

What was the “discrepancy” in Japan’s energy policy after Fukushima nuclear crisis?

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Executive Summary

After the Fukushima nuclear crisis in 2011, Japan fell into a confusing era of energy policy. People tend to have a certain “discrepancy” that Japan can change the whole energy structure which have no nuclear generation, huge amount of renewable energies without any burden. This discrepancy was caused by two factors, political and economic ones. Political one was a struggle of DPJ to put the blames of their own mistakes to electric power companies, exaggerating that existing electricity power supply system had been inefficient and dishonest. Economic one was a lack of market mechanism in Japan’s electricity power market, which could not eliminate the huge gap between generation costs and retail prices occurred by the shortage of capacity reserve margin in Japan. In this paper, facts after Fukushima crisis, such as fuel prices, JEPX traded power prices and quantities, electricity market system reformation are reported to clarify why the discrepancy was created. Through this paper, I am more than happy to share the truth and the knowledge with people who are interested in studying on Japan’s energy and electricity market and energy policy.

Abstract

~~After the Fukushima nuclear crisis following the Great East Japan Earthquake of March 11, 2011, it is not correct to say that Japan decided to change energy policy dramatically from a fuel mix heavily reliant on nuclear power to one involving growing use of renewable power. Nor is it correct to say that Japan intends to expand renewable energy to such an extent that it becomes Japan’s primary energy source. Japan has been facing two problems. The first is the destabilization of the energy market caused by the Fukushima nuclear power crisis and electricity market reform. The other is the destabilization of energy policy caused by the “discrepancy” between people’s perception of electricity market reform in Japan and the structure of Japan’s energy sector. The “discrepancy” means that the Japanese government has had an overly optimistic view on the crisis, believing that the rise in energy prices and energy market reform or supply shock were not serious problems for people’s lives, and that the public could handle these problems. In addition, this discrepancy arose as a consequence of Japan’s incomplete energy market liberalization which began in the 1980s, and also due to political factors under the administration of the Democratic Party of Japan. Currently, Japan’s energy policy is discussed more logically and calmly because this “discrepancy” has been progressively eliminated. In fact, the Sendai nuclear power plant owned by Kyushu Electric Power Co. restarted operation on August 11th 2015.~~

1. Overview of Japan's energy supply shock caused by the Fukushima nuclear crisis

According to the government energy policy announced in April, 2015, nuclear power generation will account for 20-22% of energy supply in 2030, which is slightly less than that before the Fukushima nuclear disaster. The same policy predicted that renewable energy would account for 22-24% of supply, double that before the Great East Japan Earthquake. It also suggested that the policy be reviewed every three years to take account of the fuel market balance between supply and demand in Asia and the rest of the world, and exchange rate fluctuations.

As we all know, a massive earthquake of magnitude 9.0 occurred on Friday 11 March, 2011 off the Pacific coast of the northeastern part of the Japanese mainland (Tohoku Region), and devastating damage was caused by the subsequent tsunami. Almost all nuclear and thermal power plants located in Eastern Japan (the northeastern half of the mainland) were damaged by the earthquake and tsunami. In particular, severe accidents, such as explosions and nuclear meltdowns, happened at Fukushima Daiichi nuclear power plant due to the failure of the emergency core cooling system (ECCS) resulting from the loss of electric power.

Japan's geography is one of the main reasons that the tsunami caused such devastating damage to power plants. Japan is comparatively narrow and runs from north to south, with mountains covering almost 70% of the land area. A consequence of this is a lack of rivers with a sufficiently large catchment area to make them suitable for power plant cooling. Therefore, almost all power plants (other than hydro) need a massive amount of seawater to operate, and tend to be located on the coast, especially along the Pacific seaboard.

Japan also has a unique electricity supply structure. This is due to historic factors whereby systems operating on different frequencies were installed during the Meiji Era (1868-1912) when Japan began its modernization. While Hokkaido and the northeastern half of mainland adopted 50Hz, the remainder of the country uses 60Hz. As a result, electric power cannot easily be transmitted from western to eastern Japan. Although there are three frequency conversion points that can transmit electricity between the two

grids, these have a maximum capacity of only 1.2 GW.

