

Chapter 3

Energy Mix and Market Structure in Europe

March 2017

This chapter should be cited as

ERIA (2017), 'Energy Mix and Market Structure in Europe', in Yokota, E. and I. Kutani (eds.), *Study on Electricity Supply Mix and Role of Policy in ASEAN*. ERIA Research Project Report 2015-18, Available at:

http://www.eria.org/RPR_FY2015_No.18_Chapter_3.pdf , pp.47-63.

Chapter 3

Energy Mix and Market Structure in Europe

The market structure of ASEAN member states varies by country. While there are ASEAN member states such as the Philippines and Singapore that have managed to achieve electricity generation sector liberalisation, there are also countries such as Cambodia and the Lao PDR with state-run companies that operate as monopolies.

In order to respond to projected future increases in electricity demand, there are moves in many ASEAN member states to utilise IPPs and other private sector companies to relieve electricity supply shortages.

Conventionally in ASEAN member states, state-run companies have been central to electricity source development. However, there are now moves to entrust markets to free competition due to the inadequate know-how, human resources, and capital at state-run companies and also as a result of policies aimed at overcoming the inefficiency of state-run companies.

Moves such as these are rational in that they make it possible to streamline project implementation and take advantage of the dynamism of the private sector. At the same time, however, leaving the development and selection of electricity generation plants up to private companies within a competitive environment weakens the influence of governments on markets and leads to concerns about excessive electricity generation capacity surpluses and shortages as well as imbalance in the types of electricity generated.

Therefore, in this chapter, we will analyse the cases of electricity liberalisation carried out in European countries in the 1990s in order to look at the potential effects of electricity market liberalisation on the implementation of electricity mix-related policies. Specifically, we will provide an overview of changes in electricity mixes and electricity industry structures based on the results of surveys conducted in several European countries.

Table 3-1: Market Structure in ASEAN Member States

Country	Market Structure		Current situation of energy use
	Power generation	retail	
Cambodia	Monopolistic regulated market	Regulated market	• Hydro, oil, natural gas, lignite exist, but not developed. • More than 90% of electricity generation from diesel generator.
Lao PDR			• Hydro power for export , coal-fired power for domestic use.
Myanmar	Liberalised market + Single buyer		• Focus on hydro power development.
Viet Nam			• energy exporting country now, but capable of turning to energy importing country. Considering oil stock.
Indonesia			• Less than 20% of oil-fire, more than 30% of natural gas-fire, 33% of coal-fired, 5% of RE by2025.
Thailand			• No natural resources. Difficulty in developing coal-fire.
Malaysia			• energy exporting country now, but capable of turning to energy importing country.
Brunei			• Plenty of oil, natural gas, but take resources preservation policy.
Philippines		Liberalised market	• Hydro is the key source. • There 's spare development capacity.
Singapore	Liberalised market		• Almost 100% of primary energy depends on import. • Difficulty in developing coal-fired.

Source: Study team.

1. Case of the UK

1.1. Transition of Energy Mix in the UK

The United Kingdom (UK) has abundant fossil fuel resources. In addition to coal, which became the primary fuel from the 1970s, gas and oil field development in the North Sea gained momentum in the 1960s and 1970s, and the UK was energy self-sufficient for approximately 20 years from the 1980s onward. However, North Sea gas and oil output began to drop off from the start of the 21st century and from 2004 onward the UK became a net energy importer.

