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ENERGY INSECURITY AND RENEWABLE ENERGY POLICY: COMPARISON BETWEEN THE PEOPLE'S REPUBLIC OF CHINA AND JAPAN

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Abstract

As the world's second and third largest economies, both the People's Republic of China (PRC) and Japan are facing the challenge of energy insecurity. To meet this challenge, both countries are adopting and enhancing renewable energy policy. This research tries to compare the two countries' approaches to ensuring energy security and particularly the similarities and differences in their renewable energy policy. The dependence rates on primary fossil energy of both countries are very high. Both countries have huge potential and urgent necessity for renewable energy. Therefore, both countries have been devoted to its development and expansion.

The PRC has rapidly increased its investment in hydroelectric, solar and wind power, which makes its renewable energy sector grow faster than its fossil fuels and nuclear power. Suffering from environmental pollutions caused by fossil fuels, the PRC government has become determined to make laws to regulate energy use. Japan has set its policy of lowering dependency on nuclear power and expanding the use of carbon-free renewable energy in the wake of the Great East Japan Earthquake happened on 11 March 2011. Similarly to the PRC, Japan also combines its national strategy of energy security with its international strategy on its low-carbon goal.

To further enhance the development of renewable energy, the PRC and Japan should put renewable energy as the first priority, increase governmental subsidies and continue encouragement policy, strengthen public−private partnership, search for a global market for renewable energy, take renewable energy as an opportunity to reform and upgrade industries, and conduct cooperation between the two countries.

Keywords: energy insecurity, renewable energy, PRC, Japan

JEL Classification: Q42, Q48, O57, D04, H25, K32

Contents

1. INTRODUCTION

As the world's second and third largest economies, both the People's Republic of China (PRC) and Japan are facing the challenge of energy insecurity. To meet this challenge, both countries are adopting and enhancing their renewable energy policy. This research tries to compare the two countries' approaches to ensuring energy security and particularly the similarities and differences in their renewable energy policy. There are some obvious differences in their approaches to energy security. For example, after the Great East Japan Earthquake happened on 11 March 2011 (3.11 thereafter), the Japanese government has found it difficult to continue using nuclear energy, while the PRC is still trying to enlarge the scale of its nuclear power. However, both countries have been devoted to the development and expansion of renewable energy.

The PRC has rapidly increased its investment in hydroelectric, solar and wind power, which has led to its renewable energy sector growing faster than its fossil fuels and nuclear power. Suffering from environmental pollutions caused by fossil fuels, the PRC government has become determined to make laws to regulate energy use. The Action Plan for the Prevention and Control of Air Pollution, issued by the PRC's State Council in 2013, called on the share of renewable energy to be increased. As of 2017, renewable energy comprises 26.4% of total power generation, as a result of its green energy policy. Innovation and public−private partnership are playing very important roles in the PRC's renewable energy policy.

Japan has set its policy to reduce dependency on nuclear power and expand the use of carbon-free renewable energy in the wake of 3.11. The latest energy plan reaffirms that renewable energy will account for 22% to 24% of the nation's total electricity generation. Japan has faced a "sense of crisis" as the pace of investment increase in renewable energy is relatively slow. Meanwhile, Japanese companies are relying more on imports of renewable technology, such as solar panels, to increase the use of renewable energy. Similarly to the PRC, Japan also combines its national strategy of energy security with an international strategy on its low-carbon goal. For example, under the 2015 Paris climate accord, Japan aims for an 80% cut from the 2013 levels in greenhouse gas emissions by 2050.

Both the PRC and Japan are taking some substantial measures to encourage and spread the development of renewable energy. For example, both countries have made strategic visions and plans, passed laws and regulations, and provided public subsidies to enhance renewable energy development. In terms of the automobile industry, both countries are encouraging the development and use of electric vehicles.

In addition to energy insecurity, the motives of renewable energy policy in the PRC and Japan are diverse and multifaceted, including international trends, industrial innovation, economic growth strategy, and environmental protection etc.

The core questions for this topic are as follows. What are the similarities and differences between the PRC and Japan's energy insecurity?; How are the two countries dealing with the challenges to their energy insecurity?; What role can renewable energy play in improving energy security in the two countries? In the following sections, the chapter will first briefly review the literature on energy security and renewable energy, and specifically studies on energy security in the PRC and Japan. The chapter will then analyze and compare the detailed situation of energy security in the PRC and Japan, and examine and compare the renewable energy policy and the policy effects in both countries. Based on the analysis and comparison of energy insecurity and renewable

energy policy in the PRC and Japan, the chapter will then provide some policy recommendations for both countries to cope with the challenges of energy insecurity. Finally, the conclusion will be made.

2. LITERATURE REVIEW

2.1 Energy Security and Renewable Energy

Both energy security and renewable energy have become hot topics in academic research. There are a number of recently published works on both topics, as nowadays it is difficult to talk about energy security without talking about renewable energy. Most of the literature argues that the world is facing a global transition in terms of energy security and renewable energy will definitely play the most important role in this transition (Aklin and Urpelainen 2018; Peake 2018). Some studies focus on the economic and technological impacts from renewable energy and argue that renewable energy will bring up significant technological innovation and lead to sustainable development for modern countries, which all rely very much on energy consumption for economic development. For example, in his newly published book, Peake (2018) examines both the practical and economic potential of the renewable energy sources to meet the challenge of energy insecurity. It provides both perspective and detail on the relative merits and state of progress of technologies for utilizing the various "renewables."

