PILOT SMART GRID PROJECT IN JEJU ISLAND AND KEPCO'S AMI DEPLOYMENT

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ABSTRACT

KEPCO (Korea Electric Power Corporation), as a sole electric company in Korea, is also playing an important role in Smart Grid. KEPCO has 2 plans to accelerate Smart Grid in Korea; one is "the Pilot project for Smart Grid in Jeju Island" and the other is "AMI deployment project with 18 million customers until 2020".

To develop Smart Grid into the business model, KEPCO is going on with "the Pilot project for Smart Grid in Jeju Island", which started in Dec. 2009, for 3 and a half years. And the total budget for the project is around 68 million USD. Jeju Smart Grid pilot project consists of 5 categories; they are Smart Place, Smart Electricity Service, Smart Power Grid, Smart Renewable and Smart Transportation.

Ⅰ. INTRODUCTION

In the Independence-day speech on Aug. 15, 2008, the president of Korea announced "Low carbon Green growth" as a new national vision. The Korean government has encouraged most of industry sectors, especially energy sector, to achieve the new goal. One of the most essential elements to achieve this goal is 'Smart Grid'.

KEPCO (Korea Electric Power Corporation) is also playing an important role in Smart Grid. KEPCO has two plans to accelerate smart grid in Korea; one is "Smart Grid Pilot Project in Jeju Island" and the other is "AMI deployment project with 18 million customers until 2020"

To deal with environmental issues including global warming, the Korean government decided to deploy smart grid all over Korea by 2030. To keep in step with the government, KEPCO has participated in "Smart Grid Pilot Project in Jeju Island" since Dec. 2009. The duration of the project is three and a half years and its total budget is around 68 million USD. Jeju Smart Grid pilot project consists of 5 categories; Smart Power Grid, Smart Renewable, Smart Transportation, Smart Place (aka Smart Consumer or Smart Residence) and Smart Electricity Service.

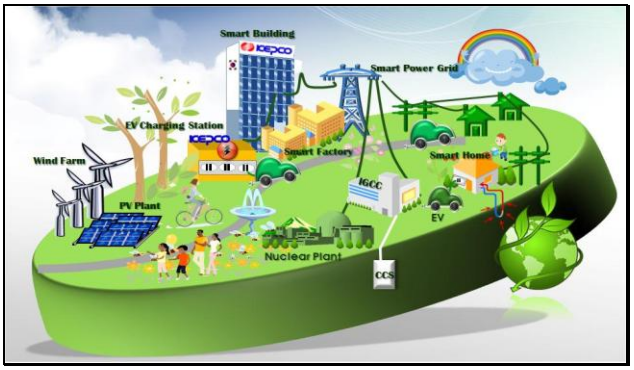

Figure 1 – Concept of a smart grid city

Ⅱ. SMART GRID PILOT PROJECT IN JEJU ISLAND

A. Smart Power Grid

Smart Power Grid project is to enhance the system reliability and efficiency by converging electricity and IT. The main areas of Smart Power Grid project are intelligent transmission, digital substation and smart distribution.

For the intelligent transmission, KEPCO will install monitoring devices to check current and tension of line. In addition, meteorological sensors and ball sensors are going to be installed to monitor temperature, wind, solar radiations and lightning.

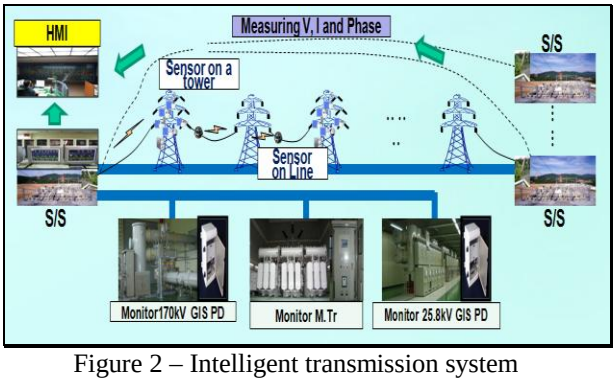

Figure 2 – Intelligent transmission system

For the digital substation, KEPCO will change an existing analog substation into a digital substation. The size of the substation will be smaller than ever by 10% and the reliability will be improved by 50%.

