电力规划设计总院
Electric Power Planning & Engineering Institute

Development of Energy Storage for the Expanding Renewable Energy in China

Electric Power Planning & Engineering Institute, China

October 25, 2017

Content

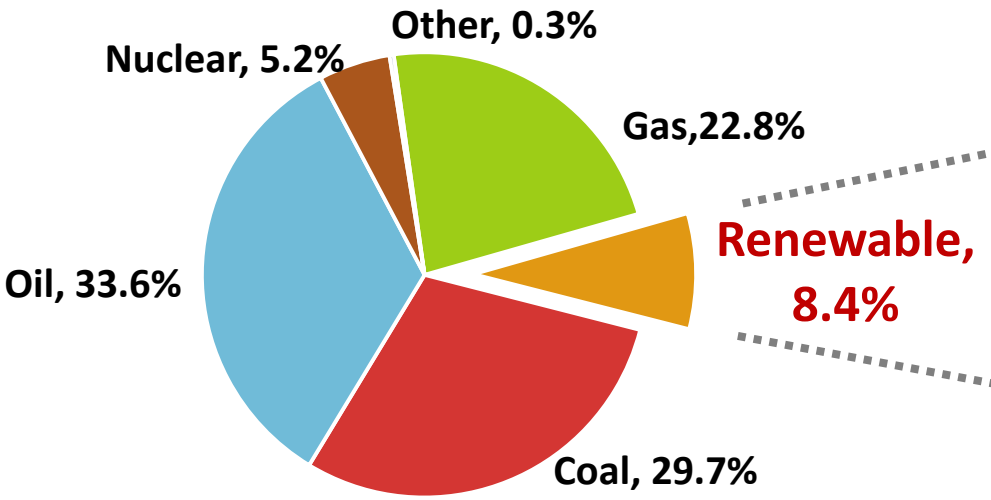
1. Development of Renewable Energy
2. Development of Energy Storage
3. Pilot Projects

Content

1. Development of Renewable Energy
2. Development of Energy Storage
3. Pilot Projects

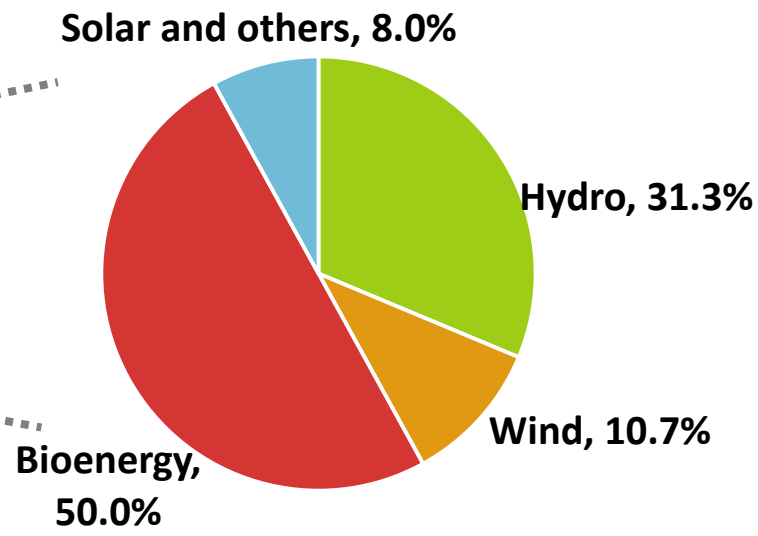
Status of Global Renewable Energy Development

Primary Energy Supply (2016)



Total Amount: **12924** Mtoe

Renewable Energy Supply (2016)

