Developments, Challenges, Opportunities & Prospects of Smart Grid in China
Outline

1. Development & Achievements
2. Challenges and Opportunities
3. Future Prospects
1.1 Overview of SGCC

Largest utility in the world
Total Assets 426.7 billion USD
Ranked 7 in Fortune Global 500

2013 Revenue 341.5 billion USD
1.1 billion customers
Annual Sales 3522.7 TWh
1.2 Concept of strong & smart grid

Concept of strong & smart grid

Systematic strategy framework

SGCC Master Plan on Smart Grid (2009-2020)

SGCC 12th Five-Year Plan of Smart Grid

Strong Smart Grid:
Take the UHV power grid as the backbone network, with coordinated development of subordinate grids at all levels and featured by IT-based, automated and interactive.

Targets of Smart Grid development
1.3 Development planning of strong & smart grid

SGCC develops 3 stages to promote the construction of strong & smart grid:

2nd Stage  Comprehensive construction

Speed up the construction of UHV power grid and urban-rural distribution network, form the operation control and interactive service system of smart grid, and achieve the breakthrough and extensive application of key technology and equipment.

2011 ～ 2015

1st Stage  Planning & pilot

Focus on the development and planning of strong & smart grid, develop the technical and management standards, launch the key technology and equipment R & D, and carry out the pilot work in each sector.

2009～ 2010

3rd Stage  Improvement

Almost completed the strong smart grid, improve the grid resource allocation capability, safety, efficiency, and significantly increase interaction among the power grid, power sources and users.

2016 ～ 2020
The published "Smart Grid Technology Standard System Planning" proposes 8 major directions, 26 technical fields, 92 standard series, and recommends 22 key standards.

Develop and revise 220 corporation standards, 97 industry standards and 30 national standards, develop 14 International standards with IEC and IEEE.

The published "smart grid key equipment (system) development plan" covers 7 fields, 28 topics and 153 key equipment. Currently 132 key equipment & systems has been completed.
1.5 R&D Capability and Facilities

National Wind Power Integration R&D (Test) Center (NWIC)
(Established in Nov, 2009)

National Solar Power Generation R&D (Test) Center
(Established in Sep, 2009)

National Energy R&D (Test) Center for Smart Grid
(Established in Oct, 2010)
1.5 R&D Capability and Facilities

National Smart Grid R&D Center

- Smart transmission technology sub-center
- Flexible transmission technology sub-center
- Micro-grid technology sub-center
- Customized power technology sub-center
- IT security sub-center
- Energy storage technology sub-center
- Energy efficiency technology sub-center
Since **2009**, there have been **298** demonstration projects completed and put into operation.
1.6.1 UHV AC/DC Transmission

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Start date</th>
<th>commissioning date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huainan-Shanghai</td>
<td>10/2011</td>
<td>09/2013</td>
</tr>
<tr>
<td>Zhebei-Fuzhou</td>
<td>04/2013</td>
<td>12/2014</td>
</tr>
<tr>
<td>Xiangjiaba-Shanghai</td>
<td>12/2007</td>
<td>07/2010</td>
</tr>
<tr>
<td>Pingjin-Sunan</td>
<td>12/2009</td>
<td>12/2012</td>
</tr>
<tr>
<td>Hami-Zhengzhou</td>
<td>05/2012</td>
<td>01/2014</td>
</tr>
<tr>
<td>Xiluodu-Zhexi</td>
<td>07/2012</td>
<td>06/2014</td>
</tr>
</tbody>
</table>

Legend
- **1000kV AC**, Commercial operation
- **1000kV AC**, Under construction
- **±800kV DC**, Commercial operation
- **±800kV DC**, Under construction
1.6.2 Zhoushan multi-terminal Flexible HVDC Project

- Improve power reliability
- Improve power quality
- Improve the operation flexibility of system dispatching and solve the problem of renewable energy integration

**1st five-terminal flexible HVDC project in the world put in operation in 2014**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Commissioning date</th>
<th>Capacity / voltage</th>
<th>No. of Terminal</th>
<th>Application field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhoushan Islands Interconnection (China)</td>
<td>2014.6</td>
<td>400MW ±200kV</td>
<td>5</td>
<td>Islands inter-connection wind power integration</td>
</tr>
<tr>
<td>Nanao Wind Farm Integration (China)</td>
<td>2014.12</td>
<td>200MW ±160kV</td>
<td>4</td>
<td>Wind power integration</td>
</tr>
<tr>
<td>Super Station (United States)</td>
<td>2015.12</td>
<td>750MW ±345kV</td>
<td>3</td>
<td>Power grid inter-connection electricity trading</td>
</tr>
<tr>
<td>South-West Southern (Sweden - Norway)</td>
<td>2016.6</td>
<td>700MW ±300kV</td>
<td>3</td>
<td>Power grid inter-connection wind power integration</td>
</tr>
</tbody>
</table>
1.6.3 Zhangbei Wind-PV-ES-Transmission Demo project