Compared items	Analog substation	Digital substation
Components	Relay, Aux. relay, Contact	IED
Communications	Hard wire	Optic fiber
Data processing	Analog	Digital
Circuits	Electrical & mechanical sequence	Logical sequence

Table 1 – Comparison between Analog and Digital substations

The smart distribution in KEPCO is like an upgraded version of DMS (Distribution Management System). DMS has functions of monitoring feeder information, such as voltage and current, and it can cover FLISR (Fault Location, Isolation and System Recovery) for radial networks. But the smart distribution will be able to monitor more, such as sag, swell, harmonics of the system, and it can apply to more sophisticated systems with distributed generators.

Compared items	DMS	Smart Distribution
Number of items to be monitored	37	300
Applicable protocols	DNP	DNP, IEC
FLISR	Radial system Earthed system only	Closed loop system (Self healing) Distributed generator Earthed and unearthed system
Accuracy of measurement	CL 3.0	CL 1.0

Table 2 – Comparison between DMS and Smart Distribution

B. Smart Renewable

The Smart Renewable project is to improve the power quality of renewable sources, especially wind turbines, when they are connected to power grid. KEPCO wants to test the operating system to stably supply energy considering wind power and grid status, BESS (Battery Energy Storage System) to maximize revenue by energy sales according to power demands and electric rates, and STATCOM to improve voltage stability by supplying reactive energy.

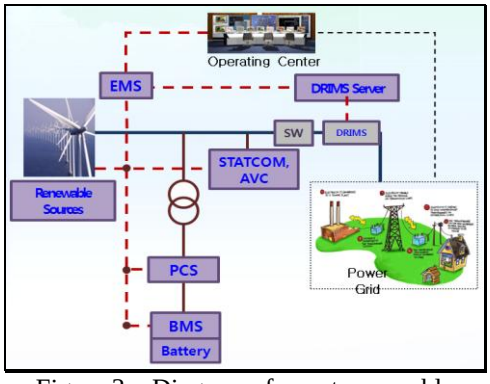

Figure 3 – Diagram of smart renewable

The main components to be tested in Jeju Island are EMS (Energy Management System), PCS (Power Conditioning System), BMS (Battery Management System) and batteries. We have two test models for smart renewable pilot project; type-A for big source with tens of MW, whose EMS has up to 20,000 points, and type B for medium source with several MW, whose EMS has up to 5,000 points.

The protocol between operating center and EMS will be IEC 61970, and IEC 61850 will be applied between EMS and PCS.

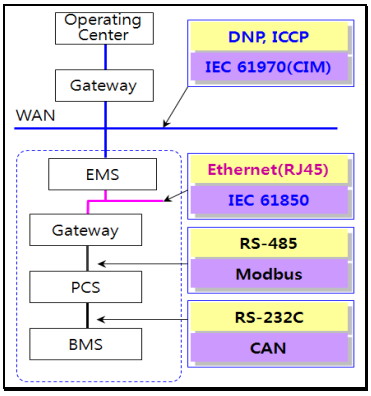

Figure 4 – Protocols

C. Smart Transportation

KEPCO will establish charging infrastructure for electric vehicles through this project. KEPCO test two kinds of EV chargers in the project; High-speed charger and Low-speed charger. The high-speed charger has a concept to charge an EV directly via DC charger with a capacity of 50kW; it takes 10 to 30 minutes to charge a car. For low-speed charger, on the other hand, it charges an EV via AC charger with a capacity of 7.7 kW; it takes 6 to 8 hours to charge a car.

KEPCO signed MOU with Hyundai Motors, the leading automobile company in Korea, for mutual cooperation in the EV charging sector.

KEPCO will also establish and test some added services for EV charging systems. It can give drivers real-time traffic information, the location of charging stations and the car.

Specifications	High-speed charger	Low-speed charger
Capacity	50 kW	7.7 kW
Voltage	AC 3P 380V / DC 450V	AC 1P 220 V
Pins of a connector	9 pins	5 pins
Number of chargers installed	14 chargers	22 chargers

Table 3 – EV charger to be tested in Jeju smart grid test field

D. Smart Place

Smart Place, which is also called as smart home or smart residence, is the project to establish the infrastructure for efficient energy consumption through DR (Demand Response) by means of two-way communication systems between a utility and consumers.

KEPCO and three other consortiums are establishing 3,000 smart places including residences, buildings and factories. In particular, KEPCO's smart place models are categorized into four (4); basic DR model, advanced DR model, renewable model and building and factory model.

For the basic DR model, KEPCO is installing a smart meter and an IHD (In-Home Display) only and give price signals to a consumer. The consumer can get the price signals from the IHD and he will respond to them.

