



Renewable Energy Integration – Challenges and Practices

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1 Challenges Faced by China



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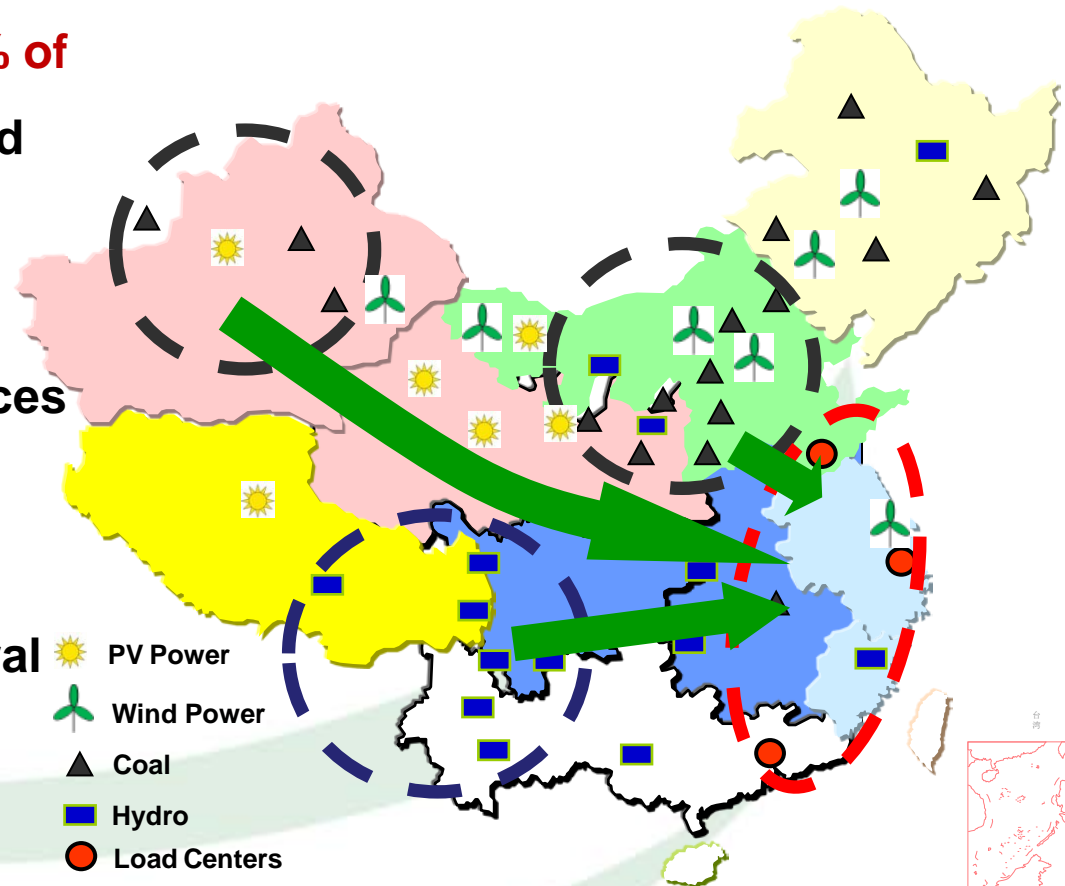
◆ **76% of coal resources and 80% of wind/solar resources**, is located in North, Northeast and Northwest.

◆ **80% of the hydropower resources** is located in Southwest.

◆ **Over 2/3 of the power demand** concentrates in East and Central China.