Within a few days of the tsunami, Tokyo Electric Power Co. (TEPCO) and Tohoku Electric Power Co., located in 50Hz area, had lost more than 30% of their total electricity supply capacity of more than 20GW. Figure 1 shows the location of some of Japan's nuclear and thermal power plants. Tsunami damage forced the shutdown not only of the two nuclear power plants in Fukushima Prefecture, but also of a number of thermal power plants along the Pacific coast. Sendai City also lost its supply of natural gas for a time due to earthquake damage.

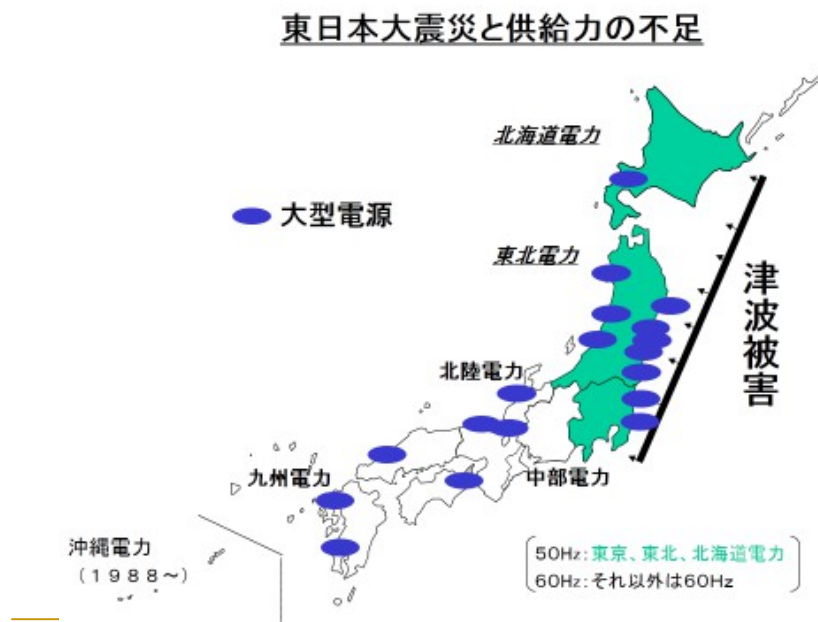


Figure 1: Location of GW-class generators and tsunami

Source: Federation of Electric Power Companies (2011) and Nishimura, Hashizume and Kajiki (2012)

To deal with expected power shortfalls, TEPCO and Tohoku Electric Power Co. planned to implement rolling electric power blackouts. In fact, only TEPCO went ahead with its blackouts, which disrupted power supply to most of its supply area from the 14th to the 28th of March, 2011. The result was mass disruption to the public, transportation and industry because few people in Japan had ever experienced a massive power outage, even planned blackouts, in recent decades. When the cooling system failed at another reactor at Fukushima Daiichi nuclear power plant, it had to emit a large amount of

radioactive material into the air. In addition to conflicting information about the situation, this led to widespread fears of a nuclear accident and fears of nuclear power generation itself in Japan.

The remainder of this paper is organized as follows. Section 2 describes in detail what happened in Japan's energy market after the Fukushima nuclear disaster and explains how the system of the Japanese energy market worked during the period. Section 3 examines why the destabilization of the energy market occurred by analyzing Japan's incomplete energy liberalization and political factors. Finally, section 4 presents the author's views on Japan's future energy policy.

2. Overview of electricity market in Japan

Before describing the changes in the fuel and electricity market in Japan, it is worthwhile considering the structure of the electricity business in Japan, its history, and the liberalization of the electricity market in recent years. This overview is important for understanding the present situation in Japan.

