KEPCO’s SG Biz Model and Strategies for Expanding

Nov 19. 2014

KEPCO Smart Grid & ESS Department
Status and Background
1. KEPCO in Brief

- **Government**
  - 51%

- **Total Assets:** $133 billion
- **Revenues:** $45 billion
- **Customers:** 20,475,899
- **Employees:** 19,278 persons

(As of Dec. 31, 2013)

(1USD=1,100KRW)

**Generation Capacity & Peak**

<table>
<thead>
<tr>
<th>Year</th>
<th>'12</th>
<th>'13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (MW)</td>
<td>81,737</td>
<td>86,968</td>
</tr>
<tr>
<td>Peak (MW)</td>
<td>75,987</td>
<td>76,522</td>
</tr>
</tbody>
</table>

**Domestic:**
- 14 District Divisions
- 233 Branch Offices

**Generation:**
- 84%

**Transmission:**
- 100%

**Distribution:**
- 100%

**Power Sales:**

(51%)
2. Status of KPI

The Key Performances of KEPCO

![Graphs showing Key Performances of KEPCO](chart)

- **SAIDI**: System Average Interruption Duration Index
- **NDIS**: New Distribution Information System
- **MTPI**: Maintenance Technology without Power Interruption

*Note: The graph illustrates improvements in SAIDI, T&D Loss, and Load Factor with key performance initiatives such as New maintenance Technology, SCADA, DAS, NDIS, MTPI, Pilferage prevention program, Voltage upgrade, Low loss facilities AMI, Direct Load Control AMR Deployment, and Time Of Use.*
3. Power Quality and Operation System

Power Quality Improvement Saturation

- **Voltage C/R**
  - 2001: 99.86
  - 2007: 99.90
  - 2009: 99.99
  - 2011: 99.99

- **Frequency C/R**
  - 2001: 99.41
  - 2007: 99.80
  - 2009: 99.94
  - 2011: 99.94

- **SAIDI**
  - 1982: 555
  - 2000: 21
  - 2010: 15.1
  - 2011: 12.4

Cost increasing compared to the effects of power quality improvement

Limits of Power Systems Interconnection

Operating by Separated System

**SCADA**
- Monitoring transmission line
- Substation equipment monitoring, protection, control

**DAS**
- Monitoring distribution, remote control
- Voltage management
- Protective coordination

**AMR**
- Automation Meter Reading
- Measurements of customer voltage

- Increasing renewable sources
- Power equipment deterioration
- Difficulty to expansion
- Necessity of integrated system

Renewable

Integrated

6/36
4. Changes of Power Industry in Korea

**Carbon Dioxide Emission Reduction & Renewable Energy Expansion**

### National Target for CO₂ Reduction
- **30% Reduction from CO₂ Emission**
- Prospect by 2020

<table>
<thead>
<tr>
<th>Year</th>
<th>'05 Emissions (Unit: m Ton)</th>
<th>'20 Prediction of Emission</th>
<th>'20 Target of Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>594</td>
<td>813</td>
<td>569</td>
</tr>
</tbody>
</table>

### Increase in Renewable Energy Supply by Introduction of RPS
- **Renewable Energy Scale:** 2% ('12) → 10% ('22)
- **Photovoltaic Scale:** 200MW ('12) → 1,500MW ('16)

<table>
<thead>
<tr>
<th>Year</th>
<th>'12</th>
<th>'13</th>
<th>'14</th>
<th>'15</th>
<th>'16</th>
</tr>
</thead>
<tbody>
<tr>
<td>New (MW)</td>
<td>220</td>
<td>330</td>
<td>480</td>
<td>470</td>
<td>-</td>
</tr>
<tr>
<td>Sum (MW)</td>
<td>220</td>
<td>550</td>
<td>1,030</td>
<td>1,500</td>
<td>1,500</td>
</tr>
</tbody>
</table>

