



Development Trends for Electricity Distribution Systems in China

Dr. Yinbiao SHU

**President
State Grid Corporation of China
10 June 2013**

Outline

- 1** SGCC profile
- 2** Current status of China's distribution systems
- 3** Opportunities and challenges
- 4** Development goals and directions
- 5** Conclusions

SGCC Profile

(1) Business Overview



Geographic coverage

88% of China's territory

Customers

over 1.1 billion (83%) of China's population

Employee

1.898 million

Core business

Power grid construction and operation

Overseas business

- National Grid Corporation of the Philippines (NGCP)
- National Energy Network of Portugal (REN)
- SG Brazil Holdings
- South Australia's ElectraNet

Fortune Global 500

7th in 2011 and 2012

(2) Key Performance Indicators

SGCC	2003	2012	Cumulative growth
Total asset (Billion USD)	168	373.4	124%
Revenue (Billion USD)	76.7	299.3	290%
Length of transmission line of 110kV and above (km)	304,666	713,081	134%
Transformation capacity of 110kV and above (GVA)	731	2,807	284%
Length of distribution line of 35kV and 10kV grid (km)	----	3,741,500	----
Transformation capacity of 35kV and 10kV grid (GVA)	----	984	----
Electricity sales (TWh)	11,20	32,54	191%

(3) Strong & Smart Grid Initiative

UHV AC & DC Transmission Projects:

- Highest operating voltage
- Longest transmission distance
- Largest transmission capacity

Smart Grid:

- Automated, ICT-based, interactive
- Covering Generation, Transmission, Transformation, Distribution, Consumption and Dispatching.



UHV AC & DC projects in operation



National Wind/Solar/ Energy Storage/Smart
Grid Demonstration Project

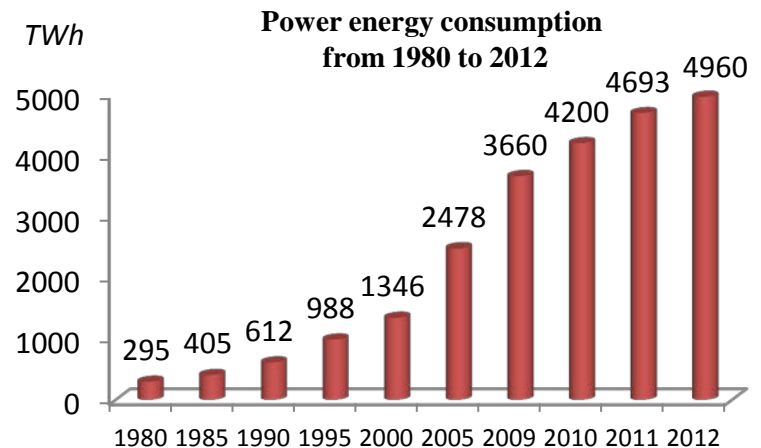
Outline

- 1 **SGCC profile**
- 2 **Current status of China's distribution systems**
- 3 **Opportunities and challenges**
- 4 **Development goals and directions**
- 5 **Conclusions**

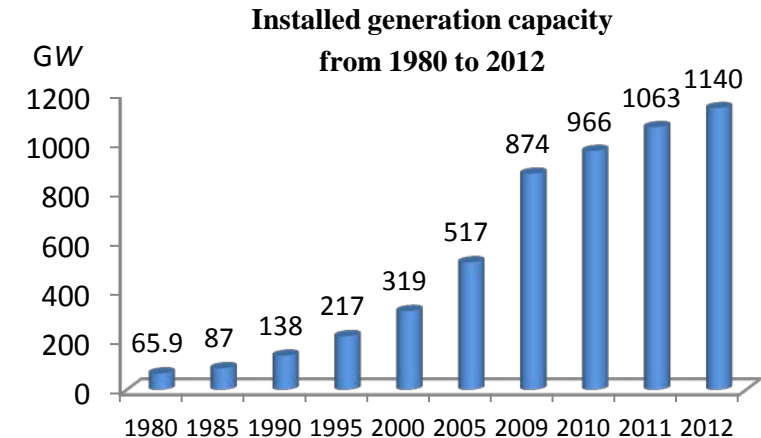
Current status of China distribution systems

(1) Fast Growing Electricity Demand

- **Power consumption in China:** 4960 TWh in 2012, and SGCC service area accounts for 80%.
- **Average annual growth rate:** 9.3% during the past 32 years.



- **Installed generation capacity in China:** 1140 GW in 2012 and SGCC service area accounts for 77%.
- **Average annual growth rate:** 9.4% during the past 32 years.