The electricity business in Japan started in the 1890s in Tokyo, Kyoto, Osaka and other big cities. Services were operated by venture businesses in each area in much the same way as in US and Europe at the time. These venture companies grew in size through takeovers during the 1900s to 1920s.

In the 1930s and during WWII, the Japanese government centralized the electricity industry in a similar manner to pre-liberalization UK. During the post-WWII US administration, the electricity industry was reorganized into nine areas managed by vertically integrated utilities, meaning that each utility handled generation, transmission, distribution, and retailing within its own particular geographic area.

After global energy liberalization began in the 1980s, particularly in the US and Europe, Japan began its own step-by-step liberalization. This started in 1995 with the liberalization of generation, then in retailing to users with contracts above a certain level, and finally the introduction of the JEPX (Japan Electricity Power Exchange). As a result, it is worth saying that over 60% of the retail market in Japan had already been liberalized by 2011. However, because liberalization was only partial, new entrants accounted for less than 5% of the liberalized retail market. It did not lead to the

separation of system operation and the creation of independent system operators (ISOs), nor the legal separation of transmission from retail and generation.

Therefore, structural issues in the electricity sector in Japan meant that the shortage of supply was not directly reflected in retail prices.

As a result, utilities had to keep electricity prices at pre-earthquake levels, even though the cost of generation and JEPX prices kept rising due to the nuclear power plants being shut down and rising fuel prices. The only way to resolve this problem for the utilities was the authorization by the government of a “regulated tariffs revision”, a process that usually takes several months of deliberation. Legally, utilities do not require approval from the government to raise electricity charges in the liberalized retail market. However, because the pricing mechanism was based on all costs for both regulated and liberalized users, utilities could not in practice increase the prices for both categories of user.

3. Three changes in Japan’s energy supply

Due to the Great East Japan Earthquake and Fukushima nuclear crisis, three changes occurred in Japan’s energy industry. First, suspending the restart of nuclear power plants caused a sudden increase in demand for oil and natural gas for use in thermal power plants. However, the liquidity of the worldwide market for crude oil meant that this demand increase did not noticeably influence the price of crude oil. In Japan, power generation accounted for less than 10% of Japan’s total demand for crude oil. In contrast, natural gas prices rose steeply in Japan despite world prices remaining stable. As shown in Table 1, Platts Japan Korea Marker (JKMTM), a liquefied natural gas (LNG) benchmark price index for spot physical cargoes delivered to Japan and South Korea, rose rapidly. For example, JKM increased from 8.62 \$/MMBtu in 2010 to 15.20 \$/MMBtu in 2011 and 16.68 \$/MMBtu in 2013, while Henry Hub (HH) decreased from 4.19 \$/MMBtu in 2010 to 3.61 \$/MMBtu in 2011.

Table 1: Natural gas price index (\$/MMBtu)

	2010	2011	2012	2013	2014
HH (US)	4.19	3.61	3.07	4.04	3.80

NBP(UK)	7.36	9.33	9.75	10.39	7.69
JKM	8.62	15.20	15.79	16.68	11.24

Source: Prepared using statistics from Thomson Reuters

JKM: Japan Korea Marker

Second, a clear change was evident in trading on the Japan Electric Power Exchange (JEPX). Just after the earthquake and Fukushima disaster, a large decrease in total transaction volume (TTV) was observed in JEPX due to suspension of electricity trading in the Tokyo area. However, spot market prices on JEPX were increasing again within a few months of the Fukushima nuclear accident as demand gradually increased. At that time, in order to make up for electricity shortfalls, utility companies such as TEPCO and Kansai Electric Power Co., (KEPCO) suffered from a lack of reserve capacity and were forced to purchase electricity directly from bilateral contracts with major wholesale power users with their own generation capacity. However, to maintain adequate reserve capacity, utility companies began trading wholesale power in JEPX. Before the earthquake, JEPX power trading mainly consisted of new entrants to the energy market who lacked sufficient generation capacity of their own and lacked the ability to procure wholesale power to supply to their customers. As a result of the change in electricity procurement behavior by utility companies, the pressure on utilities to purchase electricity on JEPX was heightened. This was the key factor in the sharp rise in JEPX's spot prices.