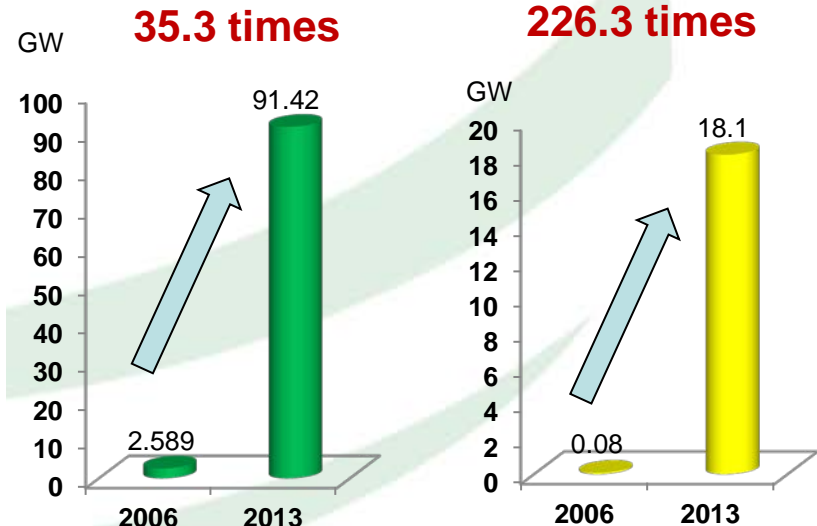
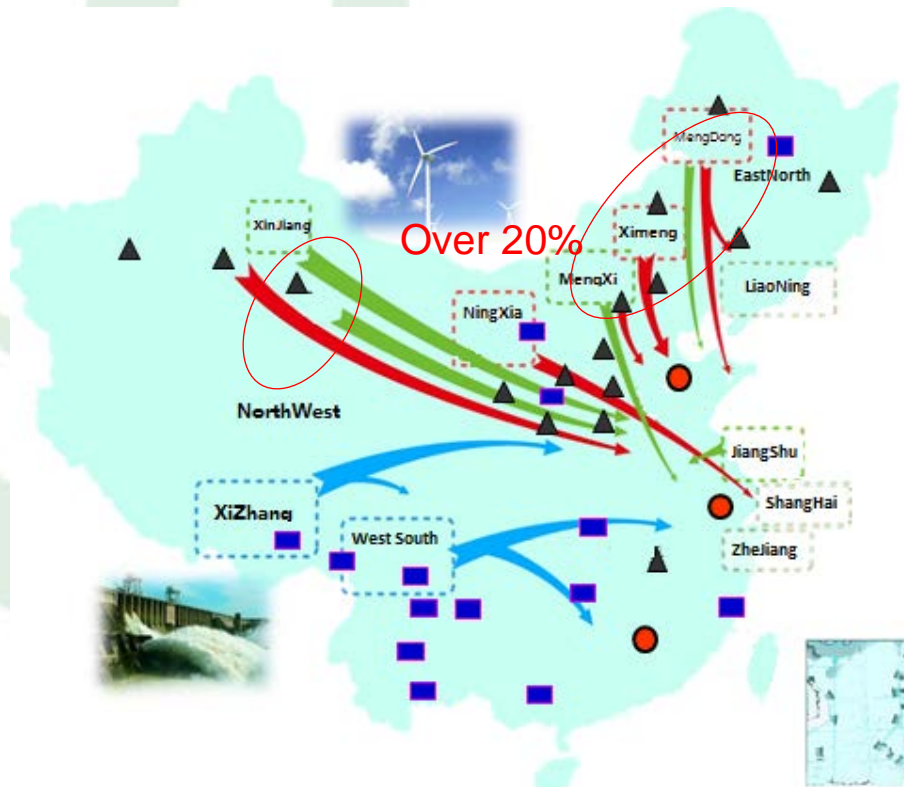
◆ Distance from energy bases to load centers: **800 km ~ 3000 km**

◆ China needs to develop remote and bulk power transmission to optimize the power allocation nationwide.



1 Large-scale Renewable Energy ---Rapid development

- ◆ **Hydro power** : 290 GW, ranking **No.1** in the world;
- ◆ **Wind power** : 91.42 GW, ranking **No.1** in the world;
- ◆ **PV power** : 18.1GW, ranking **No.2** in the world;
- ◆ **Wind power** has been the **third biggest power source** in China.