Looking at each fuel separately, before 1970, resources were abundant with national coal production reaching 100 million tonnes of oil equivalent. However, with gas and oil field development in the North Sea, from the 1970s onward pipeline infrastructure was constructed throughout the UK in order to facilitate the expanded use of natural gas. The creation of an environment allowing large-scale utilisation of natural gas led to the ‘Dash for Gas’, a major shift towards greater natural gas usage. In the electricity generation sector, a series of gas-fired power plants (CCGT) were constructed in the UK in the 1990s and with this move coal-fired power plants were closed down. In the late 1990s, the UK even became a net

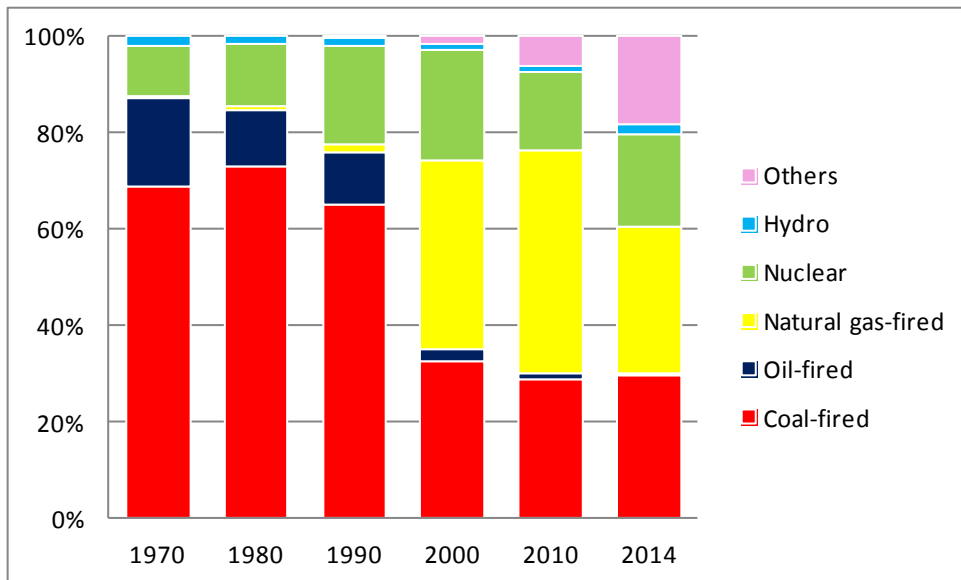
exporter of natural gas but it started to become increasingly clear that the North Sea gas fields were becoming depleted and national production levels have been dropping since peaking in 2000.

Enacted in 2008, the 2008 Climate Change Act stipulates that by 2050 GHGs should be reduced to 20 percent of the level in 1990. In addition, in 2009 the European Union issued the Renewable Energy Directive which requires the UK to see that 15 percent of its final energy consumption is based on energy from renewable sources by 2020 (equivalent to 240 GWh of electricity per year). Approximately half of this 15 percent is to be achieved through the electricity sector, and, in order to achieve this, at least 40 GWh worth of renewable electricity sources will need to be brought online.

In response to the issuance of the 2008 Climate Change Act and the European Union's Renewable Energy Directive of 2009, renewable energy has been increasingly used with a focus on wind power and biomass.

With regard to nuclear power, following electricity liberalisation and privatisation in 1990, the construction of new nuclear power plants has slowed, but the issue of increasingly pronounced depletion of the gas and oil fields from 2000 led the government to issue the 2008 White Paper on Nuclear Power and a decision was made to pursue the construction of additional new nuclear power plants. Renewable energy and nuclear power were also further promoted with the passing of the Energy Act 2013, which included electricity market reforms aimed at promoting investment in low-carbon electricity sources including nuclear power.

Figure 3-1: Trend of Energy Mix in the UK



Source: International Energy Agency, Energy Balance of OECD Countries 2015.

1.2. Electricity Market Reform and Energy Policy in the UK

With its abundant domestic coal resources, development of coal-fired electricity plants in the UK played a central role early on. On the other hand, following the discovery of the major North Sea gas fields in the mid-1960s the UK government made a transition from coal to low-cost natural gas in order to increase energy security. To promote the use of natural gas, the British Gas Corporation was established in 1973 to take sole responsibility for gas purchasing, conveyance, and distribution. By the latter half of the 1970s, the British Gas Corporation had completed the installation of gas trunk pipelines and infrastructure. This meant that it had a monopoly over the gas industry and it was through the British Gas Corporation that the government carried out its energy policy shift.