It is worth noting that energy issue is not only an economic issue, but also a politics and even geopolitics issue. As a result, many studies examine the renewable energy policy from the political or geopolitical perspective. For example, some studies deal with the politics and political economy of renewables and energy security (Moe and Midford 2014). Some studies offer comprehensive political analysis of the rapid growth in renewable wind and solar power, mapping an energy transition through theory, case studies, and policy analysis (Aklin and Urpelainen 2018). Energy policy, like other national policy, is sometimes the result of political decision. It is also worth noting that a comparative approach is often used to examine energy security in different countries or regions. Some studies compare energy security policy and cooperation between Asia and Europe (Godement 2004), and other studies compare the policy taken by different countries to cope with the challenge of energy security (Duffield 2015).

Energy as a global resource has always been the driving force for international cooperation and conflicts. Many researchers have made this point. For example, some empirical studies have combined the approaches of both economics and area study to examine energy security as a factor influencing both domestic industrial policy and regional economic cooperation (Moe and Midford 2014; Kong and Ku 2015). Another study analyzes renewable technologies in diverse and highly topical countries including Japan, the PRC and Northern Europe (Moe and Midford 2014), and another study analyzes the factors that shape each country's fundamental energy interests in the region, how these interests impact their attitudes toward engaging Northeast Asia on energy security and the way they carry out their regional engagement (Kong and Ku 2015).

2.2 Energy Security in the PRC

Energy security in the PRC has attracted attention from both Chinese and international scholars. Many scholars recognize that the PRC has noticed the importance of renewable energy in its national energy strategy. In particular, as the PRC's economy has kept growing at a high speed in recent decades, the traditional energy policy cannot meet its energy needs anymore. Thus, transformative innovation is needed in the PRC's energy industry. As a matter of fact, the PRC is devoted to developing renewable energy, such as solar energy. In many areas of renewable energy, the PRC is even catching up with advanced countries.

There are mainly three perspectives from which studies examine the energy security issue and renewable energy policy in the PRC. First, the environmental issue and environmental pollution are a decisive driving force for the PRC to enhance its renewable energy policy. If the government wants to keep its gross domestic product (GDP) growing at a relatively high rate, green growth is the only choice. Within such a framework, some studies discuss energy use and its environmental footprint in the PRC, as well as issues concerning the transitional green growth of its economy (Pang, Bai, and Lovell 2018).

Second, energy policy decision-making is another perspective from which scholars study energy security in the PRC. There is always an interest in finding a balance in the bargaining between the government and industry in the decision-making of economic policy in the PRC. This is also the case for energy policy. From relying heavily on fossil energy to being active in developing renewable energy, the policy change has undergone significant changes. What are the reasons behind such policy changes? To answer this question, some studies examine the PRC's energy policymaking processes, and provide detailed analysis of the PRC's efforts to reform and reorganize the energy sector and reset policy priorities (Zhao 2014).

The third perspective is the domestic regulation and legislation. Without legislation, green growth cannot be achieved. Companies in the PRC are so dependent on fossil energy that it is difficult for them to abandon traditional energy. The government needs to make decisive laws to encourage the development and use of renewable energy. Under such circumstances, some studies identify various aspects of energy challenges faced by the PRC's central and local governments and study how best to achieve green growth and a low-carbon transition in a developing country like the PRC (Su, Bin, and Thomson 2016).

2.3 Energy Security in Japan

As for energy security in Japan, most scholars are concerned with the influence of the Great East Japan Earthquake on Japan's energy security and energy policy. Japan's energy fuel mix has been required to shift after the country experienced a catastrophic nuclear accident at the Fukushima Power Plant in 2011. What kind of new challenges have been brought about and how Japan should deal with these challenges are of common concerns in the literature.

Most of the literature argues that the disaster has exacerbated Japan's existing energy security challenges and looks for policy options to enhance Japan's energy security. Specifically, some studies examine the drastically changed environment following the disaster in order to analyze Japan's energy security challenges and evaluate Tokyo's energy policy options (Vivoda 2016). Meanwhile, some research directly pointed out the importance of renewable energy for Japan to get rid of the energy problem after Fukushima. For example, one study investigates renewable energy policies and the renewable energy market in Japan, identifying the country's advantages of and barriers to renewable energy promotion through applying a strengths, weakness, opportunities, and threats (SWOT) analysis (Yamaguchi 2015).

Although most recent studies are focused on the energy security issue brought up by the Fukushima disaster, some research also pays attention to the impact of energy on Japan's diplomacy and security policy and argues that politics is a determining factor for Japan's energy policy (Morse 1981).