(2) Rapid Development of Renewable Energy

Total installed capacity by 2012 :

■ Wind Power :

60.8 GW (56.8 GW in SGCC).

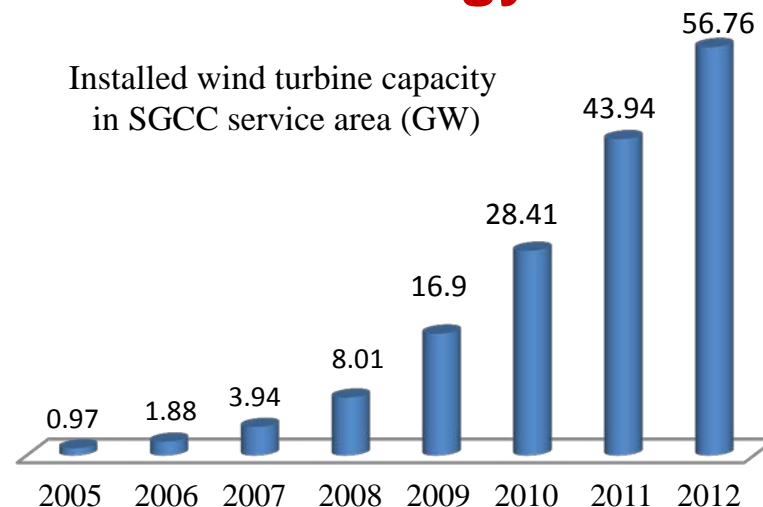
■ Solar Power :

3.58 GW (3.3 GW in SGCC).

■ Distributed Generation (DG) in SGCC: 34.36 GW, where:

- **Small Hydro:** 23.76 GW (account for 69%).
- **Distributed Wind:** 0.48 GW (account for 1.4%).
- **Distributed Solar:** 1.03 GW (account for 3%) .

Installed wind turbine capacity
in SGCC service area (GW)



DG types	Capacity (GW)
Small Hydro	23.76
Distributed Solar	1.03
Distributed Wind	0.48
Gas	0.38
Biomass	0.45
Waste Generation	0.96
Residual Heat	7.30
Total	34.36

(3) Specifics for China's Distribution Grids



Regional Differences:

East v.s. West

- Economic gap
- Grid scale and power supply quality

Urban v.s. Rural areas

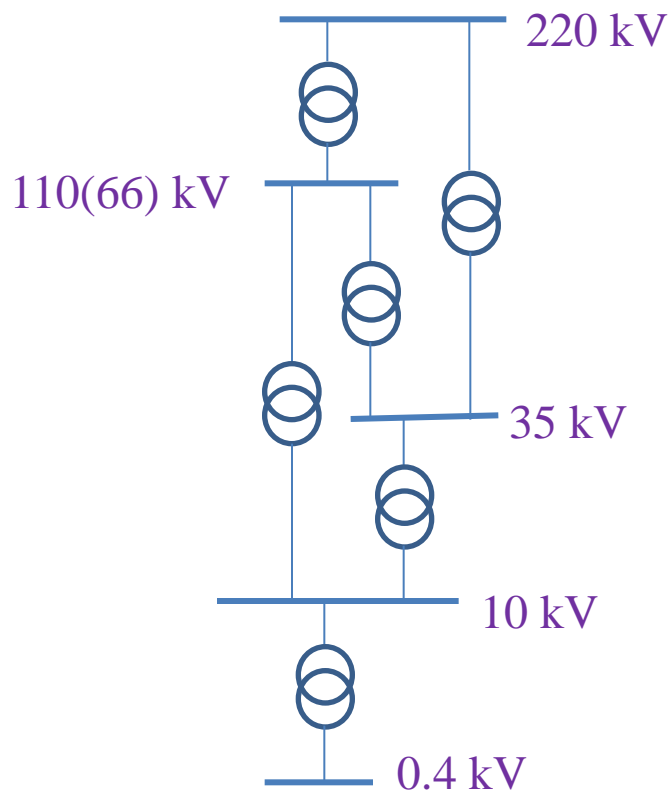
- Load density and consumption pattern
- Construction standards

North v.s. South

Coastal v.s. Inland

- Natural conditions
- Equipment selection principles

(4) Voltage Sequence



Major voltage sequence

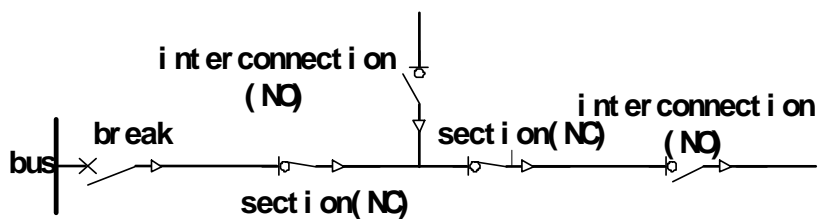
Most urban areas: 110 (66)/10/0.4 kV

Most rural areas: 35 (66)/10/0.4 kV

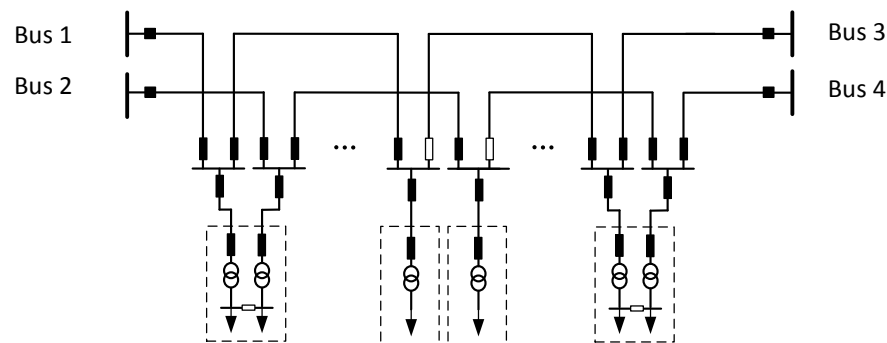
In some cities: 220/35/10/0.4 kV

(5) Network Structures

- 10 kV overhead lines: radial, multi-sectioned and multi-interconnection.
- 10 kV cables: radial, single loop and double loops.
- Interconnection rate of 10 kV distribution: 78% in urban areas in 2012.
- “N-1” compliance rate of 10 kV distribution: 68% in urban areas in 2012.