In addition, at the time that the UK's electricity market was under the monopoly of the Central Electricity Generation Board. Its monopoly over the market and that it therefore faced no risk from competition or loss of customers provided an additional boost to the energy policy shift from coal to gas.

With the advent of the first Thatcher administration, the introduction of the competition principle and the selling off of state-run companies to reduce budget deficits became core policies. At the time, the UK was experiencing a period of stagnation that was mockingly referred to as the 'British Disease' and one of its causes was understood to be the inefficiency of state-run company monopolies. For this reason, the electricity sector was also targeted and in 1990 moves were made to simultaneously liberalise the electricity market and break up and privatise state-owned electricity companies. The Central Electricity Generation Board, which had a monopoly over electricity generation and transmission, was split and privatised into three electricity generation companies and one transmission company.

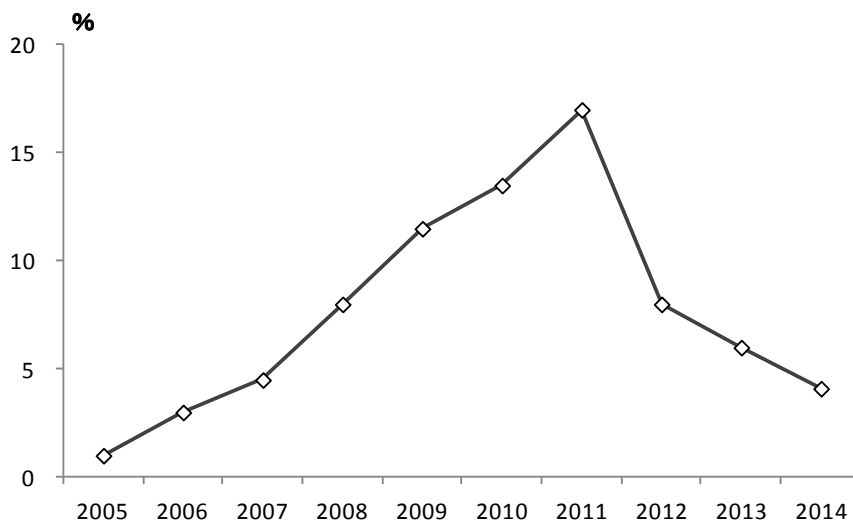
Liberalisation led to a series of new companies entering the market and increased competition, and vigorous merger and acquisition (M&A) activities led to large electricity companies being bought by major German, French, and Spanish energy companies. As a result, the British electricity market has been consolidated under six large groups including British Gas, RWE (Germany), E.ON (Germany), EDF (France), SSE (UK), and Iberdrola (Spain).

In recent years, energy policies in the UK have been promoting a shift to low-carbon electricity sources such as renewable energy, nuclear power, and carbon capture and storage (CCS) thermal power stations. However, the competitive electricity market, the creation of which began in the 1990s, functions in such a way as to exclude high-cost electricity generation plants. This environment means that high-cost electricity generation plants such as those using renewable energy, nuclear power, and CCS thermal power will not be developed without special policies aimed at encouraging this.

And since competitive markets have elements of uncertainty, there is a tendency to hold off from investing. Since particularly in the UK the electricity industry is funded by overseas capital, circumstances in the countries from which the capital originates have a direct impact on development planning in the UK. Recently, E.ON and RWE of Germany have backed out of nuclear power development plans in the UK as a result of expectedly reduced cash flow due to the decommissioning of nuclear power plants in Germany, and there is concern that there may be considerable supply shortages in the medium to long term.

There were also plans for the construction of coal-fired power plants in the past, but there are currently no such plans. The European Union also placed a limit on the total number of hours a coal-fired power plant can operate in accordance with the plant's pollutant emission levels, and a number of older coal-fired power plants in the UK reached this limit in close succession, leading to the decommissioning of 15 coal-fired power plants in the country since 2012. As a result, the UK's electricity reserve margin has continued to decrease and by 2014 had gone below 5 percent. In 2015, UK's electricity reserve margin had kept below 5 percent.