3. EMPIRICAL SURVEY

3.1 Comparison of Energy Security Situation

3.1.1 Energy Security in the PRC

Energy security is one of the top priorities of the PRC's national policy. The PRC's rapid economic growth in recent decades has produced an unprecedented energy vulnerability that could threaten the sustainability of its economic development, a linchpin to social stability and ultimately the regime legitimacy of the Chinese Communist Party (CCP) as well as the foundation for the PRC's rising power aspirations (Zhao 2014). The PRC is now the largest energy consumer in the world. Its primary energy consumption volume in 2017 reached 2,234.9 million tonnes of oil equivalent, accounting for 23.2% of world consumption. The PRC's energy consumption has increased rapidly in the past decade, from 3,361 million tonnes of oil equivalent in 2009 to 4,490 million tonnes of oil equivalent, according to the National Bureau of Statistics of China. It should be noted that in 2012, the consumption volume for the first time surpassed 4,000 million tonnes of oil equivalent and has kept rising, although the rising pace has slightly slowed down since then.

There are several problems that seriously threaten the PRC's energy security. First, the energy efficiency is very low. In 2017, the GDP from per standard oil was $3,911 in 2017, less than half of the US level. The low energy efficiency requires a huge volume of energy consumption given the large scale and high growth rate of the PRC's economy. How to improve the energy efficiency in the PRC is not only a problem of energy, but one related to how to reconstruct and reform its industries. Renewable energy is certainly one of the most important and necessary solutions to this problem.

Second, the make-up of the PRC's energy consumption is extremely unbalanced. The primary energy still accounts for most of the energy consumption. In 2017, coal accounted for 60.42%, oil 19.42%, and natural gas 6.6%. The primary energy already accounts for 86.44% of all energy consumption (BP 2018). Coal is not only used for industrial production, but also everyday life in a large volume. For example, in the northern region of the PRC, coal is the major energy source for heating systems in the winter season. This leads to another big problem that will be examined in the following paragraphs, namely environmental pollution.

Third, the PRC is relying more and more on imports for its energy necessity. In 2017, the PRC's total consumption of primary energy was 4,490 million metric tons of standard coal equivalent, of which 900 million metric tons of standard coal equivalent was imported (BP 2018). That means 20.04% of the PRC's energy consumption relies on imports. Table 1 shows how fast the PRC's imported volume of coal, oil, and natural gas has grown in the last decade. For example, the amount of coal imported has increased by six times, oil has more than doubled, and natural gas has increased by more than 10 times. The increasing rates are extremely high, in particular for natural gas.

In recent years, the PRC has carried out a robust maritime foreign policy. This is partly to ensure the sea-lanes for its energy importing. The PRC leaders have often stressed the so-called "Malacca dilemma," which means that about 85% of the PRC's oil importing has to go through the Malacca Straits. There is no doubt that the rising energy dependence on imports has brought more challenges to the PRC's foreign policy. Renewable energy has the potential to alleviate the burden of energy imports and can also reduce the possibility of foreign conflicts.

Table 1: The PRC's Import Volume of Primary Energy
(Coal and Oil in million tons; Natural Gas in million cubic feet)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Coal	40	126	163	222	288	327	291	204	255
Oil	179	204	238	254	271	282	308	336	381
Natural Gas	4,600	7,630	16,470	31,150	42,060	52,540	59,130	61,100	_

Data Source: National Bureau of Statistics of China.

Fourth, environmental pollution can be seen as the most serious challenge to the PRC's energy security. As domestic and overseas mass media have reported, in the last decade, the worsening pm2.5 issue and smog issue in Beijing and its surrounding cities are exacerbating the air quality and decreasing the quality of life for citizens. The biggest reason for the air pollution is that the PRC is still relying mainly on fossil energy. The ideal solution is to use more clean energy for its heating systems and also develop more new energy vehicles. Luckily the PRC has already taken some action in these areas. This will be introduced in the next section.

3.1.2 Energy Security in Japan

As mentioned in the literature review section, Japan's energy insecurity has deteriorated significantly due to the Great East Japan Earthquake that happened on 11 March 2011. The accident changed Japan and the world's views on the safety of nuclear power and provoked controversies on the utilization of nuclear power. Nuclear power used to be a very important strategic power source for Japan's energy security. As Table 2 shows, the proportion of nuclear power in energy structure has decreased from 11.2% in 2010 to 0.8% in 2016, close to the level in 1973. Although Japan's energy situation was not rosy even before 2011, the accident made Japanese energy security even more vulnerable. As the table also shows, Japan has become more dependent on primary energy. Renewable energy has been expanded by nearly double since 2010, but its share is still quite low. Although a few nuclear power plants have recovered into operation, the possibility of going back to nuclear power is very low. Given the potential of renewable energy, its further development is an urgent subject for Japan.

Table 2: Energy Make-up in Japan
(in %; 1973, 2010, 2016)

	Coal	Oil	LNG	Nuclear	Hydro	Renewables
1973	16.9	75.5	1.6	0.6	4.4	1.0
2010	22.7	40.3	18.2	11.2	3.3	4.3
2016	25.4	39.7	23.8	0.8	3.3	7.0

LNG = liquefied natural gas; METI = Ministry of Economy, Trade and Industry, Japan.
Data Source: Agency for Natural Resources and Energy, METI. 2017.