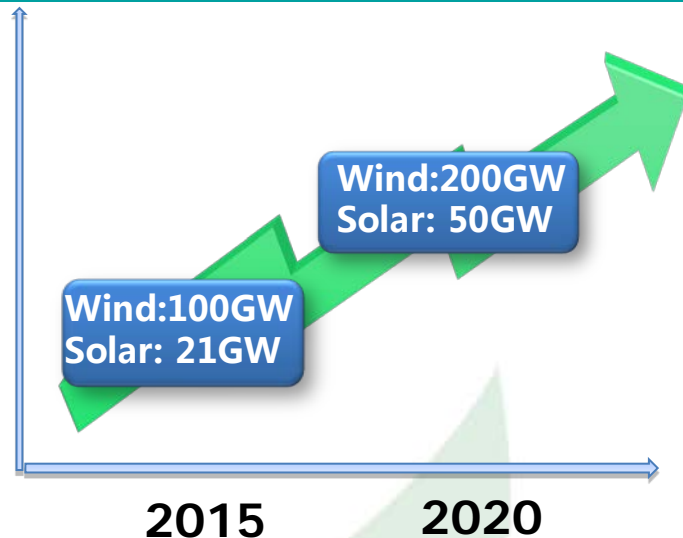
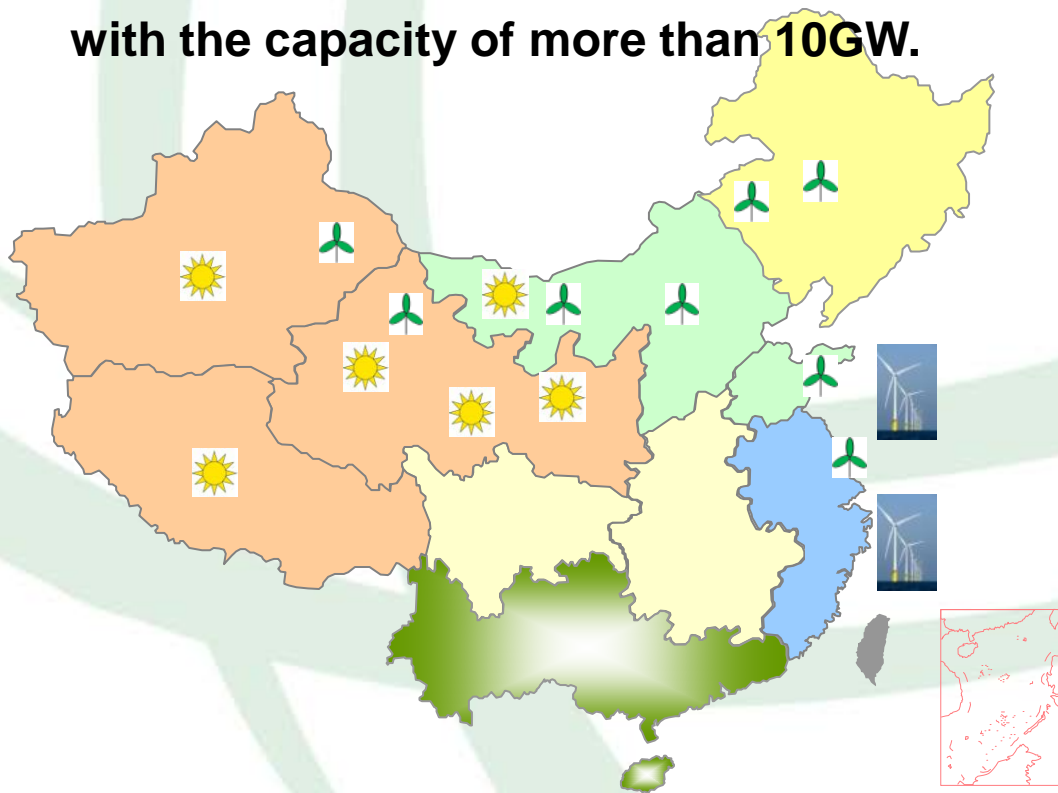


Wind and PV power capacity growth from 2006 to 2013



1 Large-scale Renewable Energy ---Development plan

- ◆ RE development strategy in the “Twelfth Five-Year Plan” : **Centralization + Distribution.**
- ◆ **8** large-scale wind power bases are in plan and construction, each of them is with the capacity of more than **10GW.**



