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# Unbundling Models and Operators in Electricity Governance: Recent Lessons from Other Countries

**Hanee Ryu**[1]

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**Abstract** The electricity industry is undergoing big challenges at present. There is a need to understand the implications of traditional transmission unbundling issues on electricity governance at the time of renewable energy penetration. As the interdependence between the regional power systems is increasing and the power market has more liquidity, interest in electricity governance that can enhance the coordination of power systems is growing. Four types of electricity governance according to unbundling model or the relationship between the market operator and the system operator can provide implications for Korea when considering a new form of electricity governance.

**Keywords** electricity governance · system operator · transmission owner · market operator · transmission unbundling · coordination

## Introduction

Climate change has been a major challenge to the power industry. As the proposition of greenhouse gas reduction suggests a realistic goal that could be achieved, traditional fossil fuel –fired power generators in the electricity sector, which is a representative greenhouse gas emission sector, have been shut down and dismantled under the guiding principle of global

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✉ Hanee Ryu
hanee.ryu@gmail.com

[1] Research Fellow, The Center for Energy Governance & Security, Hanyang University, Seoul

energy transition. As the proportion of traditional utilities, which were mainly responsible for the base load and the mid load, decreased and renewable sources increased, the power supply system changed as the characteristics of generation technology changed. In particular, policy-driven changes are present in the generation mix and in the market environment.

Generally, issues related to the restructuring of the power industry have been centered on the recovery of efficiency according to market competition. However, the British textbook model developed in the 1990s, which aims to liberalize the electricity market, has emerged in various industrial structures in the 2000s, taking into consideration the conditions of each country based on trial and error of market reform. In particular, without aiming at competition, the policy objective of a national economic viewpoint, such as achievement of resource adequacy and securing of industrial competitiveness, has been emphasized, along with pursuing competition and integration at the same time in accordance with needs and conditions or combining various market trading methods. In this situation, the national goal of climate change response has emerged as a new axis in addition to restructuring of the electric power industry.

Since the speed and direction of liberalization are different in each country, there are differences in the degree of power market liberalization and the way of operating the power supply system. In addition, since the level of social acceptance differs in promoting generation mix changes in each country, governments seek the best reform plan reflecting this context. In other words, each country is moving toward pursuing liberalization through long-term structural restructuring of the power sector, while recognizing the diversity of the industrial structure and adjusting its direction accordingly. The effects of climate change response policy can thus differ between countries and contexts. Therefore, it is necessary to evaluate electricity governance in terms of responding to climate change emerging as a new axis. This is because supply reliability as an issue around the traditional discussion of the power industry structure—productivity, efficiency, competitiveness, and investment incentive—needs to be addressed at the center of the discussion in the context of climate change response. The expansion of renewable energy sources, the expansion of decentralized power sources, and changes in the power trading system will inevitably lead to the expansion of stakeholders and the strengthening of the capacity for coordination, and therefore the issue of electricity governance will become more prominent in the future.

In this paper, the relationship between the operators that can consider the coordination problem in electricity governance will be focused on. Electricity governance can be conceptualized and categorized according to whether the market operator and the system operator are the same. Through the modeling of electricity governance, we will discuss the characteristics, issues, and implications for Korean electricity governance in the era of energy transition.

## The operators in the unbundling model

### Transmission unbundling and system operator

Prior to 1990, the European electricity industry was generally operated in the form of state-owned or public utility companies with regulated prices. The power systems of each country

progressed to be connected extensively through the grid to secure the power supply through mutual trade in peak load periods and to seek economic benefits. However, the linkage of power systems between countries has been determined by power system reliability rather than from an economic point of view, and the problem of efficiency deterioration due to the excessive investment in power generation facilities and the competitive market structure of the particular country has continued to occur. In the mid-1990s, the European Commission (EC) promoted European energy market liberalization with the aim of diversifying energy sources and enhancing energy market efficiency through a single energy market in the region for customers to select the supplier that offered a reasonable price. The EC adopted the first energy package in 1996 (Directive 96/92), the revised 2003 Second Energy Package (Directive 2003/52), and the 2009 Third Energy Package (Directive 2009/72) to promote electricity market liberalization. A variety of unbundling models in a series of energy packages have become the basis for classification, and other countries have also taken the model as a benchmark.

