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論文

Korean Electric Power Industry Trend and Future Perspective

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Abstract

Korean electric power industry is facing new challenges as a paradigm of traditional power industry has been recently shifting. Movements toward low carbon and clean energy society are one of the challenges and require long-term gradual restructuring of Korean electric power industry. In this paper, the national energy master plan published in 2008 containing such changes is introduced and a variety of measures to balance economic growth and clean environment are discussed. Korean electric power industry which takes an important role in the energy plan is also briefly presented. A recent rolling blackout in Korea revealed the weakness of current power system and solutions for the problem are analyzed. In the long term, smart grid is the ultimate destination that Korean electric power system is pursuing and the overall vision for Korean smart grid is presented.

Keywords: Korean Electric Power Industry, Rolling Blackout, Smart Grid

I. Introduction

Korea is one of major energy importers in the world, ranking fifth in oil, third in coal and eighth in gas. Oversea energy dependency of Korea reaches 97% and its annual energy consumption is consistently growing. The Korean government has continuously put an effort to decrease severely high oversea energy dependency, but the attempts have been made mainly by specific sectors and oil prices during 90s and early 2000s have not been high enough to arouse the importance of long-term strategies for national energy plan [1].

In the middle of 2000s, the world has seen a spike in oil prices, regulations for carbon emissions have been reinforced in many countries and resource nationalism has become prevalent across the world. Many advanced countries started putting energy policies on the top priority and recognizing energy as a commodity requiring long-term national strategies.

Electric power industry plays an important role in the energy policy [2] and many countries have announced their plans to reform power industries [3] such as Electricity Market Reform White Paper published in 2011 in Britain [4]. The Korean government also recognized the importance of strategies for energy and built an energy master plan to achieve efficient and sustainable energy environment [5]. The Korean government also proposed a long-term smart grid vision and expects its power system to be efficient, reliable and environment-friendly [6].

This paper consists of three sections. In the first section, the national energy master plan is introduced. A brief introduction of Korean electric power system and a recent rolling blackout are presented in the second section. In

the last section, an overall vision for Korean smart grid is given.

II. Korean Electric Power Industry

1. Energy Master Plan

The Korean government made the first long-term national energy master plan in 2008. In this plan, a movement toward low energy consumption and high energy efficiency is taken as one of the most important steps. Among many measures to implement the movement, realization of energy prices, enhancement of signal function in energy prices and diversification of customer tariff are worthy to notice for their effectiveness.

Secondly, the plan is aiming at optimal energy supply mix from both economic and environmental perspective. Considering price volatility and carbon emission of fossil fuel, a drastic reduction in energy from fossil fuel is required and a great increase in renewable energy is needed. The Korean government is targeting to increase the share of renewable energy from 2.4% to 11% by 2030 and decrease the share of fossil fuel from 83% to 61% while lifting the level of self exploitation of fossil fuel from 4.2% to 40%.

Thirdly, the plan proposes a new growth engine based on green technology and clean energy. It is called green growth in Korea and has a role of balancing between the economic growth and the clean environment. Renewable, nuclear, carbon capture and storage, high efficiency coal-fired power plant, LED lighting, building energy management, etc. are proposed as green technologies and will be intensively fostered as the future growth engine. The Korean government is expecting those technologies to meet and lead the global standards and improve the quality of life.

Among green technologies, renewable energy takes a big role. The Korean government has been supporting renewable power producers with feed in tariff (FIT) since 2002, but its supporting mechanism is changing to renewable portfolio standard (RPS) with an expectation of leading to technology development through competition. However, as generation companies are taking the burden of obligation, realization of electricity tariff should be preceded.