- **Zhangbei Demo Project**
  - **1\textsuperscript{st} Phase Capacity:** wind power 100MW, PV power 40MW, energy storage 20MW, with one 220kV smart substation
  - **2\textsuperscript{nd} Phase Capacity:** wind power 400MW, PV power 60MW, energy storage 50MW
  - The Wind-PV-ES output power quality is similar to that of conventional power source

- **Renewable Generation Prediction**
  - **Weather forecast center**
  - 6 pilot projects on renewable energy generation predication in Xinjiang, Jilin, Gansu and etc.
  - Wind power generation predication system used in 810 wind farms.

Till March 2014, 74.64 GW wind power and 18.41 GW PV power have been integrated to the grid.
1.6.4 Smart Transformation

- 927 Smart Substation built and put into operation
- 6 demonstration projects on smart substation upgrade according to business requirement.

Full optical-fiber electronic Instrument transformer  Smart Patrol Robot  Smart Station in Hubei
1.6.5 Smart Distribution

Distribution Automation

- Distribution automation systems in core areas of 65 cities

DG and Microgrid

A series of measures were published, with commitment to the free integration and full acquisition of distributed PV power generation. So far 2.79 GW (3039 households) distributed PV power are integrated to the grid in the business area.

- 《Opinion on the grid integration service of DG》
- 《Opinion on the management promotion of DG’s grid integration》
- 《Technical regulations on the DG’s integration in distribution network》

Dispatching Center in Qingdao

Pole Switches
1.6.6 Energy data acquire system

- The largest energy data acquire system in the world
- Complete 27 master station systems in provincial companies and put into operation
- 196 million smart meters installed, covering more than 2 million households
1.6.7 EV Facilities

Complete 400 charging/battery-swapping stations, 19,000 charging spots, covers 26 provinces

Su-hu-hang Inter-City demo project
- Commissioning in Dec, 2011
- 9 charging/battery-swap stations
- Achieve the provincial-cross travel
- Total operating mileage of 70,000 km

Qingdao Xuejiadao smart charging/swapping/storage integration station
- Commissioning in July, 2011
- Service 250 buses
- 223,000+ cumulative swaps
- Vehicle mileage of over 28.18 million km

Zhejiang charging/swapping service network
- 153 charging/battery-swapping stations, achieve Hangzhou’s five inter-city connectivity
- Servicing 700 EVs, including 200 taxis
- Total operating mileage of 30.65 million km
1.6.8 Smart Utilization

- Built 28 smart communities in Shanghai, Beijing, etc.
- Established 3 Smart buildings in Chongqing, Zhejiang & Shanghai and carried out 3 Smart Park pilots in Shandong, Jiangsu & Gansu, guiding the enterprises to participate in the demand response and improve the energy efficiency.

Smart community
Showcase in smart community

Electric service station system in Smart Park area
Rooftop PV in Smart Building
1.6.9 Comprehensive demonstration projects

7 smart grid comprehensive constructive projects have been completed and put into operation in Sino-Singapore Tianjin eco-city, Yangzhou Development Zone, Jiangxi Gongqing City, Zhejiang, Shaoxing New-District, Henan Zhengzhou New-District, Hunan Shaoshan, Shanghai Expo-Park, and 18 smart grid comprehensive demonstration projects are undergoing in Beijing, Shandong etc.

China’s President Xi is visiting the Sino-Singapore Tianjin eco-city.

The comprehensive smart grid demo project in Sino-Singapore Tianjin eco-city

1. DG integration
2. Energy storage
3. Comprehensive state monitoring of smart grid equipment
4. Smart substation
5. Distribution Automation
6. Power quality monitoring and control
7. Electric energy data acquire system
8. Smart community/building
9. EV charging/discharging infrastructure
10. Information and communication network
11. Grid Intelligent operation visualization platform
Outline

1. Development & Achievements
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2.1 Smart Grid and the third industrial revolution

- The smart grid provides the foundation platform of the 3rd industrial revolution, and plays a role on its overall promotion. In the promotion of energy reform and development of strategic emerging industries, the smart grid not only is facing challenges but also brings opportunities.
2.2 Promote the reform of energy consumption mode

- Based on new energy generation technology and large-scale energy storage technology, strong & smart grid provides powerful support for the integration of large-capacity renewable energy, promotes the reform on the energy development, and also faces huge challenges.