Previous studies have focused on the effects of restructuring as evaluating the efficiency of restructuring, production cost, and financial performance (Craig & Savage, 2013; See & Coelli, 2012), consumer welfare improvement including the price effect for the end-user (Swadley & Yucel, 2011; Fiorio & Florio, 2013), and facilities investment incentives and technological innovation (Chaton & Guillerminet, 2013). Empirical studies emphasizing supply stability (Nardi, 2012; Gugler et al., 2013) have been presented. More recently, the discursive approaches to electricity governance aspects (Meletiou et al., 2018) have been noteworthy.

## Under the first and second energy packages

### *Accounting unbundling*

Toward the policy goal of market liberalization and integration, the first energy package directive in 1996 involved accounting separation. Accounting unbundling, which is the least stringent form of electricity generation unbundling, requires utilities to keep separate internal accounts for each of their transmission and distribution activities, to prevent cross-subsidization. Under accounting unbundling (AU), vertically integrated (VI) ownership can be accepted. Both network and generation business can be owned and managed by the same entity.

### *Legal unbundling*

Legal unbundling (LU) requires transmission systems to be operated by separate legal entities when VI exists. In principle, legal unbundling means that the essential inputs must be controlled by a legally independent entity, but a firm doing business in the downstream market is still allowed to own this entity (Meletiou et al., 2018). Ownership under legal unbundling entitles the downstream firm to receive the entity's profits, but interference in the entity's operations is forbidden (Höfflerffler & Kranz, 2011).

## Three unbundling options

### *Independent transmission operator (ITO)*

The ITO model was proposed in 2008 by eight EU member states, including Germany and France. Germany, which is mainly opposed to the second directive, has transformed its unbundling option to the ITO model. Croatia and Switzerland also apply an ITO model. In compliance with the rules of the third directive, an ITO model may be adopted when the transmission system belongs to a VI. Under the ITO model, the ownership structures emerge from the issue with the transmission system operator (TSO) intact (Meletiou et al. , 2018).

An ITO has to be organized as a legal entity with independent corporate identity, neutral name, and separate premises. The ITO is prohibited from using the vertically integrated company's internal services without discrimination and guaranteeing independent investment decisions. It is under a neutral supervisory body, with regulatory authorities responsible for control and monitoring.

Germany has traditionally had a strong monopoly on the horizon of vertically integrated firms, which has long been a sticking point in political circles. From the standpoint of the federal government of Germany, the major utilities in the country want to gain a competitive advantage in the EU's internal energy market (IEM). There are some aspects that have intensified the market concentration. In fact, E.On and RWE, which were created through the merger of existing large utilities between 2000 and 2001, became the second- and third-largest utilities in the European market. It will explain their strategy well.

### *Independent System Operator*

nder the ISO model, both the TO and SO are ownership unbundled from the rest of the system, with the SO being asset-light and the TO having no system operation function (Pollitt, 2008). However, the ISO model also allows for the remainder of the transmission assets to be within the VI when, for instance, it is difficult to proceed with separating ownership of generation and transmission assets (Nardi, 2012).

Recently, the ISO model has only been applied in the UK, Ireland, and Latvia , avoiding ISO under the third package. In the UK, the National Grid acts as a TSO for the English and Welsh ownership-unbundled network, while the ISO of the Scottish network is still owned by two VIs (Moselle, 2008).

The ISO model is common in North America. PJM, as an independent system operator, covers 14 eastern states of the U.S. The structure of the power industry in the PJM region differs according to the degree of restructuring. In the states that show less stringent restructuring, the former system of monopoly is mainstream. In the states where the restructuring has been more fully introduced, the basic structure is similar, but there are differences according to the restructuring stipulations of the state concerned. In other words, transmission and distribution are monopolistic, but generation and the retail market operate in full competitiveness.

Under reform, it is common that a former utility switch its function from transmission company to seller of generation facilities or that it relocate to a subsidiary company. The

transmission owner transfers control of the high-voltage transmission line to an ISO, but earns revenue from the transmission network connection fee. Transmission owners should work with ISOs to ensure reliability of the power system. They can also participate in the electricity market as load suppliers (LSE) or power generation suppliers. However it is necessary to separate the operation of the grid and the business activities of the generation, and data sharing is restricted.

There is a hybrid model where both the ISO and the TO are ownership unbundled from the rest of the system. The ISO is asset-light, while the TO has no system operation function. Pollitt (2008) identified this as ISO/ITO, which is the case in electricity provision in Chile and Argentina.

