Consideration on Electric Power Business of Finland in Scandinavia

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This paper presents consideration on the electric power business of Finland. Because of the cold climate, Finland has world-class annual electricity consumption per capita. Like Japan, Finland is not blessed with fossil resources and relies on imports from other countries. Therefore, abundant hydropower resources, nuclear power and biomass like wood fuel and peat are utilized for power generation. Finland can import and export electricity across national borders through Nord Pool, and import a large amount of electricity. Finland's main electric power business operators are PVO, TVO and Fortum. PVO and TVO have been in deficit in recent years and have been accelerating the closing and selling of aging thermal power plants with high costs due to the high prices of fossil fuels and the low prices on the wholesale electricity market. Meanwhile, Fortum is preparing for acquisition of Uniper affiliated with E.ON, which is the largest business operator of Germany. Due to the acquisition of Uniper, the fuel cost of domestic thermal power generation could be lowered and the amount of electricity imported from neighboring countries could be reduced. Also, the system of Mankala in Finland would be useful for the baseload electricity market under consideration in Japan.

Keywords: Finland, Energy, Electricity, Electric power business, Nord Pool

1. Introduction

This paper analyzes Finland’s energy conditions and electric power business system and its business environment facing electric power business operators from various angles.

2. Comparison between Japan and Finland

2.1 Comparison of power generation and consumption

Finland features a large demand for energy for heating due to its cold climate and energy-intensive industries such as paper and pulp. As shown in the left side of Figure 1, Finland’s per capita annual power consumption is at one of the world’s highest levels. Finland uses abundant hydro resources and nuclear energy for power generation, takes advantage of vast forests characterizing its national land for spreading biomass such as wood fuel and peat and promotes CHP (combined heat and power) plants. Benefitting from low-cost nuclear and hydropower generation, Finland has seen a low power price level as shown in the right side of Figure 1.

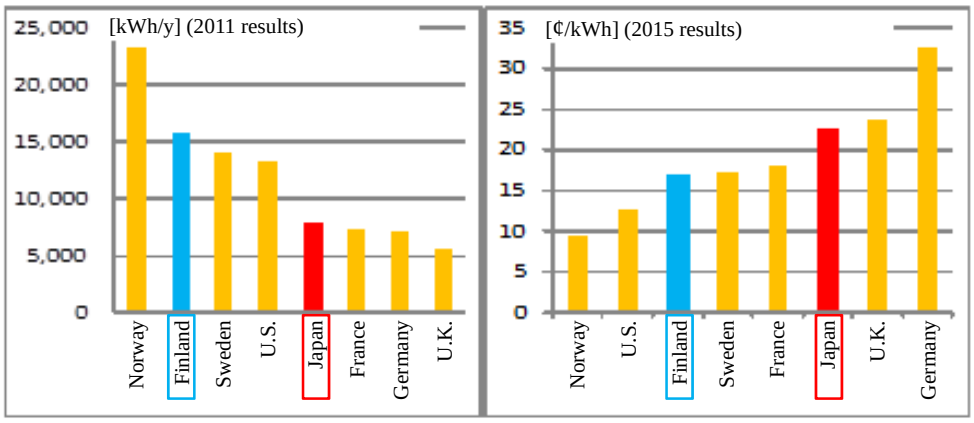

Figure 1 Per capita annual power consumption comparison [left]
Average unit power price comparison [right] [1)]

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Like Japan, Finland is poor with fossil fuel resources including oil, natural gas and coal and depends on fossil fuel imports from other countries. Therefore, securing stable energy supply is a central energy policy challenge.

In contrast to Finland that can import and export electricity to and from other countries as described later, Japan has no choice but to import electricity while depending on energy resources imports from other countries, making its energy supply less stable. Figure 2 compares the two countries' generated electricity mixes.

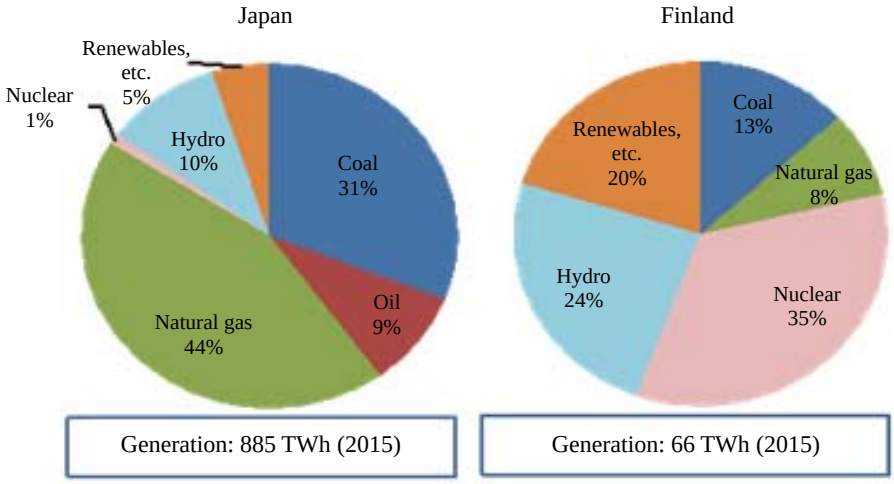

Figure 2 Generated electricity mix comparison[2)]

Table 1 shows details of power generation by source. The capacity factor is as high as 93% for nuclear power plants against a remarkably low level of 18% for fossil thermal power plants.