Figure 3-2: Trend of Generation Reserve Margin in the UK



Source: Winter Outlook, National Grid.

In order to respond to this issue, the UK government made major changes in 2010 to its electricity policy direction to increase the role of market mechanisms with the decision to implement the Electricity Market Reform policies. The objective of these policies is to inexpensively achieve targets relating to low-carbon energy, stable electricity supply, and renewable energy usage, and involves the following four policies:

1. Renewable energy/nuclear power/CCS-oriented Feed-in-Tariff (FIT) (Contract for Difference [CfD])
2. Introduction of the Capacity Market system

3. The Carbon Price Floor (CPF) system
4. Direct CO₂ emission regulations (Emission Performance Standard [EPS])

The Feed-in-Tariff system involves long-term fixed price purchasing of electricity generated using low-carbon methods. One of the characteristics of the system is that the difference in price between the fixed price and the electricity market price is settled between electricity generators and electricity purchasers. This system means that if the electricity market price goes below the exercise price, electricity generators receive the difference from electricity purchasers and if the electricity market price goes above the exercise price, electricity generators pay the difference to electricity purchasers. Another characteristic is that, in addition to renewable energy, the system also applies to CCS and nuclear power.

Since the exercise price is determined through bidding, the system promises to, within a liberalised market, encourage competition between electricity generators, make it possible to avoid excessively large subsidies, and maintain the income of electricity generators at a certain level.

The Capacity Market system was designed with the aim of attracting investment in electricity generation plants. In response to the increasing use of renewable electricity generation, the output of which is unstable, the UK will need thermal power plants in order to balance out supply. However, the existing thermal power plants, which are primarily coal-fired, are being phased out due to age-related deterioration, and the reserve margin is predicted to decrease further. In addition, since the utilisation rates of thermal power plants to be used as a backup for renewable electricity sources would be extremely low, they would generally have low economic potential, meaning private sector companies would not consider them a target for proactive investment.

The system involves electricity generators promising to provide, at times of electricity shortages, electricity generating capacity for a certain period of time at a price determined in contracts with electricity system operators. The introduction of this system promises to enable electricity generators, within a liberalised market, to move ahead with the construction of new electricity generation plants and the upgrading of existing ones. It also makes it possible to earn profits by providing electricity capacity not only during normal times

but also during emergencies, and it shows promise as a method of stimulating investment aimed at increasing supply capacity and bridging gaps between supply and demand

The Carbon Floor Price system involves setting a minimum limit for carbon prices based on the European Union Emissions Trading System (EU-ETS). Reflecting the excess of supply over demand, EU-ETS carbon prices have been low, and they remain at a level that is insufficient to encourage low-carbon energy investment. By maintaining carbon prices at or above an adequate level, it is expected to work in such a way as to encourage more low-carbon electricity generation.

Direct regulation of CO₂ emissions involves placing an upper limit on per kilowatt-hour CO₂ emissions of newly constructed electricity generation plants (450 g of CO₂ per kWh per year). The 450g/kWh target is not possible to achieve with ordinary coal-fired power plants, meaning in effect that it limits thermal power generation options to biomass, gas, coal-biomass co-combustion, and CCS coal-fired power plants. This system is also expected to work in such a way as to encourage more low-carbon electricity generation.

As explained above, these policies are being used to make up for issues arising from electricity market liberalisation. After liberalising the electricity market and then pushing forward with climate change countermeasures, by moving to strengthen regulations, the UK government is currently attempting to respond simultaneously to issues of supply stability, price adjustment, and the need for global warming countermeasures.

2. Case of Germany

2.1. Trend of Energy Mix in Germany

Germany yields large amounts of lignite and coal and the country's industry historically developed based on its coal resources. Since the 1973 oil crisis, the government has protected the domestic coal industry. In 1996, the obligation to take in domestic coal was abolished but protective measures still continued in the form of subsidies.

