in this region it had severe effects on the Japanese economy. Debates about the economic viability of the fossil fuels import dependence, and the risks associated with relying to a high extent on only oil, ensued. New policies were created to counter the dependence on imported oil through diversifying both energy sources and suppliers (Lesbriel, 2004). Imports of coal and gas increased in relation to oil, as did the use of domestic nuclear power. Energy imports from the Middle East were reduced, and instead there was an increase in imports from the Asia-Pacific region. However, the dependence on

Middle Eastern imports started rising again after 1985, and eventually increased to a higher point than in 1973 (Figure 3; Lesbriel, 2004).

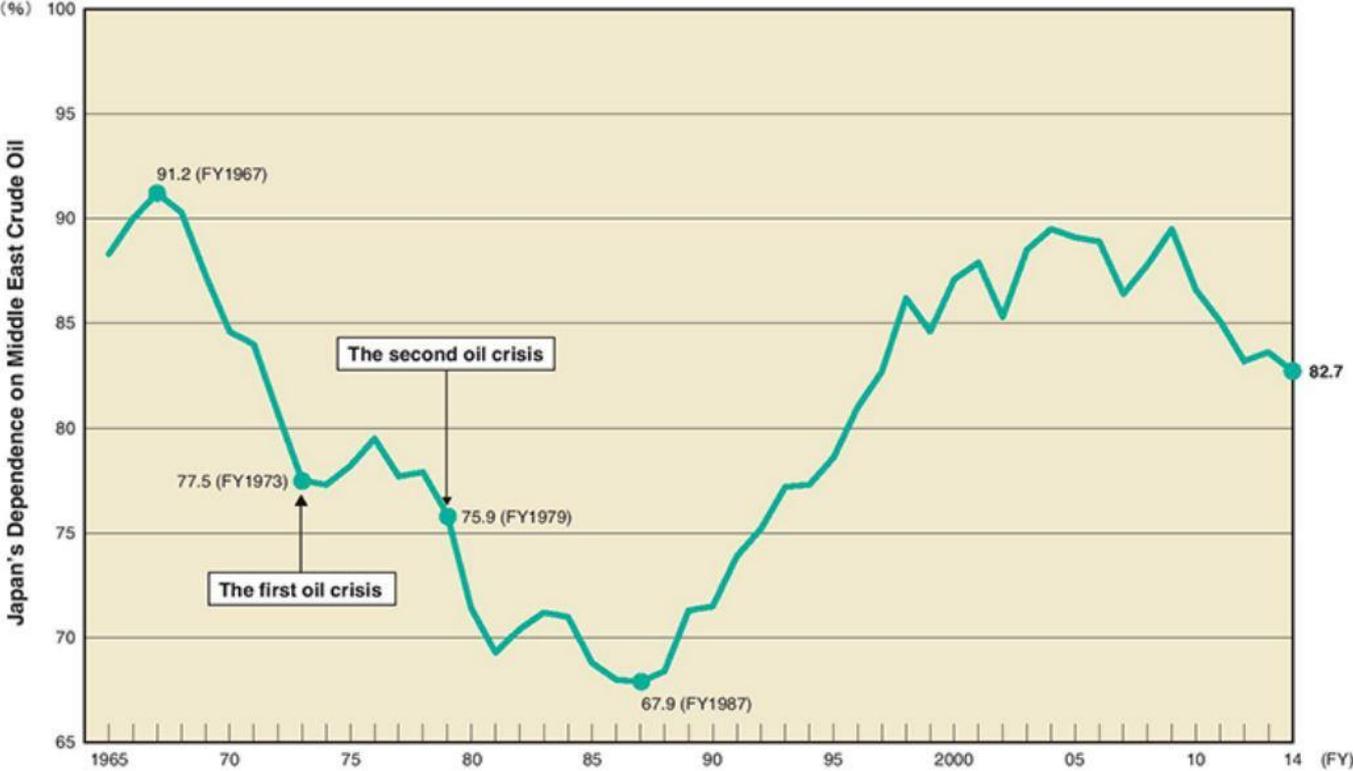


Figure 3: Percentage of Middle East Crude Oil of Total Oil Imports, 1965-2014 (FEPC, n.d)

Despite this reversal with respect to diversification of energy suppliers, the diversification of energy sources was successful in reducing the reliance on imported oil in relation to other energy sources, from 98 percent in 1970, to 61 percent in 1999 (Lesbriel, 2004). In the 1980s oil discoveries in the North Sea led to a decline in oil prices, and increased competitiveness in energy markets (Lesbriel, 2004).

Thus, Japan’s attempts to reduce dependence on the Middle East have not been successful, and the risks associated with import dependence remain. The vulnerability of the economy has been slight reduced, however, by increased stockpiling (Vivoda & Manicom, 2011).