Table 1 Power plant capacity factors by power source in Finland (2015)[3)]

	Nuclear	Fossil fuels					Renewables			Hydro	Others	Total
		Coal	Gas	Oil	Mixed	Total	Wind	Biomass	Total			
Power generation capacity (MW)	2,752	3,295	1,743	1,695	1,687	8,420	1,082	1,919	3,001	3,263	243	17,679
Power generation (TWh)	22.3	5.5	5	0.2	2.7	13.4	2.3	10.7	13	16.6	0.8	66.1
Capacity factor (%)	93%	19%	33%	1%	18%	18%	24%	64%	49%	58%	38%	43%

2.2 Comparison of power supply systems

(1) The four Nordic countries of Norway, Sweden, Finland and Denmark with different power mixes founded Nordel, an association for electricity cooperation, in 1963, supplying power to each other. In 1991, Norway established the Energy Act to fully deregulate retail power sales, divide its vertically-integrated, state-run power utility into a power transmission company and a power generation firm and promote price competition in the power generation sector. In 1993, Norway opened a wholesale power market for fair power transactions in the power generation sector. Joined by Sweden in 1996, by Finland in 1998 and by Denmark in 2000, the wholesale market developed into an international power market called Nord Pool.

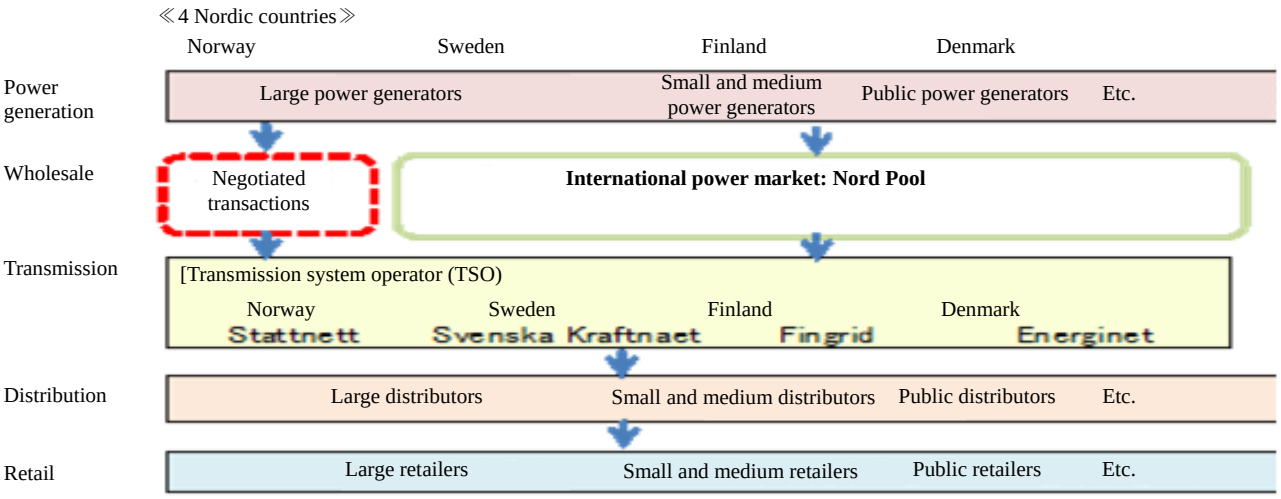

Figure 3 Nordic power supply system

Nord Pool was divided in 2002 into Nord Pool Spot as a spot exchange and Nord Pool as a financial derivatives exchange. The financial derivatives exchange was acquired by NASDAQ OMX in 2008 and is now called NASDAQ OMX Commodities. Power generators sell electricity to distributors, retailers and users through negotiations or Nord Pool Spot.

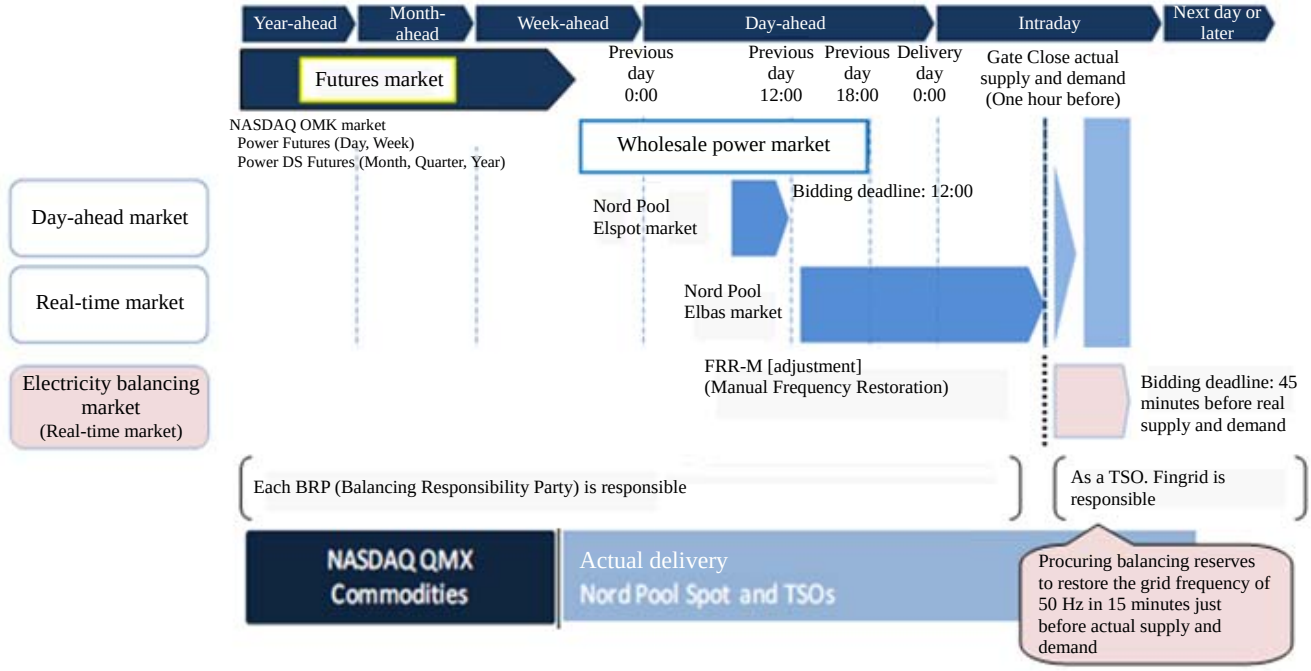

Figure 4 Finnish futures market, wholesale power market, electricity balancing market