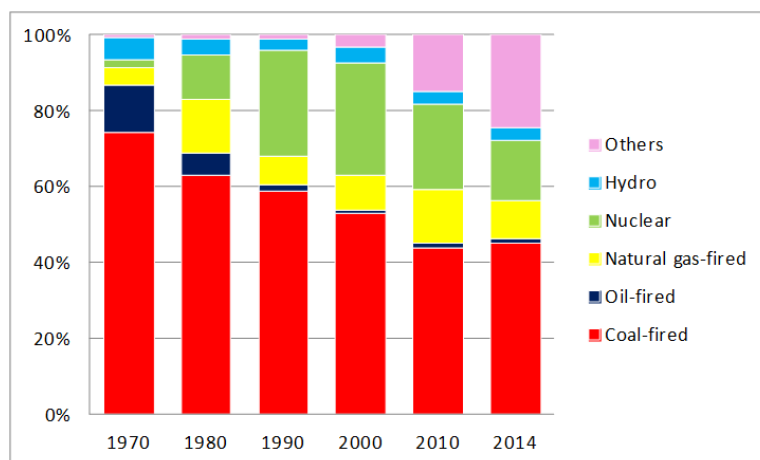
Another form of energy that garnered attention following the oil crisis was nuclear power. With the commissioning of Germany's first nuclear power plant in 1975, the government adopted a policy of promoting nuclear energy and moved forward with the development of

17 nuclear power plants. As a result, the proportion of electricity generated by nuclear power plants increased from 5 percent in the 1970 to approximately 27 percent in 1985, giving it the second largest share after coal. On the other hand, anti-nuclear activities grew more pronounced following the Chernobyl disaster in 1986, and the coalition administration formed in 1998 by the Social Democratic Party (SPD) and the Green Party amended nuclear power legislation in 2002 to decommission nuclear power plants in sequential order after they reach their 32nd year in operation.

On the other hand, the Merkel administration, which took office in 2009, carried out a partial review of nuclear power legislation and extended the allowed operational lifetime of nuclear power plants by 12 years. Following the Fukushima disaster, however, there was a shift in direction towards breaking with nuclear power and a decision was made to incrementally decommission all nuclear power plants by 2022.

The government has pushed forward with development of renewable energy and co-generation as a replacement for nuclear energy, and a Feed-in-Tariff (FIT) system was introduced based on the 1991 Electricity Feed-In Act and the 2000 Renewable Energy Act (EEG) that obligated electricity companies to purchase electricity generated using these power sources at high prices. As a result, renewable energy development made progress centred on solar and offshore wind power, and there is a plan to increase the share of electricity generated using renewable energy to at least 35 percent by 2020.

Figure 3-3: Trend of Energy Mix in Germany



Source: International Energy Agency, Energy Balance of OECD Countries 2015.

2.2. Electricity Market Reform and Energy Policy in Germany

Germany's new Energy Industry Act came into effect in 1998, leading to comprehensive liberalisation, and more than 100 new businesses (primarily retail) were formed. Existing electricity companies resisted this by conversely charging high consignment fees, while also decreasing capital investment and reducing costs in order to lower retail prices. As a result, new companies successively went out of business and the oligopoly of the major electricity companies became increasingly pronounced. The major companies have also merged and generation, transmission, and distribution is now largely concentrated under four major companies (E.ON, RWE, EnBW, and Vattenfall), which have about a 70 percent share of the retail market.

In order to remedy the high consignment fees, the government introduced an electricity transmission/distribution fee approval system in 2005 and reforms were implemented in 2009 to legally separate electricity transmission companies, among others. However, from the perspective of encouraging the participation of new companies and restraining prices, there have been no significant results.