- RPS (Renewable Portfolio Standard): Energy providers must supply and sell a certain percentage of produced energy by renewable energy, since 2012
4. Changes of Power Industry in Korea

Expansion Plan of EV & Charging Infrastructure

**Electric Vehicle**

Unit: (Cumulative total) 1,046,200

**Charging Stations**

Unit: (Cumulative total) 22,200

**Quick Charger**

- Planning: 85,700
- Performance: 1,896

**Slow Charger**

- Planning: 70
- Performance: 170
5. National Smart Grid Road Map

- 2009: Selection Jeju Island as SG Test Bed
- 2011: Completion of Infrastructure for SG Test Bed
- 2012: Announcement of the 1st SG Master Plan
- 2013: Enforcement of Promotion Act of SG
- 2015: Implementation of SG Deployment Projects
- 2015: Selection of Hub Cities for SG Expansion to Mainland
- 2020: Metropolitan Smart Grid
- 2030: Nationwide Smart Grid
Incubating SG Biz Models
SG Demonstration Projects in Jeju

**Goal**
To Develop Smart Grid into the Business Model and the Export-Oriented Industry

**Duration**
Dec, 2009 ~ May, 2013 (42 months)

**Budgets**
About 240 million dollars

**Scale**
2 Substations, 4 Distribution Lines, Around 6,000 Households

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5 sub-projects of Smart Grid

1. **Smart Power Grid**
   - Real-time monitoring & control for intelligent T&D power system

2. **Smart Customer**
   - Enhancing energy efficiency through demand response
   - Two-way information exchange between consumers and suppliers

3. **Smart Transportation**
   - EV charging infrastructure
   - Control center for charging infrastructure

4. **Smart Renewable**
   - Connection of renewable energy to the grid
   - Power quality compensation & stabilization of output

5. **Smart Elec. Service**
   - Development of various tariffs and service models
1. Smart Power Grid - Intelligent Transmission

**Target**
- To monitor power status and prevent faults of power facility
- To enlarge the capacity of transmission line through real time calculation based on conductor temperature

**Testing Facilities**
5 Sensors (Solar radiation, Wind direction/velocity, Ambient temperature, Current, Line temperature, Dip), 1 OS

![Diagram of testing facilities](image-url)
1-2. Smart Power Grid – Digital Substation

**Target**
Reduction of fault and introduction of international standard protocol

**Testing Facilities**
IEDs (3 kinds 26 sets for 154kV T/L, M.Tr and 23kV GIS)
* IED: Intelligent Electronic Device

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**Front View of Building**

**Image**

**Devices**
- 170kV GIS
- IED for Transmission Lines (8)
- 154kV M.Tr
- IED for Transformers (5)
- 25.8kV GIS
- IED for Distribution Lines (13)
Target
- To monitor DG & power quality of distribution lines and detect bi-directional fault current

Testing Facilities
- Intelligent Re-closer, S/W, Lightning Monitoring unit, DG Interface unit
2. Smart Place

- **Target**: To develop the optimal service model for Smart Place (Customer)
- **Facilities**: Smart meters, IHD, smart appliances, renewable energy resources being installed in customer’s houses
- **Operation**: Remote meter reading, demand response, TOU, and RTP
3. Smart Transportation

**Target**
- Construction of charging infrastructure to expand EV deployment
- To find optimal business models for EV operation

**Partners**
22 Companies including KEPCO (Charging Station 29 places)

**Slow-Charger**
- Method: built-in charger $\rightarrow$ battery
- Supply voltage: AC 220V (35A)
- Charge capacity: 7.7kW
- Charging time: within 6 ~ 8 hours

**Quick-Charger**
- Method: DC power supply $\rightarrow$ battery
- Supply voltage: DC 450V (110A)
- Charge capacity: 50kW
- Charging time: within 10 ~ 30 minutes
4. Smart Renewable

**Target**
To connect the DER to Power Grid and secure power quality by using energy storage devices and electric quality compensation devices