◆ 2015

Large PV station	10GW
Distributed PV	10GW
CSP	1GW

◆ 2020年

Large PV station	20GW
Distributed PV	27GW
CSP	3GW

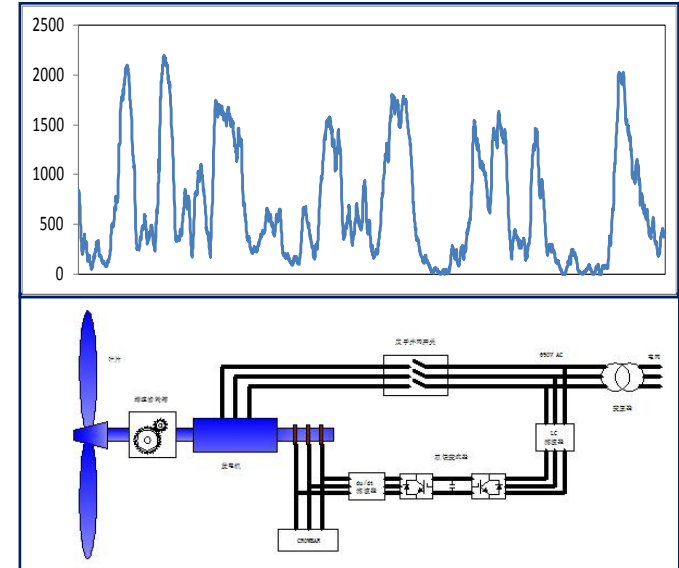
2 Main characteristics of wind power



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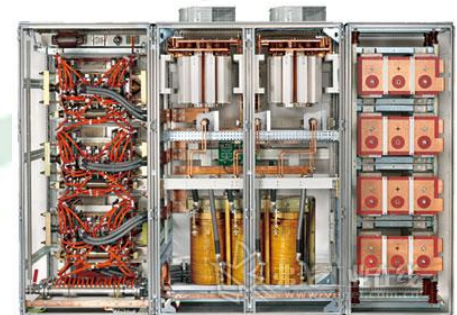
- Main characteristics of wind power

- Fluctuation of power output
- Different generation technology
- Distribution characteristics



- The use of **power electronic equipment** in wind power brings changes to the characteristics of power system operation and security.

- Weak adaptability to disturbance
- Weak support to power grid



2 Challenges



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- Impacts on power balance
- Impacts on reactive power and voltage
- Impacts on power quality
- Low voltage and high voltage fault ride through capability