### *Ownership Unbundling*

Under ownership unbundling (OU), commercial (generation and supply) and transmission activities must be controlled or owned by independent entities, with these entities not allowed to hold controlling interests in both activities. More specifically, a single entity is not entitled to exercise control over an undertaking performing any of the functions of production or supply, nor to exercise control or any right over a TSO or transmission system.

Following Meletiou et al. (2018), the ultimate shareholders are identified as those who control an absolute majority (i.e., more than 50%) of the voting rights (VRs) or hold enough VRs to control the entity (Faccio & Lang, 2002).

Table 1 shows unbundling models and ownership structures based on the second and third directives.

**Table 1** Unbundling model and ownership structure

| Ownership structure | ITO(LTSO) | ISO | OU(ITSO) | ISO/ITO |
|---|---|---|---|---|
| FS | MAVIR<br>ZRt.(Hungary)<br>HOPS d.o.o. (Croatia) | ESB Networks(Ireland)<br>LET AS(Latvia)<br>IESO(Canada Ontario)<br>OCCTO(Japan) | Statnett SF(Norway)<br>SvK(Sweden)<br>Energinet.dk(Denmark) | Transelec, (Independent TO, Chile)<br>Transener(Independe nt TO , Argentina), |
| MS | RTE(France)<br>APG(Austria)<br>Swissgrid(Swizerland) | | Terna(Italy)<br>REE(Spain) | |
| MP | Transnet BW, Amprion(Germany) | | TenneT TSO, 50 Hertz(Germany)<br>Fingrid Oyj(Finland) | |
| FP | | NGET in Scottish Network(UK)<br>SHETL,SPTL,NIE Networks(UK)<br>PJM(US Eastern 14 states)<br>NYISO(US Newyork state) | NGET in English and Welsh Networks(UK) | |

Note : The acronyms FS, MS, MP, FP stand for Fully State owned, Mostly State owned, Mostly Private owned and Fully Private owned, respectively.
Source : Meletiou et al.(2018), Pollitt(2007), Sioshansi and Pfaffenberger (2006), Pollitt (2004) and author reorganizing

## Market operator

### *Understanding the power market*

The electricity market is diversified, and the wholesale market is organized in a different way from the retail market. The power wholesale market can be roughly classified according to the place and the trading time. Participants in the wholesale market consist of generators, power suppliers (suppliers buy electricity from generators to sell it to consumers in the retail market), and large industrial consumers. Depending on the type of contract in the market, transactions occur at different times.

***Forward contracts*** are bilateral contracts between buyers and sellers to make or take the physical delivery of electricity at some time in the future at a specified price. The price might be fixed or floating, and the contracts are usually traded over-the-counter (OTC). The liquidity of the market depends on the willingness of the buyers and the sellers to enter into a forward contract. The risk that can happen is credit risk. Some of these contracts are registered through the medium of futures exchanges (ECA, 2015).

***A futures contract*** is a legally binding agreement on a recognized exchange to make or take a specified commodity or instrument at a fixed date in the future at a price agreed upon at the time of dealing. Futures transactions are made anonymously and provide price transparency to buyer and seller. The limited availability of contracts introduces basis risk. Exchange margins secure profit and loss but introduce cash flow issues.

Although a general preference has been expressed by traders for the flexibility of products that can be offered through brokering, in practice, most brokered products are standardized and will usually be substantially (or completely) based on standard agreed terms. Therefore, the main differences between exchange-traded futures and brokered forwards are the credit terms and price matching processes (ECA, 2015).

Because of limited storability, the physical trade of electricity only takes place in real time, and is thus the only true “spot market.” Other markets are all “forward markets” that trade derivatives products maturing in real time on the spot market (EC, 2013 ; Avila, 2014).

After ***the day-ahead market*** (and in some cases the intraday markets), and considering bilateral trading, SOs use congestion management mechanisms to solve foreseen congestions. Congestion management is usually based on the redispatching of generating units, so that the results from day-ahead and intraday markets are made technically feasible in the physical system.

The ***intraday markets***, which take place after the day-ahead market, offer the possibility to update the energy schedules. In Europe, energy markets such as the day-ahead and intraday markets are managed by the market operators, which do not consider network or security constraints. SOs carry out these latter tasks.

### *Market liquidity*

There is a historical background that the futures market in the UK has not developed. The key players in the UK market are brokers, and they are engaged in cash trading. The electric power

companies do not make direct deals but rather trade through brokers, and brokers do not want to make financial transactions at exchanges. Developing financial markets will eliminate brokers, but since the spot market is rising, financial markets naturally develop. If the concentration level of the market rose the previous day and the reference price becomes dominant, someone will start making financial transactions.