Nord Pool Spot trading volume in 2013 totaled 353 TWh including 349 TWh for the Elspot day-ahead market and 4 TWh for the Elbas hour-ahead market. Since the founding of Nord Pool in 1996, trading volume had grown almost persistently until beginning in 2009 to level off on economic stagnation. Over recent years, however, Nord Pool Spot has boosted trading volume by expanding its coverage to include the three Baltic countries and parts of Germany and the Netherlands. Power consumption in 2013 totaled 384 TWh in the four Nordic countries and 26 TWh in the three Baltic countries. The total for the seven countries came to 410 TWh. As a result, spot trading volume accounted for about 86% of power consumption within the Nord Pool coverage. As for futures trading on the NASDAQ OMX Commodities, volume came to 2,524 TWh.

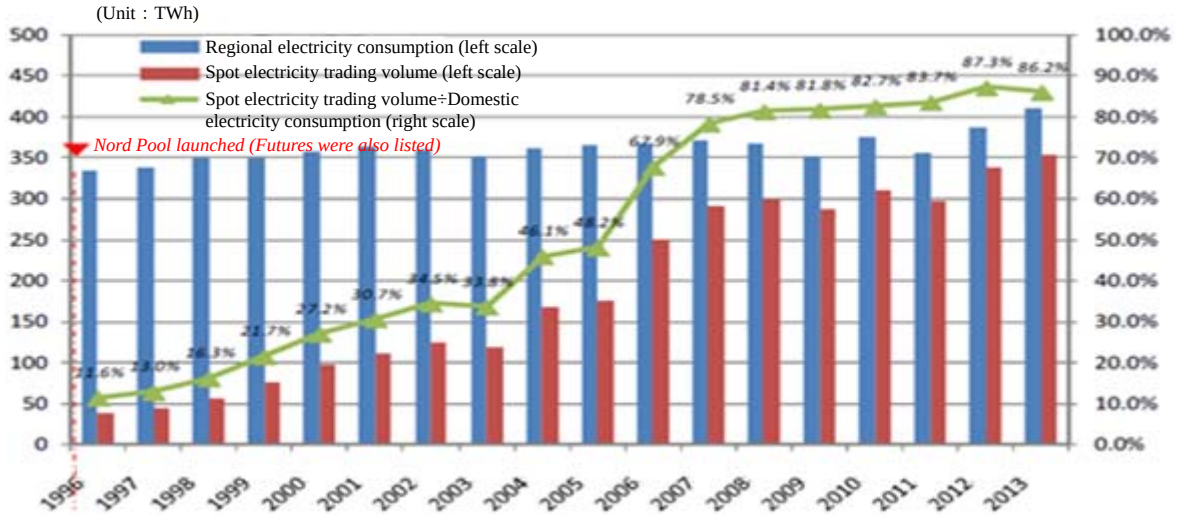

Figure 5 Nord Pool trading data and trends[4)]

(2) Japan has the Japan Electric Power Exchange (JEPX), its only wholesale power market, where Japanese power generators sell electricity while retailers procure electricity. Electricity is transacted mainly on a spot (day-ahead) market where electricity is traded for next-day delivery. The JEPX has not listed futures but has introduced forward delivery transactions.

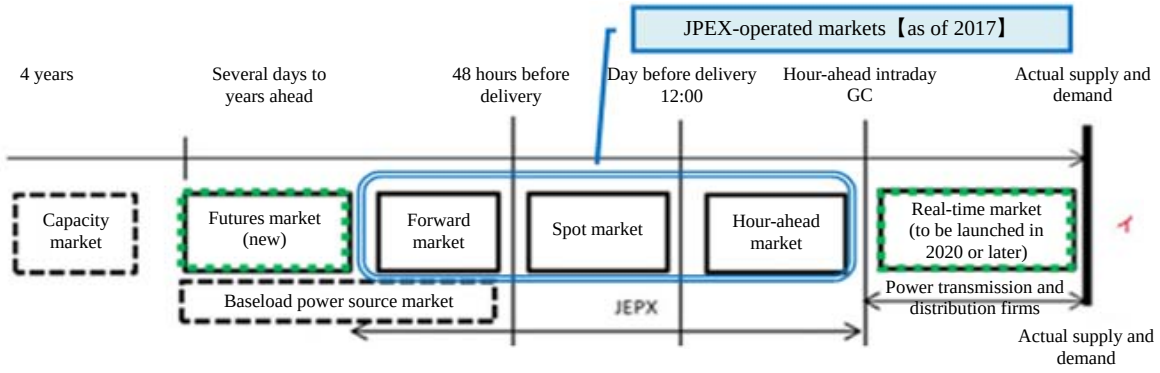

Figure 6 Japan's wholesale power market[5)]

Power generation and demand plans for every 30 minutes must be fixed one day ahead of delivery. Power generators plan the actual amount of power generation at plants they own or contract, reconfirms the amount already contracted for wholesale and consider whether to sell surplus electricity or buy electricity covering shortfalls on the spot market. They are assumed to sell surplus electricity at prices above their generation variable cost and buy electricity covering shortfalls at prices below the cost. However, some unexpected events such as plant accidents could force power generation plans to be revised. There is the hour-ahead market to balance electricity in response to such unexpected events after the preparation of generation plans one day ahead of delivery.