three sections with two interconnection (Overhead)



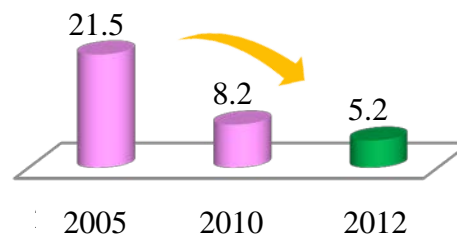
Double loops (cable)

(6) Operating Index

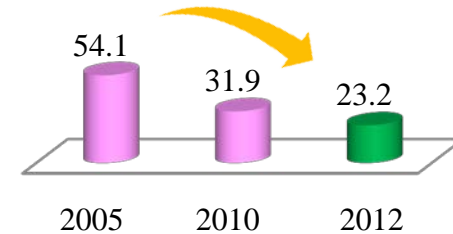
■ Power supply quality

■ Line loss rate

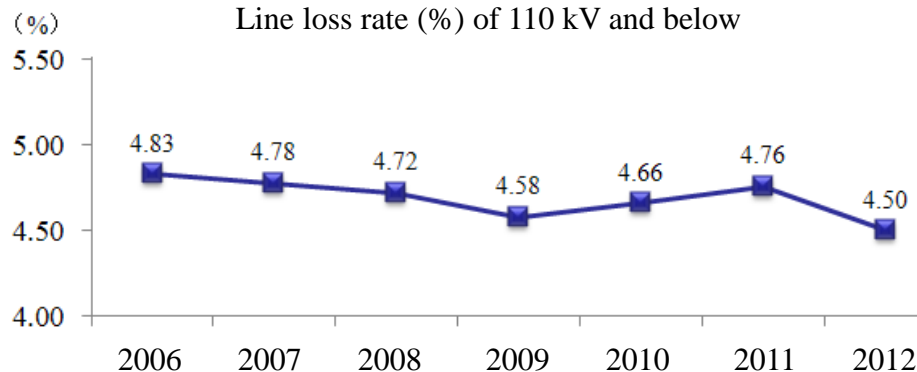
Urban Average Interruption Duration Index (hour)



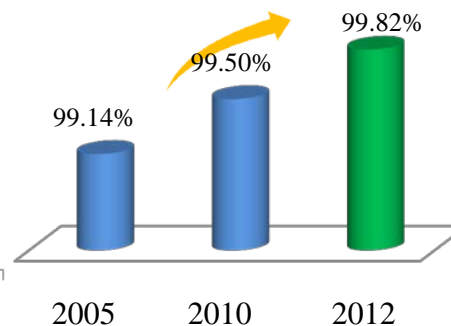
Rural Average Interruption Duration Index (hour)



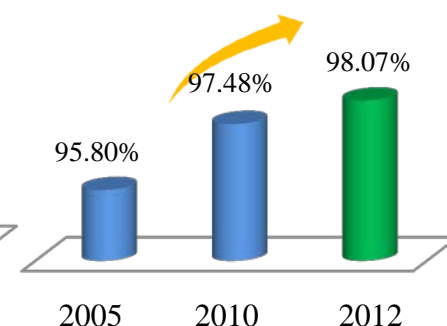
Line loss rate (%) of 110 kV and below



Urban Voltage Qualification Rate (%)



Rural Voltage Qualification Rate(%)



(7) Equipment Status

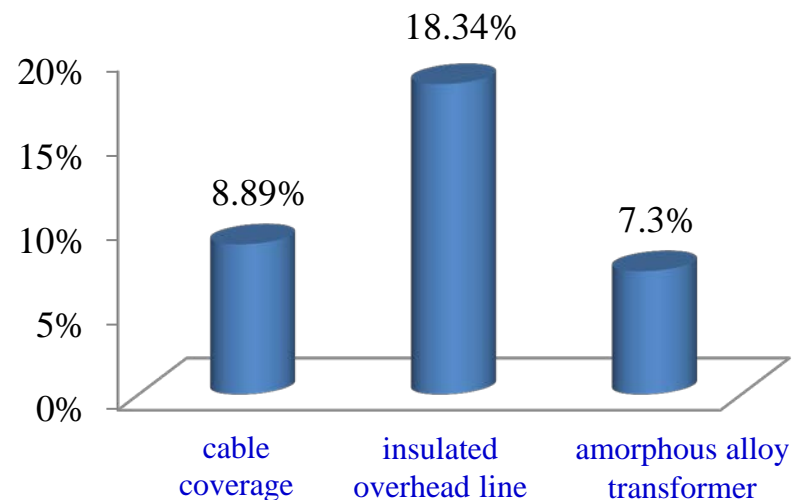
By 2012,

■ Cable coverage in distribution:

- 110(66) kV: 2.96%.
- 35 kV: 5.47%.
- 10 kV: 8.89%.