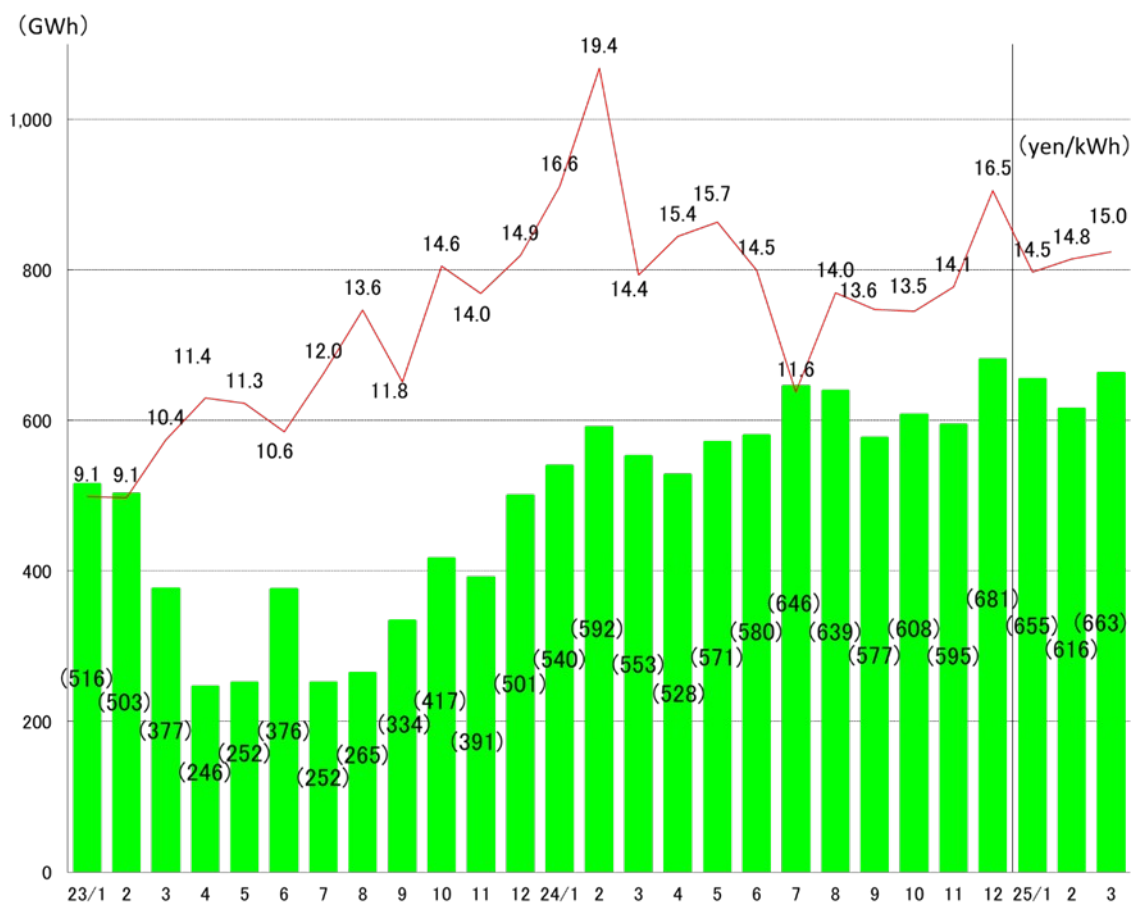


Figure 2: Trend in JEPX's spot prices and TTV (since Dec. 2013)-

Bars in GWh; Line in yen / kWh

Source: JEPX (2014)

Third, after the earthquake, nuclear power plants outside Fukushima also suspended operations, and were not permitted to resume operation even after regular scheduled inspections. This took place without official verification by the government committee and the issue has been a major influence on Japan's energy market since 2011.