Item	Japan [Results for the first half (April-September) of FY2016] Forward market	Spot (day-ahead) market	Hour-ahead market
Major required roles	・Risk hedge ・Economical power procurement	・Economical power procurement	・Economical power procurement
Trading volume	About 60 million kWh	About 10.3 billion kWh	About 570 million kWh
Share in power sales	About 0.01%	About 2.5%	About 0.1%
Major vitalization measures	・Baseload power source market (to be launched in FY2019)	・Offering surplus power ・Gross bidding (Launched in FY2017)	・Offering surplus power

Scandinavia (Nord Pool) [2013 results]	About 86%
U.K. [FY2013results]	About 51%
France [FY2015 results]	About 25%

Figure 7 Trading results at Japan electric power exchange and their comparison with foreign trading results[6)]

As shown in Figure 7, trading volume on Japan electric power exchange accounts for only about 2.6% of overall power sales. The spot market share of about 2.5% is far smaller than about 86% for Nord Pool. In particular, forward market trading volume is limited to only about 0.01% of overall power sales. Therefore, as a current situation, there is no power price index with high transparency and objectivity for predicting investment recovery. If the volume of electricity market trading is small, the volatility of the market price increases, as a result, the credit as an economic indicator decreases. And if the amount of transactions that can be procured from the market is limited, it becomes difficult for market participants to use it, and further the market becomes ineffective. From this background, Japan is considering launching a baseload electricity market[1] to vitalize the market and competition under an electric power business system reform. The new market would allow new electric power business operators (generation companies and retailers), which have no nuclear or large hydropower plants, to receive cheap electricity through the electric power exchange. Baseload power sources from which they would procure electricity without risks should be owned jointly by new electric power business operators and former general electric utilities to secure equitability and asymmetric regulations. From the viewpoint of stable power supply, Japan should make a comprehensive decision on a desirable system for the country to make the new market consistent with its past energy policies.

(3) Figure 8 shows electricity generation, consumption, imports and exports in the past 10 years in Finland and Sweden. Finland and Sweden connect to their Nordic neighbors Denmark and Norway with transmission lines. The four countries can import and export electricity across their borders through Nord Pool, as mentioned above. The figure indicates that Sweden generates more electricity than it consumes and exports more than Finland, while Finland imports more electricity than Sweden to cover domestic generation's gap with consumption.

[1] The baseload power source market is assumed to cover some 30% of peak power supply by new power business operators to their customer's demand. New electric power business operators are expected to become able to combine the baseload electricity market and the spot market to flexibly procure electricity in response to demand.

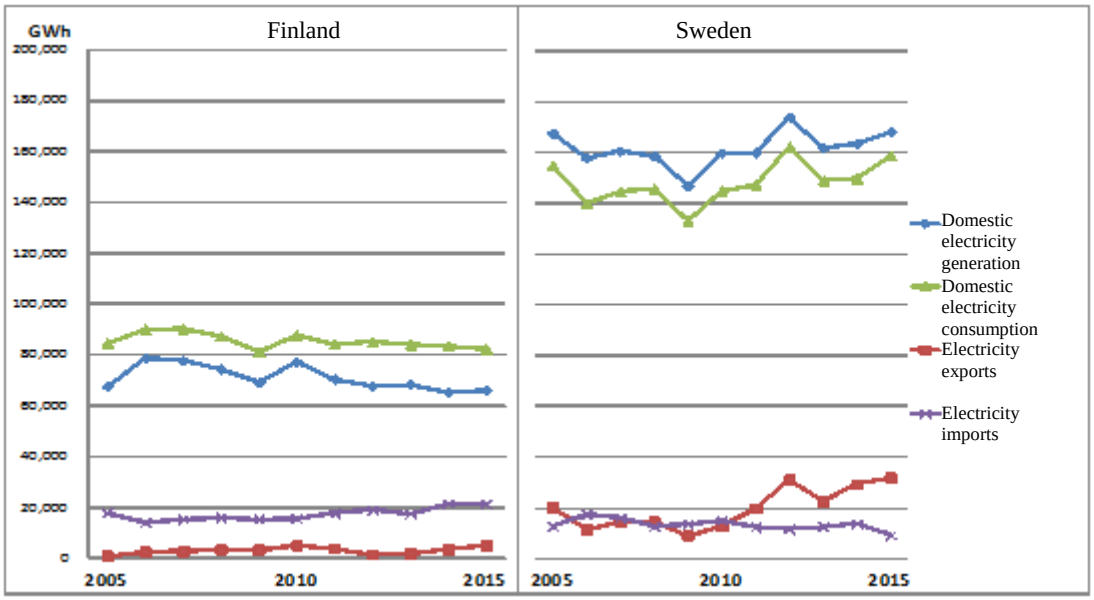

Figure 8 Electricity generation, consumption, imports and exports in Finland and Sweden[7)]

Annual import and export volumes through Nord Pool depend heavily on hydropower generation of the main power source in Nordic countries, which fluctuates in response to precipitation changes. In a year when precipitation is abundant, for example, Sweden with a high hydropower share of about 46% and Norway with a very high hydropower share of about 100% provide cheap electricity to Nord Pool, while Finland expands electricity imports. In a year when precipitation is limited to a low level, Finland reduces electricity imports and expands supply from domestic fossil power plants to meet demand.

Figure 9 shows Finland's wholesale power price [FI] and system price [average price] trend in 2016. In the Nordic countries, hydropower generation depending on regional precipitation (snowfall) and dam storage levels, generally have a large influence on the level of wholesale power prices. When low dam storage levels coincide with high power demand in cold winter, for example, the power supply-demand balance tightens to boost wholesale power prices. In 2016, the system price stood at high levels in January, plunged later and rose back on a tightening supply-demand balance from September.