■ Insulated 10kV overhead line: 18.34%.

■ Amorphous alloy transformers: 7.3%.



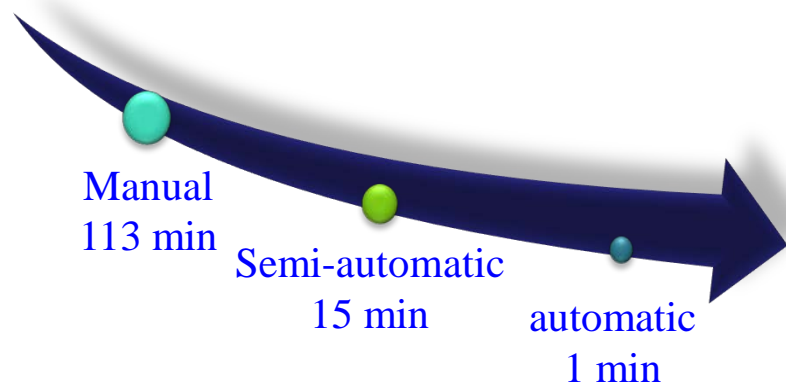
10 kV distribution equipment status

(8) Automation Level

By 2012,

- **Distribution Automation (DA)** : Pilot projects in 23 major cities completed.
- **Electricity information acquisition terminals**: 50.2% coverage rate.
- **110(66)/35 kV smart substations**: 220 in operation.
- **Coverage rate of optic fibers**:
 - 110(66) kV substations: 98%.
 - 35 kV substations: 80%.
- **EV charging facilities**:
 - 353 charging substations.
 - 14,500 charging poles.

10kV Fault Isolation Time shortened with the evolution of automation in 23 major cities



Outline

- 1 **SGCC profile**
- 2 **Current status of China's distribution systems**
- 3 **Opportunities and challenges**
- 4 **Development goals and directions**
- 5 **Conclusions**

Opportunities and challenges

(1) Socio-economic Boom Calls for Accelerated Distribution Grid Construction

2020 forecast:

- Urbanization rate : 70%.
- Per capita GDP : USD 9000.
- Per capita consumption : 6000 kWh.

Social and economic development forecast

Year	2012	2020
GDP/Trillion USD	8.24	12.7
Population/Billion	1.35	1.45
Urbanization rate/%	53	70
Per capita GDP/USD	6100	9000

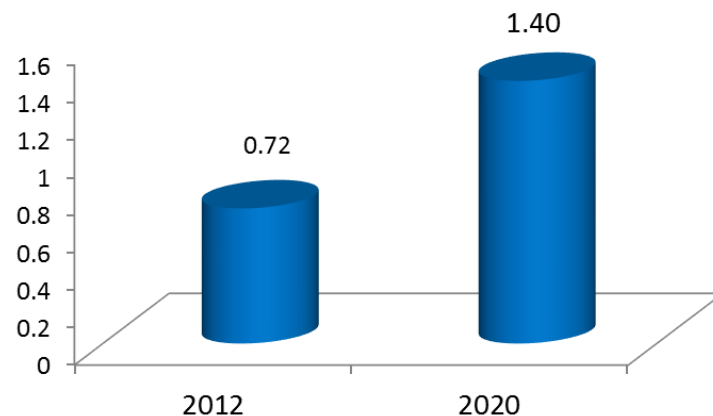
Load forecast

Year	2012	2015	2020
Total consumption (TWh)	4.96	6.40	8650
Max. load (TW)	0.72	1.04	1.4
Per capita consumption (kWh)	3662	4600	5966

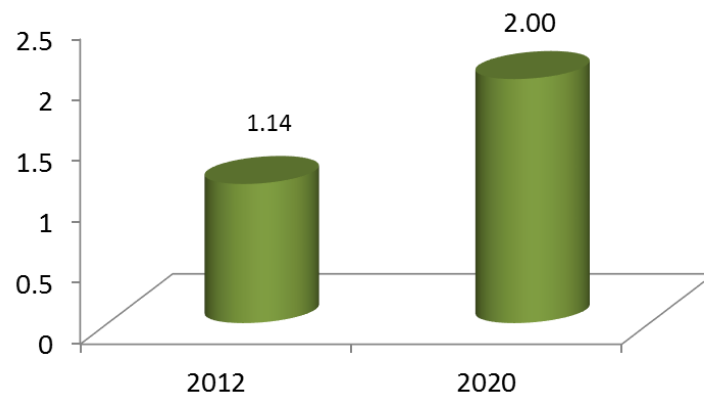
By 2020,

- **Power demand:** 1.4 TW (1.94 times of 2012).
- **Generation capacity:** 2.0 TW (1.75 times of 2012), where green energy accounts for 35%.
- **Transformation capacity ($\leq 110\text{kV}$):** 4.9 TVA, 2 times of 2012.