Market segmentation differs from country to country, and transaction level, product type, and development level are all different. Generally, market developments are caused by bilateral transactions in the day-ahead and intraday markets. In order to offset the volatility of the spot market, forward transactions increase. Japan is the country where the spot transaction is mainly developed, and the UK is the country where the increase in the forward trade is shown. As the liquidity in the forward trading increases and the accuracy of the forecast for the forward trading curve increases, futures trading increases, mainly in the French and German power markets. In these countries, in-kind transactions are mostly OTC, and futures transactions are made by financial transactions. The most developed forms of market exist in the United States and the Nordic countries, where various derivative products appear in the financial markets, and it becomes more prominent in futures markets.

## Coordination problems

Transmission unbundling is a matter of governance between system operator and transmission owner. This leads to traditional separation and independence issues, which have been key concepts in the restructuring of electricity governance in Europe, as we have already seen. The unbundling model can be distinguished by whether the transmission sector is separated from the vertically integrated firm and whether the system operator is consistent with the transmission assets owner.

There is considerable controversy about who has responsibility for supply reliability. Concerned voices have been raised about electricity industry restructuring (i.e., liberalization) designed to improve supply efficiency, but which may deteriorate electricity supply reliability (Botterud & Doorman, 2008; Joskow, 2006). That is, trade-offs between the efficiency and the reliability of supply characterize the electricity industry. An empirical analysis of the relationship between restructuring and the provision of a steady supply of electricity is needed to address industry trade-offs.

A fully functional ITO (TSO) incorporates and integrates system operation and asset management. A separation of system operation and asset management bears the risk that the consistent and unique responsibility for the grid is disrupted. But responsibility for the grid is indivisible. If a disturbance occurs, the system operator will accuse the asset owner of not delivering a grid that is fit for purpose. The asset owner will accuse the system operator of not operating the grid correctly. There can be no security of supply without security of investment. Investment planning and decision-making are the genuine tasks of the asset owner.

One of the success factors of Nord Pool is the fact that it is owned by a TSO. Split market governance stimulates competition and decreases the market liquidity. Nord Pool does not face that kind of interference. Because the TSO holds the market, it makes the market function. Coordination between the two is pointed out as being more important in the spot market.

## Conceptualizing electricity governance framework

Table 2 summarizes the utilities of major countries according to the unbundling model and the relations between market operators. Based on this framework, four types of electricity governance are structured.

**Type (a)** shows a legally unbundled TSO system operator from a vertically integrated firm in the form that appears in major Western European countries, such as France and Germany. In France and Germany, the major market operators appear in the futures market because most deals are formed OTC. The European Energy Exchange (EEX), the leading exchange in this region, is owned by Eurex, based in Germany, and the number of participants and the traded volume are increasing. In other words, the governance of SO and MO will be discussed along with market liquidity where the share of EEX increases.

**Type (b)** is a form in which PJM is a representative MO and SO. In the North American power market, forward markets and futures markets are well developed with various derivatives. If MO and SO are matched, it can be regarded as an advantageous condition for spot market development and increasing market liquidity, which can increase the degree of integration of

**Table 2** Categorizing operators and utilities

| Country | | | MO | SO | TO | Unbunding Model |
|---|---|---|---|---|---|---|
| EU | France | | Powernext<br>EPEX SPOT | RTE | | ITO(LTSO) |
| | Germany | | EEX<br>EPEX SPOT<br>EXAA | Tennet<br>50 Hertz<br>Amprion<br>Transnet BW | | |
| | Nordic | Norway | Nord-pool | Statnett SF | | OU(ITSO) |
| | | Sweden | | SvK | | |
| | | Denmark | | Energinet dk | | |
| | Italy | | GME | Terna | | |
| | Spain | | OMIE | REE | | |
| | UK | E&W | N2EX<br>APX<br>ICE<br>EEX | NGET | | |
| | | Sco | | NGET | SHETL<br>SPTL | ISO |
| NA | US | Eastern14 states* | PJM | | various | |
| | | NY | NYISO | | various | |
| | | CA | CAISO | | various | |
| | Canada | Ontario | IESO | | various | |
| Austrailia | | 6states** (NEM) | AEMO | | various | |
| Japan | | | JEPX | OCCTO | Regional M | |
| Korea | | | KPX | | KEPCO(M) | |