The following section discusses the key factor in this issue, in other words, Japan's political environment at that time. At the time of the earthquake, the Democratic Party of Japan was in government following a general election win in July 2009. The government was facing difficult political conditions with a low approval rating due to repeated political scandals and an inability to control the bureaucratic organization of the government. Facing the disaster, the pressure on the government to do something that would win public approval led them to take credit for resolving the nuclear

problems and energy policy, issues to which many people had been paying serious attention. Using the atmosphere and public sentiment for political purposes, Prime Minister Naoto Kan ordered a suspension of operations at the Hamaoka nuclear power plant of Chubu Electric Power Company, giving as his reason that the plant had the same type of reactors as the Fukushima Daiichi nuclear power plant and was located on the Pacific coast. It is worth noting that this order was just a personal request from the prime minister, without official screening by the Nuclear Safety Commission (NSC). Similarly, the prime minister decided to prepare a draft of the New Safety Standards for nuclear power stations to maintain approval ratings for his administration. This political decision caused chronic electricity supply shortages, especially during the summer and winter, and also caused rising fuel prices and JPEX electricity prices. As mentioned, JPEX's average spot price in 2013 was more than double that in 2010, the year before the Great East Japan Earthquake. In particular, TTV in 2013 exceeded 10 billion kWh, mainly purchased by incumbent utility companies, not by new entrants.

To deal with the shortage of electricity after the Great East Japan Earthquake, the government and utility companies called on both industry and household users to save power at times of peak electricity use. In summer 2011, users located in Eastern Japan were forced to adopt power saving measures based on Article 27 of the Electricity Business Act. In Western Japan, KEPCO, which was highly dependent on nuclear power generation, had to call for power savings with a mandated target in the summer of 2011. In the summer of 2012, KEPCO had to prepare for rolling blackouts, although these were not ultimately implemented. Because of this situation, TTV trading volumes on JEPX were 1.3 or 1.4 times larger than before the earthquake.

4. Various discrepancies after the earthquake

4.1. Discrepancy in energy policy

The post-earthquake energy policy should have been discussed by the public based on considerations such as the national economy, energy security, and the world-wide environmental contribution of Japan. However, the actual discussion only considered an extremely narrow range of perspectives, resulting in a discrepancy in energy policy.

There were two energy policy proposals raised by the political administration of the Democratic Party of Japan and temporarily supported by the public.

1. Sufficient electric power for the national economy could be supplied without nuclear power generation. Accordingly, all nuclear generation in Japan should be abandoned immediately.
2. It is possible for Japan to establish an electricity supply system based on renewable energy, and this will help decrease electricity prices. The two justifications offered for this claim were firstly that some European countries have already made a decision to switch from nuclear power to renewable energy, and secondly that the cost of renewable generation can be expected to decrease due to progress in renewable energy generation technology.

The reason for the Japanese people's support for these proposals was that they misunderstood the operation of the energy market, in particular, the price discrepancy between retail prices and the cost of generation indicated by the JEPX price index. That is, despite steep rises in the JEPX price index, retail prices did not change because consumers were being protected by regulation and incomplete liberalization of the Japanese energy market. Hence, people believed this supply-shock problem did not have a major impact on their own lives or on industrial activity.

This misperception caused by a simple misunderstanding of the energy market continued because the government and media intentionally did little to correct the misleading ideas. During this period, the Democratic Party of Japan set up a committee to investigate the cost of generation, under "The Energy and Environment Council," in which the party tried to direct future energy policy in Japan toward one based on their political views, not on the energy market and economics. In response to this intention by the government, the committee on generation cost published a report stating that the cost of renewable energy and natural gas generation would decrease in the future. It goes without saying that debate on what constitutes an appropriate fuel mix (that is, what proportion of electricity should be generated by nuclear power or renewable power in the future) was already underway before the accident at the Fukushima Daiichi nuclear power plant. Whereas these issues should rightly have been examined through academic discussion with account taken of various considerations, the actual debate focused solely on the political aspects, and were supported by the public at that time

because of the growing misperception of energy policy.