First and foremost, the biggest challenge for Japan's energy security is its low self-sufficiency rate. It should be noted that Japan's energy self-sufficiency rate has suddenly decreased from 20.2% in 2010 to 11.5% in 2011 after the Great East Japan Earthquake. Since then, the self-sufficiency rate has remained under 10%, which is extremely low compared to other major countries. To raise its energy self-sufficiency rate back to the level of 2010 or even higher, renewable energy is the only practical solution as Japan has a very low primary energy reserve.

It is also worth noting that Japan's reliance on foreign energy carries an increasing political risk. More than 80% of imported oil comes from the politically unstable Middle East. Similarly to the PRC, Japan also has to ship the oil through the sea chains.

The second challenge is that Japan has a very high dependence rate on fossil energy compared to other major countries. The dependence rate of fossil energy refers to the proportion of primary energy in total energy consumption. As Table 3 shows, high dependence rate on fossil energy is a common challenge for almost all major countries except France. However, among the countries listed in the table, Japan has the highest dependence rate on fossil energy, even higher than the PRC. The difference is that the PRC relies very much on coal, while Japan relies on oil. Even though Japan has a relatively higher energy utilization efficiency, heavy reliance on fossil energy poses a very serious challenge for Japan's energy security.

The proportion of the primary energy in 1974 was 94%. Since then, Japan has made great efforts to reduce its share. Just before the 11 March Great East Japan Earthquake, it was 81%. However, as shown by the data in Table 3, the degree of dependence on fossil energy has returned to the level at the time of oil shock. In 2014, fossil energy including oil, coal, and natural gas, altogether accounted for 94.7% of Japan's energy make-up. Japan is now extremely vulnerable to another oil shock as oil accounts for more than 40% of its energy source. It will take another round of strategic efforts for Japan to develop new alternative energy.

Table 3: Dependence Rate of Fossil Energy for Major Countries
(%; 2014)

	Japan	US	UK	Germany	France	PRC	India
Oil	43.5	35.3	32.7	33.0	29.0	16.5	22.4
Coal	26.8	19.5	16.7	26.0	3.8	65.9	45.8
Natural Gas	24.4	28.2	33.3	20.7	13.4	5.0	5.2
Total	94.7	82.9	82.6	79.7	46.2	87.5	73.5

METI = Ministry of Economy, Trade and Industry, Japan.
Data Source: Agency for Natural Resources and Energy, METI. 2017.

The third challenge is that the cost of electricity has been rising. Since the Great East Japan Earthquake, electricity prices have increased considerably due to the higher cost of electricity. Specifically, electricity prices for both household and industry were respectively 20.4 yen/kwh and 13.6 yen/kwh. However, the prices climbed from 2011 and peaked in 2014, when the electricity prices of household and industry were respectively 25.5 yen/kwh and 18.9 yen/kwh. Comparing the prices in 2014 to those in 2010, it can be seen that electricity prices for households rose by about 25%, and for industry by 39%. Although the price of electricity started to decrease slowly from 2015, the current price is still at a high level compared to that of 2010. The rising price for industry means increasing costs for companies and this would in turn negatively influence their performance. The rising price for households raises the affordability for ordinary people, reduces people's consumption incentives and influences people's quality of life.

3.1.3 Comparison

There are some similarities between the energy insecurity of the PRC and Japan. Both countries are facing very urgent and serious situations. First, the dependence rates on primary fossil energy of both countries are around 90%. That means the alternative energy sources, in particular renewable energy, are so far very limited. As a result, the emissions of greenhouse gas from both countries are increasing, although Japan is in a much better situation than the PRC. Second, both countries are witnessing rising volumes of energy import. In particular for natural gas, Japan and the PRC are the largest and the second largest importers in the world, respectively. Third, both countries have huge potential and an urgent necessity for renewable energy. They have to resolve to use renewable energy to tackle the issue of energy insecurity.

The differences between the energy insecurity of the PRC and Japan are as follows. First, in general, the PRC's energy self-efficiency rate is much higher than Japan's. The PRC has a relatively high self-efficiency rate of around 80%, while that of Japan is as low as 10%. Second, specifically the PRC relies too much on coal while Japan relies too much on oil in terms of primary energy dependency. Third, Japan has a much higher energy utilization efficiency than the PRC. Industrial reform aimed at raising energy efficiency is more urgent for the PRC. Fourth, nuclear energy as a major energy source has been almost excluded in Japan due to the controversy on its use after the Great East Asia Earthquake, while the PRC is still expanding its nuclear energy facilities. Fifth, the PRC and Japan are in a different stage of environmental issues related to energy. Japan has experienced environmental problems in the 1960s and 1970s, while the PRC is currently struggling with a pollution problem. Therefore, the PRC has more environmental incentives to develop clean and renewable energy.

