Smart Grid in Korea

2013. 11. 26

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Korea Smart Grid Institute
1. Why Smart Grid in Korea
2. National Smart Grid Roadmap
3. Jeju Smart Grid Test-Bed
4. The Smart Grid Law and Five-year Implementation Plan
5. Next Step: Smart Grid Pilot Deployment
Power Grid Quality and Network Situation

Grid Quality in terms of Outage and T&D Loss (2011)

Outage duration (minutes/year)

Transmission & Distribution Loss

- Kepco, 2011 -
South Korea

- Isolated country in terms of Electricity Network
Increase of Electricity Use and Demand Peak Issue

**Increasing of Electricity Demand and Maximum Peak**

- Expecting that Energy Consumption will continually increase (1.4% annually)

**Concentration of electricity demand**

Result in increasing Generation Capacity

- *Unit: 10MW
- *Including DR adjustment

**Generation Capacity**
- Reserved Margin
- Nuclear
- GAs
- Oil
- Coal
- Hydro

**Electricity Consumption**
- Time: 0, 12, 24
To Avoid Blackout, Additional New Power Generation Capacity?

- Never in Spring and Fall season
- Not in Night and Weekend (Enough and Over)
- Only two and half hours in the morning in Winter season (-10°C)
- Only three and half hours afternoon in Summer Season (+30°C)

For these very short moments, to install huge amount of facility may be a waste!
→ We should manage the demand in more smart way
Electricity consumption rate is higher than other OECD countries which GDP per person is twice
Electricity Price Rates

Korean Electricity Price is half of OECD average

<table>
<thead>
<tr>
<th>Sector</th>
<th>Industry($/kWh)</th>
<th>Household($/kWh)</th>
<th>Industry/Household(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>0.058</td>
<td>0.083</td>
<td>69.88</td>
</tr>
<tr>
<td>France</td>
<td>0.106</td>
<td>0.157</td>
<td>67.52</td>
</tr>
<tr>
<td>Japan</td>
<td>0.154</td>
<td>0.232</td>
<td>66.38</td>
</tr>
<tr>
<td>UK</td>
<td>0.121</td>
<td>0.199</td>
<td>60.80</td>
</tr>
<tr>
<td>USA</td>
<td>0.068</td>
<td>0.116</td>
<td>58.62</td>
</tr>
<tr>
<td>OECD(Average)</td>
<td>0.110</td>
<td>0.157</td>
<td>69.87</td>
</tr>
</tbody>
</table>

Industry/$kWh:
- Korea: 0.058 (100)
- France: 0.106 (183)
- Japan: 0.154 (267)
- UK: 0.121 (210)
- USA: 0.068 (117)
- OECD(Average): 0.110 (190)

Household/$kWh:
- Korea: 0.083 (100)
- France: 0.157 (199)
- Japan: 0.232 (279)
- UK: 0.199 (239)
- USA: 0.116 (139)
- OECD(Average): 0.157 (189)
Change of Energy Environment

The **Fukushima nuclear disaster** in March 2011

A **rolling blackout** in Korea on 15\(^{th}\) Sept, 2011

- Recording under 0.24 million kW at its minimum reserve margin and 7.5 Million Households were affected

**Power Line construction suspended in Miryang**

- Construction of high-voltage transmission cable towers in Miryang, nearly eight months after work on them was suspended due to fierce opposition from residents
• Green Growth

• Creative Economy
Creative Economy: New market creation from convergence between various industries and ICT

President Park proposed ‘creative economy’ for job creation through convergence between industry and industry, and industry and culture.

**Current Industry + ICT → Job Creation + Economy Growth**
Signal Says ‘Electricity Demand Could be reduced by information’

- Electricity Saving Campaign

If information comes to consumer
Electricity demand move
ESS & Pumped-storage Hydroelectric Power

Pumped-storage hydroelectricity

- Low-cost off-peak electric power (at night time) is used to run the pumps.
- During periods of high electrical demand (at day time), the stored water is released through turbines to produce electric power.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Muju</th>
<th>Sancheong</th>
<th>Yangyang</th>
<th>Yecheon</th>
<th>Cheongsong</th>
<th>Cheongpyung</th>
<th>Samrangjin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap (MW)</td>
<td>300</td>
<td>350</td>
<td>250</td>
<td>400</td>
<td>300</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Turbines</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total Cap (MW)</td>
<td>600</td>
<td>700</td>
<td>1000</td>
<td>800</td>
<td>600</td>
<td>400</td>
<td>600</td>
</tr>
</tbody>
</table>

EV will bring the same result if it is charged at night time and recharged at day time.
Deployment Direction and Sectors
1. Why Smart Grid in Korea