*Serving all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia
**Queensland(QLD), South Australia(SA), AustralianCapital Territory(ACT), Victoria(VIC), Tasmania(TAS), New South Wales(NSW)

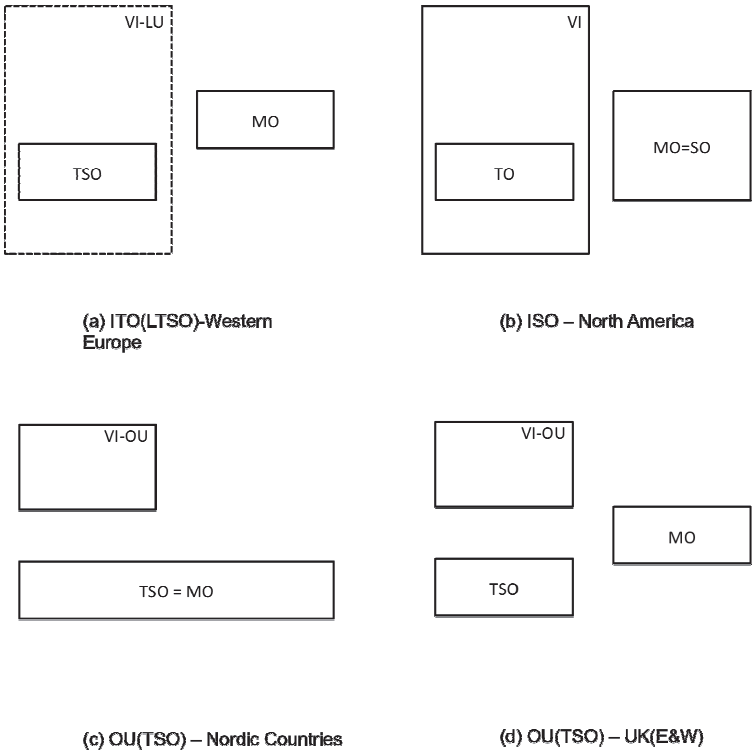



**Fig. 1** Categorizing electricity governance by relations between TO, SO, MO

market operators' coverage. Today, all the ISOs in the United States have adopted a "central bidding pool," where it is necessary to negotiate a fixed schedule regardless of the market price. The ISO also supports financial settlements for bilateral transactions. Recently, a distributed resource aggregator to control and optimize large-scale distributed resources consisting of active distribution companies (DSOs), including interface issues with the wholesale electricity market and sub-distribution resources, has emerged as a market improvement initiative.

**Type (c)** is a Nordic model rated as a successful integrated power market. The ownership structure of the Nord Pool is 28.2% for Statnett in Norway, 18.8% for Fingrid in Finland, 28.2% for Kraftnet of Sweden, and 18.8% for Energinet in Denmark. In particular, Norway, Sweden, and Denmark have very similar forms of electricity governance, and it is estimated that fully state-owned TSOs have created successful trading pools by functioning as MOs.

**Type (d)** is the governance model of NGET, a TSO of the English and Welsh networks. Similar to other countries in Western Europe, the UK also has a high proportion of OTC transactions. Unlike the ownership structure of the Nord Pool, the UK exchange is composed of N2EX (Nord Pool, Nasdaq OMX), APX (EEX, HGRT), ICE (multiple financial institutions), and EEX (Eurex). As the ownership is a foreign exchange, TSO, or financial institution, NGET, which is a UK TSO, requires individual coordination with these exchanges. The transaction volume of the exchange is dispersed, making it difficult to increase liquidity.

## Discussion of electricity governance in Korea

Liberalization of the power industry, which started in the UK under liberalism around 1990, in South Korea began with the 1994 management performance evaluation of Korea Electric Power Corporation (KEPCO), which had been operating in the form of a monopoly public corporation since 1982. The basic plan for restructuring the power industry in 1999 was to focus on introducing a competitive system. In the short term, with division of the generation sector, the introduction of competition, and the step-by-step privatization of divided companies, it was heading towards the opening of the wholesale and retail markets. This was the first goal of increasing efficiency through a competitive structure for the power supply. These changes were implemented in 2001, and the power sector was divided into six companies. The KPX was a system operator as well as a market operator, and privatization plans for power generation companies were confirmed in 2002. However, it ended with the suspension of privatization. Since then, there has been no actual result from the restructuring of the electric power industry, but major issues have been discussed along with changes in the power industry environment and incidents of electricity supply and demand.

