Association of Power Exchange
17-19 October 2010

Smart Grid in Korea
(Jeju smart grid pilot project)

Hwang, Bong Hwan
Korean Power Exchange
Smart Grid Roadmap
Korea has a globally competitive power industry in terms of both quality and quantity:
- Power capacity stands at 73,470 megawatts
- Annual average household blackout time is only 16 minutes
- Rate of transmission and distribution loss is only 4%

But we are aware of the need for new growth engines and effective response to climate change.

Smart Grid Road Map 2030 completed
Jeju Island test-bed project is under way
Smart Grid Promotion Act to be enacted
Preparing to facilitate standardization and deployment of smart grid technology
Smart meters to be deployed nationwide by 2020
Smart Grid Roadmap

Key Objectives

- Construction of a smart green city
  - 1st phase (2009~2012)
- Expansion of smart city (Enabling consumer)
  - 2nd phase (2013~2020)
- Completion of Nationwide smart grid
  - 3rd phase (2021~2030)

Milestones

- Legal arrangements to support Smart Grid
  - 2010
- Commence Test bed Project
  - Develop Smart Grid Roadmap (Jan. 2010)
- More Smart pilot project will be selected
  - 2012
- Initiate wide range smart grid project
  - 2013
- Complete consumer’s side of smart grid
  - 2020
- Complete changing infra in metro area
  - 2020
- Jeju pilot project completion
  - 2020
- Complete rollout toward nationwide smart grid
  - 2030
Smart Grid Roadmap: 5 domains

- Smart Place
  - To build energy efficient infrastructure
- Smart Renewable
  - To operate a stabilized clean energy
- Smart Transportation
  - To build electric vehicle infrastructure
- Smart Electricity Market
  - To build total control center and operate the competitive power market
- Smart Power Grid
  - To construct and operate intelligent power grid network
Jeju Smart Grid Pilot Project
Why do pilot project in Jeju Island?

- There is a renewable energy research complex (Korea Institute Energy Research)
- Abundant renewable energy resources (Wind power, solar power etc.)
- Excellent reliability
  - connected with 300MW HVDC lines from mainland
- Easy to improve legal/institutional framework as special autonomous province
- Has a Green & Clean Global Image
- Advantageous for PR as tourist attraction

Has potential to be a carbon free island

Dol Harbang
Pilot Project Overview

- **Location**: Gujwa-eup (northeast of Jeju), 185km², 6,000 households
- **Period**
  - 1st stage: December 2009 to May 2011 (to build infrastructure)
  - 2nd stage: June 2011 to May 2013 (to test integrated operation)
- **Consists of 5 domains**
  - Smart electricity market, place, transportation, renewable, and power grid
- **Participation**: 12 consortiums combined by 168 companies
  - Power, Telecommunication, automakers, home appliances manufacturers, etc
- **Budget**: $200 million ($50 million public fund, $150 million private investment)
### Companies Participating

<table>
<thead>
<tr>
<th>Companies</th>
<th>Companies with Consortiums</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SK Telecom</td>
<td>Samsung electronics, Iljin electrics, etc (29 firms)</td>
<td>G : $4.3, P : $25</td>
</tr>
<tr>
<td>KT</td>
<td>Samsung SDS, Samsung Trade, etc (14 firms)</td>
<td>G : $4.1, P : $26</td>
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<tr>
<td>LG Electronics</td>
<td>LG powercom, GS construction , etc (15 firms)</td>
<td>G : $4.0, P : $15</td>
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<tr>
<td>KEPCO</td>
<td>Samsung electronics, Nuri telecom , etc (38 firms)</td>
<td>G : - , P : $8.0</td>
</tr>
<tr>
<td>KEPCO</td>
<td>Samsung SDI, Lotte data communication, etc (22 firms)</td>
<td>G : $4.0, P : $12</td>
</tr>
<tr>
<td>SK Energy</td>
<td>SK Networks, Iljin Electrics, etc (14 firms)</td>
<td>G : $4.0, P : $11</td>
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<tr>
<td>GS Caltex</td>
<td>LG CNS, ABB Korea, etc (7 firms)</td>
<td>G : $3.5, P : $7.0</td>
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<tr>
<td>KEPCO</td>
<td>Hyosung, LS industry, etc (16 firms)</td>
<td>G : $4.1, P : $15</td>
</tr>
<tr>
<td>Hyundai Heavy</td>
<td>Maxcom, Icell Korea, etc (6 firms)</td>
<td>G : $4.1, P : $7.0</td>
</tr>
<tr>
<td>Industry</td>
<td>POSCO ICT</td>
<td>G : - , P : $7.8</td>
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<tr>
<td>KEPCO</td>
<td>LS industrial, KEPCO KDN, etc (21 firms)</td>
<td>G : $17.7, P : $8.9</td>
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<tr>
<td>KEPCO</td>
<td>Uam Corporation, Bitec information, etc (5 firms)</td>
<td>G : $5.5, P : $11</td>
</tr>
</tbody>
</table>
**Smart Place (Smart home & building)**