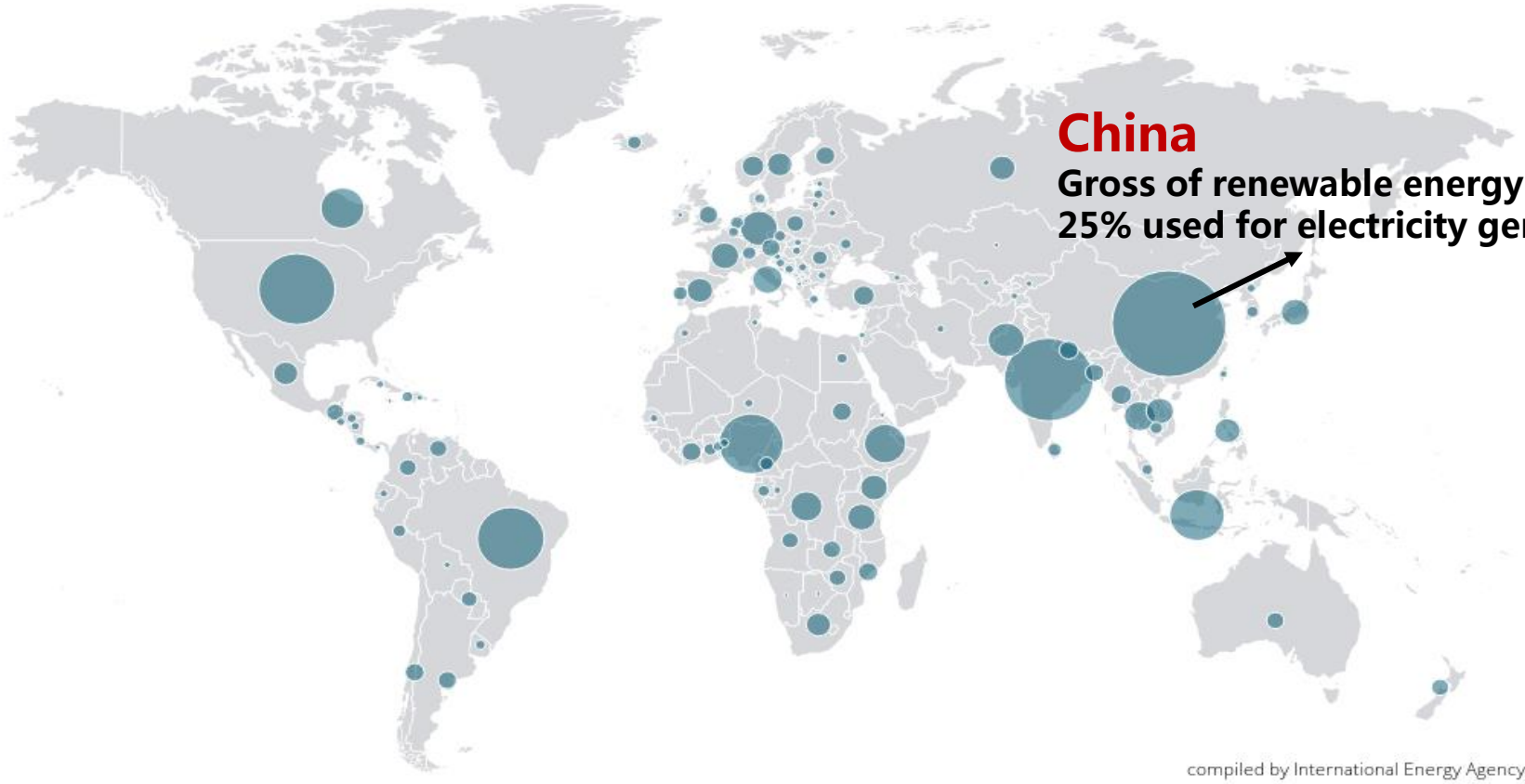


Total Amount: **1092** Mtoe

Source: International Energy Agency

1. Development of Renewable Energy

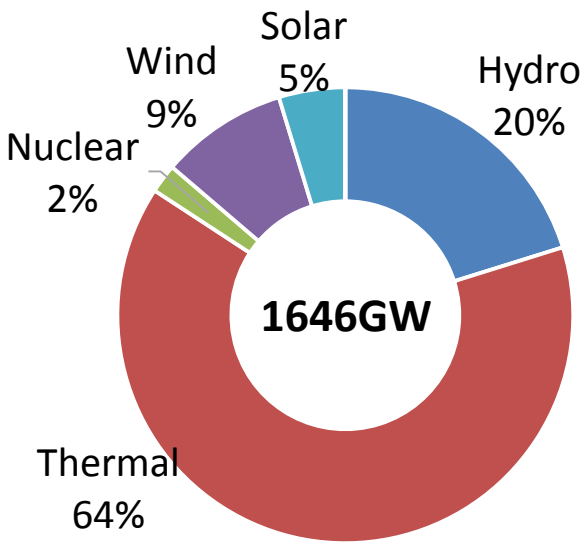
Global Renewable Energy Production
（2016）



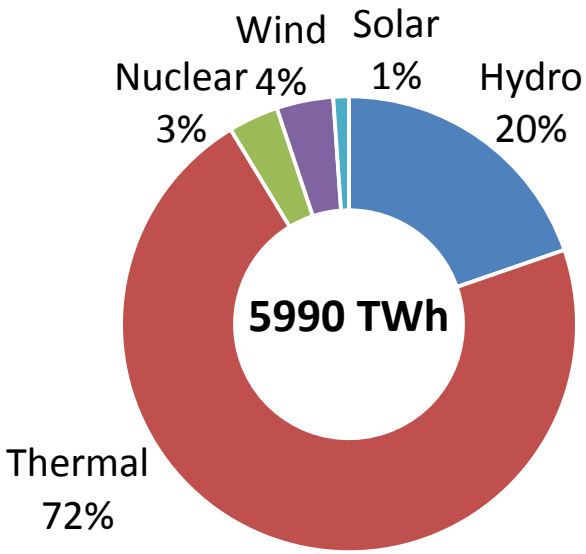
China, India and the US are the largest renewable energy producers around the world.

Renewable Energy Develops Fast in China

Percentage of Installed Generation Capacity by Source in 2016



Percentage of Electricity Generation by Source in 2016

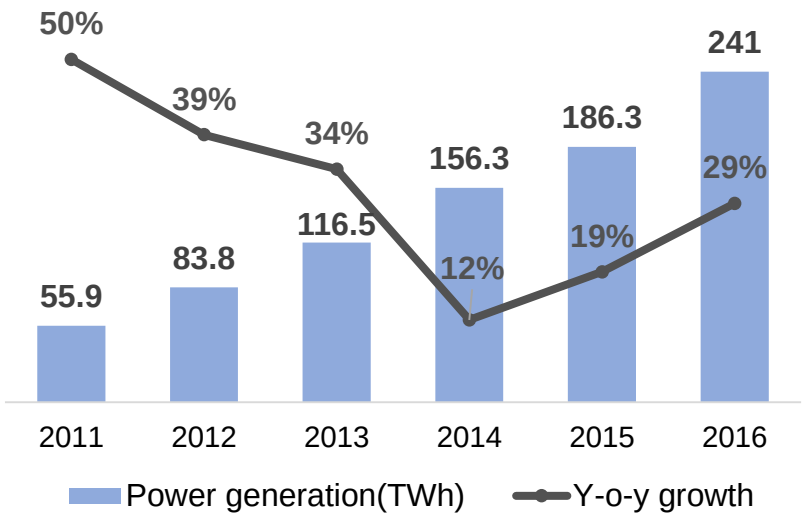


Now China has the largest installed capacity of hydropower, wind power and solar power in the world.