3.2 Comparison of Renewable Energy Policy

3.2.1 Renewable Energy Policy in the PRC

In recent years, through a combination of subsidies, policy targets, and manufacturing incentives, the PRC has spent more on cleaning up its energy system than America and the European Union combined (*The Economist* 2018). The environmental and social price of the PRC's dependency on fossil energy has become clear, and its leadership is moving as rapidly as it can to change energy direction (Mathews 2016).

The PRC has made very specific laws and regulations to encourage the development of renewable energy. In January 2006, the PRC started to enforce the first Law on Renewable Energy in Asia, and became the pioneer in Asia to start governmental subsidies for investment in the renewable energy industry. The subsidies policy in general includes the following specific measures. First, the government provides subsidies to electricity power generated from renewable energy, such as solar power, wind power, and bioenergy. Second, government is also enlarging its investment in clean and renewable energy. Investment in the energy industry has continuously increased in recent years, from 2,162.7 billion yuan in 2010 to 3,283.7 billion yuan in 2016. Since 2009, the government started the so-called "Golden Sun" project, providing a budget of about 10 billion yuan each year to subsidize the construction of solar panels. Recently, the PRC's National Energy Agency (NEA) pledged a 2.5 trillion yuan ($361 billion) investment in clean energy generation. Third, the government also has a favored taxation policy for renewable energy start-ups. Tax is reduced or even exempted for some companies.

With encouragement from the government, many new companies dealing with renewable energy development have started up. Most of them started quite recently but are developing very fast. For example, the world's biggest solar-panel manufacturer, Shanghai-based Jinko Solar, is a relative newcomer that started only 11 years ago. In 2017 alone, the PRC firm shipped a massive 9.81 GW of solar modules globally.

With regard to solar power in particular, the PRC is the world leader. Since 2008, the PRC has been the world's largest manufacturer of solar panels. Since 2013, the PRC has been the world's leading installer of solar photovoltaics (PVs). Table 4 shows a list of the top 10 solar companies in the world as of 2018. A quick glance shows that 6 out of 10 are the PRC companies, while Japan only has one company, the Kyocera, on the list.

Table 4: Top 10 Solar Companies in the World

Ranking	Company	Country
1	Jinko Solar	PRC
2	Trina Solar	India
3	Canadian Solar	Canada
4	JA Solar	PRC
5	Hanwha Q Cells	Republic of Korea
6	GCL System Integration	PRC
7	Longi Solar	PRC
8	Shunfeng	PRC
9	Kyocera	Japan
10	Yingli	PRC

Data Source: Barik 2018.

As Table 5 shows, the electricity power from solar energy has grown steadily in recent years. A quick comparison between the power volume from solar energy in the quarters of the years 2016, 2017, and 2018 shows that the quarter-to-quarter growth rate is over 50%. One big problem is that much of the solar power generating capacity has been built in the relatively less populated west of the PRC, whereas the major electricity consumption areas are in the east. This raises difficulties and expenses for transferring the energy.

Table 5: Electricity Power from Solar Energy in the PRC
(billion Kwh)

Q2 2016	Q3 2016	Q4 2016	Q2 2017	Q3 2017	Q4 2017	Q2 2018	Q3 2018
6.61	10.28	9.01	15.81	16.50	16.24	23.17	22.34

Data Source: National Bureau of Statistics of China.

In addition to solar power, the PRC has also enlarged its investment and production in the area of hydro, wind, and other renewable energy. For example, electricity power from wind has increased from 44.62 billion kwh in 2010 to 237.07 billion kwh in 2016. Hydroelectricity consumption also increased from 139.3 million tonnes oil equivalent in 2009 to 261.5 million tonnes oil equivalent in 2017. Unlike Japan, the PRC has not abandoned nuclear energy as an important source of electricity power. As Table 6 shows, after 2011 the volume of electricity power from nuclear energy has increased even faster than before. There are at least two reasons for this difference. One is that the PRC still considers nuclear power as a secure energy source as it has no similar experience to that of 11 March and it has not experienced frequent earthquakes. The other is that the PRC also considers nuclear energy as one of the alternatives to replace fossil energy, in particular coal, which has caused serious environmental problems.

Table 6: Electricity Power from Nuclear Energy in the PRC
(billion kwh)

2008	2009	2010	2011	2012	2013	2014	2015	2016
68.39	70.13	73.88	86.35	97.39	111.61	132.54	170.79	213.29

Data Source: National Bureau of Statistics of China.

Renewable energy is closely related to the PRC's industrial reform. By investing in cleaner energy and technologies, the PRC's heavy industry sector can contribute to reining in pollution and tackling the country's overcapacity problems (Zhang 2017).

The PRC has also made enormous efforts in developing new energy vehicles (NEVs). Environmental impact and climate change urge governments across the globe to prioritize the development of NEVs. Since 2010, the PRC government has introduced numerous policies to accelerate the development of the NEV industry (Zhang and Qin 2018). This strategic policy is to catch up in the renewable energy area with other automobile producers in advanced countries.