Power demand (TW)



Generation capacity (TW)



(2) Urbanization Brings Higher Requirements for Distribution Grids

- **Limited urban space:** Difficult to obtain substation space and line corridors.
- **Change of consumption structure:** Rapid increase in residential and service industry consumption.



(3) Rapid Development of Renewable Energy Poses New Challenges

Wind Power Planning

In 2015

Large-scale wind power bases 80 GW
Offshore wind power 5 GW
Distributed wind power 5 GW

In 2020

Large-scale wind power 140 GW
Offshore wind power 30 GW
Distributed wind power 15 GW

Solar Power Planning

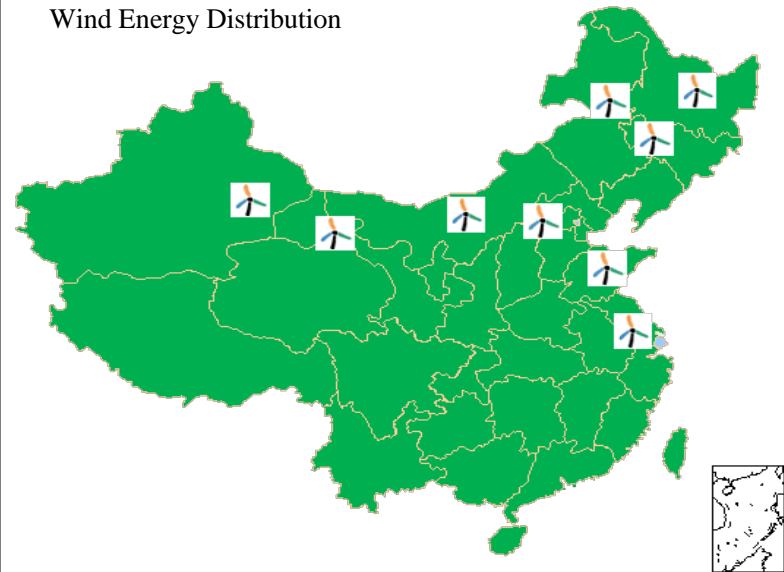
In 2015

Large-scale PV power 10 GW
Distributed PV power 10 GW
Solar thermal power 1 GW

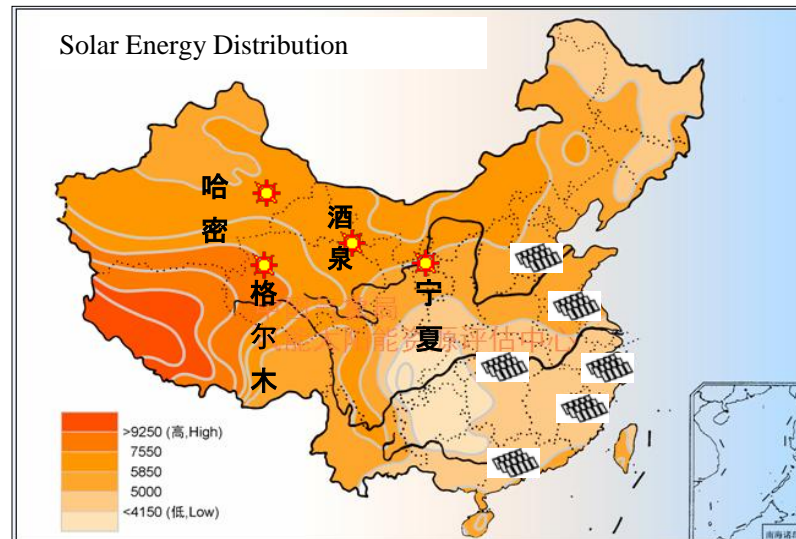
In 2020

Large-scale PV power 20 GW
Distributed PV power 27 GW
Solar thermal power 3 GW

Wind Energy Distribution



Solar Energy Distribution



(4) Integration of Diverse Loads Requires Breakthrough Technologies

- Energy storage devices
- Electric Vehicles:
0.5 million in 2015, 5 million in 2020