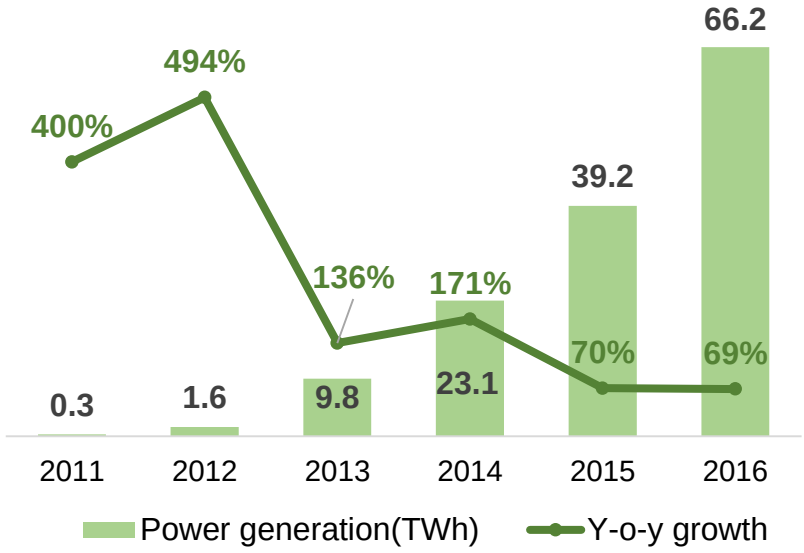
Source: China Electricity Council

Renewable Energy Develops Fast in China

Wind Power Generation



Solar Power Generation



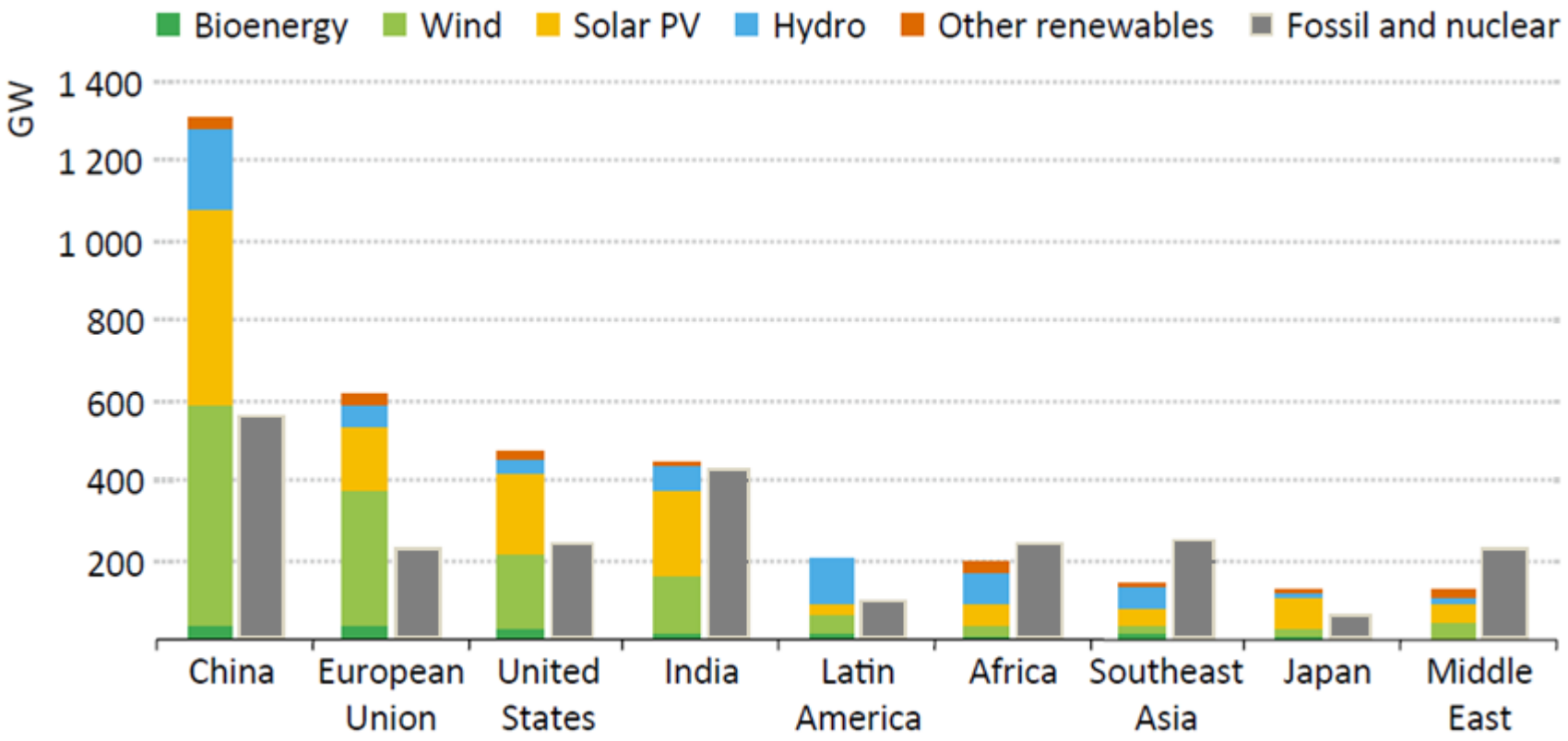
China's wind power and solar power industry maintains fast growing momentum in recent years.

Source: National Energy Administration of China, China Energy Research Society

1. Development of Renewable Energy

电力规划设计总院
Electric Power Planning & Engineering Institute

Forecast of Power Capacity Addition till 2040



Renewable energy will remain the fastest developing power sources in China in the future.

Source: International Energy Agency

1. Development of Renewable Energy

To expand the development of renewable energy has to overcome the problems and challenges brought by its **randomness and intermittently** to the power grid.

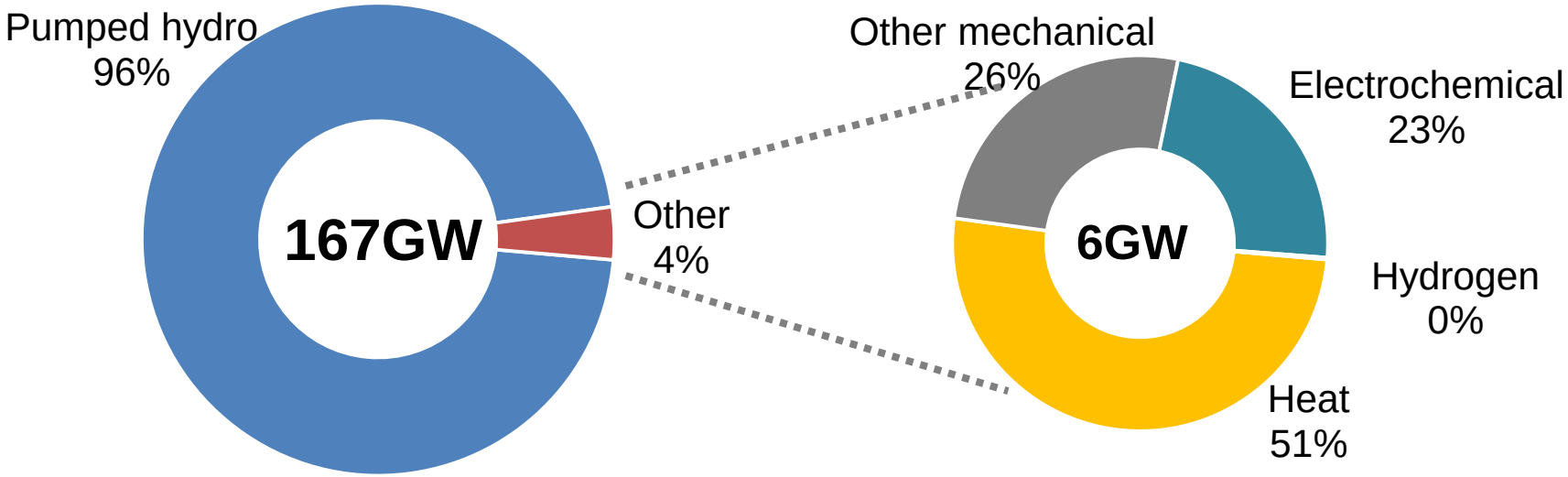
Energy storage technology is used in renewable energy generation, which can convert the random power generation into relatively stable output. It can improve the controllability of power generation output, suppress power fluctuation, and improve the quality of power, so that the wind power generation and PV generation can be widely used in power supply system.

Content

1. Development of Renewable Energy
2. Development of Energy Storage
3. Pilot Projects

Status of Global Energy Storage Development

By 2016, the global cumulative operational energy storage capacity reaches **167GW**, of which pumped hydro accounted for **96%**. The heat, other mechanical, electrochemical and hydrogen provide the rest, with the capacity of 3GW, 1.6GW, 1.4GW, 0.01GW respectively.

