Jeju Smart Grid Field Trial

Hyungsoo Kim
General aspects
Jeju Field Trial
Lessons Learned
Economy Overview – South Korea

- Area: 99,720 km² (115th in the world)
- Population: 48 million (26th in the world)
- GDP: US$929.1 billion (14th in the world [2007])
- Trade: US$950 billion (10th in the world)

Key Industries and Global Ranking

1st: Semiconductor
5th: Petrochemical
5th: Automobile
5th: Steel
1st: Shipbuilding
System overview in 2008

- **Installed Capacity 72,491MW (12th in the world)**
  - Output: 422,355MWh
  - Peak Demand: 62,794MW (2008)
  - Trading Volume: 24.3 billion dollars
- **Transmission lines: 29,929 c-km**

- **Rate of transmission & distribution loss: 4.01% (1st in the world)**
- **Blackout duration (SAIDI): 16.08min (2nd in the world)**
- **Load factor: 76.6% (1st in the world)**

**SAIDI:** The System Average Interruption Duration Index
Energy dependency

- One of 10 largest energy consumption countries
- Foreign Energy Dependency (97%), (2008: U$141.5 billion)

Unit: one hundred million dollars

Source: Ministry of Knowledge & Economy
Electricity Industry

- KEPCO: TO, DisCo, LSE
- KPX (Korea Power Exchange): SO, RTO, MO
- 6 KEPCO affiliated Companies: GenCo
- Other 7 IPPs

Restructured from 2001:

- TO: Transmission Owner
- DisCo: Distribution Company
- LSE: Load Service Entity
- SO: Service Operator
- RTO: Regional Transmission Org
- MO: Market Operator
- GO: Generation Company
- IPP: Independent Power Producer

Diagram:

- GO (affiliates)
- GO (IPP, Private)
- Self-Generation Plant Owners
- MO (KPX)
- T&D, Sales (KEPCO)
- Consumer
- Consumer
- Consumer
- Large Volume Consumer
- Community Consumer
- Surplus
- Shortage
- CHP
- Private Distribution Lines
- Heat
- Electricity
“Electricity usage is increasing because of low price and easy access.”
General aspects

Jeju Field Trial

Lessons Learned
Announced National Vision (Low Carbon Green Growth)

Aug '08

Launched Smart Grid Jeju Trials

Apr '09

Smart Grid National Roadmap Committee

Dec. '09

Technology R&D

Law & Regulations Revision

Standardization

Field Trial in Jeju Island

Jeju Island
- Abundant Renewable energy source
- Independent Power system
- Tourism (World Natural heritage)
Five Domains

**Smart Power Grid**
Construct intelligent grid network

**Smart Renewable**
Operation of stable & clean energy

**Smart Electricity Service**
Provide new electricity service

**Smart Place**
Build energy efficiency use Infrastructure

**Smart Transport**
Build Electric Vehicle Infrastructure

Diagram showing interconnected domains:
- Power Plant
- Factory
- Home
- Building
# Consortia