As indicated in the figure, the Finland's wholesale power price is always higher than system price by about 5 to 10 euros. This is because, in Finland, demand is consistently above demand and depend on imports from neighboring countries. In this way, the Finland's wholesale power price fluctuates depending on regional supply and demand conditions as well as drought, cold waves and other weather conditions exerting influence on power supply and demand.

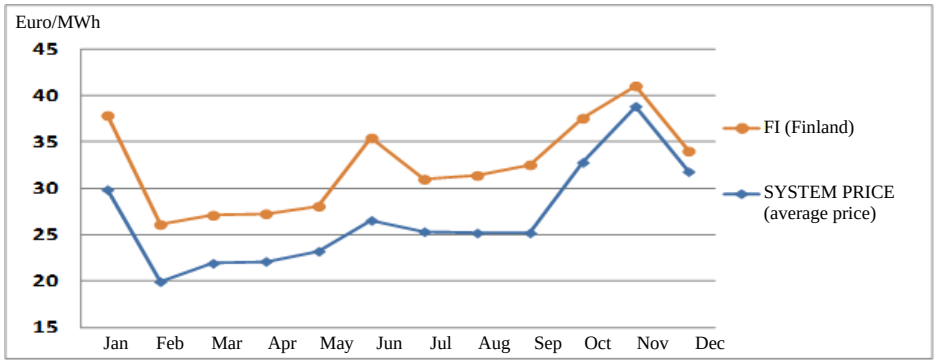

Figure 9 Annual trends of Finland's wholesale power price [FI] and system price (average price) (2016) [8)]

As shown in Figure 10, the trend of Finland's hydropower generation volume in the upper is inversely correlated with that of the wholesale power price [FI] in the lower. In a year when hydropower generation volume is limited to a low level, domestic thermal power generation with higher generation cost covers supply shortfalls that is still insufficient even imports It leads to a rise in the wholesale

power price.

The Finland's wholesale power price trend in the lower indicates that the wholesale power price remained in a low range of 30-41 euros/MWh, while prices of fossil fuels (gas and coal) for power generation stayed in a high range of 30-37 euros/MWh [on a power supply basis]. Particularly, gas power generation had difficulties in making a profit in recent years.

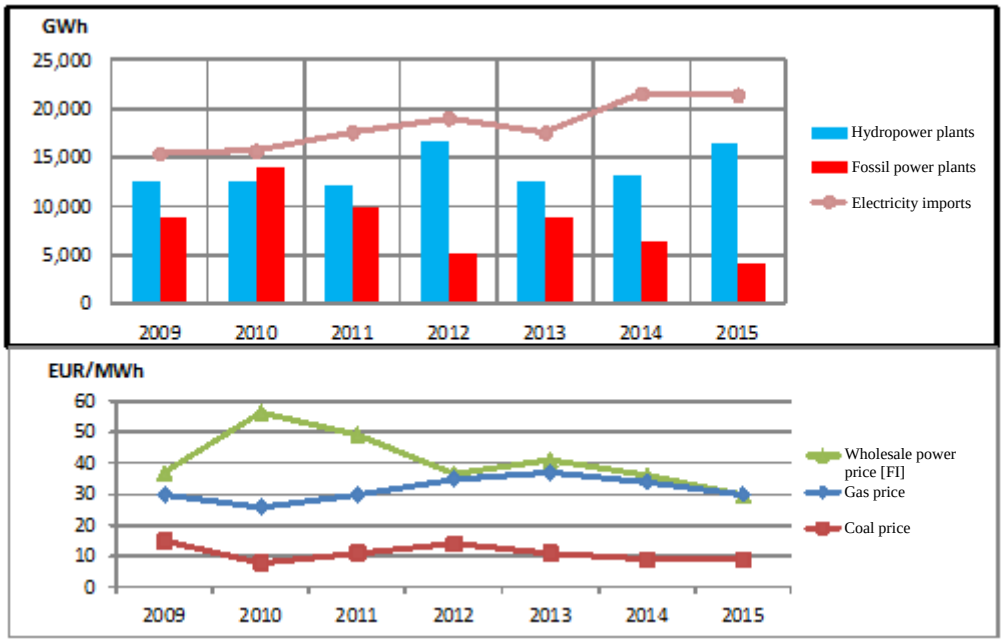

Figure 10 Trends of power supply (hydropower generation, thermal power generation, imports) [upper] and prices (wholesale power, gas, coal) [lower] [9)]

3. Finland's electric power business

Finland, as mentioned above, effectuated the Electricity Market Act in 1995 and implemented full power market deregulation from January 1997 to participate in Nord Pool, a deregulated Nordic wholesale power market, along with other Nordic countries. It imports and exports electricity within the Nord Pool framework. In Finland, numerous electric power business operators engage in power generation, transmission, distribution and retail sectors. Electric power business operators covering multiple sectors are required to establish accounting, legal and function walls between sectors. (Those other than power transmission business operators are not required to separate ownership.)

Finland has about 120 power generation business operators running about 550 facilities. Effectively, however, three major electric power business operators – PVO (Pohjolan Voima Oy), TVI (Teollisuuden Voima Oyj) and Fortum Corporation – have an oligopoly on the power generation market, accounting for 45-50% of total installed power generation capacity. Fortum is a state-run electric power business operator owned 50.8% by the government at the end of 2016. The three, Helsingin Energia and Kamijoki occupy most of the power generation market in Finland.

In addition, small and medium-sized electric power business operators jointly own non-profit power generation consortiums and procure electricity at cost from these consortiums according to their respective equity stakes called "Mankala." The Mankala business model has developed to complicate ownership relations between electric power business operators. In recent years, new wind power generators have growingly participated in the power generation sector.