In 2009, the PRC government adopted a plan to leapfrog current automotive technology and seize the growing NEV market. On 1 June 2010, the PRC announced a trial program to provide incentives for NEVs of up to 60,000 yuan for the private purchase of new battery electric vehicles and 50,000 yuan for plug-in hybrids in five cities (Motavalli 2010). In June 2012, the State Council of the PRC published a plan to develop the domestic energy-saving and NEV industry. The plan set a sales target of 500,000 NEVs by 2015 and 5 million by 2020. It is worth noting that the sales of NEVs passed 500,000 in March 2016 and reached 1 million in early 2017. The PRC reaffirmed their priority to promote NEVs in its 13th Five-Year Plan (2016−2020). Table 7 shows the cumulative sales of NEVs in the PRC between January 2011 and December 2017. With the governmental subsidies, sales of NEVs have witnessed an incredible increase in recent years. However, there also exists anxiety about how long the governmental subsidies will last.

Table 7: Cumulative Sales of New Energy Vehicles in the PRC

Year	2011	2012	2013	2014	2015	2016	2017
Sales of NEVs	8,159	20,950	38,592	113,355	444,447	951,447	1,728,447

Data Source: China Association of Automobile Manufacturers.

In 2017, renewable energy's share in electricity power energy sources reached 38.1%. (Wang 2018) In the same year, the NEA and the National Development and Reform Commission in the PRC jointly announced the Strategy on Energy Production and Consumption Revolution (2106−2030), in which the goal was set to raise the share of renewable energy in electricity power source to 50% by 2030 (China Electricity Council 2017). It could be concluded that in the past decade, the PRC's renewable energy policy has made significant achievements. However, the challenges to energy security for the PRC remain serious. The PRC needs to continue its encouraging policy for renewable energy investment and production.

3.2.2 Renewable Energy Policy in Japan

The renewable energy policy most worth noting in Japan is the so-called Feed-in Tariffs (FIT) scheme. The FIT Act, or the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities) was passed in August 2011 to encourage the investment and development of renewable energy in Japan. The policy has been enforced since July 2012. Under the FIT scheme, the government sets procurement conditions of renewable electricity (period and price) and obliges the utilities to purchase it. By implementing renewable energy support policies in the initial stage of deployment, the gradual cost reduction will eventually enable renewable energy to compete over time in the electricity market against conventional energy sources, inclusive of social costs, without any particular policy support (Kimura 2017). The vast bulk of this investment has flowed into solar PVs. Prices for larger solar PV systems fell almost 30% between 2012 and 2017 (Hughes 2018).

The FIT scheme has shown to be a success, especially in the solar PV sector. However, dark clouds still hang over Japan's renewable energy industry due to the lack of an appropriate policy regime that protects and enhances renewable energy development within Japan's conventional power market (Yamaguchi 2015). Japan's share of renewable energy in electricity power is about 14.5%, as shown in Table 8 − much lower than the PRC and advanced countries in Europe.

Table 8: Share of Renewable Energy in Electricity Power in Major Countries
(%; 2015)

Germany	Spain	UK	France	Italy	US	Canada	Japan	PRC
30.6	35.3	25.9	16.3	39.8	13.6	63.8	14.5	35.0

METI = Ministry of Economy, Trade and Industry, Japan.

Data Source: Agency for Natural Resources and Energy, METI. 2017; China Electricity Council.

In April 2014, the Japanese Diet passed the Basic Energy Plan, in which Japan decided to speed up its development of diverse renewable energy over the next three years. However, the plan did not set a long-term goal. In the Prospect on Long-term Energy Demand determined by the Ministry of Economy, Trade and Industry, the goal was set to increase the share renewable energy to 22%−24%, much lower than the goals of European countries (Brown 2015). The Basic Energy Plan set its goal for Japan's energy

structure by 2030. Compared to 2013, it aims to reduce the share of oil from 15% to 3%, coal from 30% to 26%, and natural gas from 43% to 27%. Meanwhile it also targets raising the share of nuclear energy from 1% to 20% ~22%, and renewables from 11% to 22%~24%. It can be seen that Japan is striving to reduce its dependence on fossil fuels, in particular on oil. Nuclear energy is now suspended, but the government has not yet abandoned the plan to recover it. Whether this goal can be achieved or not is more a political issue than an economic one. More specifically, the goal for different renewable energy's shares by 2030 are as follows: solar, 7.0%; wind, 1.7%; hydro, 8.8~9.2%; geothermal, 1.0%~1.1%; and biomass, 3.7%~4.6%. The government is determined to increase the share of solar power but not that much for wind power and hydropower, given that hydropower already had a share of 8.5% in 2013. Table 9 shows the share of different energy in electricity power from 2010 to 2016. It can also be seen that hydropower's share has not changed too much during the period. Meanwhile the share of other renewable energy, including solar power, has increased slightly.