**Partners**
17 Companies including KEPCO (Total 1,670kW)
5. Smart Electricity Service

Target
TOC construction / Development of Next-generation Electricity Service Models

Partners
KEPCO / KPX

- Monitoring Test-bed Info
- Performance Evaluation
- Real-Time Price Service Portal
- Analysis DR Service Center

KEPCO Legacy Sys
- New Customer Info Sys
- New Distribution Info Sys
- Outage Management Sys

Smart Place
- Operating Info
- Real Time Tariff

Smart Transportation
- Meter Reading
- Operating Info

Smart Renewable

Power Grid

KEPX Market Sys
- Domestic: 1 Day ago (CBP)
- Oversea: 1 Day ago, Real Time Price
### Results & Business Model

- **Development & Test of 153 Technologies including AMI, EMS, Charging Infra, ESS**
- **Development of 9 Business Models including DR Management, EV charging Service**
  - (45 detailed models)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Power Grid Devices</td>
<td>Smart Sensors, IED, Plug and play type Monitoring Device for DG, including next Generation Tech. of Power Grid</td>
</tr>
<tr>
<td>ESS</td>
<td>Conjunction with DG, Development of Management Technology for Large Scale Battery</td>
</tr>
<tr>
<td>EMS</td>
<td>Monitoring the Energy Flow and Verify a Optimal Control Technology</td>
</tr>
<tr>
<td>EV Charging</td>
<td>Development of Quick · Slow Charger &amp; Making EV Communication Infrastructure</td>
</tr>
<tr>
<td>AMI</td>
<td>Demand Response by Real-time Communication</td>
</tr>
<tr>
<td>Grid Integration Technology</td>
<td>Connecting Micro-grid, Renewable, Electric Car Battery to the Power Grid and Allow Electricity to Transmit both Ways</td>
</tr>
</tbody>
</table>

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**KEPCO**

19/36
Implementing SG Biz Models
1. MG System for Isolated Island

- **Target**
  Replacement Diesel Generation to Renewable Energy and Smart grid

- **Duration**: Nov. 2011 ~ Oct. 2013 (2 years)

- **Partners**
  KEPCO, Jeju, KOSPO, Woojin, Shin-kobe co.

- **Location**: Gapa Island in Jeju

- **Configuration**
1. MG System for Isolated Island

Components

- Seawater Desalination Plant (50kW)
- Advanced Distribution Automation System
- Micro-Grid Operation Center
- Energy Storage System (1.86MWh)
- RTU for Diesel Generation (150kW*3)
- PCS (1.35MVA)
- Advanced Metering Infrastructure
- EV Charging 3 units

PV - 30kW*1 - 3kW*37
WP 250kW*2
2. AMI (Advanced Metering Infrastructure)

### Key Performances

- **Controlling** Power Demand through sending Demand Response signal by Bidirectional Communication Network
- **Supporting** Utility’s Businesses Such as Marketing and Distribution Area

### Configuration

![Configuration Diagram](image)

### Installation Plan (Budget $1,562 million)

<table>
<thead>
<tr>
<th>Item</th>
<th>‘13</th>
<th>‘14</th>
<th>‘15</th>
<th>‘16</th>
<th>‘17</th>
<th>‘18</th>
<th>‘19</th>
<th>‘20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation (10 thousand unit)</td>
<td>200</td>
<td>230</td>
<td>250</td>
<td>257</td>
<td>250</td>
<td>250</td>
<td>330</td>
<td>364</td>
</tr>
<tr>
<td>Cumulative Installation (10 thousand unit)</td>
<td>263</td>
<td>493</td>
<td>743</td>
<td>1,000</td>
<td>1,250</td>
<td>1,500</td>
<td>1,830</td>
<td>2,194</td>
</tr>
</tbody>
</table>
3. ESS Management Technology

Key Functions
- Demand Mgt., Load Leveling, Stabilization of Renewable Energy

Scale
- 4MW/8MWh Li-ion Battery

Duration /Budget
- 2011. 7 ~ 2014. 6 (3 years) / $24.1 million

Partners
- KEPCO, Samsung SDI, Hyosung, KPX, Etc.