For the advanced DR model, KEPCO is installing H-EMS (Home Energy Management System) and other smar t devices, such as load controllers, smart appliances, besid e of a smart meter and an IHD. The EMS will automatical ly manage the energy consumption according to price sign als and consumer's requirements. This is more costly than the basic DR model but more highly effective.

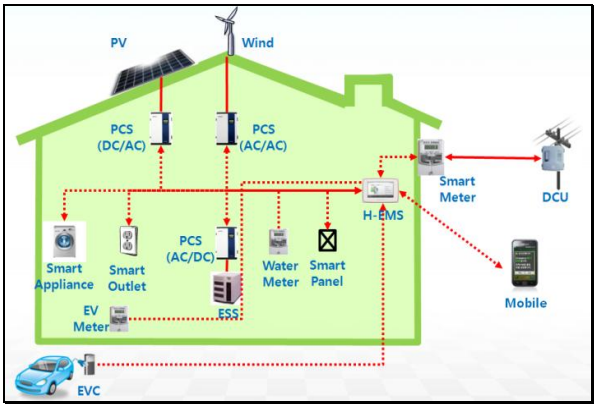

Figure 5 – Diagram of the renewable model

The renewable model covers also distributed generators including wind and solar power sources, energy storage systems and EV chargers.

The building and factory model is for big commercial and industrial customers. Combining B-EMS into existing BAS (Building Automation System), we can make the building/factory more energy-efficient.

Description	Basic model	Advanced model	Renewable model	Building & Factory model
number of places	300 places	240 places	20 places	10 places
Main Components	Smart meter IHD	Smart meter IHD, EMS Smart Appliance	Smart meter IHD, EMS Renewable, EVC	Smart meter B-EMS or F-EMS Smart panel

Table 4 - Kinds of smart place models

As shown above, the core technology in home or building areas is EMS. EMS is the system to optimize consumer-side demand response according to pricing signals. It receives the energy rate changed time by time in a day ahead from the operating center, make a schedule to control in-home devices, such as appliance, lighting, air-conditioning and heating, and report them to users through IHD.

In the view point of utilities, the smart place can give some benefits. Most of the benefits come from AMI which is core infrastructure for the smart place. KEPCO is planning to test a new OMS functionality based on AMI infrastructure. In the past, OMS was operated by DMS or calls from customers. The DMS system can only monitor outage on block area basis, but not in detailed area. When we have the AMI system, we can monitor outage in small area, or even customer by customer.

KEPCO also provides EIP (Energy Information Portal) service to our customers in the test field. We developed EIP for high and medium voltage customers, called PCCS (Power Consumption Consulting Service last year. And we will expand it to all customers soon. They can get som e information in real time to use energy efficiently. The sy stem will provide a customer with current energy rate com pared to yesterday, last month or last year, and also give h im tips how to save his energy cost.

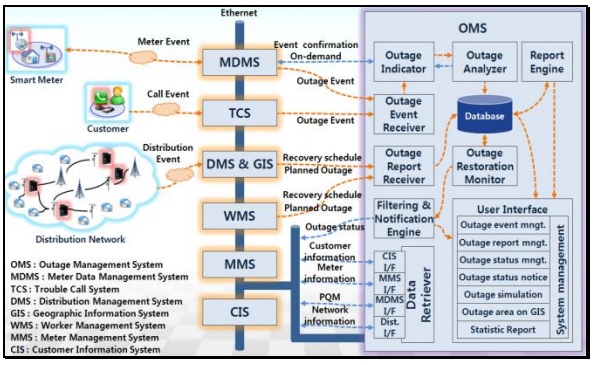

Figure 6 – OMS data flow diagram

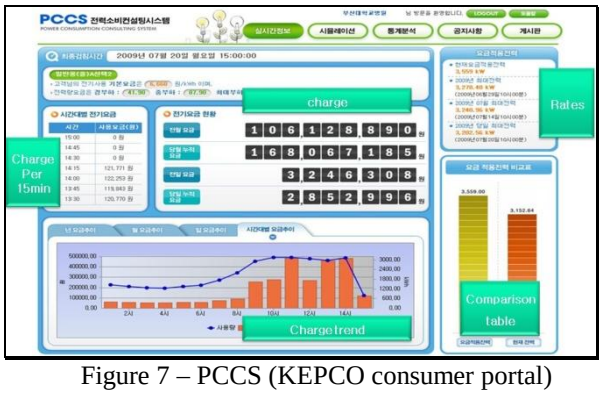

Figure 7 – PCCS (KEPCO consumer portal)

E. Smart electricity Service

Smart Electricity Service is for developing various tariffs and service models to meet the future-oriented electricity service infrastructure including Real-Time Pricing. In the Jeju pilot, KEPCO is testing several rate systems including 1-part and 2-part RTP (Real Time Pricing). For small consumers with contract capacity less than 10 kW, dynamic TOU (2 or 3 TOU) will be applied. For large consumers, on the other hand, the rates will be changed every 15 minutes ~ 1 hour.