In 2009, KEPCO's integration of power generation subsidiaries with its proprietary transmission/distribution company emerged on the surface due to the need to vertically reintegrate the power industry so as to strengthen its global competitiveness. This was done through securing cost competitiveness through the integrated purchase of fuel and securing scale competitiveness to advance overseas. In 2011, the issue of integration of SO and TO highlighted that KEPCO should take charge of system operators due to a severe blackout. Concerns have arisen that the need to improve supply stability through integration and the neutrality of system operations may be detrimental. Several key reports on the rationale behind the restructuring suggest competition in the development sector, open market competition, and the governance debate between ISO and TSO as reasons .

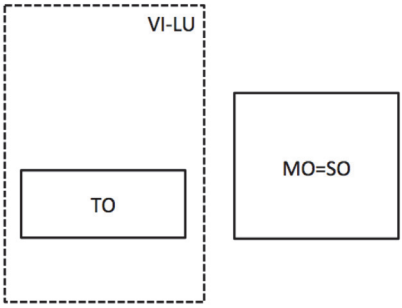
Under the global energy paradigm shift and the domestic energy transition, debate about new electricity governance is also beginning to take place in Korea. In Korea, structural reforms focusing on efficiency and growth have been underway, but a response to climate change has not emerged as an important axis in the ongoing restructuring discussions. It has been pointed out that there should already have been discussions on the changes in the future electricity market and the reorganization of the energy market, including the activation of micro grids, smart grids, and the increase of renewable energy supply, but market structure have not substantially escaped from traditional efficiency issues.

At this point, discussions on power governance are taking place in the context of environmental change, in which the axis of climate change response as well as the issue of traditional restructuring are highlighted at the same time. In addition to the restructuring that has been underway since the 1990s, utilities have been challenged to dramatically reduce greenhouse gas emissions in the generation sector by adjusting the generation mix. In other words, Korea should pursue measures to cope with utility 2.0, which is the expansion of renewable energy and innovation of the electric power industry, while the task of the utility 1.0 era, which is the formation of a competitive market, is still going on.

A vertical integration firm, KEPCO, which started as a monopoly state-owned enterprise and has undergone changes, has found it necessary to grasp the power governance benchmark

where liberalization has progressed rapidly and renewable energy has been widely spreading. In particular, it is important to discuss the governance that can strengthen the capacity for coordination to cope with the changing electricity trading in terms of climate change response.

There are differences between the development path of the electric power market in each region and country and the progress intensity of the restructuring, and there is a great difference in the acceptability of the context of energy transition to cope with climate change.




(e) ISO-Korea current

**Fig. 2** Electricity governance in Korea according to the categorized model

Nevertheless, European electricity governance has been the basis for estimating the effects of the expansion of the renewable energy sources In view of the European model, Korea's model is similar in form to the ISO model, intended to follow the UK model, and the TO and generation sectors are separated from each other. The restructuring has differed from that of Europe, which was vertically divided into power generation sectors. The key is to be able to attract investment in generation capacity and transmission investment in line with changing market systems. The separation of TO (KEPCO) and GENCOs (generation subsidiaries) from operations is evaluated as a form that does not enjoy the benefits of TSO in terms of supply reliability.

It is necessary to discuss the form of governance to secure the power supply in the expansion of renewable generation sources. During the blackout on September 15, 2011, discussions on the integration of KEPCO and SO were started, and this discussion will become more evident when the spot market is expanded and the regional network is established. Nord Pool, which is regarded as a successful exchange, needs to pay attention to the TSO-MO debate, as the benchmark target of the Northeast Asia power network is the starting point, and MO governance in Northeast Asia is the beginning stage of the discussion.

## Conclusion

At this time, it is difficult to consider policy objectives such as climate change response, or more specifically, expansion of renewable energy penetration, as the main driver for changing

the power industry and leading to changes in electricity governance. In the power industry, the issue of market incentive design, which guarantees the level and efficiency of the end-user's electricity price, is still the most important issue. Nevertheless, as the interdependence between regional systems is expected to increase and the electricity market becomes more liquid, the provision of electric power systems to secure the reliability of the power supply and demand is becoming more important. There is a growing interest in electricity governance that can enhance the coordination of power systems.

The traditional ISO model in Europe pursued in terms of securing independence can be discussed with the emergence of a new axis of climate change response, reigniting the discussion of the responsibility of systemic disability and the effectiveness of investment incentives. In addition, changes in power trading patterns and market systems, the emergence of a successful integrated market, and MO and SO operation are getting attention again.

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