Location
- Jeju 154kV Jocheon Substation (Currently in Operation)

Configuration

Substation 22.9kV Bus
- PMS: Power Management System
- PCS: Power Conditioning System
- BMS: Battery Management System

Image
- Battery Room
- ESS
- PCS

MarineD/L (Wind Power)

CB

CB
### 4. ESS for F/R – Pilot Project

#### Installation Sites

<table>
<thead>
<tr>
<th></th>
<th>Site #1 Seo-Anseong S/S</th>
<th>Site #2 Shin-Yongin S/S</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capacity (MW)</td>
<td>28</td>
<td>24</td>
<td>52</td>
</tr>
<tr>
<td>Participating Companies</td>
<td>PCS : 2 Battery : 2</td>
<td>PCS : 2 Battery : 1</td>
<td>7</td>
</tr>
</tbody>
</table>

#### Locations

- **345kV Seo-Anseong S/S (28MW)**
- **345kV Shin-Yongin S/S (24MW)**
4. ESS for F/R – Pilot Project

**Schedule**

- **Sep. ’14**: Start Construction
- **Sep. ~ Nov. ’14**: Installing Grid Connected Facility (M.Tr, CB)
- **Nov. ~ Dec. ’14**: Installation ESS
- **Jan. ’15~Jun**: Test & Operation

**Components**

**Bird-Eye’s view**

- 154kV 모선
- 1차 변압기
- 22.9kV GIS
- PCS
- 베타리

16kW-30kW ESS (용량: 11.75MWh, 40ft: 8set)
5. SGIOS and EV Sharing

**SG Integration Operation System**

- **Goal**: Providing Information and Business Support using SPG Data
- **Duration**: ’11.5 ~ ’14.4 (36months)
- **Budget**: $15.5 million
- **Main Development Contents**
  - Building of Global Standard (CIM) based SG Total Platform
  - Development of Operation System that can Analyze, Adjust & Plan Transmission/Substation/Distribution/NCIS
- ※ Demonstration at JeonNam (’13.10~’14.4)

**EV Sharing Pilot Project**

- **Goal**: Development of EV Sharing Business Model and Securing of Operation Technique
- **Duration**: ’11.12 ~ ’14.7
- **Budget**: $4.5 million
  (Government $2.6M, KEPCO $1.2M & Etc.)
- **Area**: Seoul, Bundang, Ilsan
- **Scale**: EV 20EA, Charger 18 Unit
6. Smart Grid Station

**Overview**

- **Goal**: Optimization of Building Energy management by using SG
- **Duration**: ‘13.10 ~ ‘13.12 (3months)
- **Main Development Contents**
  - PV, ESS, Smart Plug, Light control,
  - BAS, AMI, SG Station Center
  - Demand management & control
  - Smart Equipment
- **Expected Effects**
  - Peak reduction 5% of total kW
  - Energy saving 9.6% of total kWh
  - CO2 emissions reduction 12t/yr
SGS Operation System

System Configuration

Power Demand Control

Realtime Operation Monitor

Analysis & Record
Ⅳ Strategies for Expanding
1. SG Expansion Project

**Concept**
Commercializing BM Based on Jeju Test Bed in Hub Cities for Expanding

**Duration/Budget**
2015 ~ 2017 / $155 million

**Cost covered**
National, Local Govt and Corporate Matching Funds

**VISION**
Leading National Smart Grid Implementation

- Energy Saving Efficiency Improvement
- Peak Reduction
- CO₂ Reduction

1. DR Management
2. EV Charging Service
3. Energy Consumption Consulting
4. Intelligent Grid Stabilization
1. SG Expansion Project

Regional Business Model

Seoul (Educational institutions)
- Power Trading by DER(ESS, V2G)
- EV Charging Infra, Car Sharing
- Power resale(AMI)