4.2 Discrepancies caused by incomplete liberalization of the Japanese energy market

In order to explain why the energy market in Japan failed to work appropriately, it is worthwhile looking more closely at the tariff system used by utility companies in Japan. For both regulated and liberalized users, utility companies contract with customers directly based on fixed tariffs that consist of a basic charge and a variable charge. The variable charge is calculated under the assumption of generation using a particular fuel mix at a certain point in time. In order to change the tariffs for regulated users, all costs for the basic and variable charge are reviewed by the regulator, the Ministry of Economy, Trade and Industry (METI). Once approved, the utilities are required to use the same cost assumptions when calculating tariffs for all regulated users, such as residential customers, until the next application. The tariffs for liberalized users are also largely determined using this same mechanism.

JEPX does not act as an effective mechanism for reflecting the rising generation costs in retail prices because TTV is extremely limited in all transactions. In practice, the incomplete liberalization of the Japanese energy market means that rising generation costs do not flow through to retail energy prices. Due to this incomplete liberalization, the Japanese public did not bear the cost nor understand the difference between generation costs and retail prices, even though national wealth was diminished by 3.5 trillion Japanese Yen (JPY).

Additionally, the government reduced the impact of the increased cost of generation by setting fuel costs below actual market costs when incorporating future fuel cost forecasts into the calculation. This acted to perpetuate public misunderstanding of the actual cost impact. This protection of electricity consumers meant that it was utility company shareholders who bore the difference between rising generation costs and stable retail prices. With the exception of TEPCO, all utility companies have experienced falling equity values every year since 2011 due to lost earnings resulting from this treatment. In TEPCO's case, the company was placed under government

control and received a large amount of government funding from the compensation support agency so that victims of the nuclear disaster could start rebuilding their daily lives. Table 2 shows the extent to which equity losses by utility companies have made up for the effect of deficits in the energy market on the national economy.

Table2: Equity capital ratio and share prices
of the three biggest utility companies in Japan

(fiscal year, %, YEN)

	2010	2013	Difference
TEPCO	8.9%	38.7%	+29.8%
	1853	182	1671
KEPCO	23.1%	11.7%	▲11.4%
	1919	715	1204
Chubu Electric Power Co.	29.5%	22.0%	▲7.5%
	1908	1091	817

Source: Federation of Electric Power Companies (2015)

— Share price: lowest price of each year

<http://www.nikkei.com/markets/company/history/yprice.aspx?seode=9503&ba=1>

If Japan had dealt with the various problems raised in the electricity supply system after Fukushima by using market mechanisms under a completely liberalized market like the PJM market in the USA or markets in the UK and some other European countries, this “public misperception” would not have happened. The reason is that, in a completely liberalized energy market, a steep increase in generation costs caused by a shortage of energy supply would likely flow through to retail prices in a few months. If this had happened in the Japanese energy market, it would have been impossible for the

Democratic Party of Japan to use the suspension of operation at nuclear power plants without official verification as a way to maintain its own approval rating.

4.3 ~~Contrast with 2001 California energy crisis~~

~~Japan is not the first market in the world to experience a huge gap between generation costs and retail prices. In 2001, Pacific Gas and Electric and Southern California Edison experienced a similar supply shock to that experienced by the Japanese energy sector. Under a liberalization program started in 1998, the regulatory authority ordered them to purchase all their electricity from the California Power Exchange (CalPX), while keeping retail prices unchanged regardless of changes in energy market prices. This led power producers to intentionally limit the supply of power in order to raise the market price and earn higher profits. The asymmetric regulation made it impossible for existing retailers to cover the cost gap. As a result, California experienced a huge blackout despite having enough power supply capacity. Economists who analyzed this situation commented that it happened due to incomplete liberalization of the market that prevented generation costs from flowing through to retail prices. Meanwhile, Paul Robin Krugman, a famous US economist, commented in a NY Times column that retail electricity prices in California would have to rise enormously to reduce demand enough to avoid electricity shortages, and that such a steep rise in the electricity price would be politically unacceptable. The defenders of deregulation should stop making excuses and look seriously at what went wrong.~~