<table>
<thead>
<tr>
<th>Leader</th>
<th>Participants</th>
<th>Investment (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smart Place</strong></td>
<td>Samsung electronics, Korea Cable TV, Jeju broadcast etc (29 companies)</td>
<td>Govt: 5 million Private: 25 million</td>
</tr>
<tr>
<td></td>
<td>Samsung SDS, Samsung Trade, Rosotech etc (14 companies)</td>
<td>Govt: 4.7 million Private: 30 million</td>
</tr>
<tr>
<td></td>
<td>LG U+, GS pure cell, GS construction etc (15 companies)</td>
<td>Govt: 4.7 million Private: 17.5 million</td>
</tr>
<tr>
<td></td>
<td>Samsung electronics, Taihan Electric, Nuri Telecom etc (38 companies)</td>
<td>Govt: - Private 10 million</td>
</tr>
<tr>
<td><strong>Smart Transportation</strong></td>
<td>Samsung SDI, Lotte data communication, P&amp;E Solution etc (22 companies)</td>
<td>Govt: 4.5 million Private: 14 million</td>
</tr>
<tr>
<td></td>
<td>SK Network, Iljin Electrics, Ientech etc (13 companies)</td>
<td>Govt: 4.5 million Private: 13 million</td>
</tr>
<tr>
<td></td>
<td>LG CNS, ABB Korea, NexCon Take etc (7 companies)</td>
<td>Govt: 4 million Private: 8 million</td>
</tr>
<tr>
<td><strong>Smart Renewables</strong></td>
<td>KOSPO, Hyosung, LSIS etc (16 companies)</td>
<td>Govt: 4.7 million Private: 15.3 million</td>
</tr>
<tr>
<td></td>
<td>Maxcom, Icellkorea etc (6 companies)</td>
<td>Govt: 4.7 million Private: 7 million</td>
</tr>
<tr>
<td></td>
<td>LG Chem, Wojin Industrial System, Daekyung Engineering etc (6 companies)</td>
<td>Govt: - Private: 9 million</td>
</tr>
<tr>
<td><strong>Smart Power Grid</strong></td>
<td>LS IS, KDN (KEPCO affiliate), wtc (18 companies)</td>
<td></td>
</tr>
<tr>
<td><strong>Smart Electricity Service</strong></td>
<td>Wooam Corp., Bitect, IC etc (5 Companies)</td>
<td></td>
</tr>
</tbody>
</table>
Trial Sites

Smart Place
Smart Transport
Smart Renewable

Smart Power Grid
Smart Green Homes
Smart Power Market
Smart Renewables
Smart Transport
Domain 1 - Smart Place

### Objectives
- To increase energy efficiency and reduce energy use via AMI
- To control energy use via two-way communication energy management System

### Key Technology Deliverables
- Develop AMI and set standard (2012)
- Develop system to connect DR with the grid (2020)

### Business Model
- Emergence of smart appliances and energy management service providers
- Emergence of prosumers (sell and consume)

### Goals by Critical Index

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy save(%)</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Smart meter installation(%)</td>
<td>5.6</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Demonstration
**Objectives**

- To establish charging infrastructure
- To allow consumers to charge during low-demand/low-rate hours and re-sell during peak hours

**Key Technology Deliverables**

- Develop EV parts and materials (2012)
- Develop Vehicle to Grid system and ICT service (2020)

**Business Models**

- Emergence of EV/battery rental service
- Emergence of EV operating management service business

**Goals by Critical Index**

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV Distribution</td>
<td>0.5</td>
<td>152</td>
<td>2,456</td>
<td></td>
</tr>
<tr>
<td>EV Charging infra</td>
<td>10</td>
<td>430</td>
<td>2,714</td>
<td></td>
</tr>
</tbody>
</table>
Domain 3 - Smart Renewables

Objectives
- To create large-scale renewable generation power plants
- To build green homes and buildings that are energy independent using renewable energy

Key Technology Deliverables
- Develop technology for stable connection of renewable generation to the grid (2012)
- Develop ESS for bulk renewable generation (’20)

Business Models
- Production and sales of renewable energy
- Exportation of ESS that is connected to the grid

Goals by Critical Index

- Renewable Energy (%)
  - 2012: 3.1
  - 2020: 6.1
  - 2030: 11.0

- Zero net energy building (%)
  - 2012: 10
  - 2020: 30
  - 2030: 30

Pilot City
- 2012: 3.1
- 2020: 6.1
- 2030: 11.0
Objectives

- To establish bidirectional power grid that allows new integrated/complex businesses
- To increase energy efficiency and quality through self-automated recovery system

Key Technology Deliverables

- Pilot smart grid technology: distribution/transmission ('12)
- Implement self/automated recovery system for broad area

Business Models

- Testing/certifying system of smart power grid technology
- Exporting key smart power grid

Goals by Critical Index

<table>
<thead>
<tr>
<th>Transmission/Distribution Loss(%)</th>
<th>Power failure (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>'12 3.9 '20 3.5 '30 3.0</td>
<td>'12 15 '20 12 '30 9</td>
</tr>
</tbody>
</table>
**Domain 5 - Smart Electricity Service**