In addition, subsidisation policies aimed at increasing the amount of electricity generated from renewable energy, such as the FIT system, have led to the need for additional subsidies. Specifically, renewable energy flowing into the market without regard to demand conditions has led to a slumping of wholesale electricity prices, while existing thermal electricity generation plants are suffering from low utilisation rates and margins. Thus, there are increasing moves to decommission existing thermal electricity generation plants. At first glance, this may appear to be a good example of success in expanding the use of renewable energy. However, thermal power plants are in fact essential as backup for the more unstable supply of electricity generated from renewable energy and the decommissioning of existing thermal power plants is in fact an unfortunate development. The German government is therefore facing the need to provide subsidies to enable electricity generators to maintain their thermal power plants even when market prices and the utilisation rates of thermal power facilities are low.

In this way, Germany's example shows that when subsidies are provided to a certain electricity source, market distortions are created that lead to a situation in which additional subsidies have to be created to other electricity sources in order to keep the system viable. The German government has moved forward with electricity market reform including the separation of businesses into generation, transmission, and distribution. However, given the subsequent move to break away from nuclear power and the concomitant increase in the amount of electricity generated from renewable sources, there is currently a shift towards strengthening regulation. This is an attempt to respond simultaneously to issues such as supply stability, price adjustment, and the need for global warming countermeasures.

3. Interview Survey of European Experience

This research involved visiting government organisations, electricity companies, investment banks, etc. in European countries that have already achieved electricity liberalisation to conduct interviews with a focus on the following questions:

1. What are the conditions required prior to carrying out electricity liberalisation?
 - a. Sufficient electricity supply capacity
 - b. An electricity transmission network
 - c. Market participants
2. Taking into consideration the maturity of a market, what kind of market structure do you recommend?
3. From the perspective of infrastructure development and energy policy implementation, what led to problems post-liberalisation?
4. What kinds of policy implementation tools can be used to achieve the desired share of certain electricity sources in line with liberalised markets?

3.1. Summary of Interview Survey in the UK

- From the perspective of facilitating liberalisation, unbundling is thought to be effective, but a monopolised market makes it easier for long-term investment to be carried out.
- In order to achieve the aims of energy policies in a liberalised market, the government needs to evaluate submitted applications for new electricity sources in accordance with energy policies. However, changes of government can result in changes to energy policies, and this can be a factor that hinders long-term investment.
- As a result of subsidising CO₂ emission reduction technologies to eliminate investment recovery risk, the gap between FIT-CfD and market prices grew larger.
- Although the use of solar and wind power as low-carbon electricity generation methods is increasing, the output of these electricity sources varies considerably and this is difficult to control. Therefore, countermeasures such as the Capacity Market system have been implemented.

3.2. Summary of Interview Survey in Germany

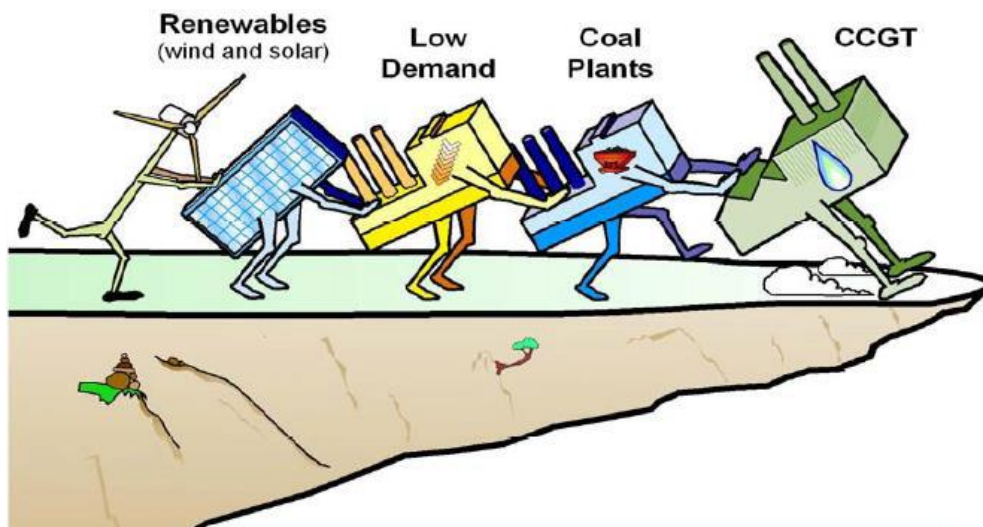
- The introduction of regulations such as FIT has resulted in electricity market distortions such as difficulty in maintaining the kinds of electricity sources that are necessary for maintaining energy security.
- While the government has set a target of achieving an 80 percent renewable energy share by 2050, achieving this target will require intervening with how people utilise electricity by, for example, drastically raising peak time electricity prices.
- There are concerns that moves such as these will interfere with electricity liberalisation and cause a return to increased regulation.