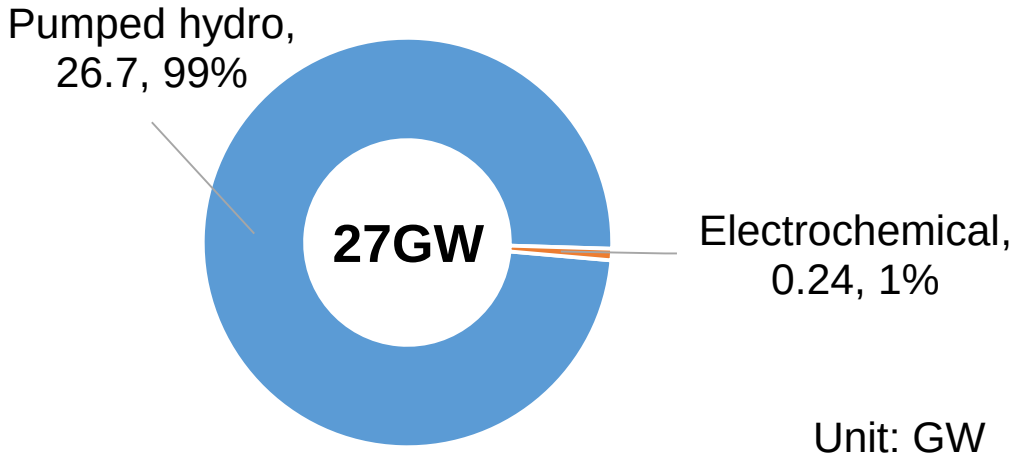


Source: DOE Global Energy Storage Database

Status of Energy Storage Development in China

Generally speaking, China's energy storage development focus on the development of pumped storage and electrochemical storage, such as Flow Batteries and Li-ion Batteries.

By the end of 2016, the installed capacity of energy storage units in China has reached **27GW**, of which **99%** is pumped hydro energy storage and **1%** is electrochemical energy storage.



Unit: GW

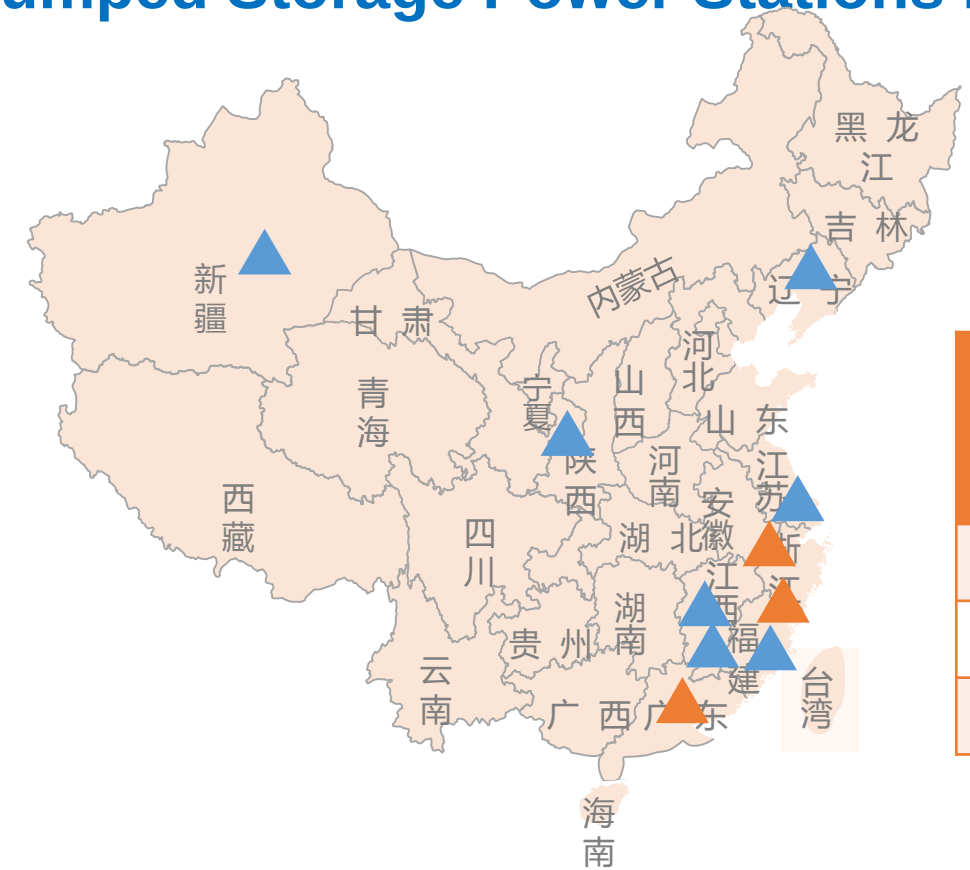
Source: China Electricity Council and CNESA

Development of pumped storage in China

In 2016, 3 new pumped storage power stations were put into operation, with combined capacity of 3.74GW. The newly operational capacity hiked 306% from that in 2015.

New Pumped Storage Power Stations in 2016

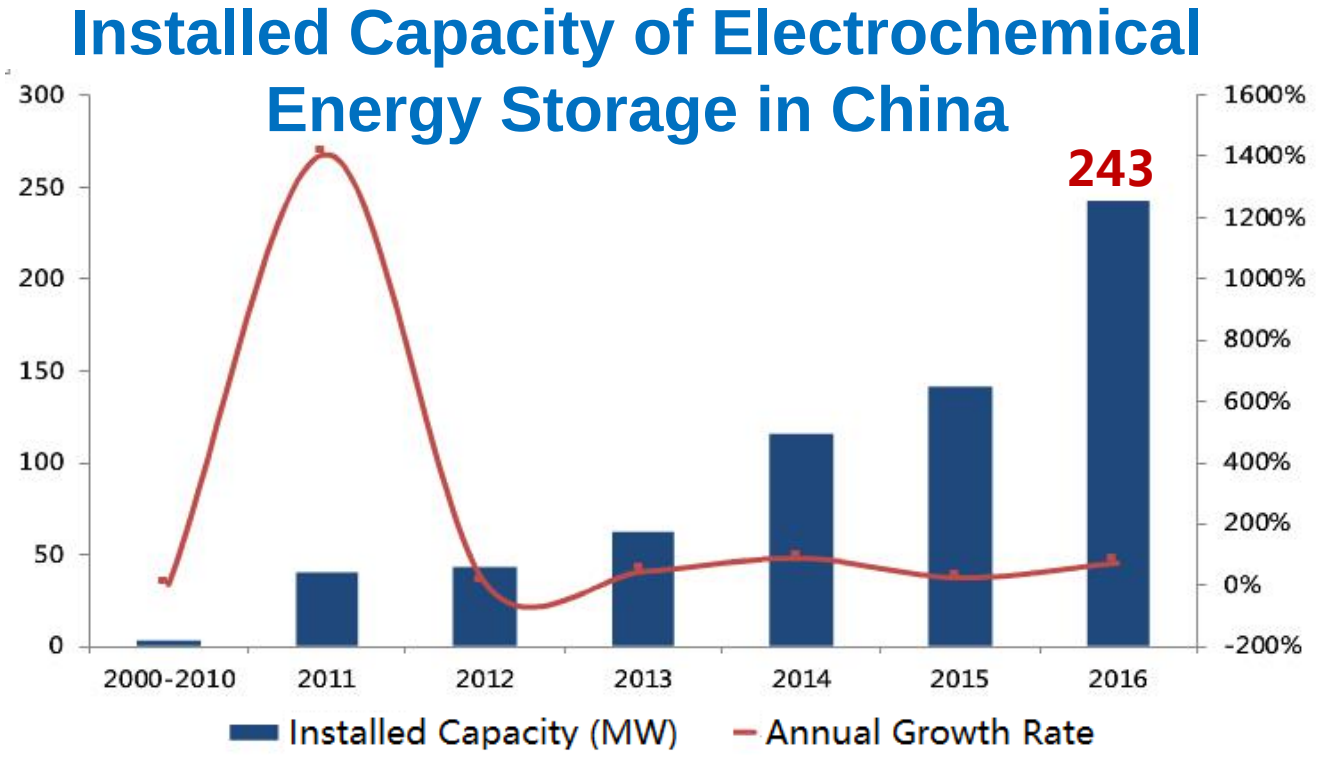
Approved pumped storage power station	Installed capacity (MW)
Liaoning Qingyuan	1800
Jiangsu Jurong	1350
Xinjiang Fukang	1200
Fujian Xiamen	1400
Fujian Yongtai	1200
Fujian Zhouning	1200
Shaanxi Zhenan	1400