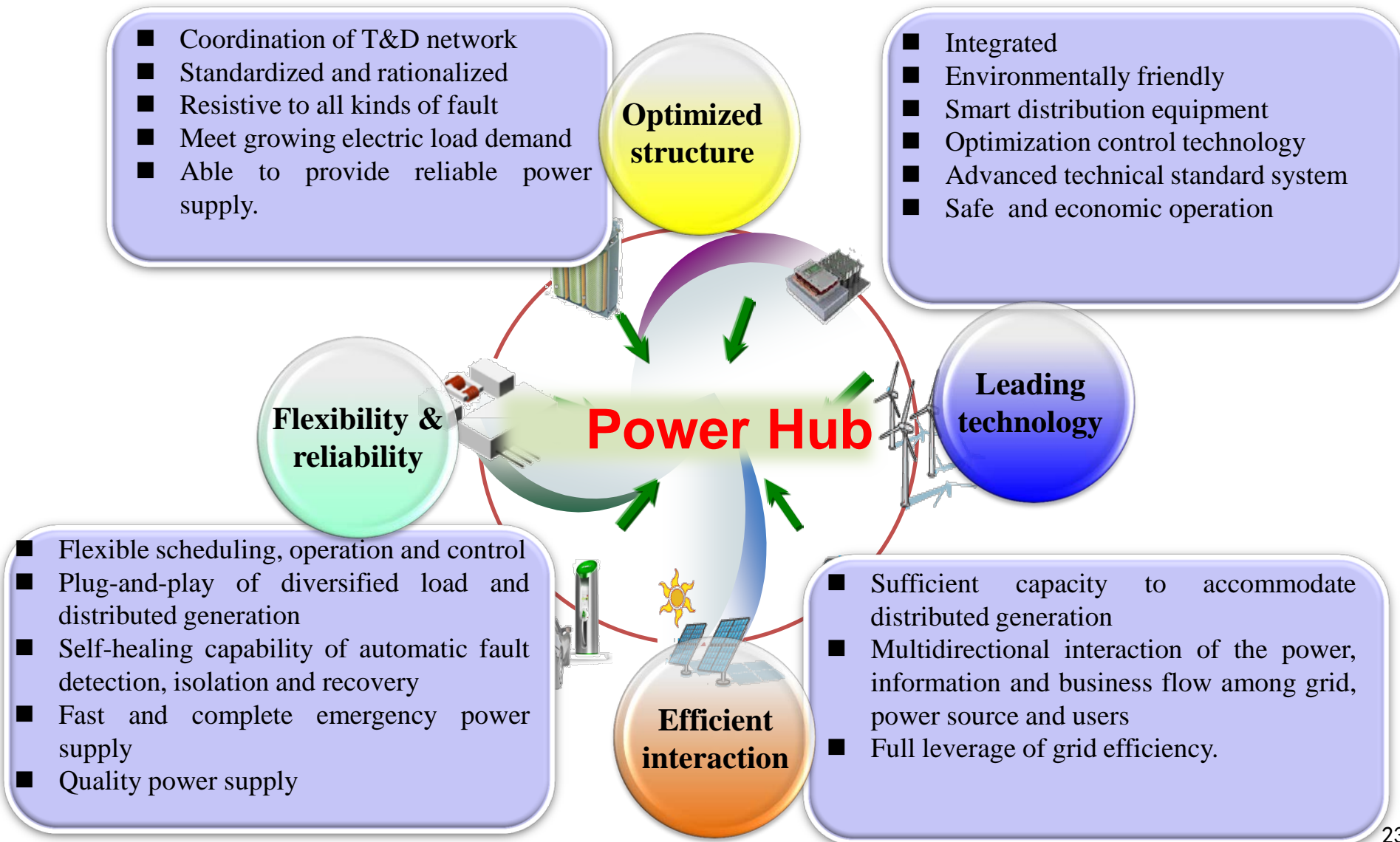
Outline

- 1** **SGCC overview**
- 2** **Current status of China's distribution systems**
- 3** **Opportunities and challenges**
- 4** **Development goals and directions**
- 5** **Conclusions**

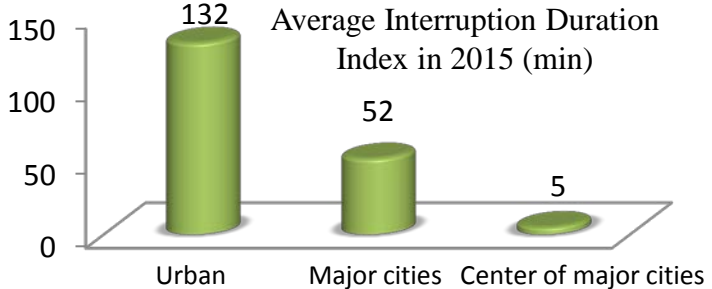
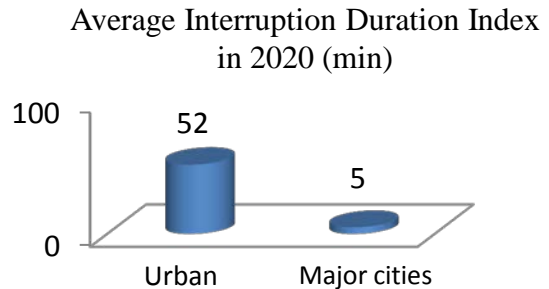
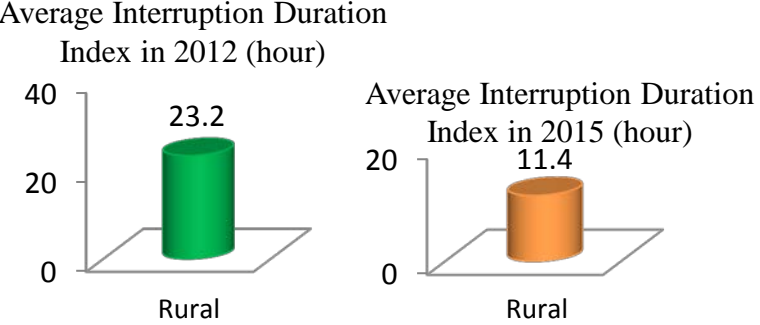
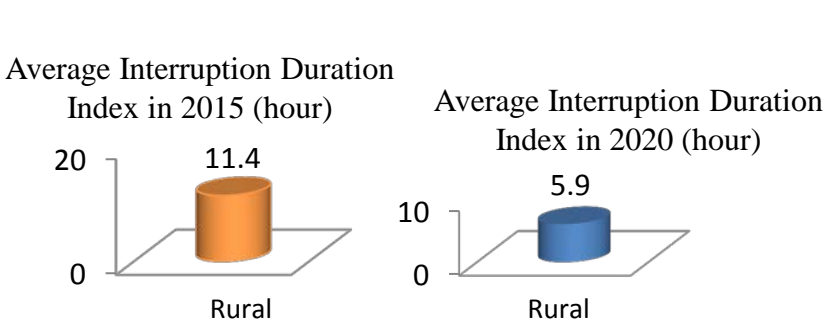
(1) Modernization of Distribution Network