3.3. Summary of Interview Survey in Switzerland

- Merit order means that high-cost generation methods such as CCGT are under threat.
- As a result, the use of CCGT has been decreasing in recent years.

- That is, subsidising one energy source results in the paradoxical situation of causing other energy sources to erode to crisis levels, thereby constituting a threat to energy security.

Figure 3-4: Merit Order Pushed High-Cost Electricity Sources to the Brink of Crisis



Source: Mirco Borgdorf, Alpiq, October 2015.

3.4. Summary of Interview Survey in France

- Renewable energy has to be a source of economic growth for one country. The ideal approach therefore is to utilise renewable energy that is plentiful in the country and incrementally reduce subsidisation of that renewable energy once its use is well-established.
- In addition, replacing the capacity lost through the decommissioning of nuclear power plants with renewable energy will not result in an increase in the share of low-carbon energy, as nuclear itself is already low-carbon energy. If the total combined share of nuclear power and renewable energy is not increased, CO₂ emissions will not be reduced.
- Although electricity demand in advanced nations tends to be flat or decreasing, electricity demand in emerging markets including those in Asia is predicted to increase. With such an increase, usage of coal is also expected to increase. Since coal will continue to be a necessary energy source for many countries in Asia, it is recommended that instead of

reducing the number of coal-fired power plants, inefficient coal-fired power plants be replaced with efficient ones.

- On the other hand, energy saving measures ought to be implemented prior to replacing coal-fired power plants; if energy conservation can be achieved, most issues can be solved because reduction of electricity demand will result in a decrease of usage of coal power generation.

3.5. Summary of Interview Survey in Sweden

- Since energy prices can fluctuate at any time, it is necessary when pursuing liberalisation to create a system that enables long-term predictions to be made in 10-year units. Debates regarding energy policies ought to be based on this rather than a short- to medium-term perspective.
- When carrying out electricity liberalisation in countries that, unlike advanced nations, will experience a growing electricity demand, investment in CCGT plants, from which costs can be recovered quickly, will increase rapidly. Under such conditions, governments will stop supporting other electricity sources such as nuclear power and this may hinder the successful creation of energy mixes.
- The beginning of electricity liberalisation did not cause the government to change its energy policies. Changes in energy policies were the result of changes of government.
- Prior to liberalisation, countries in northern Europe only gave consideration to their own domestic energy mix, but this changed after liberalisation and they began to consider the energy mix of northern Europe as a whole. Sweden and Norway were the first to reach a cooperative agreement in 1994.
- The fact that nuclear power plants remained in Sweden even after the electricity liberalisation in northern Europe in the 1990s is largely down to economic reasons. Since the price of electricity in Sweden is high compared with other European Union countries and with global levels, electricity generation using low-cost nuclear power enjoys support from the general populace. Although increased anti-nuclear sentiment following the Three Mile Island and Chernobyl accidents led to a decision to phase out nuclear power,

this decision was later rescinded in response to issues such as climate change with the understanding of the populace. In the 2000s, the (EU-ETS) system which differentiated power generation plants by amounts of CO₂ emission provided additional impetus.