108

GB

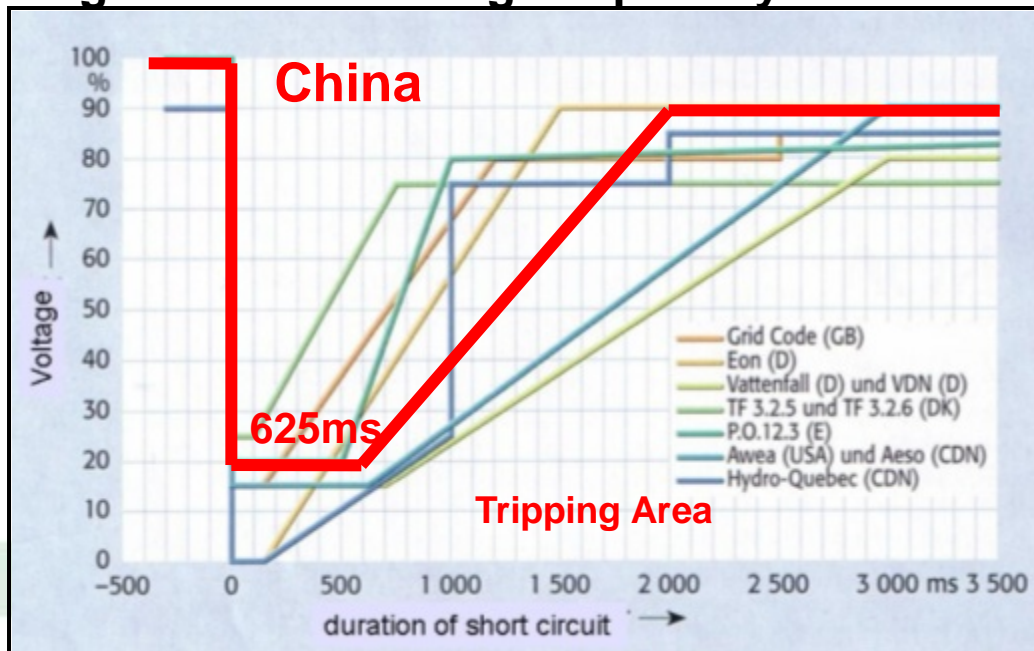
中华人民共和国国家标准

GB/T 19963
代替 GB/Z 19963-2005

风电场接入电力系统技术规定
Technical rule for connecting wind farm to power system

GB/T 19963-2011
Technical rule for connecting wind farm to power system

2011 - 12 - 31 发布 2012- 06 - 01 实施
中华人民共和国国家质量监督检验检疫总局 发布



LVRT

Source: IEA Wind Task 25, 2009

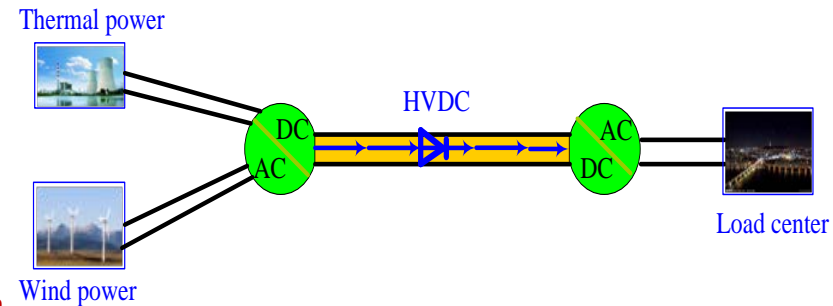
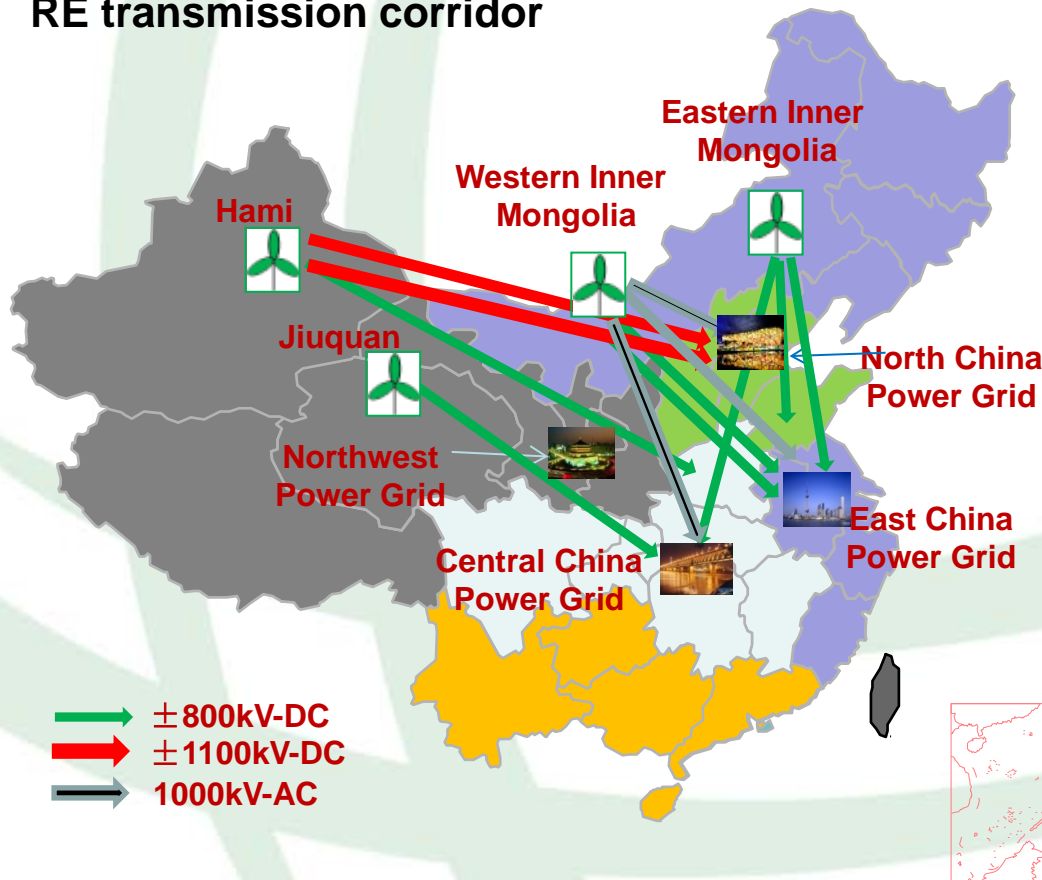
3 Power grid enhancement