- Optimized network structure, high-quality equipment and integrated ICT technologies
- Distribution Automation, Electricity Consumption Information Acquisition and Intelligent Scheduling System
- Distributed generation and diverse load friendly, adequate and reliable power supply, active control and optimal adjustment.
- **Features:** Smart, Reliable, Efficient and Adaptive

A typical modern distribution network



(2) Development Goals of Distribution System

	Goal in 2015	Goal in 2020
	Shaping up of a modern distribution systems Coordinate urban and rural distribution grid development to meet power demand and provide reliable and quality power supply.	Establishment of a modern distribution systems Able to accommodate all kinds of loads and distributed generation, and support plug-and-play of DG and diverse loads.
Urban	 <p>Average Interruption Duration Index in 2015 (min)</p> <p>Voltage Compliance Rate > 99.904%</p>	 <p>Average Interruption Duration Index in 2020 (min)</p> <p>Voltage Compliance Rate > 99.968%</p>
Rural	 <p>Average Interruption Duration Index in 2012 (hour)</p> <p>Average Interruption Duration Index in 2015 (hour)</p> <p>Voltage Compliance Rate > 99.02%</p>	 <p>Average Interruption Duration Index in 2015 (hour)</p> <p>Average Interruption Duration Index in 2020 (hour)</p> <p>Voltage Compliance Rate > 99.45%</p>



(3) Development Trends of China's Distribution Grids

China's distribution grids will go along the following trends to achieve those goals:

- Enhanced Network Structure
- Further Automation
- Smart Power Consumption
- ICT Integration
- Diverse Load Accommodation
- Friendliness

Trend 1: Optimize Network Structure

- **Optimize voltage sequence:** Optimize and coordinate the voltage sequences to avoid 110 kV, 35 kV repeat voltage step-down.
- **Optimize network structure:** Build more reliable and economical network structures; Make tailored schemes for different regions.



Urban : 100% grid connection rate of 10kV to solve the “bottleneck” of power supply by 2015.

Centre of major cities: “double-loop network” and other highly reliable network structure in 10kV by 2015.

Rural : adopting piecewise moderate contact and radial structure in 10kV power system by 2015.

Trend 2: Further Automated

- **Realizing the self-healing of power distribution network:** automatic early fault detection and isolation, timely restoration by automatic control
- **Live line working:** 80% live line working rate of overhead line in urban distribution network and 90% in major cities by 2015.
- **Condition-based maintenance:** apply state-of-the-art online detection technologies to improve equipment fault diagnosis and evaluation in medium cities by 2015.



Trend 3: Smarter Power Use

■ Smart Power Use Information Support Platform:

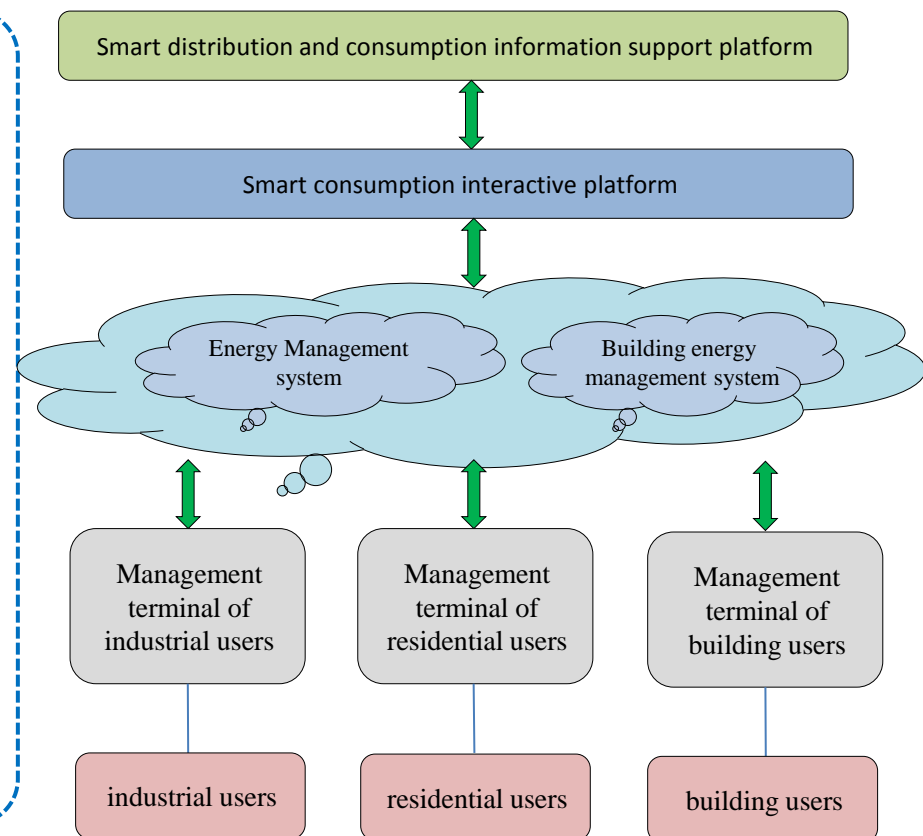
Support bi-directional interaction in power and information flow to meet personalized customer requirements