**Goal**
- To build a model to optimize the electricity consumption at home and buildings through the smart electric appliances
- To develop a model to sell the electricity produced and charged by consumers

**Business Features**
- Build advanced smart green houses and buildings
- Provide converged services between electricity and communication
  - give consumption information to the customers through internet, mobile, etc
- Develop the smart electric appliances and connect to AMI
- Build and operate the Micro Grid system including power, sewage water, seawater and geothermal heat, etc
- Standardize the home area networking and neighborhood area networking technology
- Build the demand response infrastructure

**Participation**
- Expense : $90 million (government : $13 million)
- Participation : Led by 4 consortiums by 101 companies
- Witness smart equipments applied in real homes as demonstrated from SK NOC
- 92 homes (including SK Smart home) are installed with PV arrays

SK Telecom NOC

- Test smart equipments
- Monitor participation in test-bed through operating center and provide call service
- Witness real-time pricing using IHD (In-home Display)

KT NOC

- Overnight stay for full experience of smart grid and apply feedbacks for improvement smart grid technology
- Use of smart appliances for energy efficiency
- Introduce fundamentals behind smart equipments and energy algorithm

LG Electronics Smart Home
Goal

- To build **Electric Vehicle charging infrastructure**
- To integrate Electric Vehicle as a Distributed Energy Resource (DER)
- To minimize the power grid influence caused by charging

Business Features

- Build fast recharging infrastructure
- Develop the price system for EV charging
- Develop optional service connected to EVs (maintenance, navigation, etc)
- Recharge using DER
- Concentrate on connecting with existing gas station

Participation Outline

- Participation: 3 consortiums (39 companies)
- Expense: $42 million (Government $11.5 million)
Will install 3 types of charging stations to test smart grid communications

- In order to schedule the recharging, either the charging station or the vehicle should communicate with the smart grid

- Fast chargers installed (<30m.)
- Using existing gas station network

- Slow chargers installed (1~4 hours)
- At the public parking lot

- Slow chargers installed (4~8 hours)
- At tourist place/roadside

- Electric Car: 4 (NEV: 2, FSEV: 2)
- To drive and charge EV by using EV charging meter
- Demonstration time: 20min
Smart Renewable

Goal

- To build infrastructure to integrate renewable generation units with power grid
  - Develop the technology to stabilize generation output using storage devices, etc
- In the long run, aims to expand the renewable resources

Business Features

- Implement power stabilization to increase the quality of renewable resources
  - Develop the energy storage devices, power conversion unit, reactive power compensation system, battery management system, etc
- Build energy management system for Smart City
- Build the micro-grid operation platform
- Develop the best sales business model

Participation Outline

- Participation: 3 consortia (37 companies)
- Expense: $40 million (Government $8 million)
**Smart Renewable (2)**

- **Project 1**
  - Constructed network of test site, basic design for all devices (energy storage, reactive power compensation device, PCS, EMS and so on)
  - Prepare optimal design, analysis, operation and standardization of devices

- **Project 2**
  - Concentrated on basic engineering and basic design for operation system
  - Prepare detailed design and build system for stabilizing of renewable resource output

### Project 1
- Test to integrate large scale wind power with power system
- Build energy management system available for Smart City

![Woljeong Wind Farm](image1)

### Project 2
- Build a micro-grid operation platform for islands, downtown and industries
- Test to stabilize the power output of large wind power

![Kimyoung Wind Farm](image2)
Smart Power Grid

Goal

- To build the test bed to verify the performance of the existing R&D
- To design the real time electricity tariff structure

Business Features

- To build the test bed and test the devices made by R&D results
  - On-line monitoring of T/L, reactive power of power system
  - Test the status of devices and operating system for digital substation
  - Monitor the status of devices for automation of distribution sector, etc
- Design the optimal operating technology of power grid for smart grid
- Design and operate the real time electricity tariff structure
- Test the effects of tariff structure and response of the customers

Participation Outline

- Participation: 3 consortiums (21 companies)
- Expense: $27 million (Government $18 million)
Smart Power Grid : Power System IT R&D Products
Smart Electricity Market (1)

- To provide a retail trade environment and new wholesale electricity market
- To build and test function of the integrated operation center (TOC)
- To develop the technology for operating power system in smart grid environment
- KPX has played key roles