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- UHVDC transmission plan involved wind power bases

RE transmission corridor



Combination transmission of wind power and thermal power

3 Large capacity energy storage



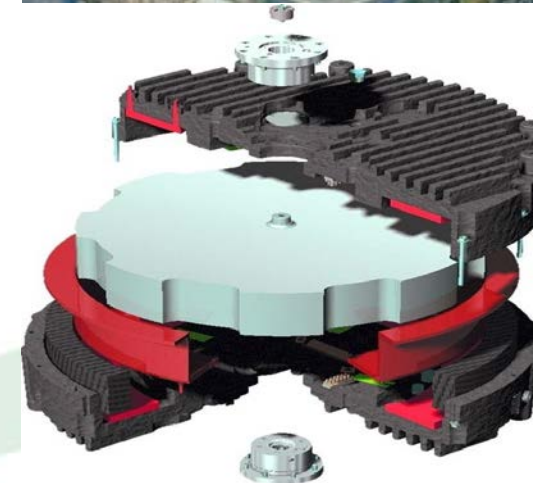
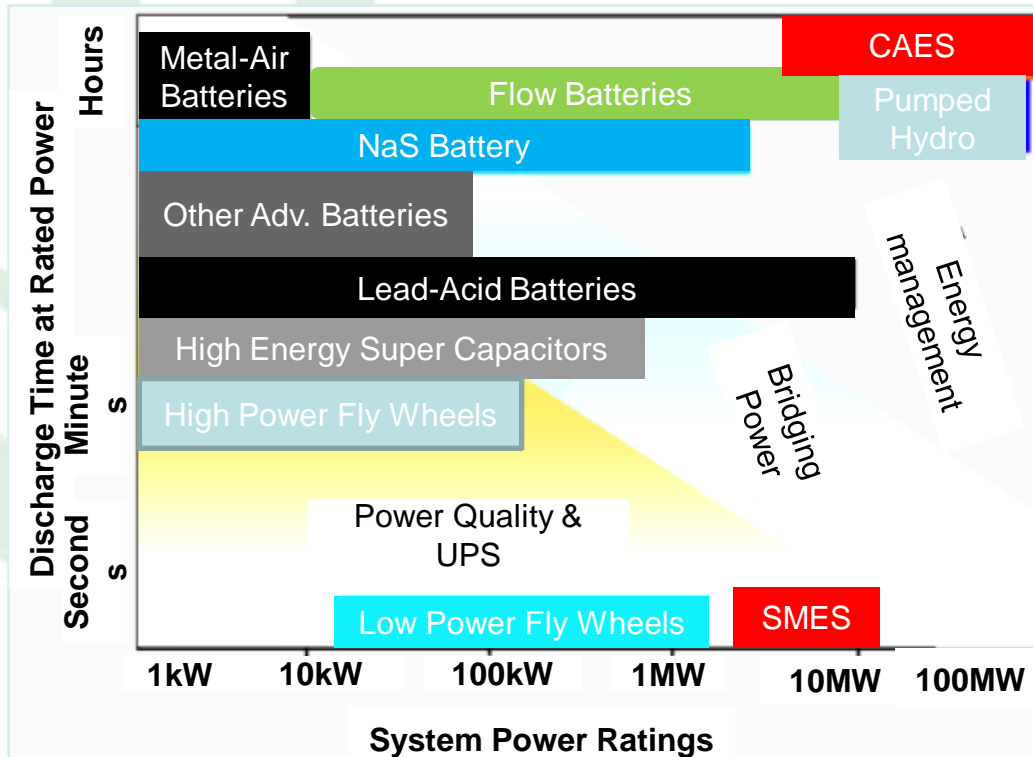
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- Use different energy storage technologies to resolve problems

