APEC Workshop on Small Hydro and Renewable Grid Integration

Smart Grid Master Plan in Chinese Taipei

Bureau of Energy, MOEA

April 5, 2013
Outlines

I. Introduction

II. Smart Grids in Chinese Taipei

III. Investment and Expected Benefits

IV. Summary
## Power System in Chinese Taipei

| Source: Bureau of Energy, Ministry of Economic Affairs |

### Power System (2011)

- **Power Capacity**: 48,750 MW
- **Power Generation**: 252,173 GWh

### Install Capacity and Power Generation

| Source: Bureau of Energy, Ministry of Economic Affairs |

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Install Capacity</th>
<th>Power Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Hydro</td>
<td>5.34%</td>
<td>1.15%</td>
</tr>
<tr>
<td>Coal</td>
<td>39.65%</td>
<td>49.47%</td>
</tr>
<tr>
<td>Oil</td>
<td>7.70%</td>
<td>3.27%</td>
</tr>
<tr>
<td>LNG</td>
<td>32.54%</td>
<td>25.84%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>10.55%</td>
<td>16.70%</td>
</tr>
<tr>
<td>Renewable Energy</td>
<td>6.92%</td>
<td>3.56%</td>
</tr>
<tr>
<td>Conventional Hydro</td>
<td>4.19%</td>
<td>1.59%</td>
</tr>
<tr>
<td>Wind</td>
<td>1.07%</td>
<td>0.59%</td>
</tr>
<tr>
<td>PV</td>
<td>0.15%</td>
<td>0.03%</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.23%</td>
<td>0.13%</td>
</tr>
<tr>
<td>Waste</td>
<td>1.28%</td>
<td>1.23%</td>
</tr>
</tbody>
</table>
Hydro Power System

Total 15 hydro power plants contribute 9.52% of total installed capacity and 2.74% of power generation in 2011.

One pump hydro contributes 36.4% of total hydro power capacity.

The others are conventional hydro power plant. 2 of them with capacity > 1 GW; 3 of them with capacity between 100 ~ 200 MW, the other 9 less than 100 MW.
The installed capacity of renewable energy was 3,683 MW in Dec 2012.
Targeted renewable power generation capacity is 12.5 GW by 2030.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>2012</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-shore Wind</td>
<td>621</td>
<td>866</td>
<td>1,200</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Off-shore Wind</td>
<td>0</td>
<td>15</td>
<td>600</td>
<td>1,800</td>
<td>3,000</td>
</tr>
<tr>
<td>Hydro Power</td>
<td>2,060</td>
<td>2,052</td>
<td>2,112</td>
<td>2,502</td>
<td>2,502</td>
</tr>
<tr>
<td>Solar PV</td>
<td>201</td>
<td>492</td>
<td>1,020</td>
<td>2,500</td>
<td>3,100</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0</td>
<td>4</td>
<td>66</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Biogas</td>
<td>9</td>
<td>29</td>
<td>29</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Waste to Energy</td>
<td>792</td>
<td>848</td>
<td>925</td>
<td>1,369</td>
<td>1,369</td>
</tr>
<tr>
<td>Ocean Energy</td>
<td>0</td>
<td>1</td>
<td>30</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>H2&amp;Fuel Cells</td>
<td>0</td>
<td>7</td>
<td>60</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>Total</td>
<td>3,683</td>
<td>4,314</td>
<td>6,042</td>
<td>9,952</td>
<td>12,502</td>
</tr>
</tbody>
</table>

Percentage of installed capacity: 7.7%, 10.0%, 10.6%, 14.8%, 16.1%

Source: Bureau of Energy, Ministry of Economic Affairs
Why Smart Grid & Energy Storage?

- **EICT**
- **Smart Grid**
  - Central power plant
  - Smart Meter
  - Micro turbine
  - House
  - Industrial Plants
  - CHP
  - Fuel cells
  - Wind

- **Green Building**
  - Inverter
  - Washing machine
  - Dish washer
  - Bread machine
  - Display (PDA)

- **Storage Device**
  - Load simulation
  - 4D Dynamic simulation
  - Control of demand response management and load transition (variation)

- **BEMS/HEMS**
  - Demand – response management (Dynamic peak load adjustment)
  - Output/input

- **Building Energy Management System (BEMS)**
Scope of Smart Grids

- Generation and Dispatch
- Transmission
- Distribution
- Customers

- Dispatch center
- Renewable Generation
- T&DAS
- Energy Storage
- AMI
- Electrical Vehicle
- EMS
Scenario of Energy Storage

Larger scale renewable source balancing

Substation ride-through

Community storage (commercial, industrial, residential)

Distributed renewable resources

V2G storage

Source: 技術在線, 2009; ITRI, 2010
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Smart Grid Master Plan

- Bureau of Energy initiated the planning of “Smart Grid Master Plan”
- “Smart Grid Master Plan” is announced on 3 Sept. 2012.