Operational pumped storage power station	Installed capacity (MW)
Zhejiang Xianju	1580
Jiangxi Hongping	1200
Guangdong Qingyuan	960

Development of electrochemical energy storage in China

In 2016, the additional capacity of electrochemical energy storage is 101MW. Since 2012, the installed capacity of electrochemical energy storage keeps steady growth. The AAGR since 2012 is 54%.



Additionally, 846MW is in programming and construction

Source: CNESA

Guidance of Government

Innovative action plan for energy technology innovation(2016-2030)

It was jointly issued by National Development and Reform Commission(NDRC) and National Energy Administration(NEA) of China in 2016. Key tasks:

- Solar-thermal efficient utilization storage technology;
- Large-capacity heat (cooling) storage technology in distributed energy system;
- Physical energy storage technology for peak-shaving of power grids and for regional energy supply;
- Energy storage technology for renewable energy using, distributed system and micro-grid, electric vehicles.

Guidance of Government

The 13th five-year plan for electric power development

It was jointly issued NDRC and NEA of China in 2016. Key tasks:

- Pilot application of various energy storage technologies, such as large-capacity electromechanical energy storage, molten salt energy storage etc.
- Pilot application of **Integrated Multi-energy System**.
- Construction of pumped storage power station. The installed capacity will reach **40GW** till 2020.
- Research on the price policies to promote the use of renewable energy and the development of energy storage.

Guidance of Government

Guidance on promoting energy storage technology and industrial development

It was issued by NDRC of China in 2017. Key tasks:

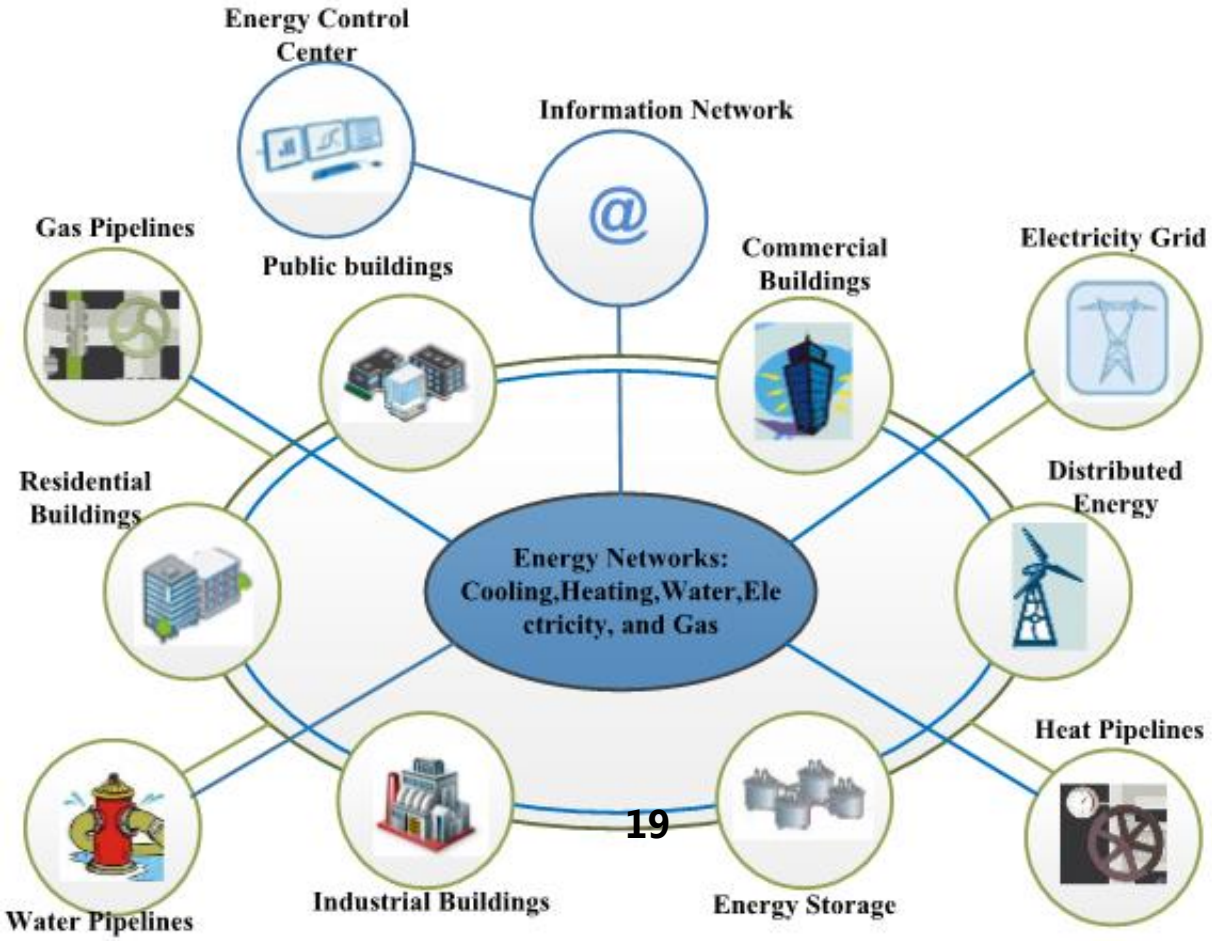
- Develop pilot research of energy storage technologies and equipment.
  - 10MW/100MWh CAES, 10MW/1000MJ Flywheel Energy Storage, 100MW Li-Ion Battery
- Promote pilot application of energy storage, expanding the utilization of renewable energy.
  - Encourage to allocate energy storage for renewable energy
  - Study on the compensation regulation of energy storage allocated for renewable energy
- Promote pilot application of energy storage diversification supporting Energy Internet.