Table 9: Share of Different Energy in Electricity Power in Japan 2010−2016
(%)

	2010	2011	2012	2013	2014	2015	2016
Hydro	8.5	9.0	8.4	8.5	9.0	9.6	8.5
Coal	25.0	25.0	27.6	30.3	31.0	31.6	29.6
LNG	29.3	39.5	42.4	43.2	46.2	44.0	41.4
Oil	6.4	12.8	16.2	13.3	9.3	7.7	4.7
LPG	1.1	1.6	2.1	1.6	1.3	1.3	5.7
Nuclear	28.6	10.7	1.7	1.0	0.0	1.1	1.7
New Energy	1.1	1.4	1.6	2.2	3.2	4.7	5.9

LNG = liquefied natural gas, LPG = liquefied petroleum gas, FEPC = Federation of Electric Power Companies of Japan.
Data Source: FEPC InfoBase 2017.

Thanks to the FIT Scheme, solar energy has seen a significant increase in recent years. The amount of electricity power generated from solar energy was only 2,627 thousand kw in 2009. However, the amount climbed to 42,041 thousand kw. Within only eight years, the electricity power from solar energy in Japan has increased by 16 times. Meanwhile, as Table 10 shows, in terms of electricity power volume from solar energy, Japan has climbed to second place in the world as of 2016. Given Japan's geographic limits and budget shortage, this could be counted as a significant achievement.

However, there are also problems for solar energy development in Japan, one of which is the high cost of electricity production by solar energy. Japan has the highest cost for electricity production from solar energy, more than twice that of France, the US, India, Australia, the PRC, and Germany. Due to the high cost, the purchasing price of electricity generated from solar energy has also been gradually reduced since 2012. In 2012, the purchasing prices of electricity from solar energy in Japan for industry and households were respectively 40 yen and 42 yen, while the prices in 2017 became 21 yen and 28 yen respectively. Within only six years, the price has been reduced by almost half. The decreasing purchasing price is a rather negative factor for the solar energy investors and developers. There are reasons to worry that the pace of solar energy development might slow down in Japan.

Table 10: Ranking of Electricity Power Volume from Solar Energy as of 2016
(thousand kw)

Ranking	Country	Volume
1	PRC	78,080
2	Japan	42,041
3	Germany	41,186
4	US	40,436
5	Italy	19,297
6	UK	11,630
7	India	9,010
8	France	7,164
9	Australia	5,985
10	Spain	5,483

Data Source: International Energy Agency. 2017.

Different from solar power, the FIT scheme has not worked too well for the enlargement of wind energy. Wind power has increased very slowly in the past several years. In 2010, electricity power from wind energy in Japan was about 2,475 thousand kw, while the amount in 2017 only slightly increased to 3,503 thousand kw, according to the data from the New Energy and Industrial Technology Development Organization. One of the reasons for this is that the cost of electricity production from wind energy is also very high compared to other countries. As a matter of fact, the cost of electricity production from wind energy in Japan is double or more than double than that in other major advanced countries.

Japan is also making efforts to enhance the production and use of electric vehicles (EVs). The government has passed laws to reduce tax for so-called “eco-cars,” including the hybrid automobiles and EVs. Table 11 shows that Japan has the third largest EV market, next to the PRC and the US among countries in the list. However, the share of EVs in Japan, in a broad definition, is extremely higher than that in other countries. There is no doubt that Japan is leading in this area in the world. Table 12 shows Japan’s goal to further spread EVs. If the policy continues and the goals are realized, Japan would become the pioneer in having its number of EVs account for more than half of its total number of automobiles by 2030.

Table 11: Sales Number and Percentage of EVs in Major Countries in 2017
(million for sales number; in % for EV percentage)

Country	Japan	US	Germany	France	PRC	India	Thailand
Sales Number	5.13	17.22	3.72	2.55	27.94	3.69	0.85
EV Percentage	31.6	4.0	3.0	4.8	3.0	0.03	2.7

Data Source: Agency for National Resources and Energy.

Table 12: Percentage of Next Generation Automobiles in 2016 and Percentage Goals in 2030
(%)

	Conventional	Next Generation	Hybrid	EV	Plug-in Hybrid	Fuel Battery	Clean Diesel
2016	65.15	34.85	30.76	0.37	0.22	0.02	3.46
2030	30~50	50~70	30~40	20~30		3	5~10

Data Source: Agency for National Resources and Energy.

It can be concluded that the FIT scheme has contributed greatly to the development of renewable energy. However, for different categories of renewable energy, the effects of FIT are quite different. Japan has made some achievements in its renewable energy policy, but whether the policy is sustainable remains to be seen. To cope with its energy insecurity, Japan needs to do much more in the area of renewable energy.

3.2.3 Comparison

Based on the empirical analysis above, it can be seen that both the PRC and Japan have recognized renewable energy as a solution to energy insecurity and have conducted governmental policy to encourage investment in the renewable energy industry. Given the high cost of renewable energy development at the initial stage, providing governmental subsidies has become the main content of encouragement policy in both countries. Both countries have made great achievements in renewable energy development, while energy insecurity still remains a serious challenge.