In 1996, Fingrid was founded to exclusively own and operate Finland's power transmission sector. As of July 2016, Fingrid was owned about 71% by the Finnish government and the National Emergency Supply Agency, about 17% by Ilmanrinen Mutual Pension Insurance, an institutional investor, and about 12% by other shareholders. In January 2015, the government gave Fingrid a network license under the Electricity Market Act and designated the company as TSO (transmission system operator) responsible for operating the transmission system.

As for the power distribution sector, the Electricity Market Act requires DSOs (distribution system operators) to be legally separated from power generation and retail sectors if their annual sales to users through 400V distribution lines total 200 million kW or more. At the

end of 2015, 46 of 80 DSOs had implemented the legal separation. As DSOs are not required to separate ownership, most of them belong to groups of power generation and retail business operators. DSOs also include public operators in which local governments have majority or 100% equity stakes.

Power retailers numbered 72 in 2015, including 51 engaging in nationwide power supply. The three largest retailers account for about 35-40% of Finland's power retail market covering about 3.3 million users. The largest retailer is Fortum Sahkonsiirto Oy in the Fortum group, followed by Vattenfall Verkko Oy (a Swedish state-run business operator).

4. Finland's representative electric power business operators

This chapter analyzes business operations and trends of Finland's three representative electric power business operators (PVO, TVO and Fortum).

Figure 11 shows the three companies' total assets, sales, sales-profit ratio and investment in the past five years. The total assets graph (1) shows that Fortum has had the largest business size, followed by TVO and PVO. As indicated by the sales graph (3), Fortum posted far greater sales than TVO or PVO. This is because Fortum has expanded into the other Nordic countries, the Baltic countries, Poland and northwestern Russia, while TVO and PVO do business in Finland alone. The profit sales ratio graph (3) shows that Fortum posted a high profit sales ratio of about 18-28%, although its sales decreased in recent years. The profit sales ratio is naturally lower for the other two that take advantage of the Finnish power generation sector's unique Mankala joint investment business model for power supply. In recent years, they remained in deficit. The investment graph (4) indicates that Fortum reduced investment in recent years after aggressive overseas investment projects including the acquisition of a hydropower generation business under control by Russia's Gazprom and that TVO continued investment in a new nuclear power plant (Olkiluoto Unit 3 (OL3) with capacity at 1,600 MW) planned to start operation in 2018.

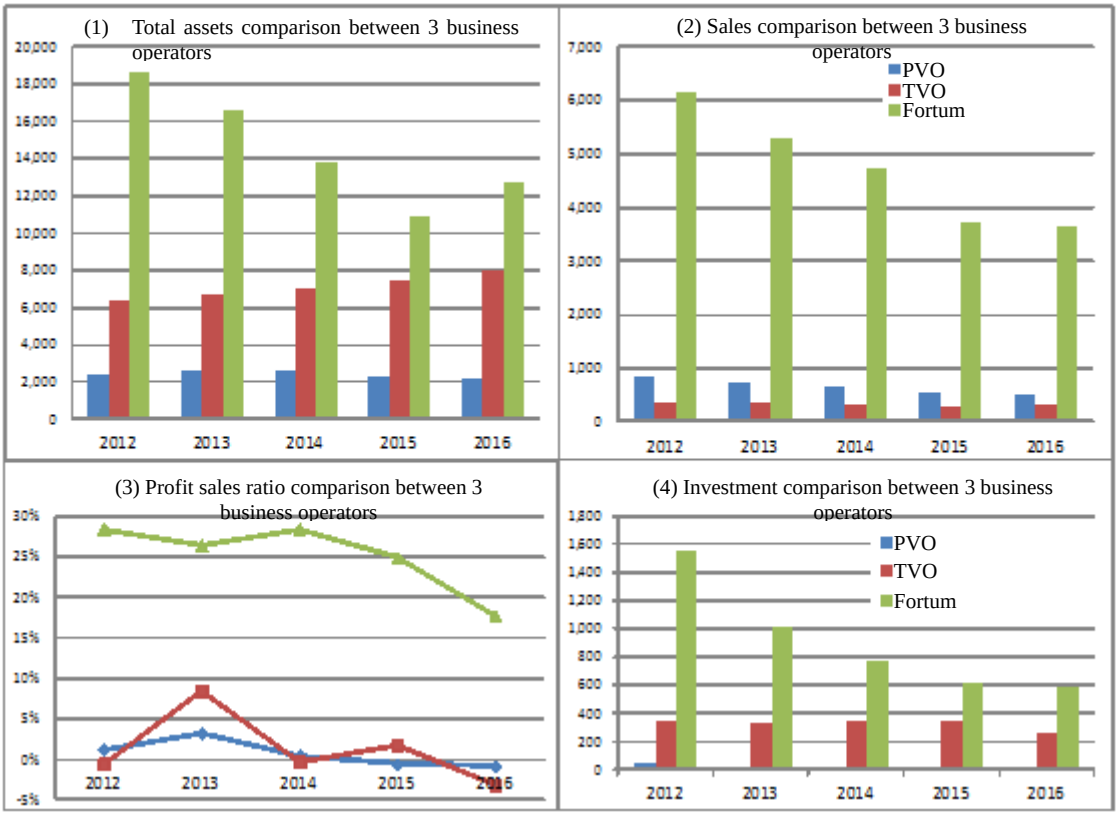

Figure 11 (1) total assets, (2) sales, (3) profit sales ratio and (4) investment trends for 3 biggest electric power business operators (PVO,TVO, Fortum) [10)]

4.1 PVO

Private sector companies and local governments jointly founded PVO in 1943 for generating power and supplying heat. Generating about 16% of electricity consumed in Finland, PVO provides 22 shareholders with electricity and heat at cost from hydro, thermal and

nuclear power plants in which they have invested under the Mankala system, supported by low power generation costs. Regardless of whether each shareholder receives electricity actually, it is required under the PVO articles of association to pay debt repayment and other fixed costs for constructing and operating power plants.