Table 1 Renewable Energy Resources by 2030

Renewable Resources	2010	2015	2020	2030
Solar Heat	0.5%	0.5%	2.0%	5.7%
Photovoltaic	1.8%	2.7%	3.2%	4.1%
Wind	2.9%	9.2%	11.6%	12.6%
Bio	13.0%	18.8%	24.0%	31.4%
Hydro Power	12.8%	9.1%	6.6%	4.4%
Geothermal	0.6%	2.4%	3.1%	3.8%
Ocean	0.9%	3.3%	5.2%	4.7%
Refuse	67.4%	53.8%	44.3%	33.4%
Total	100%	100%	100%	100%

Of renewable energy, wind energy is expected to develop at a great amount as shown in Table 1. The Korean government anticipates generating 7301MW of electricity from wind power generation plants by 2030. Most of new wind farms will be installed offshore and experiences in offshore engineering of Korean heavy industries are expected to help develop offshore wind farms.

2. Korean Electric Power System

Examining the change of final energy consumption by source over the decades in Korea, the importance of power industry is found to be constantly increasing. Economic growth and change of life pattern have continuously contributed to the change and a shift of heating energy source from fossil fuel to electricity due to high oil prices in 2000s has also made a contribution in past years. For the reasons, annual average demand growth rate is quite high comparing to countries with mature economies as shown in figure 1.

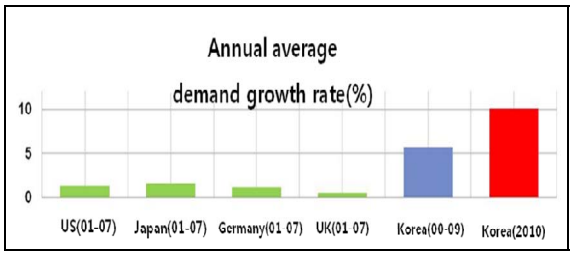

Figure 1 Annual average demand growth rate

While smart grid technologies are expected to provide high energy efficiency through better control and communication, overall demand appears to increase in the near future and appropriate government policies to induce investments in power plants are vital for efficient and secure power system. Figure 2 shows generation output in 2010 by source.

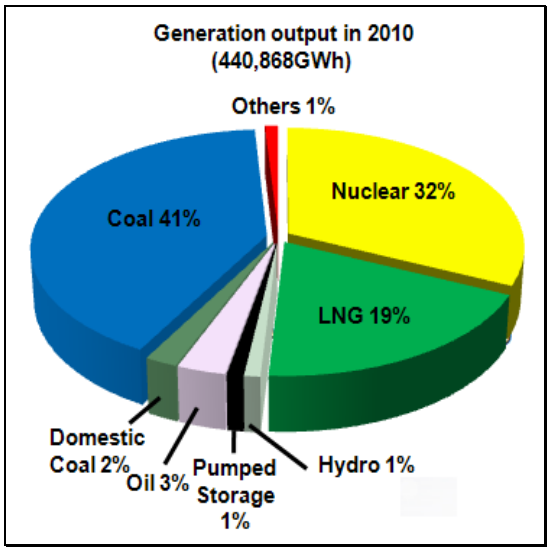

Figure 2 Generation Output in 2010

Coal and nuclear power plants provide base load power and accounted for 73% of total generation output in 2010. Annual load factor records above 70% in Korea, which is comparatively high, and relatively low electricity tariff of midnight power for industries largely contributed to it. To reduce carbon emissions, the Korean government has a plan to increase the share of nuclear power up to 59% by 2030 while decreasing the share of fossil fuel plants. The backbone of Korean electric power system consists of 154kV, 345kV and 765kV as shown in figure 3.