Competitive Biz Model
- Competitive pricing with the DR resources (Capacity Price, AS payment)
- Two settlements to hedge market price volatility

Demand Response
- Price Responsive Demand
  - Wholesale demand bid
- DR resources set market prices on wholesale level

Market Design
- Seamless market structure
  - Dayhead, Realtime Price (30Min, 5min)

Current Market
- Data sharing with Current Market (CBP)
  - Load forecasting and Gen. Offer data

Electricity Market
- Seamless market structure
  - Dayhead, Realtime Price (30Min, 5min)
- Functionalized market
- Competitive Biz Model
- Demand Response
- Current Market
- Market Design
- '10.5: Developed the algorithm for the day-ahead and real time market
- '10.7: Started simulation for demand-side bidding and generation scheduling
  - Understanding of trading system through the simulation for demand side bidding
  - Test the stabilization of generation scheduling system

**Power Grid**
- Smart Transmission
- Active Telemetrics
- Digital substation
- Smartpower distribution

**Smart Place**
- Smart electric appliances
- Display
- Demand control
- Temperature control system
- Home server

**Smart Transport**
- Recharging Infra

**Smart Renewable**
- Distributed Energy Resources
- Storage System

**Wholesale Electricity Market**
- Demand bidding
- Demand response bidding

**Basic Data**
- Settlement data
- Facility data

**Additional Connections**
- Weather/Traffic Information
- CO₂/Regional Information

**TOC**
- Information management
- Market operation
- System operation
- Real time utility rate
- Security control

- Real time data connection
- Demand Side Bidding
Total Operating Center

Control Room: Bird’s-eye-view (Draft)

- GIS based Test bed Total Operation Monitoring
- Jeju & Test bed T/D Monitoring
- Mainland & Jeju system status: HVDC interconnection, Capacity, Demand, Reserve, etc
- Test bed Operation Status: RES Generation, DR, Batt. CO2 Reduction
- GIS based EV movement Monitoring, charging station information, V2G status
- Real Time Market Price (5 minutes)
- Cyber Security Control Center
## Common Barriers to Implement

### Market Barriers
- **Policy & Regulation**
  - Market uncertainty and unclear policy on market structure and rules
  - Revenue uncertainty due to regulatory structure
- **Public Barriers**
  - Consumer Engagement
  - Low public awareness and engagement
- **Technology Barriers**
  - Lack of R&D coordination
  - Lack of large scale deployment projects
- **Standards**
  - Interoperability and scalability assurance
  - Fragmentation and Lengthy Process in Technology Standards
- **Skills and Knowledge**
  - Insufficient skilled resources
  - Limited understanding of smart grids in public planning
- **Cyber Security & Data Privacy**
  - Threats to cyber security in networks and consumer information
  - Concerns about private data abuse

**Notes:**
- Threats to cyber security in networks and consumer information
- Concerns about private data abuse
Korea Smart Grid Week

- **KSGW Overview**
  - Held in the Jeju Smart Grid Test Bed on Nov 8th–14th (During G20 Seoul Summit)
  - To “Experience” Korea’s smart grid concepts and Jeju test bed and “Join” the Smart Grid Information Clearinghouse
  - Inviting the business leaders, reporters, etc. Business summit 20(B20) is going to be held with G20 summit

- **Smart grid information clearinghouse**
  - To share the new smart grid information across the country

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**Policy**
- MEF International Smart Grid Action Network Sub-Ministerial Meeting
  - High-level gathering to coordinate World’s Smart Grid Direction

**Technology**
- IEA Smart Grid Workshop
  - IEA scheduled to announce The first Smart Grid Roadmap

**Standards**
- EV charging Infra forum on Technology and Standards
  - Address Urgent need for EV infra Standards coordinated by 5 economies

**Demonstration**
- Global Smart Grid Test Bed Conference
  - Case Study of key smart grid test beds across the globe
Main Visitor Center in Jeju

Operation Plan

- Integrated and distinctive visitor center (5 distinctive and 1 integrated)
- First-hand smart grid experience at the center
- The center will commence before the G20 meeting, which takes places on November

Anticipated Outcomes

- Promote lifestyle change on the green age
- Tourist attraction (Smart grid theme park)
- A place to experience Smart Grid life style
Recent Restructuring Plans (2)

- **Strengthen** the competitions in the generation sectors
  - Increase the autonomy and the responsibility to the management
  - Facilitate the competition among the 6 Gencos
  - The 6 Gencos will be supervised by the government directly, not by KEPCO
- **Consistently develop** the electricity market along with the current framework

Prospects

- **Current government** doesn't want abrupt change of the industry framework now
- Restructuring will be gradually implemented in the long term

Thank you so very much