While benefitting from the Mankala system, PVO remained in deficit recently due to fossil fuel price spikes and slumping wholesale power prices. PVO has thus accelerated the closure or sale of high-cost outdated fossil thermal power plants. A breakdown of PVO's power generation indicates that fossil thermal power generation halved in the four latest years, as shown in the left side of Figure 12. At the end of 2016, nuclear plants accounted for 38% of PVO's total installed power generation capacity, hydropower plants for 17% and fossil thermal power plants for 24%. The nuclear plants are TVO's Olkiluoto Units 1 and 2 (OL1 and OL2) in which PVO has a 59% stake to receive 1,000 MW in electricity. PVO also has a 60% stake in Olkiluoto Unit 3 (OL3) under construction to receive 963 MW. After OL3 starts operation in late 2018 as planned, therefore, PVO's dependence on nuclear power generation will further increase.

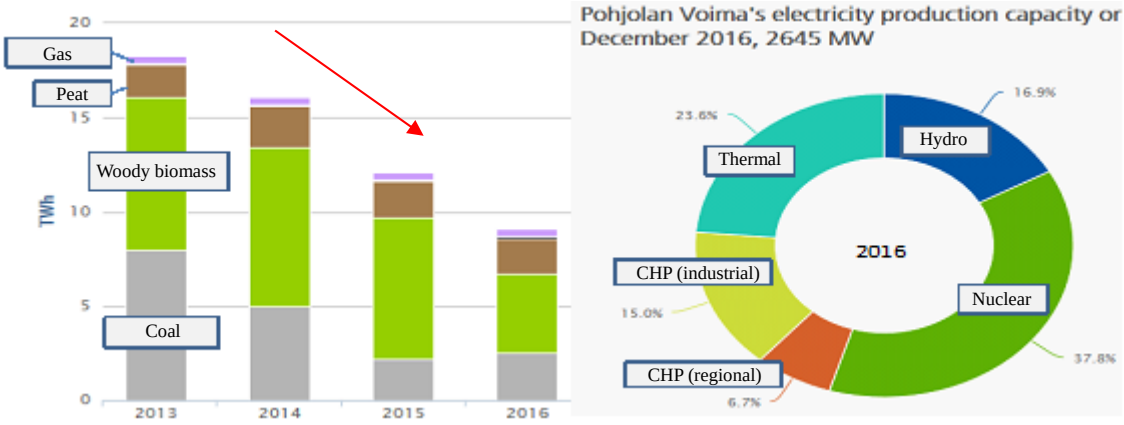

Figure 12 PVO's thermal power generation trend ［left］ and power mix [2016] ［right］ [11)]

4.2 TVO

TVO is a nuclear power generator owned by Voimaosakeyhtiö SF（a consortium of electric power industry companies） and Fortum. In Finland, it operates two nuclear plants (Olkiluoto Units 1 and 2 with total capacity of 1,760 MW) and is constructing a third one that is a European pressurized water reactor（EPR）. As a power utility wholesaling electricity to shareholders at cost under the Mankala system, TVO provided 17.5% of electricity consumed in Finland in 2016. Thanks to stable nuclear plant operation over a long term since 1979, the TVO nuclear plants' capacity factor has remained as high as around 95% as shown in the right side of Figure 13, leading to low power generation costs. TVO has a 45% equity stake in the Meri-Pori coal power plant owned by Fortum.

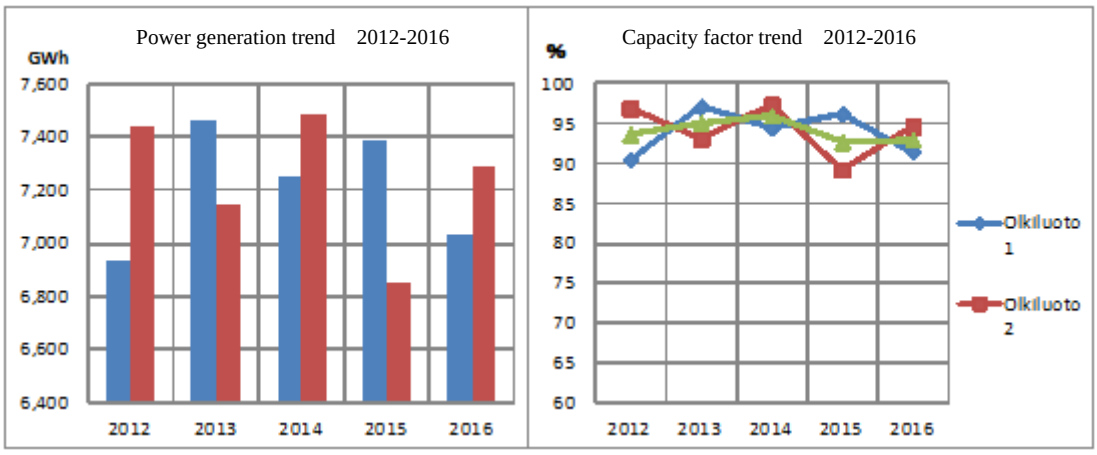

Figure 13 TVO nuclear plants' power generation trend [left] and capacity factor trend ［right］ [12)]

4.3 Fortum

Fortum is a state-run electric power business operator owned 50.8% by the government and has the largest number of customers among electric power business operators in the Nordic region including Finland. Also, Fortum ranks 15th among power generators in Europe including Russia.