**Vision**
To establish a high quality, high efficiency and environmental friendly smart grid to get forward the realization of the low carbon society and sustainable development.

**Objectives**
To Ensure Reliable Power Supply; To Encourage Energy Conservation and Emission Reduction; To Enhance the Use of Green Energy; To Develop Low-Carbon Industry.

**Phase**
- **Phase I**
  - Technology Test
  - (2011~2015)
- **Phase II**
  - Technologies I. & P.
  - (2016~2020)
- **Phase III**
  - Technologies Extend App.
  - (2021~2030)

**Six Implementation Areas**
- Smart Generation & Dispatch
- Smart Transmission
- Smart Distribution
- Smart Users
- Smart Grid Industry
- Smart Grid Environment Construction
Objectives

(1) Ensure Reliable Power Supply:
   - The SAIDI (System Average Interruption Duration Index) should be maintained on the top five of the world in 2030. \(2030: 15.5 \text{min./year}\)
   - Reducing the power transmission loss from 4.8% to 4.4% in 2030.

(2) Encourage Energy Conservation and Emission Reduction:
   - Reducing 100 million ton CO\(_2\) emission per year in 2030.

(3) Enhance the Use of Green Energy:
   - Improving the renewable power interconnection capability to 30% in 2030.

(4) Develop Low-carbon Industry:
   - Driving smart grid industry to create NTD 700 billion value in 2030.
Six Implementation Areas

Smart Generation & Dispatch
- Enhance the use of renewable energy.
- To improve the efficiency/reliability of power plants.

Smart Transmission
- Improve the efficiency of power transmission.
- Improve the safety of power transmission.

Smart Grid Industry
- Key equipment and service
- Develop user information infrastructure
- Prospective service

Smart Users

Smart Distribution
- Improve the efficiency and the safety of distribution network.
- Integrate the distributed energy.

Environment Construction
- R&D
- Standard
- Regulation/Policy
- Demo Site
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The total investment is around USD $4 billion during 2011-2030

**Investment**

- **Smart Customer**: 68.5%
- **Smart Distribution**: 7.0%
- **Smart Transmission**: 7.6%
- **Smart Generation & Dispatch**: 5.3%
- **Environment**: 5.9%
- **Smart Grid Industry**: 5.6%
## Expected Benefits (1/2)

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</thead>
<tbody>
<tr>
<td>Ensure Reliable Power Supply</td>
<td>SAIDI (min/customer · year)</td>
<td>21</td>
<td>17.5</td>
<td>16</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>Reduced transmission loss (%)</td>
<td>4.72</td>
<td>4.64</td>
<td>4.54</td>
<td>4.42</td>
</tr>
<tr>
<td></td>
<td>Improve power supply bottleneck</td>
<td>64 item</td>
<td>solve 20%</td>
<td>solve 40%</td>
<td>solve 80%</td>
</tr>
<tr>
<td></td>
<td>Smart Substation</td>
<td>-</td>
<td>25 stations</td>
<td>303 stations</td>
<td>583 stations</td>
</tr>
<tr>
<td></td>
<td>DAS</td>
<td>70%</td>
<td>80%</td>
<td>88%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>AMI (meters)</td>
<td>HV 1,200</td>
<td>HV 23,000</td>
<td>LV 6 million</td>
<td>national wide deployment</td>
</tr>
</tbody>
</table>
## Expected Benefits (2/2)

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Conservation and Emission-Reduction</td>
<td>Emission-Reduction (million To ton./year)</td>
<td>-</td>
<td>11.78</td>
<td>35.99</td>
<td>114.71</td>
</tr>
<tr>
<td>Enhance the Use of Green Energy</td>
<td>Improving renewable power interconnection capacity (penetration)</td>
<td>10% under</td>
<td>15%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Develop Low-carbon Industry</td>
<td>Smart Grid Revenues (NTD)</td>
<td>25 billion</td>
<td>100 billion</td>
<td>300 billion</td>
<td>700 billion</td>
</tr>
</tbody>
</table>
The expectations of Smart Grid Master Plan are not only to upgrade existing power grids, but also to enhance the supplementary schemes including regulations and policies.

Following work:

- A supra-ministerial mechanism is required to coordinate the resources and manage the progress of different departments.
- Establish a rolling review mechanism to adjust objectives of each phase.
Thank you for your attention

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