■ Smart Power Use Interaction Platform:

Integrate data from industrial customer, smart home and smart building to enable self energy management.

■ High-speed, Bi-directional, Real-time, and Integrated ICT Network:

Meet various information communication requirements.



Trend 4: Integrated Information Systems

- Unified and GIS based information platform
- Seamless integration of all kinds of information systems
- Optimized information collection, processing, analysis and visualization.



Trend 5: Accommodate Diversified Loads

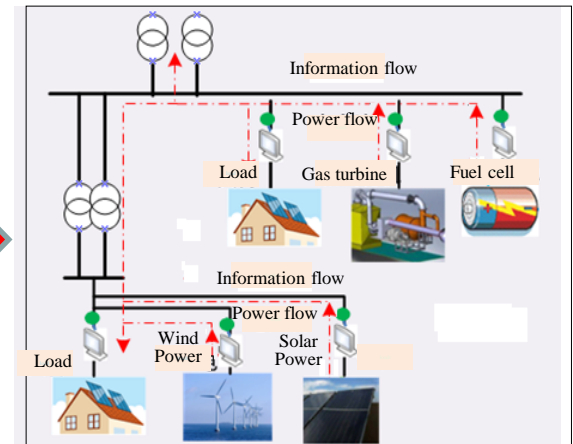
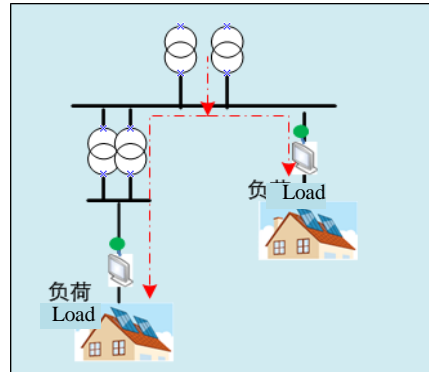
- By 2020, 15,000 charging/ swapping stations and 4 million charging poles will be built to support the EV popularization.
- Distribution grids upgrade to accommodate increasingly diversified loads.
- Achieve “plug and play” of diversified loads by means of integrated control systems.



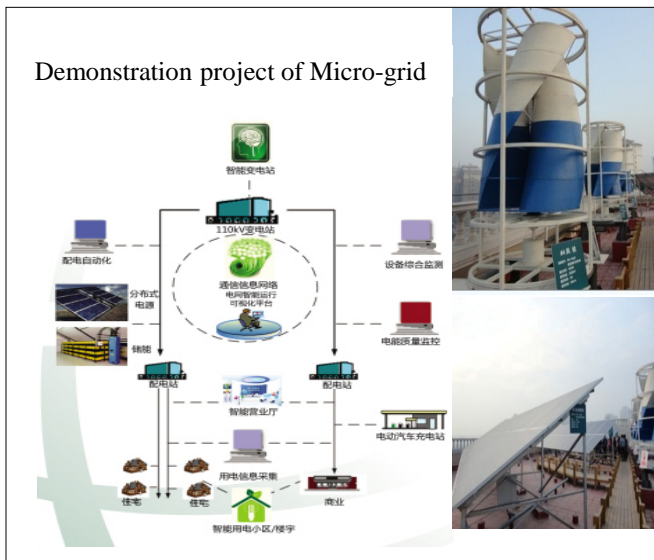
Trend 6: A Friendly Network

■ Friendly distribution network:

- Easy access for distributed generation
- From partial control to grid-wise coordination



Demonstration project of Micro-grid



■ Micro-grid R&D:

- Real-time adjustment by storage and control devices
- Self-balancing so that the micro-grid can either operate on itself or integrate into distribution systems.

Outline

- 1** SGCC profile
- 2** Current status of China's distribution systems
- 3** Opportunities and challenges
- 4** Development goals and directions
- 5** Conclusions

Conclusions

- Modern & Smart Distribution Grid
- Worldwide Communication & Cooperation





Thank you !