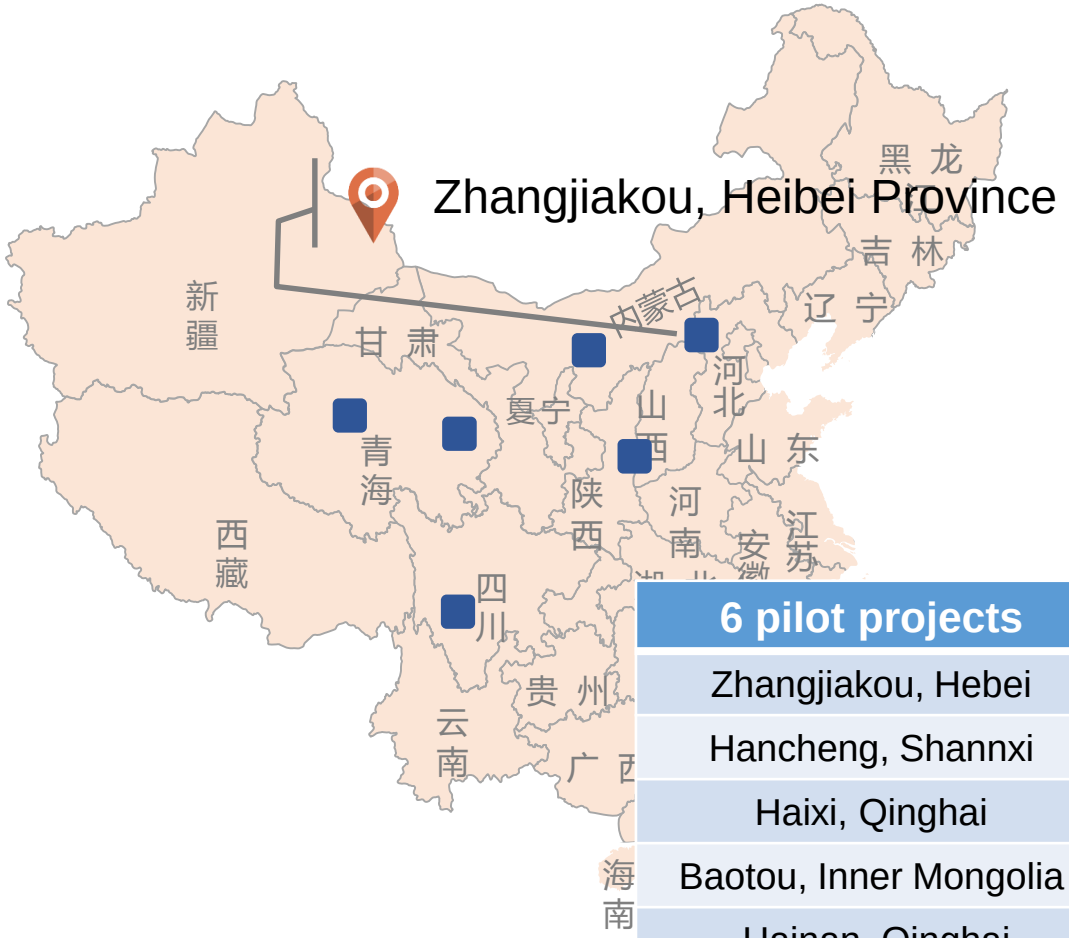
Content

1. Development of Renewable Energy
2. Development of Energy Storage
3. Pilot Projects

3. Pilot Projects

China is working on **6 pilot projects** of supply-side multiple energy integrated system.





6 pilot projects
Zhangjiakou, Hebei
Hancheng, Shannxi
Haixi, Qinghai
Baotou, Inner Mongolia
Hainan, Qinghai
Lianshan, Sichuan

19

3. Pilot Projects

Zhangbei National Renewable Energy Pilot Zone

Zhangjiakou, Heibei Province, China

Gross investment: **$1.5 billion**

3. Pilot Projects

Zhangbei National Renewable Energy Pilot Zone

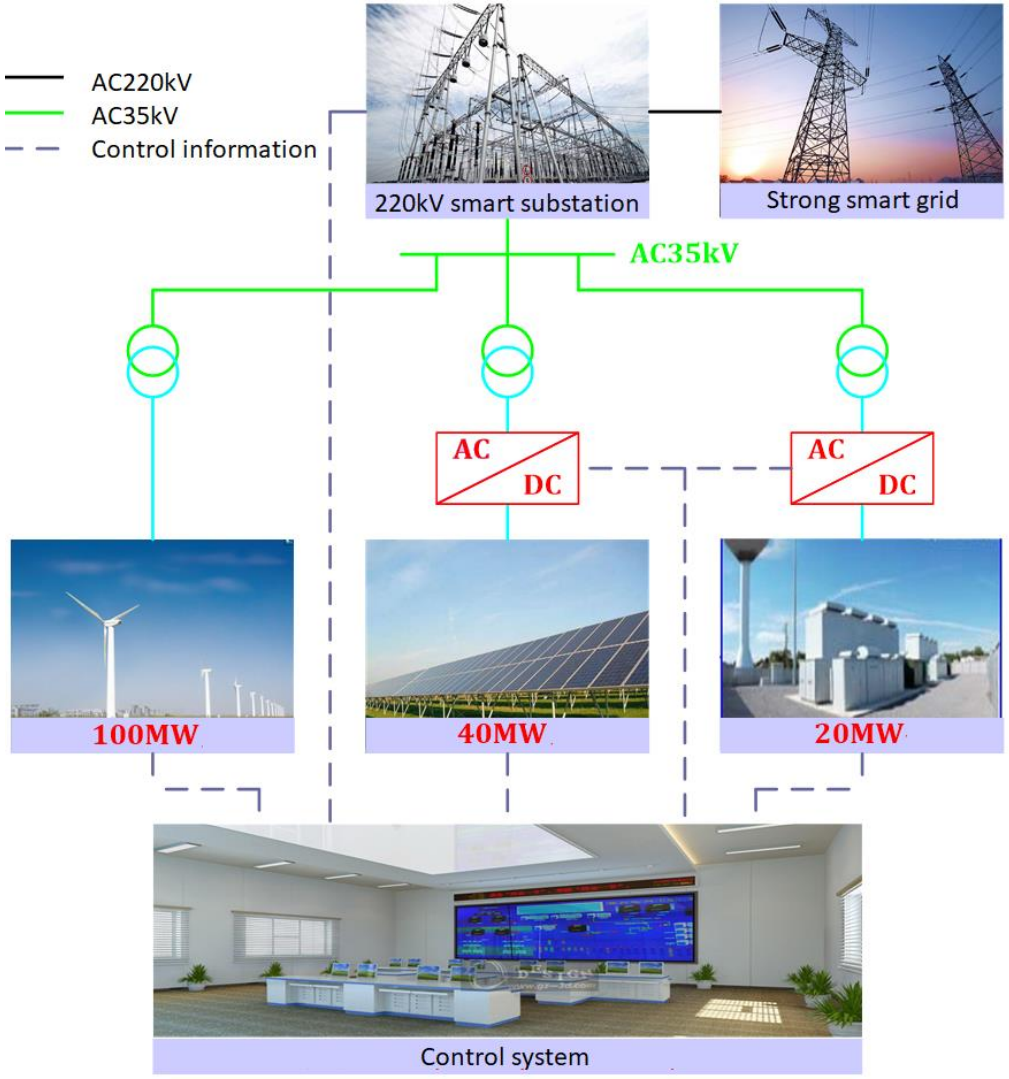
- Planning Capacity
  - Wind: 500MW
  - PV: 100MW
  - Storage: 70MW
- The first phase
  - Wind: 100MW
  - PV: 40MW
  - Storage: 20MW
- The second phase
  - Wind: 400MW
  - PV: 60MW
  - Storage: 70MW