2. National Smart Grid Roadmap

3. Jeju Smart Grid Test-Bed

4. The Smart Grid Law and Five-year Implementation Plan

5. Next Step: Smart Grid Pilot Deployment
National Smart Grid Roadmap 2030

Vision and Goals of Korea’s Smart Grid

**Vision**

*Pave the way for low carbon, green growth through a Smart Grid*

**Goals by phase**

**Build a nationwide Smart Grid across metropolitan areas**

**2030**

**Build a Smart Grid Test-bed**

**2020**

**Five implementation areas**

- **Smart Power Grid**
  - Build a monitoring & control system of the power grid
  - Build a failure prediction & automatic recovery system of the power grid

- **Smart Place**
  - Distribute nationwide smart meters
  - Build an automated energy management system

- **Smart Transportation**
  - Build a nationwide charging infrastructure
  - Build an ICT-based electric vehicle operating system

- **Smart Renewable**
  - Create a large-scale renewable energy generation complex
  - Develop large capacity energy storage devices

- **Smart Electricity Service**
  - Develop a various pricing system
  - Develop consumers’ electricity trading system

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*Smart Consumer*  *Smart Transport*  *Smart Renewables*  *Smart Power Grid*  *Smart Elect. Service*
Smart Grid Concept I

Source: Unless otherwise indicated, all material derives from IEA data and analysis.
Smart Grid Concept II

The Existing Electric Grid
- Supplier Centric
- One-directional
- Closed power platform

Information and Communication Technology (ICT)
- Real time information exchange

Smart Grid
- Consumer Centric
- Bi-directional
- Open business platform

Smart Power Grid

Smart Renewables

Smart Consumer

Power Elec. Service (Real Time)

EV Charging Infrastructure
Smart Grid Concept III

The Existing Electric Grid
Supplier Centric
One-directional
Closed power platform

Information and Communication Technology (ICT)
Real time information Exchange

Smart Grid
Consumer Centric
Bi-directional
Open business platform
* Milestone

- Ground breaking of ‘Juju Island Smart Grid Test bed’ (Dec)
- Established ‘the Act on promoting SG establishment and Usage’ (May)
- Designated as an ISGAN vice-chair country and hosted the roll of the secretariat (Jun)
- Enacted the Smart Grid Act (Nov)

- Established ‘Smart Grid National Roadmap(2030)’ (Jan)

- Started Smart Grid Deployment

- Established ‘SG Five year Master Plan’ (Jun)

- Finishing the 2nd phase of SG Juju Test Bed project - Total Investment: KRW 0.24 Trillion

- 2005~ 2013 : 10 Power IT Projects (KRW 0.25 Trillion)
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Jeju Smart Grid Test-bed

Target
Set-up of the world largest smart grid test-bed at an initial stage
➡ Commercializing technologies & Business model

Budget
Total KRW 249.5 billion (Public KRW 76.6B, Private KRW172.9B)

Status
Phase 1  (Dec. 2009 ~ May. 2011) construction of demonstration infra struct
Phase 2  (Jun. 2011 ~ May. 2013) Integrated operation

Participation
: 168 companies
Jeju Smart Grid Test-bed
[10 Consortia in 5 areas]
Jeju Smart Grid Test-bed
[New Business Models]

- Electricity Retail
  - Demand Response
  - Consumer-generated power trading service
  - Operation of Virtual Power Plant based on EV

- EV Charging
  - EV quick charger, Charging stand
  - Moving/Emergency charging service for EV

- Others
  - Consulting on energy consumption
  - EV rental service
  - Stable NRE production & better power quality
Jeju Smart Grid Test-bed [Technology Verification]

AMI, EMS, Smart Appliance
- Real-time information exchange between consumers and suppliers that optimizes electricity supply and demand through technology development and trial operation
- AMI, EMS, Smart Appliances

EV Charging Infrastructure
- Development of quick and standard charging service and delivery of various services for the electric vehicle infrastructure communication
- EV Charging, V2G

Energy Storage System
- Conjunction with distributed generation, develop a management technology for discharge and charging technology for high-capacity battery charge that have different capacity and usage
- Microgrid, ESS

Grid Integration Technology
- Connecting Microgrid, electric car battery to the power grid and allow electricity to transmit both ways
- Transmission, Distribution Technology Development

Demand Response
- Depending on the changes of the electricity rates in real-time consumption, test a system that consumers are able to induce and adjust the electricity consumption freely
- DR price market
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Enactment of the Special Act* on Establishment of Nationwide Smart Grid (November 2011)
* Act on Promoting Smart Grid Establishment and Usage

Establishment of Regulatory Basis for Stable Building of SG
- Execution of Five year plan & annual inspection to the action plan
- Designation and support of the base cities projects for national expansion

Establishments, Utilization, and Protection of SG information
- Securing of reliability, stability, and interoperability of information.