- Following a Court of Justice of the European Union decision that Sweden's charging of low tax rates on nuclear power was in contravention of European Union law, the Swedish government decided to charge nuclear power operators a capacity tax. As a result, the tax rate has been gradually increasing in recent years.
- In Sweden, compared with nuclear power, hydro power and electricity transactions with neighbouring countries such as Norway are relatively economically advantageous. Importation of electricity is increasing in Sweden.

3.6. Implications

The following implications were derived from the interviews relating to the experiences and issues of European countries that have already carried out electricity liberalisation:

1. What are the conditions required prior to carrying out electricity liberalisation?

It goes without saying that before liberalisation is carried out, the necessary infrastructure such as an electricity distribution network to enable free transactions needs to be in place. If such infrastructure is inadequate, even if the system were liberalised, it would not be possible for competition to arise.

If there is a state-run company monopolising the market or a vertically integrated system of several companies operating regional monopolies, it is difficult for new IPPs to enter the market and for liberalisation to progress. Therefore, state-run companies need to be privatised and vertically integrated companies need to be separated before moving to liberalisation to create an environment that makes it easier for new IPPs to participate.

Furthermore, it is necessary to recognise that there are considerable hurdles for those who wish to participate in the electricity industry. For example, engaging in electricity generation requires land, personnel, know-how, and capital, so the kind of company that is able to participate is naturally limited.

In addition, the UK and Germany cases show that, in theory, the result of appropriate competition is that markets head towards oligopolies. Once an oligopoly is established, it is not easy to revitalise competition in a market.

2. Taking into consideration the maturity of a market, what kind of market structure do you recommend?

Monopolised markets are stable and easy to manage over the long term. Since the investment environment is stable, it becomes easy to attract investment. Therefore, for countries that are yet to construct infrastructure, maintaining the market monopolies of state-run companies makes it possible for governments to proceed with development that is in line with their energy policies.

Although the experiences of European countries are often referred to when proceeding with liberalisation, it is important not to forget that many European countries transitioned to liberalisation only after state-run monopoly companies had created adequate electricity generation plants and transmission/distribution networks. In other words, electricity infrastructure has up to now been created in monopolised markets and there are no examples of major infrastructure being created in free competition environments.

On the other hand, it is possible to facilitate free competition by splitting up vertically integrated companies in stages as electricity infrastructure and market participants mature.

3. From the perspective of infrastructure development and energy policy implementation, what led to problems post-liberalisation?

Once markets were liberalised and competition began, investment in profitable electricity sources increased and the country's electricity portfolio became imbalanced. In the case of Europe, low-cost coal-fired power generation increased and the more environment-friendly gas-fired power generation decreased considerably. In the case of Germany, even cutting-edge gas-fired power plants with a generation efficiency of 60 percent were unprofitable and are scheduled to be decommissioned before they reach the end of their

lifetime. These changes are based on market principles and are desirable from the point of view of competition policies, but clearly not from the point of view of climate.

In addition, even if the government provides incentives for the construction of new electricity generation plants to correct the overall electricity source mix, it is difficult to develop a long-term outlook, and the resulting difficulty in finding willing investors is an issue. Electricity generation plants have an operational lifetime of approximately 30 years, and with liberalised markets it is extremely difficult to predict market conditions 30 years in advance.

4. What kinds of policy implementation tools can be used to achieve the desired share of certain electricity sources in line with liberalised markets?

The methods that governments can use to control disproportionate participation and investment of private sector companies in liberalised markets are limited. The selection of the types of new electricity plants to be constructed is left up to private sector companies. The methods governments can use are inevitably indirect, for example electricity generation efficiency regulations and CO₂ emission regulations.

European countries are using FIT to increase the utilisation of renewable energy, but, as explained above, this method creates market distortions. European countries are also attempting to use the Capacity Market system to maintain thermal power stations as backup for renewable energy-based electricity generation, but it will take more time before the success or failure of this endeavour can be determined. In any event, the cases in European countries indicate that in order to be able to carry out electricity source development in accordance with policies, there is perhaps no option but to use a somewhat regulatory approach.