Operational

3. Pilot Projects

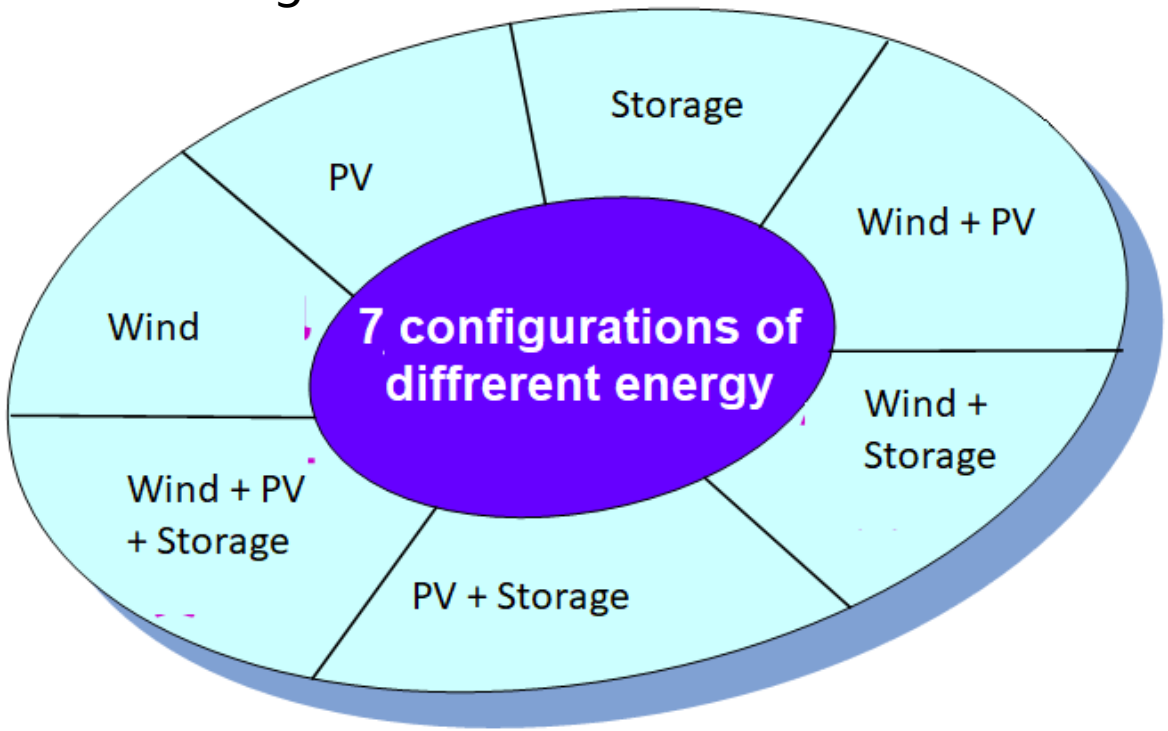
电力规划设计总院
Electric Power Planning & Engineering Institute

Zhangbei National Renewable Energy Pilot Zone



- The first phase

  Wind: 100MW
  PV: 40MW
  Storage: 20MW



3. Pilot Projects

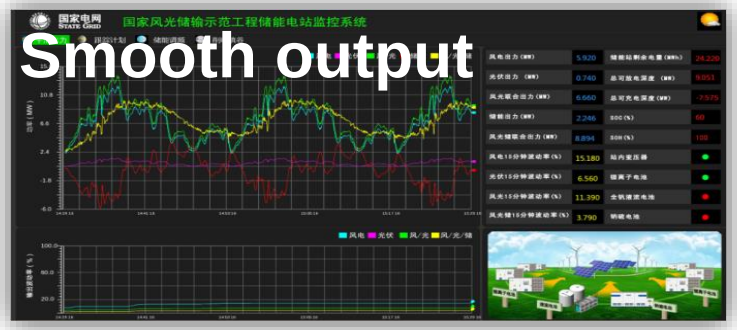
Zhangbei National Renewable Energy Pilot Zone

- The first wind-PV-storage-transmission pilot renewable energy project over the world.
- The innovation of wind-PV-storage joint control and dispatch system.
- The grid-friendly wind farm with the most types of wind turbines.
- The largest-capacity power-adjustable PV station.
- The largest-scale multi-type chemical energy storage station.

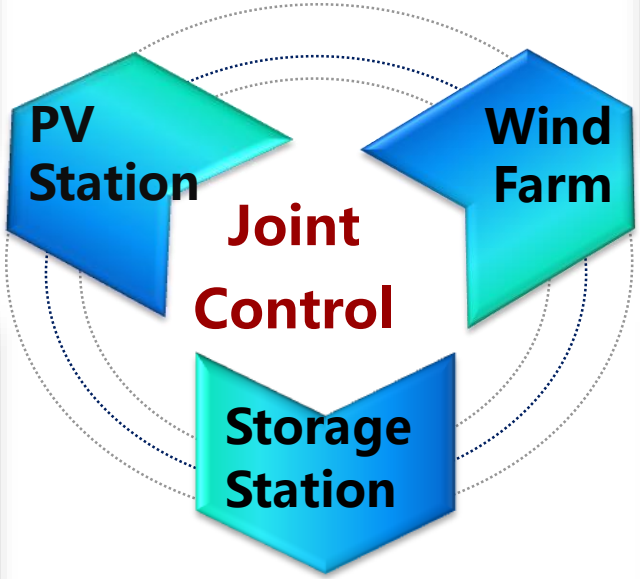
3. Pilot Projects

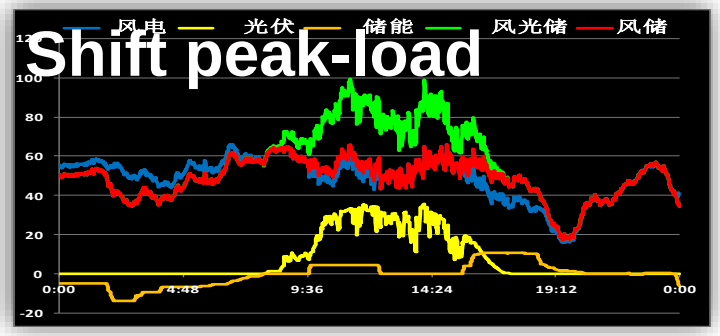
电力规划设计总院
Electric Power Planning & Engineering Institute

