Development of Distributed Generation and Microgrids in China

Prof. Chengshan Wang

School of Electrical Engineering and Automation
Tianjin University, Tianjin, China
Demand & Pressures & Resources

Increasing Energy Demand:

China is still in the stage of
- Industrialization
- Urbanization

Environmental Problems:

Chinese Government:

40%~45% of GHG Emission for unit GDP
will be reduced by 2020 compared to 2005.

Abundant Renewable Energy Resources

Solar Energy Resources
The 12th Five-Year Plan of the Development of Renewable Energy

Motivated by:

- Increasing energy demand
- Depleting fossil fuels
- Environmental problems
- Abundant renewable energy

To further:

- Adjust energy structure
- Transform economic development pattern
- Achieve sustainable development

Goal: The percentage of non-fossil energy (to energy consumption) will increase to: 11.4% by 2015 and 15% by 2020.
The 12th Five-Year Plan of the Development of Renewable Energy requires to promote the development of Distributed Renewable Energy.

By the year of 2015:

County:
- 200 Green Energy Demonstration Counties
- 1000 Solar Energy Demonstration Villages

City:
- 100 New Energy Demonstration Cities
- 1000 New Energy Demonstration Parks

Microgrids: 30 New Energy Microgrids

- Total investment is as much as 1800 billion Yuan (293 billion Dollars)
- Distributed energy is a vital part.
Incentives for DGs and Microgrids

Subsidies:
- Investment
- Electricity Price
- Access Charge

Development Fund:
- National Finance
- Other Incomes according to law

Tax Preferences:
- Levy-Refund Policy
- Discount taxable income
**Status: Distributed Generations in China**

**Installed Capacity of DGs of Major Countries in 2010**

- **China**: Installed Capacity (MW) range from 0 to 30,000
- **USA**: Installed Capacity (MW) range from 0 to 15,000
- **Japan**: Installed Capacity (MW) range from 0 to 10,000
- **Germany**: Installed Capacity (MW) range from 0 to 5,000
- **UK**: Installed Capacity (MW) range from 0 to 5,000
- **Denmark**: Installed Capacity (MW) range from 0 to 2,000

**Composition of DGs in China**

- **Geothermal**: 3%
- **Biomass**: 1%
- **Solar**: 2%
- **Comprehensive Utilization**: 5%
- **CCHP**: 19%
- **Small Hydro**: 67%
- **Wind**: 0%

**Graphical representation**

- **CCHP**: Light Green
- **Small Hydro**: Blue
- **Solar, Wind, etc**: Brown
- **Geothermal**: Light Purple
- **Biomass**: Light Green
- **Solar**: Beige
- **Comprehensive Utilization**: Beige
- **CCHP**: Orange
- **Small Hydro**: Blue
- **Wind**: Magenta
Status: Microgrids in China

Tens of Demonstration Microgrid Constructed

- Voltage Levels
  380V; 10kV
- Installed Capacity
  1 MW; 1MW - 5 MW
  5MW - 50 MW
The Integration of DGs and MGs into Smart Distribution Network:

**Challenges:**

- Theories & Technologies
  - Stability & Reliability
  - Protection & Control
  - Plan & Design
  - Energy Management
  - Cooperative Operation

- Policies & Standards:
  - Blank in many key links
  - Non-unified

**Solutions:**

- Fund research programs on key theories and technologies
- Form a complete and unified policy & standard system
- Build new adapted management system & market mechanism
Projects supported by the Ministry of S&T

- **High-Tech Research (36)**
- **Basic Research (2009~2011)**
- **Key-Tech R&D (2011~2015)**

- **875 Million (2011~2015)**
- **140 Million (2009~)**
- **120 Million (2011~2015)**
Key-Tech R&D supported by the Ministry of S&T

K1-K3:
Comprehensive Demonstration of Smart Distribution and Power Utilization
(1) Tianjin Eco-city
(2) Jiangxi Gongqing City
(3) Chongming Island (SH)

K4-K5:
Comprehensive Demonstration of Smart Grid
(1) Hainan Province
(2) Ningxia Province
Key-Tech R&D supported by the Ministry of S&T

Tianjin Eco-City:
- ADA, EV, ICT, AMI, DG, MG, ES, DSM
- ...

Ningxia Province:
- Large-Scale Renewables
- Smart TS
- Smart DS and MG
- Smart Dispatching
- ...

Hainan Island:
- ADA, EV, ICT, AMI, DG, MG, ES
- Smart Dispatching
- Large-Scale Renewables
- Blackouts Prevention
- ...

Chongming Island:
- ADA, EV, ICT, AMI, DG, MG, ES, DSM
- WF Integration
- Large-Scale ES
- DC-Microgrid
- Smart Dispatching
- ...

Gongqing City:
- ADA, EV, ICT, AMI, DG, MG, ES
- Smart Community
- Digital City
- ...

...
Dongfushan Island Microgrid

Past: Residential electricity shortages, and electricity supplied by diesel generation is expensive. Drinking water is produced from rain purification & shipped from Zhoushan Islands.

Wind: 210kW (7X30kW)  Lead-acid batteries: 2V/1200Ah (No.480)  PV: 100kW  Diesel G: 200kW
Seawater Desalination: 24kW

MG with clean energy power sources and seawater desalination system, to supply local electricity & water.
Sino-Singapore Tianjin Eco-city: Energy Station Microgrid

Components:

- Gas Turbines (1489 kW)
- PV Arrays (470 kW)
- Battery Storage
- Thermal Storage
- Ground Source Heat Pump
Operational Modes:

<table>
<thead>
<tr>
<th>Switch</th>
<th>Heating &amp; Cooling Seasons</th>
<th>Other Seasons</th>
<th>Fault Situations</th>
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<tbody>
<tr>
<td>K4</td>
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<tr>
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<tr>
<td>PCC2</td>
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Distributed Generation Units:

- PV: single-Si, poly-Si, thin film
- Wind Turbines: PMSG, DFIG
- CCHP System with Micro Turbine
- Fuel Cell: PEM Fuel Cell System

Energy Storage Systems:

- Static ESS: Lead-Acid, Li-Ion, Redox Flow, Super Capacitors
- Rotating ESS: Flywheel, Compressed Air
Microgrid Testbed in Tianjin University

50 Operation Modes:
- Single DG Unit
- Multi-DG Units in Single Bus
- Multi-DG Units in Multi-Buses

Equipped With:
- Protection System
- Monitor & Control System
- Microgrid Energy Management System
Relative Softwares Developed in TJU SG Lab.
THANK YOU

Prof. Chengshan Wang
Email: cswang@tju.edu.cn
Tianjin University, China