The renewable energy policy conducted by the PRC and Japan has slightly different effects. Both countries have seen a significant increase in solar power. The PRC and Japan are, respectively, the first and second largest countries in solar electricity production. In terms of hydroelectricity power, the consumption volume in the PRC has almost doubled during the last decade, while the hydroelectricity power in Japan has only undergone a very limited increase. Table 13 is a comparison of hydroelectricity consumption in the PRC and Japan over the past several years. As Table 14 shows, in general, renewable energy has grown much faster in the PRC than in Japan in recent years. In terms of the automobile industry, both countries are encouraging the development and use of electric vehicles in order to increase their share in the industry. The spread of electric vehicles will definitely spur the development and use of renewable energy and thus contribute to energy security.

Table 13: Hydroelectricity Consumption in the PRC and Japan
(million tonnes oil equivalent)

	2009	2010	2011	2012	2013	2014	2015	2016	2017
PRC	139.3	161.0	155.7	195.2	205.8	237.8	252.2	261.0	261.5
Japan	15.6	19.7	18.3	17.2	17.7	18.1	19.0	18.1	17.9

Data Source: BP 2018.

Table 14: Renewable Energy Consumption Excluding Hydroelectricity in the PRC and Japan
(million tonnes oil equivalent)

	2009	2010	2011	2012	2013	2014	2015	2016	2017
PRC	11.0	15.9	22.8	29.4	42.3	51.1	64.1	81.7	106.7
Japan	6.1	6.7	7.0	7.7	9.3	11.8	15.4	18.8	22.4

Data Source: BP 2018.

4. POLICY RECOMMENDATION

Based on the comparison, this article would like to provide the following policy recommendations for the PRC and Japan to further enhance the development of renewable energy and cope with the challenges of energy insecurity.

4.1 Make Renewable Energy the First Priority

Renewable energy should be considered as the first and foremost solution to energy insecurity, as it will eventually become the global trend. Both the PRC and Japan are simultaneously also counting on enlarging fossil energy and nuclear energy to alleviate their rising demand in energy. The pitfall is that although using traditional fossil energy and nuclear energy might be much cheaper, compared to developing new energy, if countries keep increasing their budget on importing primary energy, then they will have less to invest in renewable energy. Therefore, the government should decide the budget for renewable energy first and then consider the budget for conventional energy. The return rate of renewable energy is very high. Thus, countries should not be reluctant to invest in that area.

4.2 Increase Governmental Subsidies and Continue Encouragement Policy

Renewable energy has a high cost at the initial stage. Although the potential of renewable energy is high, it is not easy to start on the course. The renewable energy business should not be monopolized by the state-owned or large-scale companies. To encourage the entrepreneur of small and medium-size companies in the business, the government needs to continue its encouragement policy. A reduction in the subsidies budget might cause the pace of renewable energy development to slow down and even halt.

4.3 Strengthen Public−Private Partnership

The role of government is not only to provide subsidies. It needs to create a benign social environment for renewable energy development and usage. The bond between the public and private sectors is vital to enhancing the development of renewable energy. In addition to companies, private organizations and agencies working in the energy industry should cooperate closely with the government and provide policy advice and consultation to the government to make sure the policy is heading in the correct direction.

4.4 Search for Global Market for Renewable Energy

The domestic market sometimes might be very limited or immature in terms of renewable energy. Sometimes the domestic market is too small to consume its renewable energy capacity. Sometimes the production technology and domestic consumption conditions do not develop at the same pace. It is necessary for renewable energy industries to look globally and seek overseas markets. Just like manufacturing, it is normal for global markets today to be more sensitive to new consumption trends than domestic markets.

4.5 Take Renewable Energy as an Opportunity to Reform and Upgrade Industries

Instead of relying on conventional energy to develop traditional industries, such as heavy industries, it is a much wiser strategy to abandon some old and ineffective industries and develop new industries in the area of renewable energy. New energy technology will definitely drive the cultivation of new industries. Countries should seize the opportunity from renewable energy to speed up industrial reform and to upgrade.

4.6 Conduct Cooperation between the PRC and Japan

Sharing energy technology with each other and encourage cooperative investment and research in renewable energy is very important for the PRC and Japan. Both the PRC and Japan have their own advantages and disadvantages in developing renewable energy. To date, there is more competition than cooperation between the PRC and Japan. The two countries should strengthen their cooperation in this area. They should realize the common interests and forge a win-win strategy in renewable energy cooperation.

5. CONCLUSION

Both countries are facing very urgent and serious energy insecurity situation. The dependence rates on primary fossil energy of both countries are around 90%. Both countries are witnessing rising volumes of energy imports. Both countries have huge potential and an urgent need for renewable energy.

There are also different challenges for the PRC and Japan. The PRC's energy self-efficiency rate is much higher than Japan. The PRC relies too much on coal while Japan relies heavily on oil in terms of primary energy dependency. Japan has a much higher energy utilization efficiency than the PRC. Nuclear energy as a major energy source has been almost excluded in Japan due to the controversy over its use after the Great East Asia Earthquake, while the PRC is still expanding its nuclear energy facilities. The PRC has more environmental incentives to develop clean and renewable energy.

Both the PRC and Japan have recognized renewable energy as a solution to energy insecurity and have conducted governmental policy to encourage the investment in the renewable energy industry. Both countries have made great achievements in renewable energy development, while energy insecurity still remains a serious challenge.

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