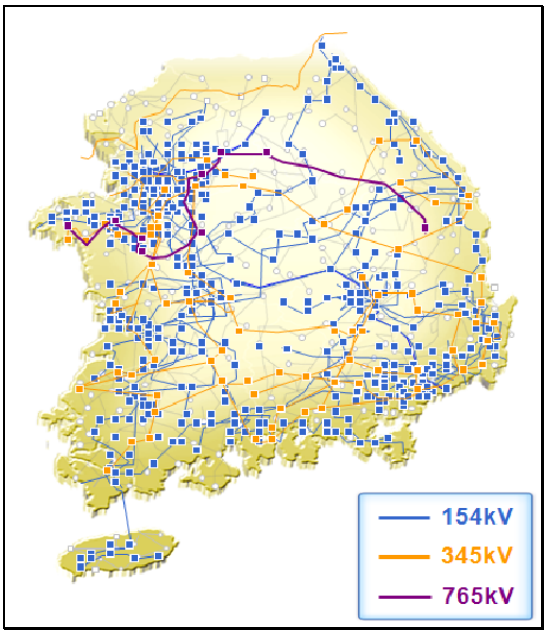

Figure 3 Korea Transmission System

A large portion of total demand takes place in the metropolitan area located in the northwest of the above map and power transfer occurs from south to north and from east to west. The rate of transmission and distribution loss is around 4% which belongs to one of the lowest level in the world. Power generation capacity recorded 77,361MW in 2010 while peak load reached 71,308 MW.

III. 9.15 Rolling Blackout in Korea

A rolling blackout refers to intentional halts of power supply for non-overlapping periods of time over geographical regions. A system operator normally uses a rolling blackout as a last measure to prevent the entire power system from a blackout by keeping localized regions out of service. Rolling blackouts have been implemented in Japan amid power shortage in the aftermath of Tohoku earthquake and tsunami and Texas in the US also recently experienced rolling blackouts due to a cold snap in 2011.

Unlike aforementioned cases, a rolling blackout can happen without notice. On 15th September in 2011 in Korea, total 4.0 million kW load was shed without pre-notification and about 7.5 million households were affected by the rolling blackout and geographical representation is shown in figure 4. Since Korean electric power system has kept low outage duration (15~20 minutes) for a long time, the rolling blackout gave a considerable impact to the nation.

At the moment of crisis, frequency dropped down to 59.25Hz and operational reserve recorded 0.24 million kW at its minimum while appropriate reserve level is considered to be 4 million kW in Korea. The peak load was forecasted to be 64.0 million kW on the day, but it actually recorded 67.2 million kW even after load shedding. Although the rolling blackout was caused mainly by a big forecasting error due to unexpected hot weather, the primary reason lies on the fast growing demand without a sufficient increase in supply. Adequate reserve margin is set to be minimum 15% in the 5th basic plan of

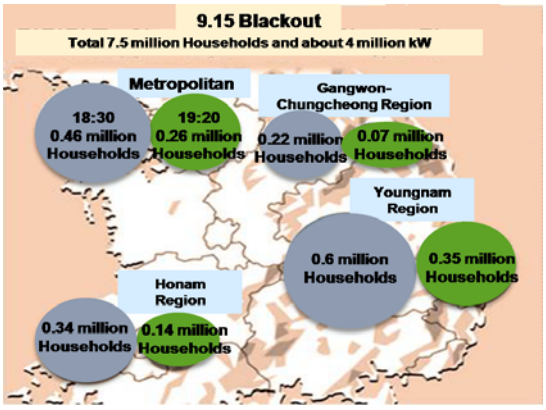

Figure 4 Impact of 9.15 Blackout

long-term electricity supply and demand in 2010, but the actual reserve margin was 6.6% in 2011 and is expected to be 7.3% in 2012.

For the short term, demand management is considered to be an inevitable measure and an improvement of short-term load forecasting technique, public communication and an increase in reserve level are considered as well. There are also voices that realization and diversification of electricity tariff is required. Electricity tariff has practically maintained its level since 2001 without a big hike while the prices of fossil fuel have almost doubled. It has caused a shift of heating energy source from fossil fuel to electricity and largely contributed to the high annual average demand growth rate in 2000s. Since the current electricity tariff doesn't properly reflect the profile of load, it is important to design adequate electricity tariff so that end-users can respond to the signal of changes in load. Introduction of time of use (TOU) rate and critical peak pricing (CPP) are regarded as options of drawing such demand responses.

In the long term, constructions of power plants are necessary. For the low carbon and clean energy society, government policies to induce investments are more important than ever.

IV. Smart Grid and Future Perspective

Solutions for smart grid had been handled on the name of Power IT until 2008 in Korea, but the overall vision for smart grid was set in 2009, which was a step behind US and Europe. The national road map for smart grid consists of 5 major areas; Power Grid, Electricity Service, Transportation, Renewable, Consumer. They cover a wide variety of fields from engineering to business and the platform is represented in figure 5.