~~The situation in California could be thought of as an example of perfect liberalization going wrong, whereas Japan was an example where perfect liberalization would have helped the market mechanism to work correctly.~~

4.4 ~~Changes in the fuel market for generation~~

~~In parallel with destabilization of the energy market after the Fukushima nuclear~~

crisis, changes have taken place in the market for generation fuels, particularly LNG. Historically, the two oil crises in 1974 and 1980 reinforced Japan's awareness that ensuring supplies of generation fuel is an importance aspect of energy security, leading to action on the import of LNG as a replacement for oil. In addition, the development of combined cycle gas turbine (CCGT) generation technology in the late 1980s made LNG the most important source of energy for power generation in Japan.

However, LNG requires huge investment in facilities that cost many billions of US dollars. That is, sellers and/or buyers need to invest in liquefaction plants, upstream gas producing facilities, and custom-built vessels for the international transport of liquefied natural gas at a temperature of -160°C . Consequently, long-term take-or-pay contracts became common in the industry to fund this huge investment. Such contracts provide little flexibility for changing the contracted quantities.

Over the past 10 years, however, many countries, in addition to traditional Asian buyers, also started importing LNG. In addition, Japan has increased crude oil and LNG imports since the Fukushima disaster to replace nuclear generation. A significant proportion of these imports have been procured by a short-term spot trading with Atlantic countries. As a result, this growing popularity of spot trading makes it easier for buyers and sellers to agree on the diversion of LNG purchased under long-term contracts to different users, thereby adding liquidity to the global LNG market. In other words, LNG has become more of a commodity in recent years. This has also provided buyers with new business opportunities in fuel trading.

Figure 3 shows that the volume of spot or short-term LNG trades has dramatically increased since the Fukushima nuclear accident. In addition, Figure 4 shows that spot market trading volumes for wholesale power on JEPX have more than doubled over the past few years.

In the USA and Europe, which have well-developed physical gas pipeline networks and liquid wholesale spot and futures markets for gas, most incumbent utility companies optimize the value of their assets by flexibly combining physical and financial transactions. In Japan, although liquidity in both markets remains inadequate, there are already clear indications of increasing liquidity in the energy market, and it is likely that this trend will continue following the gas and power market reforms currently

underway. This is prompting some Japanese utilities to look at the potential for calculating or forecasting JEPX and JKM prices to assist with buying and selling decisions for spot LNG, and to generate or trade electricity in the most profitable combination. While this requires IT systems, forecasting expertise, and financial knowledge, it can be anticipated that Japanese utilities will eventually find their own ways of asset optimization and trading.

(million Ton)

Figure3: Trend in LNG trades on global spot market

Source: GHGNL (2015)