Inchun (Industry Complex)
- DR(BEMS/FEMS+ESS)
- EV Charging Infra
- Energy Consulting(AMI)

ChungNam (New Town)
- DR(BEMS+ESS)
- EV Charging Infra, Car Sharing
- Power Trading by DER(ESS, V2G)

JeonBuk (SaeManGum Area)
- Power resale(AMI)
- EV Charging Infra, Car Sharing
- DR(BEMS+ESS)

NamYangJu (Complex Town)
- Power Trading by DER(ESS, V2G)
- EV Charging Infra
- Energy Consulting(AMI)

Gangreung (Eco-Friendly Town)
- Energy Consulting(AMI)
- EV Charging Infra
- Renewable + ESS (Improved utilization)

KyungBuk (Educational institutions)
- Power Trading by DER(ESS, V2G)
- EV Charging Infra
- Renewable + ESS (Improved utilization)

Jeju (Renewable, EV Tour)
- Power resale(AMI)
- EV Charging Infra
- DR(BEMS+ESS)
- Renewable + ESS (Improved utilization)
2. Action Plan of SG Station Expansion

**Expansion of Company Office**

**Expansion of 220 KEPCO's Offices ('14 ~ '16)**
- '14: 29 Offices with Contracted Power of over 300kW
- '15: 90 Offices with Contracted Power of 300kW or more

**Expansion of Technology**

**Implementing WP, Smart Appliances, V2G, etc ('14 ~ '15)**
- Interconnection nearby Buildings and Devices ‘Cloud-Centric SG Station’
- KEPCO Academy: Training & Edu. of Design and Operation for SG Station
- KEPRI: Improvement of SG Station and Development of New BM (R&D)

**Expansion of Area**

**Smart Grid Expansion Business, to Nationwide ('14 ~ '17)**
- '14: Consultation on Civil Applicants and Establishment
- '15: Building a BM for the Government’s SG Expansion Business
- '14 ~ : ECO-friendly Smart city and Conducting intelligent DR
3. Action Plan for ESS Deployment

Business Target

- **Biz Target**: Securing F/R ESS of 500MW for coal-fired Thermal power

<table>
<thead>
<tr>
<th>Item</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale (MW)</td>
<td>50</td>
<td>50</td>
<td>200</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>Budget (₩100 mil)</td>
<td>625</td>
<td>625</td>
<td>2,500</td>
<td>2,500</td>
<td>6,250</td>
</tr>
</tbody>
</table>

2014 Plan

- **Progress Plan**: Installing ESS to meet the Response Standards of Power Market Operation Rules
- **Capacity Installed**: 50MW
- **Progress Schedule**
  - ‘14. 2: Planning
  - ‘14. 3: Design
  - ‘14. 5: Check & Review
  - ‘14. 8: Order
  - ‘14. 10: Construction
### 4. Action Plan of Implementing MG

<table>
<thead>
<tr>
<th></th>
<th>In Operation</th>
<th>On the Way</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area/Population</strong></td>
<td>0.85km² / 281</td>
<td>22.97km² / 1,919</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>193</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Configuration</strong></td>
<td>WT+PV+ESS+AMI</td>
<td>WT+PV+ESS+EMS + Geotherm</td>
</tr>
<tr>
<td><strong>Feature</strong></td>
<td>Carbon Free Island</td>
<td>Ecology Energy Independent Island (Stabilization, Optimization)</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Operating</td>
<td>Project Started</td>
</tr>
</tbody>
</table>

- **Gapa Island**
  - Carbon Free Island (Korea’s First)
  - Operating

- **Deokjeok Island**
  - Ecology Energy Independent Island (Stabilization, Optimization)
  - Project Started

- **Ulleung Island**
  - Green Energy Independence Island (Economic feasibility + Supply reliability)
  - Planning
THANK YOU FOR YOUR ATTENTION!!

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