**7.3 Alternatives to Fossil Fuels**

Attempts to diversify have had some positive effects, however, the majority of the energy sources that were used as alternatives to oil were also fossil fuels resources. Diversification has decreased vulnerability to sudden market shocks, but it has not solved the problem of rising energy prices, and it is not beneficial to the Japanese environmental goals. Dependence

on imported fossil fuels is a problem of continuous reliance on fossil fuels, since these energy sources do not exist in sufficient quantities in Japan. This reliance has been a growing problem during the last century, and Japan is known as a technologically advanced country. Therefore, it can be questioned why alternatives to fossil fuels have not been developed.

### **7.3.1 Nuclear Power**

Nuclear power has appeared to be Japan's best bet to achieve energy security and in February 2011, right before the accident in Fukushima, nuclear power accounted for 31 percent of Japanese energy production (Hayashi & Hughes, 2012). After the meltdown, all nuclear power stations were shut down, and in May 2012 Japanese nuclear power production was at 0 percent (Hayashi & Hughes, 2012; Kingston 2013:186). Thus, the reliance on imported energy increased from 80.1 percent in 2010 to 93.7 percent in 2012, and 94 percent in 2014 (The World Bank, 2017a). To compensate for the loss of domestic energy production many thermal power plants were restarted. In 2013 two of the 50 reactors in Japan were operating again, the remaining are being inspected and awaiting safety upgrades (Komiyama, 2014:37).

The question of nuclear power was already widely debated before the Fukushima incident, and electric companies planning to expand the provision of nuclear power often had to face disapproving, and even hostile, local communities. In fact, in 2006 one of Japan's largest energy companies was forced to abandon plans to build a new nuclear plant in the Kyoto region due to local opposition (Lam, 2009:119). In the debate concerning nuclear power there are two major ways that nuclear power is framed. There are those who argue that nuclear power is dangerous, due to the risks with meltdowns and the issues of radioactive waste. On the other hand, proponents of nuclear power have created a frame that essentially portrays nuclear power as the less risky option compared to, for example, global climate change (Pralle & Boscarino, 2011). In this way nuclear power can also be framed as a more economical option than reliance on fossil fuels, and the government has plans to increase nuclear power production again, despite the controversy over security risks (UNFCCC, 2015).

### **7.3.2 Renewable Energy**

In the recent decades, progress in renewable energy has been slow, and in 2010 only about 1 percent of electricity in Japan was generated by renewable energy sources other than hydropower (Kingston, 2013:184-185). Japan's geographical conditions are suitable to the use

of hydropower, and this energy source had a prominent role in the early 20<sup>th</sup> century (Yamamoto & Yamaguchi 2005). Technological innovations led to the development of hydropower as well as the increased use of oil, and hydropower provided the main share of Japanese energy for some years. In 1936 hydropower generated 75 percent of total electricity consumption and coal was used as a back-up energy source (Totman 2014:212). Electricity production from hydropower was still high after the Second World War, however, in the 1960s reliance on imported oil increased and the share of hydropower in total consumption decreased (The World Bank, 2017a, b, c).

With the issues of fossil fuel import dependence, global warming and climate change, renewable sources are many times considered as a good domestic option to fossil fuels (Tsuchiya, 2012). The possibilities of photovoltaic power, offshore wind power and composting of biomass resources have been suggested as viable options by some (von Weizsäcker, 2016:33). Others favour geothermal power generation, which Japan has been estimated to have excellent potential for (Komiya, 2014:38).

The most common reason the renewables have not been developed further appears to be the lack of technology and capital (Honma & Hu, 2007). To make energy sources such as wind and photovoltaic power capable of providing enough power to sustain a modern industrial society, R&D is required (Lam, 2009:119). This is a highly uncertain activity, where outcomes cannot be predicted (Nelson & Winter ,1982:386), thus, actors are dissuaded by the risks. There is also the issue of renewable resources damaging ecosystems, for example the flooding of large areas for the sake of hydropower (Springer, 2016:33, Totman, 2014:221) Transition from coal-based electric generation to hydroelectric power, increasing number of rivers dammed, valleys flooded. (Totman 2014:213)

## **6.4 Energy Efficiency**

In reaction to the 1970s' oil crisis there was also pressure to conserve energy through becoming more energy efficient, and a new low carbon policy was adopted. Efficiency was mainly improved through adjustments to the industrial structure, which was the sector that most efforts were aimed at. New laws restricted oil use and set targets for the oil-supply, and provided financial assistance for maintaining petroleum products to private companies. In 1978 a large-scale Research and Development (R&D) project was launched, and in 1979

more laws were introduced that aimed at the conservation of energy, these laws have provided the foundation for future energy efficiency policy (Ren & Du, 2012).