Establishment of the Basis for the Systematic Building of the SG
- Development the grounds of financial support for the establishment of smart grid infrastructure
- Designation of the support organizations for systematic fostering and support of the smart grid
「First Five-year Master Plan」
- In accordance with Article 5 of 「the Act on Promoting SG Establishment and Usage」

It should be finalized by ‘Green Growth Committee’
- In accordance with Article 14 of 「the Framework Act on Low Carbon Green Growth」

* Description in Article 5 of 「the Act on Promoting SG Establishment and Usage」
- Middle & Long term policy goal and direction of the SG
- Development, demonstration, distribution, and expansion of SG Technology
- Operation and Usage of the Smart Grid
- Standardization, testing, and certification of the SG
- Development of the professional manpower for the SG
- Protection and Safety of the SG information
- Export and international cooperation on the SG
- Investment of SG
- Policy improvement of the SG
The Goal of the First Five-year Plan

Construction of Smart Grid Pilot Cities in 7 Wider Districts

Policy Goal

Strategic Goal

Implementation Strategies

Smart Service
- Secure 1,200 MW Capacity for Smart DR

Smart Consumer
- Install over 50% smart meters in households

Smart Transportation
- Deploy 150,000 EV chargers

Smart Renewable
- Achieve a 4.3% deployment of renewable energy

Smart Transmission and Distribution
- 10 percent increase in reliability

System Improvement
- Dynamic Tariffs
- Demand Management
- Electricity market
- Accompanied growth

Market Creation
- Domestic Demonstration
- Foreign Demonstration
- Supply core appliances
- Pilot city

Technology Development
- Development of the system
- Technology Development Strategy
- Technology development plan

Establish Infrastructure
- Standards and Security
- Human resources
- International Cooperation
- Industrial Promotion
- Consumer Participation
Five-year Master Plan

Deployment Index (2012~2016)

- **DR Resource (Accumulated) [MW]**
  - '12: 60
  - '13: 350
  - '14: 700
  - '15: 900
  - '16: 1,200

- **AMI (Accumulated) [10,000 households]**
  - '12: 105
  - '13: 305
  - '14: 530
  - '15: 755
  - '16: 1,000

- **EV Charging Infra (Accumulated) [1000 sets]**
  - '12: 0
  - '13: 6
  - '14: 32
  - '15: 72
  - '16: 150

- **ESS Capacity [MWh]**
  - '12: 1
  - '13: 11
  - '14: 43
  - '15: 100
  - '16: 200
Five-year Master Plan

Total of 3.55 trillion KRW (USD 3.55 billion)

- R&D Investment Plan
  - KRW 740 billion (USD 740 million)
- Deployment and Demonstration Projects
  - KRW 2.4 trillion (USD 2.4 billion)
- System Research and Foundational Studies
  - KRW 400 billion (USD 400 million)

Total Economic effects to be a total of KRW 9.67 trillion (USD 9.67 billion)

- New Growth Engine Effects
  - Advanced metering infra. KRW 951 billion
  - Electricity Charging Infra. KRW 834 billion
  - ESS KRW 1.63 billion
  - Demand Response (VPP included) KRW 3.68 billion
  - KRW 2.4 trillion (USD 2.4 billion)

- Market Improvement Effect
  - T & D loss reduction and Electrostatic damage reduction
    - KRW 4.16 billion
  - KRW 400 billion (USD 400 million)

- Environmental Effect
  - Reduction of CO2 Emission
    - KRW 29 billion
  - KRW 30 billion (USD 30 million)

- Economic Effect
  - Employment: 33,162 People
  - KRW 3.5 trillion
  - KRW 1.629 billion
  - KRW 7.32 billion
  - KRW 23 trillion

- Power Plant Construction Cost savings
  - KRW 6.8 trillion (USD 6.8 billion)
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## Pilot Deployment

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<tr>
<th>Test Bed</th>
<th>Pilot Deployment</th>
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<tbody>
<tr>
<td>(Technology Verification)</td>
<td>(Commercialization)</td>
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</table>

### <Test bed & Pilot Deployment>

### <Pilot Deployment Concept>

1. Framework: Roadmap, Law
2. Pilot Scoping and Design
3. Pilot Execution
4. Pilot Learning: Analysis and Action

Main Stream Scoping

Pilot Deployment: Commercialization and visualization of the effects

Tipping point
Regulatory certainty enables business cases for mainstream rollout
Total 8 Consortia Proposed for Pilot Deployment Project
(14 provinces, service providers, system integration companies, equipment providers are participated)

Business model are using technology including AMI (Advanced Metering Infrastructure), DR (Demand Response), EMS (Energy Management System), ESS (Energy Storage System), EV charging, V2G, Renewable to Grid
Creation of New Business by Smart Grid
Next Step: Smart Grid Extension of Deployment to City

- Cities are the source of the majority of energy consumption
- Seven largest cities in Korea reach over 46% of the national population and 46% of all GDP of Korea

Smart Grid is the essential infrastructure for the sustainable urban Environment
Thank You