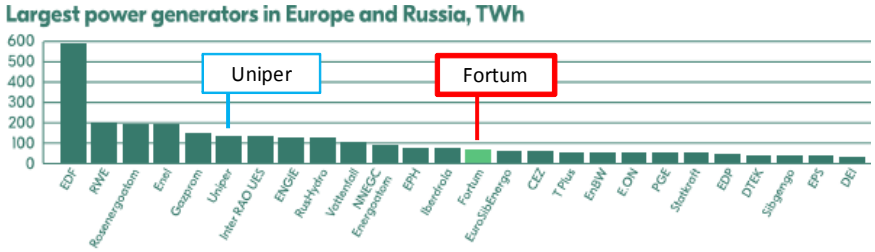

Figure 14 Electric power business operators' power generation in Europe (including Russia) [13)]

Fortum focuses on hydro and nuclear power generation. As of 2016, Fortum had owned about 260 hydropower plants with total capacity of 4,652 MW including 1,535 MW in Finland and 3,167 MW in Sweden. As for nuclear power generation, Fortum has owned the two-unit Loviisa nuclear power plant since 1977, generating some 10% of electricity consumed in Finland. In addition, Fortum has a 26.6% equity stake in TVO's Olkiluoto nuclear power plant. Including capacity represented by the stake, Fortum's total nuclear power generation capacity stands at 1,472 MW. Fortum also co-owns a 22% stake in the Forsmark nuclear power plant and a 45.5% stake in the Oskarshamn nuclear power plant in Sweden. Including the Swedish capacity, Fortum owns total nuclear power generation capacity of 1,539 MW. Figure 15 shows Fortum's power generation trends by source and country.

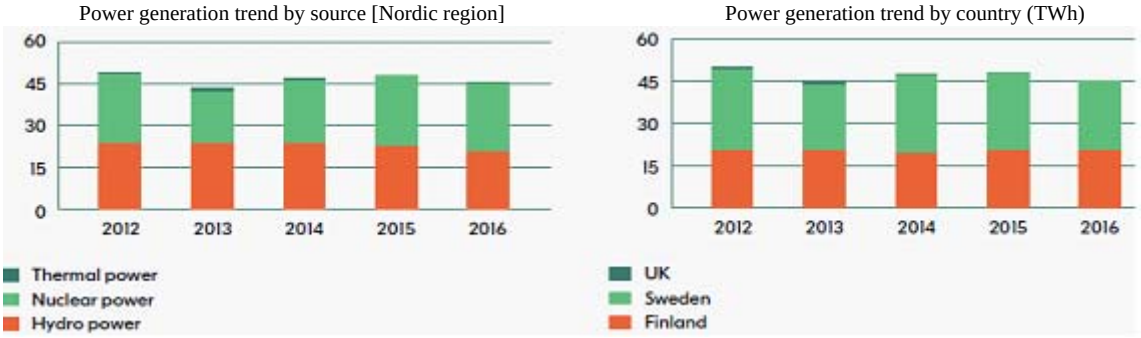

Figure 15 Fortum power generation trend by source [left] and by country [right] [14)]

Fortum has announced its negotiations and procedures to acquire all shares in Uniper that ranks higher than Fortum in power generation in Europe (including Russia) in Figure 14[2]. Uniper is a fossil and hydro power generation and fossil fuel trading company affiliated with E.ON, Germany's largest energy business operator. In this way, the European electric power industry has activated reorganization. This is because the expansion of renewable energy in Europe has made it difficult for coal or natural gas power generation to make a profit. Fortum, if acquiring Uniper, would get fossil and hydro power plants, fossil fuel trading rights and relevant knowhow in Germany and other European countries. The acquisition is expected to bring about synergy effects for Fortum in Finland and Russia and substantially expand Fortum's business portfolio that had been limited to nuclear and hydro power generation in the Nordic region, leading to the company's diversification and stabilization.

5. Conclusion

This paper from various angles compared and analyzed electric power business systems and environments in Japan and Finland that have similar social and energy conditions. Finland has taken the initiative in reforming the electric power business system from an early

[2] On September 26, 2017, Fortum announced that it had signed a contract with E.ON on the acquisition of Uniper. Based on the contract, Uniper launched a takeover bid for Uniper SE shares on November 7, 2017. [Fortum Press Release on November 7, 2017]

period.

Finland has taken advantage of low-cost power sources such as hydro and nuclear plants to limit power prices and expanded biomass and CHP. It has also promoted international electricity trade through Nord Pool, importing electricity from neighboring countries to cover domestic supply shortfalls. Finland's electric power business operators have recently closed fossil thermal power plants in response to slumping power market prices and fossil fuel price spikes. Particularly, PVO halved fossil thermal power generation in the latest four years. In the situation where the price level in the wholesale power market is low, when the fossil fuel cost is high, there is no profit even if generation operators operate the thermal power plants and sell it to the market. In other words, there is a situation in which loss occur conversely. Naturally, the occupancy rate declined, and as a result, the power generation cost increased, and it turned out that the profitability of the business leaded to deteriorate.

If Finland's state-run electric power business operator, Fortum, realizes the acquisition of Uniper to lower fossil fuel costs and raise capacity factors for domestic fossil thermal power plants, Finland may reduce electricity imports from neighboring countries to improve its trade balance. The acquisition may also diversify Finland's power source portfolio to reduce dependence on hydro power generation fluctuating in response to precipitation changes and on nuclear power generation that has so far been stable but could be suspended.

The electric power business environment in Finland basically differs from that in Japan. However, there are many similarities and systems that will be helpful for Japan. Japan is now considering a baseload power source market to be launched under an electric power business system reform. In this respect, equitability and asymmetric regulations should be taken into account. From the viewpoint of stable power supply, Japan should make a comprehensive decision on a desirable system for the country to make the new market consistent with its past energy policies. It is inferred that Mankala system for joint ownership of power plants in Finland could be used for new electric power business operators to receive electricity generated by baseload power sources such as nuclear plants.

The analysis of Finland's recent electric power business environment and Finnish electric power business operators' trends has provided useful implications for Japan's future energy and environmental policies and the electric power business system reform.

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