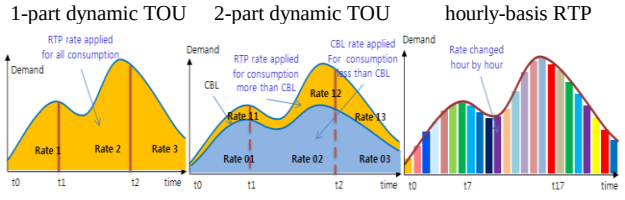

Figure 8 – Kinds of RTP tested in Jeju

F. Pilot AMI project for low-voltage customers

After KEPCO completed deploying AMI systems for about 140 thousand high and medium-voltage customers with a public wireless communication system in 2005, KEPCO had a plan to deploy the AMI system for about 18 million low-voltage customers. KEPCO started with the 1st pilot project installing 15 hundred AMI meters for low-voltage customers with Zigbee and PLC in 2005.

After the 1st pilot, KEPCO selected PLC as the main communication system for NAN because PLC is more effective than other communication methods. The PLC adopted by KEPCO is high-speed PLC based on ISO/IEC 12139-1.

In 2007, KEPCO had the 2nd pilot project with 5 thousand low-voltage customers after enhancing AMI devices including meters, modems and concentrators.

G. Plan to deploy AMI systems

KEPCO is planning to install 500 thousand smart meters in 2010, 750 thousand in 2011 and finally to complete installing all 18 million by 2020.

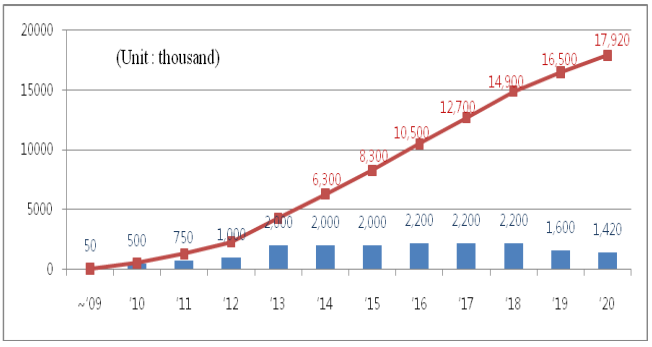

Figure 9 – Plan to deploy AMI systems

This annual deployment plan is established on the basis of several factors; they are Korean government's smart grid plan, economic analysis, meter man employment matter, and capability to supply smart meters. To successfully deploy smart meters, it is especially important to solve problems of meter man employment in advance.

H. Communication systems for AMI

There are two communication systems for AMI in KEPCO, WAN and NAN. For WAN, optical fiber network and TRS (Trunked radio System) are adopted. Recently KEPCO decided to apply WiMax to WAN in Jeju pilot project. For NAN, as mentioned before, high-rate PLC is the most commonly used, and other wireless, such as Binary-CDMA and ZigBee, are also applied although rare.

For an advanced meter, it has a plug-in type modem socket to fit with any kind of modem complying with KEPCO standards, which has an advantage to reduce the space required for installation. The basic meter, on the other hand, has an RS485 port for an external modem, which is needed to group several or tens of meters. This is more economical way because it's common that a number of meters for small residential customers are gathered in the same place, and therefore we can reduce modem cost.

Ⅲ. CONCLUSION

Thanks to an effort to keep up with the trends of green technologies, KEPCO is accumulating the experience in Smart Grid and AMI. It's expected that the outline of Jeju smart grid project will take concrete shape in the autumn of this year. Besides, The Jeju smart grid museum is going to open this coming October. In the smart grid town in Jeju Island, a visitor can experience his future's smart grid life with green energy source, green transportation and green home. KEPCO hopes to exchange our experiences with other utilities or organizations in Jeju Island to come together to solve environmental issues.