These efforts continued into the 1980s (Lesbriel, 2004), however, energy consumption in transportation, residential and commercial sectors continued to increase (Honma & Hu, 2007; Ren & Du, 2012). There were also significant regional differences in energy efficiency, since regions that relied on energy-intensive industries, with coal and oil as the main input, continued to lag behind the rest of the country (Honma & Hu, 2007). There are those who argue that law- and policymaking is not enough to create incentives for regular citizens to live more energy efficiently, for example by using electricity from renewable sources. This is also a question of information disclosure, since a sustainable choice cannot be made by the consumer without sufficient knowledge of the functioning of the electricity sector and its companies (Bell 2012).

## 8. Discussion

Evolutionary economic theory puts forth the argument that the basic challenge for countries aiming to catch up with their economic development is to “learn to master new ways of doing things” (Nelson, 2008:15). Arguably, this can also be applied to the Japanese energy situation, where the nation appears to be stuck in a pattern of dependence on imported fossil fuels. It can be speculated that increased innovation in the energy sector could be the solution to these issues. In fact, this appears to be the reasoning of the Japanese government, as they have emphasised technical innovation as a means of decreasing their consumption of fossil fuels (UNFCCC, 2015). Innovation could mitigate import dependence, and improve Japanese chances in reaching the environmental goal of reducing emissions. However, for successful innovation to take place physical and human capital is necessary. To enable the use of these endowments, an institutional structure that facilitates innovation must be in place (Nelson, 2008). The presence, or lack, of economic and institutional structures that enable innovation can be part of the explanation to why the Japanese fossil fuel import dependence has persisted for many decades.

## **9. Conclusion**

This study has examined the creation, context and continuation of fossil fuel imports in Japan. Firstly, domestic energy supplies were not abundant to begin with, as Japan lacks natural resource endowments. With industrialisation and modernisation energy needs became greater, therefore, consumption increased and domestic supplies of natural resources were no longer sufficient to meet growing energy demands. In response to the realisation of Japanese vulnerability, due to import reliance, attempts were made to diversify and improve efficiency. These attempts were successful in the industrial sector, but did not stop the consumption in other sectors from increasing, and did not manage to significantly mitigate fossil fuel import reliance. Nuclear power has been considered by many as the most viable solution, but it is a problematic solution that could have negative effects, as the Fukushima incident has proved. Renewable resources are another alternative, and hydropower has played a significant role in Japanese energy history, but there are many economic and technical difficulties with developing renewable energy sources that can supply enough energy to replace fossil fuels.

## References

- Amineh, M. P. & Crijns-Graus, W. H. J., 2014. Rethinking EU Energy Security Considering Past Trends and Future Prospects. *Perspectives on Global Development and Technology*, 13(5/6), pp. 757-825.
- Bell, M., 2012. *An Invitation to Environmental Sociology*. London: Sage.
- Bryman, A., 2008. *Social Research Methods*. Oxford: Oxford University Press.
- Brömmelhörster, J., Hughes, G. & Westphal, M., 2013. *Economics of Climate Change in East Asia*, Mandaluyong City, Philippines: Asian Development Bank.
- Byrne, D. (2016) 'What Is Thematic Analysis?', Project Planner, available at <http://methods.sagepub.com.ludwig.lub.lu.se/project-planner/data-analysis-and-interpretation/i1817>
- Campbell, S., 1996. Green cities, growing cities, just cities?. *Journal Of The American Planning Association*, 62(3), p. 296.
- De Vaus, D., 2001. *Research Design in Social Research*. London: Sage Publications.
- Enerdata (2016). Total energy consumption. *Global Energy Statistical Yearbook 2016*. <https://yearbook.enerdata.net/>
- Engerman, S. L., Sokoloff, K. L., Urquiola, M. & Acemoglu, D., 2002. Factor Endowments, Inequality, and Paths of Development Among New World Economies [with comments]. *Economía*, 3(1), pp. 41-109.
- Evans, D., McMeekin, A. & Southerton, D., 2012. Sustainable Consumption, Behaviour Change Policies and Theories of Practice. *Collegium*, Volume 12, p. 113.
- Fermann, G., 2014. What is Strategic about Energy? De-simplifyfying Energy Security. In: E. Moe & P. Midford, eds. *The Political Economy of Renewable Energy and Energy Security: Common Challenges and National Responses in Japan, China and Northern Europe*. s.l.:Palgrave Macmillan, pp. 21-45.
- Hannigan, J. A., 2006. *Environmental Sociology*. London: Taylor & Francis Ltd.
- Hayashi, M. & Hughes, L., 2012. The policy responses to the Fukushima nuclear accident and their effect on Japanese energy security. *Energy Policy*, Volume 59, pp. 86-101.
- Heller, P. S., 1976. Factor Endowment Change and Comparative Advantage: The Case of Japan, 1956-1969. *The Review of Economics and Statistics*, 58(3), pp. 283-292.
- Honma, S. & Hu, J.-L., 2007. Total-factor energy efficiency of regions in Japan. *Energy Policy*, 36(2), pp. 821-833.
- Kingston, J., 2013. *Contemporary Japan: History, Politics, and Social Change since the 1980s*. 2:a ed. Chichester, West Sussex, U.K. ; Malden, MA: Wiley-Blackwell.