**Objectives**
- To encourage TOU pricing with consumer participation
- To promote on-line system for power exchange and derivatives

**Key Technology Deliverables**
- Develop real time pricing and demand response system (’12)
- Develop on-line power exchange system (2020)

**Business Models**
- Customer based power providers
- Diverse power derivatives are expected to emerge

**Goals by Critical Index**

<table>
<thead>
<tr>
<th>TOU billing</th>
<th>Consumer participation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration</td>
<td>Nationwide</td>
</tr>
<tr>
<td>'12</td>
<td>'20</td>
</tr>
<tr>
<td>15</td>
<td>Pilot City</td>
</tr>
</tbody>
</table>
New Business Models

**Demand Response**
- 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
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 and 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
General aspects
Jeju Field Trial
Lessons Learned
Roadmap by MKE

- **2009**
  - Smart Grid promotion law enacted

- **2010**
  - Jeju Field Trial Started

- **2011**
  - 1st 5 year Action Plan launched

- **2012**
  - Jeju Field Trial 2nd Stage

- **2013**
  - May

- **2017**
  - Jeju Trial completed

- **2020**
  - Metro-wide Smart Grid

- **2030**
  - Nationwide Smart Grid
**Smart Grid Promotion Law**

**Backgrounds**

Needs for Systematic & consistent Smart Grid Business promotion

Limitation of current regulation and systems

Promoting Integration of power infrastructure with IT for co-growth

**Legislation**

- Set up Smart Grid Implementation Action Plan (5 year span)
- Smart Grid Service Provider Registration
- Subsidies for Smart Grid Private Investment
- Dedicate Areas for Smart Grid Implementation
- Certification & Standardization
Obstacles

Holdbacks Against Early Deployment

- Regulation (for Smart Grid Trials)
- Skeptical Eyes of Stakeholders
- Low Consumers’ Participation (Weak Impact on Residential Consumer)
- Lack of Business Models
- Reluctance of Market Player with Vested Interest
- Lack of Private Investment Attraction
- Low and Uniform Pricing
- Low Incentives for Private Investment
- Too Many Technologies Options vs. No Technology
Implications

Solutions for Early Deployment

- Deregulation for Market Entry, Competition
- Dedicated Joint (Gov + Private) Organization for Smart Grid Planning
- Government’s consistent Will and Driving Force
- Promotion to Provoke Participation
- R&D Competition and Incentives
- Discover DR Resources and setting up utilization plan
- Introduction of Various Pricing (TOU, CPP, Sliding Scale on Oil Price)
- Technology vs. Behavior (Habits)
- Budget for Operation for DR Market
- Make most of Other Industry Technologies
- Voluntary Competition among Local Autonomous Governments
- Network Security & Data Privacy Preparation
**Smart Grid – National Roadmap**

**Vision and Goals of Korea’s Smart Grid**

**Vision**
- Pave the way for low carbon, green growth through a Smart Grid
- Build a nationwide Smart Grid

**Goals by phase**
- Build a Smart Grid Test-bed 2012
- Build a Smart Grid across metropolitan areas 2020
- Build a nationwide Smart Grid 2030

**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

**Effects from introducing smart grid system nationwide by 2030**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creation of new jobs</td>
<td>50,000</td>
</tr>
<tr>
<td>Reduction of GHG</td>
<td>230 Million t</td>
</tr>
<tr>
<td>Reduction in energy imports</td>
<td>47 Trillion won</td>
</tr>
<tr>
<td>Increase in smart grid related exports</td>
<td>49 Trillion won</td>
</tr>
<tr>
<td>Creation of smart grid-related demand</td>
<td>74 Trillion won</td>
</tr>
<tr>
<td>Reduction in construction costs of new power plants</td>
<td>3.2 Trillion won</td>
</tr>
</tbody>
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THANK YOU FOR YOUR ATTENTION!