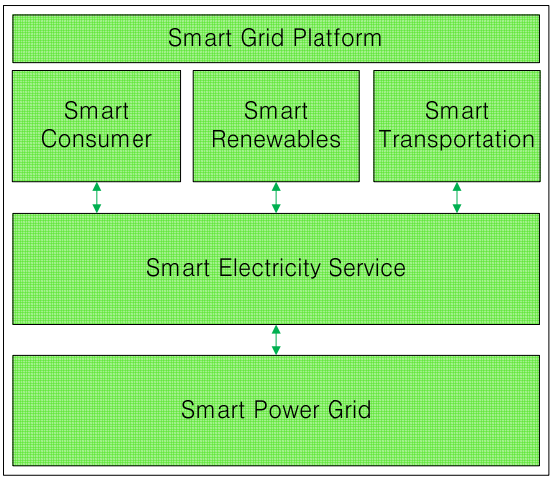

Figure 5 Smart Grid Platform

Smart grid deployment schedule is divided into three phases by 2030 as shown in figure 6. First phase is from 2010 to 2012 and the goal is building the infrastructure for smart grid environment. For the purpose, a test-bed was installed in Jeju island. Korea electric power corporation (KEPCO) and several companies have been participating in the test-bed to test and simulate their technologies and to create business opportunities under the Korean government supports.

In 2013, Jeju test-bed is completed and extensive smart grid projects are initiated on

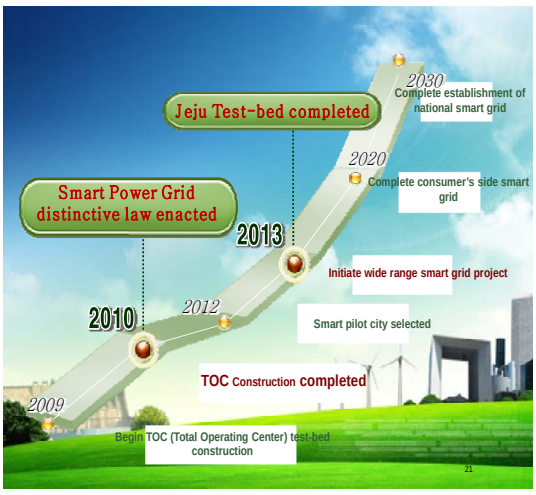

Figure 6 Smart Grid Deployment Plan

selected smart pilot cities. In this second phase, developed technologies and tested systems are applied to power grid at city level until 2020.

At the third phase, which is from 2021 to 2030, establishment of nationwide smart grid is completed. All the related technologies are integrated into smart grid in this step and active participation from demand and supply arises. In other words, bilateral electricity trading scheme is implemented and no distinct classification between suppliers and consumers exists as energy storage system and renewable become common. In this stage, energy efficiency and social welfare is maximized. Moreover, accumulated technologies and experiences are expected to open new overseas business opportunities.

To achieve the smart grid plan, critical development should be implemented and they are listed below.

○Development of Korean Energy Management System
○Development of Intelligent Transmission Network Monitoring and Operation System
○IT Based Control System for Bulk Power Transmission
○Development of Prototype for Advanced Substation Automation System Based on the Digital Control Technology
○Development of Power Equipment Monitoring System using Active Telemetrics
○Development of Intelligent Distribution Management System
○Development of Power Line Communication Ubiquitous Technology
○Power Semiconductor for Dispersed Generation and Industrial Inverter Application
○Development of Integration EMS for the microgrid and application technology to real site

V. Conclusion

Korean electric power industry is encountering challenges to transform into clean, sustainable and low carbon environment while keeping the system reliable and efficient. To deal with the challenges, the national energy master plan proposes various measures including a great expansion of renewable energy production by supporting and promoting renewable industry. 9.15 blackout emphasizes the security of power system and implies that demand side participation becomes more important. Korean smart grid vision enables full participation of both supply and demand through bilateral electricity trading scheme and suggests various solutions for highly efficient and reliable power system.

Footnote*

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