- Komiyama, H., 2014. *Beyond the Limits to Growth: New Ideas for Sustainability from Japan*. Tokyo: Springer Japan.
- Lesbriel, S. H., 2004. Diversification and Energy Security Risks: The Japanese Case. *Japanese Journal of Political Science*, 5(1), pp. 1-22.
- Mulgan, A. G., 2014. The Politics of Trade Policy. In: J. Kingston, ed. *Critical Issues in Contemporary Japan*. New York: Routledge, pp. 24-36.
- Nelson, R. R., 2008. Economic Development from the Perspective of Evolutionary Economic Theory. *Oxford Development Studies*, 36(1), pp. 9-21.
- Nelson, R. R. & Winter, S. G., 1982. *An Evolutionary Theory of Economic Change*. Cambridge, Mass.: Harvard University Press.
- Pralle, S. & Boscarino, J., 2011. Framing Trade-offs: The Politics of Nuclear Power and Wind Energy in the Age of Global Climate Change. *Review of Policy Research*, 28(4), pp. 323-346.
- Ren, J. & Du, J., 2012. Evolution of Energy Conservation Policies and Tools: The Case of Japan. *Energy Procedia*, 17(Part A), pp. 171-177.
- Ritchie, J. & Lewis, J., 2003. *Qualitative Research Practice*. s.l.:SAGE Publications.
- Ritchie, J. & Lewis, J., 2003. *Qualitative Research Practice*. London: SAGE Publications.
- Ryan, G. W., 2004. Using a Word Processor to Tag and Retrieve Blocks of Text. *Field Methods*, 16(1), pp. 109-130.
- Shove, E., 2003. *Comfort, Cleanliness and Convenience: The Social Organization of Normality*. Oxford: Berg.
- Song, A., Lu, L., Liu, Z. & Wong, M. S., 2016. A Study of Incentive Policies for Building-Integrated Photovoltaic Technology in Hong Kong. *Sustainability*, 8(8), p. 769.
- Söderholm, P. et al., 2011. Governing the transition to low-carbon futures: A critical survey of energy scenarios for 2050. *Futures*, 43(Special Issue: Energy Futures), pp. 1105-1116.
- Sørensen, B., 2017. Conditions for a 100% renewable energy supply system in Japan and South Korea. *International Journal of Green Energy*, 14(1), pp. 39-54.
- The Federation of Electric Power Companies of Japan (FEPC), n.d. *Energy & Electricity: History of Japan's Electric Power Industry*. [Online]  
Available at: [http://www.fepec.or.jp/english/energy\\_electricity/history/index.html](http://www.fepec.or.jp/english/energy_electricity/history/index.html)  
[Accessed 2017].
- The World Bank (2017a). Energy imports, net (% of energy use). *World Development Indicators*. The World Bank Group: DataBank  
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>
- The World Bank (2017b). Electricity production from hydroelectric sources (% of total). *World Development Indicators*. The World Bank Group: DataBank  
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>

The World Bank (2017c). Electricity production from oil sources (% of total). *World Development Indicators*. The World Bank Group: DataBank  
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>

The World Bank (2017d). GDP growth (annual %). *World Development Indicators*. The World Bank Group: DataBank  
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>

The World Bank (2017e). Electric power consumption (kWh per capita). *World Development Indicators*. The World Bank Group: DataBank  
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>

Thomson, E., Chang, Y. & Lee, J.-S., 2011. *Energy Conservation in East Asia*. Singapore: World Scientific Publishing.

Totman, C., 2014. *Japan - An Environmental History*. New York: I.B. Tauris.

UNFCCC (2015). Japan's Intended Nationally Determined Contribution.  
[http://www4.unfccc.int/submissions/INDC/Published%20Documents/Japan/1/20150717\\_Japan's%20INDC.pdf](http://www4.unfccc.int/submissions/INDC/Published%20Documents/Japan/1/20150717_Japan's%20INDC.pdf)

von Weizsäcker, E. U., 2016. Towards an Affluent Society with Least Use of Resources. In: Y. Hayashi, T. Yasunari, H. Kanzawa & H. Kato, eds. *Climate Change, Energy Use, and Sustainability: Diagnosis and Prescription after the Great East Japan Earthquake*. s.l.:Springer International Publishing, pp. 23-49.

Yearly, S., 1996. *Sociology, Environmentalism, Globalization: Reinventing the Globe*. London: Sage.