- Power Balance
- Frequency Regulation
- Power Quality



Pumped Hydro



Fly Wheels



Battery

3 Energy storage application



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- ◆ The **Wind-PV-Storage-Transmission Pilot project** locates at the Zhangbei county, 200km northwest of Beijing.
 - Phase I : **100MW** Wind Power, **40MW** PV power, **20MW** energy storage and a 220KV smart transformer substation.
 - Phase II : **400MW** Wind Power, **60MW** PV power, **50MW** energy storage.
- ◆ Fully demonstrate the effect of the wind/PV/Storage/Transmission coordinated operation, **Wind/PV/storage \approx conventional power sources.**



3 Other practices



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◆ Improvement of wind power forecasting

- 16 wind power/PV prediction systems in dispatching centers, covering nearly 400 wind/PV power stations, the total capacity more than 50 GW, the average absolute error is about 10%

◆ Coordinated planning and development between wind power and transmission grid, considering simultaneously

◆ Reactive power and voltage control

- Wind farm should have required reactive power capacity to compensate the reactive power losses locally.

◆ Flexible HVDC transmission application

◆ Technical standards development and application

◆ Facility testing

3 Testing of wind farm grid code



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■ National Wind Power Integration Research & Test Center

Mobile testing capability

风电机组
Wind turbine

Power performance testing

Noise testing

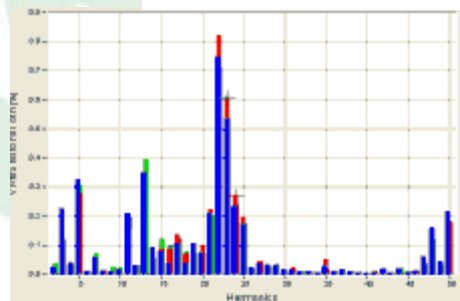
Load testing

Power quality and power control

LVRT testing

风电场
Wind farm

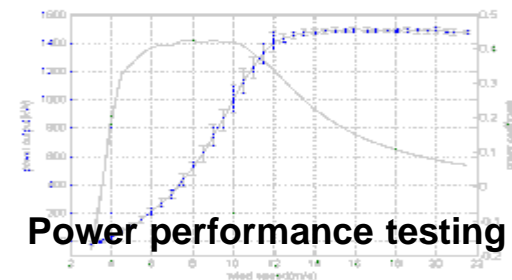
Power quality and power control



Power quality testing



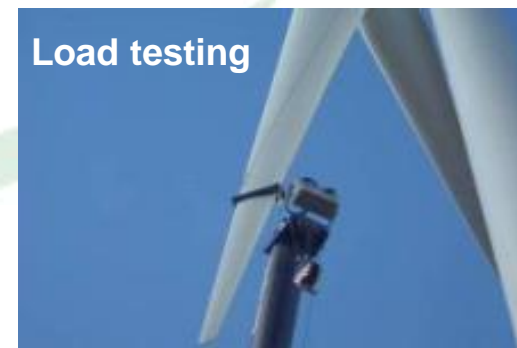
LVRT testing



Power performance testing



Noise testing



Load testing

4 Distributed Generation Integration



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- More and more DGs are integrated



4 Measures in consideration



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- **Development of local load for energy consumption**
Hydrogen production
- **Energy storage application to achieve balance within clusters**
- **Coordination among different clusters in the region**

4 Standardization Efforts



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- **Establishment of National microgrid and DER integration TC**

Responsible for developing microgrid and DER integration standards system and yearly development plan; developing related standards and standards promotion; participating international standardization activities on behalf of SAC

- **Publish of microgrid and DER integration standards system**

Covering planning and design, commissioning, integration test, operation and control, etc.

- **Development of 8 national standards, 6 industry standards, and 3 SGCC standards**



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Any question?

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