Since 2006, the integrated wind power capacity in SGCC business area grew 67 percent annually. Since 2010, the integrated solar power capacity increased at an annual rate of 300%.
2.3 Promote the reform of energy allocation mode

- Strong & smart grid can solve the energy distribution problem in China, promote the large-scale clustered energy development, and achieve the optimal energy allocation

- Large-scale energy power base
- UHV transmission
- Smart dispatching control system

Large-scale coal power base  Large-scale hydro-power base  Large-scale nuclear power base  Large-scale renewable energy generation base
2.4 Promote the reform of energy consumption mode

- Strong & smart grid adapts to the new challenges of energy consumption, brings new opportunities, and changes the energy consumption from one-way receiving to a flexible and interactive smart utilization mode.
2.5 Promote the development of strategic emerging industries

- Compared with the traditional inter-connected power grid, the strong smart grid has technology-intensive features and promotes new energy, new materials, intelligent equipment, electric vehicles, new-generation information industry and other emerging industries while facing new technology challenges.

- Improve the comprehensive technical level of intelligent equipment manufacturing

- Develop the progress on chip and new materials industry

- Promote the integration of the power industry and information industry and their technology mixing
Outline

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3.1 2015 Construction goal of smart grid

- At the end of 2015, installed capacity of integrated wind power reaches **140** GW, and solar power will reach **35** GW, to meet the national plan.

- Complete **5,700** 110 (66) kV and above smart substations in the commercial building areas.

- Average system interruption duration per year in the core area of key cities below **15 minutes**

- Promote the application of **340+ million** smart meters, providing the infrastructure security for the National development target of **500,000** EVs.
3.2 Smart Grid Demonstration Projects

Regarding DG’s rapid development and China urbanization construction policy, 6 types of 16 smart grid innovation demonstration projects are planned in 2014-2015.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Demonstration Task</th>
<th>Project Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support the development of renewable energy</td>
<td>Wind-PV-ES-Transmission Demonstration Project (2nd Phase)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Offshore Wind Power Testing Base</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Combined Heat and Wind Power Operation</td>
<td>1</td>
</tr>
<tr>
<td>Support the DG’s implementation</td>
<td>Multiple Energy Complementary of DG</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Coordinated Operation of Microgrid</td>
<td>3</td>
</tr>
<tr>
<td>Promote convenient power utilization</td>
<td>Smart Community</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Smart Building</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Smart Park Area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Smart Port</td>
<td>3</td>
</tr>
<tr>
<td>Promote the development of EV</td>
<td>EV’s Interaction with Grid</td>
<td>3</td>
</tr>
<tr>
<td>Service the construction of smart city</td>
<td>Smart City Supported by Smart Grid</td>
<td>9</td>
</tr>
<tr>
<td>Upgrade the grid’s &quot;smartness&quot;</td>
<td>330kV, 500kV New-generation Smart Substation</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Flexible HVDC transmission</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Smart Transmission Line</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>DC Distribution System</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Application of Network Technology in Substation Protection</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>41</td>
</tr>
</tbody>
</table>
3.2.1 Support the development of renewable energy

- Develop the research & practice in the overall control of various clean energy, off-shore wind power integration testing, and coordinated operation of controllable heating load.
3.2.2 Support the DG’s implementation

- Develop the research & practice in energy complementary of high-penetration DG, low-cost & practical security protection, and micro-grid power accurate control.
3.2.3 Promote convenient power utilization

- Develop the research & practice in smart meters with two-way interaction, demand response in commercial building and industrial park areas and smart port construction.
3.2.4 Promote the development of EV

- Develop the research & practice in real-time metering & billing of EV charging/battery-swapping infrastructure, vehicle information interaction, fast / normal charging integration, lower cost, function integration and better user experience.
3.2.5 Service the construction of smart city

- Develop the research & practice in the "energy Internet" of smart city and data mining of smart grid, etc.

Mass data analysis of smart city supported by smart grid
3.2.5 Upgrade the grid’s "smartness"

- Develop the research & practice in the network technology of integrated smart equipment and substation protection, flexible T&D technology and DC distribution system.
Conclusion

Smart Grid is not only the trend of the world's electricity development, but also the requirement for economic development and green societies.

State Grid Corporation of China is ready to share experiences with international peers and jointly promote research and development of smart grid to ensure safe, efficient, clean and sustainable energy supply.
Thank You

Provide clean energy, and build harmonious society.