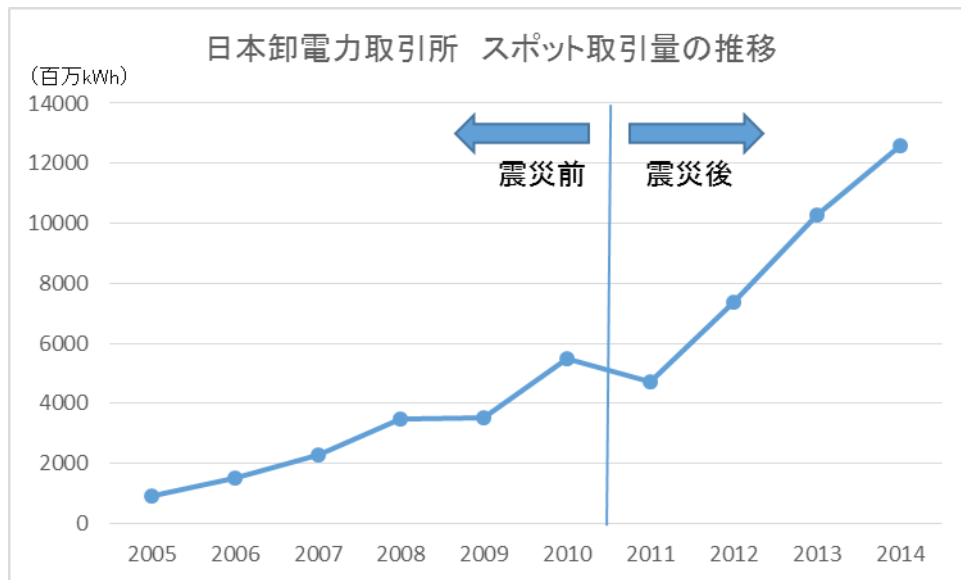


Figure4: Traded volume of wholesale power on JEPX (Day ahead, million kWh)

Source: JEPX (2015)

5 Summary: Do we learn from the discrepancy?

5.1 Situation in 2015

After 2013, all electric power companies in Japan, with the exception of Okinawa Electric Power Co., decided to increase electricity retail prices because of the rising cost of the fossil fuel power generation required to replace suspended nuclear power

generation. The Japanese public began to realize the discrepancy in energy policy through various news reports in the media that discussed the disadvantages and problems imposed on Japan's national economy by the suspension of nuclear power generation. These changes have had a great influence on public opinion, and have prompted the NRA to proceed with safety investigations at nuclear power plants based on the new standards as soon as possible in a more efficient manner. The change in public sentiment can be seen in the calm public response to the restart of the Sendai nuclear power plant compared to the antipathy toward nuclear power generation evident in 2011, although this antipathy has not completely disappeared.

Nowadays some people are still hostile to nuclear power generation. This hostility is produced by the widespread discrepancy due to incomplete energy market liberalization in Japan, as described above.

The public have still not fully understood the potential risk of energy supply shortfalls and a sharp rise in expenditure on electricity that could result if nuclear power operations remain suspended and energy market liberalization remains incomplete, which would represent a drastic change in energy policy.

5.2 Vision of energy policy in Japan

There are three key risk factors with the potential to have a great impact on Japan's energy policy. The first is the continued depreciation of the yen. The Bank of Japan has continued to keep the yen weak through a policy of monetary easing, with the possibility of this depreciation accelerating further were the US Federal Reserve Bank to raise interest rates. The weak yen relative to the US dollar is a risk factor for the Japanese economy, unless it acted to improve the trade surplus by increasing exports significantly. In practice, it is believed that the declining size of Japan's manufacturing industry has limited any positive influence on the economy from a weak yen over recent years. On the other hand, the negative influences of a weak yen accompanied by recession could force energy policy in Japan to deal with rising fuel import costs and a

loss of energy industry profitability due to falling income.

A second risk is that there will be only a limited restart of nuclear power plants in Japan. Delays in resuming operation increase the risk of energy supply shortfalls. For example, the Fukui District Court on April 14th in 2015 issued an injunction on KEPCO preventing it from restarting No.3 and No.4 reactors at the Takahama nuclear power plant in Fukui Prefecture. As the injunction has immediate effect, KEPCO cannot restart the reactors unless the injunction is reversed on appeal. This is the first court-ordered injunction prohibiting the operation of a nuclear power reactor, and it has been issued despite the two reactors at the Takahama power plant having effectively passed NRA safety inspection under the new standards, and their having been approved as complying with the new regulatory requirements.

A third risk is a rise in the price of fossil fuels, including both crude oil and natural gas. Japan is fortunate that prices for both fuels are currently stable and relatively low. However, there remains a possibility that crude oil price will rise. Depending on the situation in the Middle East, the prices of both natural gas and crude oil may keep rising in the future.

In conclusion, Japan needs to construct a new energy policy in the near future, under which a completely liberalized energy market can provide accurate and flexible price adjustments. The success of this market will depend on resolving the discrepancies discussed in this paper.

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