Zhangbei National Renewable Energy Pilot Zone

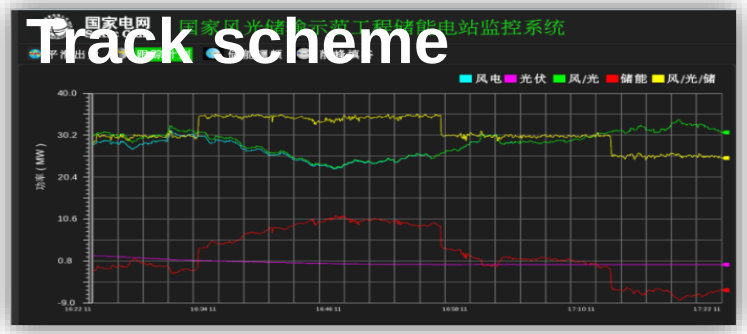


Wind power volatility rate is less than 5%/10min.

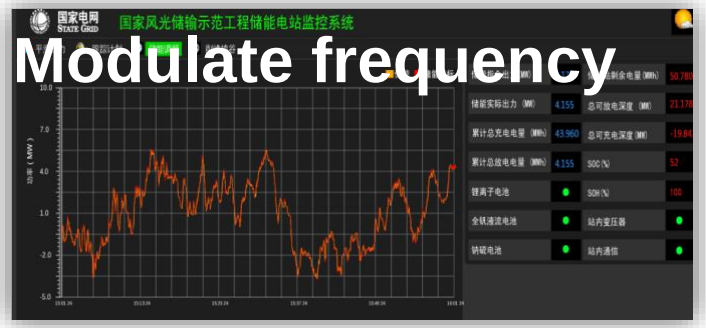




Energy storage scale: 63MWh.



Deviation from planning is less than 3%.



Deviation from the frequency adjustment target is less than 0.5%.

3. Pilot Projects

Dalian Vanadium Flow Battery Project

- Major Project 2016 of *Made in China 2025 strategy*

  (issued by Ministry of Industry and Information Technology of China)

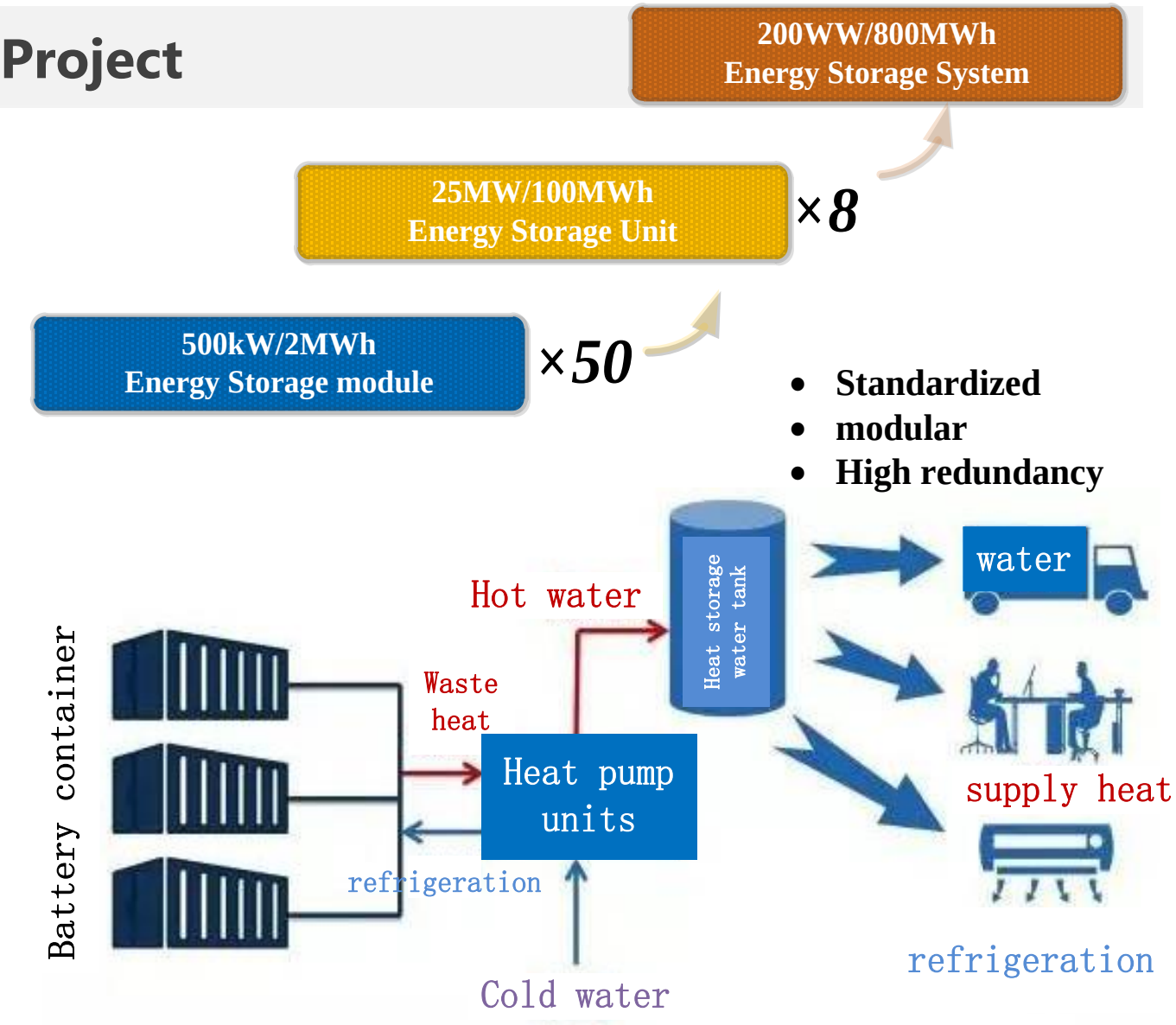
- The world biggest battery project (200MW/800MWh)

3. Pilot Projects

电力规划设计总院
Electric Power Planning & Engineering Institute

Dalian Vanadium Flow Battery Project

- Waste heat recovery system
- Modular design
- Electrical system optimization



3. Pilot Projects

Dalian Vanadium Flow Battery Project

- Provide peak-shaving.
- Enhance grid stabilization on the Dalian peninsula in northern China.
- Facilitate additional intermittent renewable energy deployment in the region.

电力规划设计总院
Electric Power Planning & Engineering Institute

谢　谢

Thank you！