Wind power in China:
development, policies and challenges

2012-03-30

Brief Introduction to NCEPU

North China Electric Power University (NCEPU)

Key university in China

Affiliated with the Ministry of Education

Beijing campus (main), Baoding campus

1,600 faculties, 35,000 full-time students

54 bachelor's programs

52 master's programs

20 Ph.D programs

Brief Introduction to NCEPU

- 542 scientific projects funded by National Natural Science Fund, "863" Program and "973" Program.

- 57 projects won the Awards for Scientific &Technological Progress at the national, provincial and ministerial levels.

School of Economics and Management

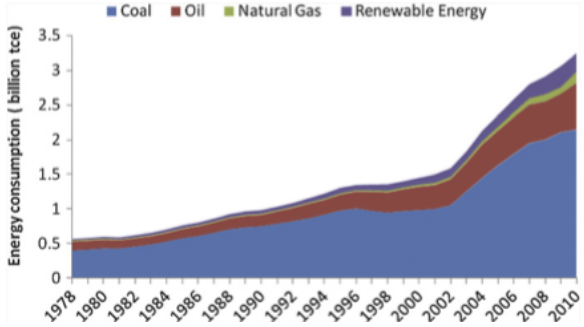
- 12 undergraduate programs
- 8 master programs
- 2 Ph.D programs

- 150 faculties
- 5000 students

- Drivers of China's wind power development
- Current development
- Policy instruments
- Policy omissions and failure
- Challenges for future development
- Future prospects

DRIVERS

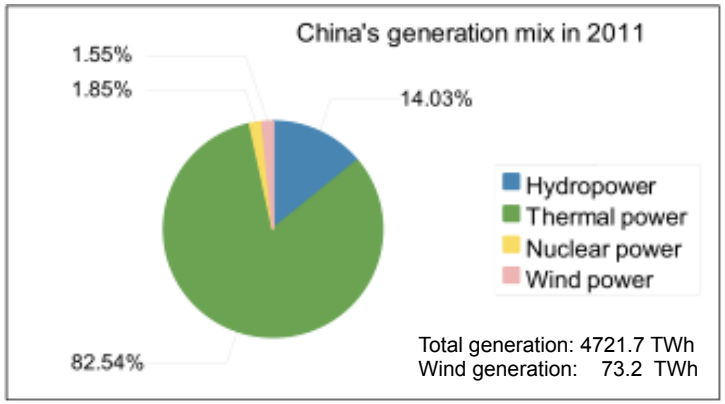
Energy consumption in China from 1978 to 2010



Source: Y. Fan, Y. Xia / Energy 40 (2012) 23-30

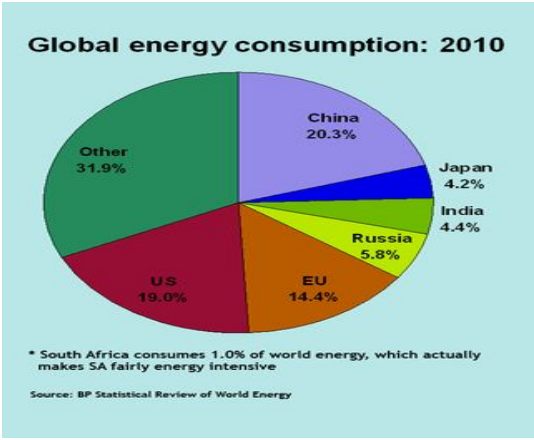
DRIVERS

Thermal power dominates China's electric generation



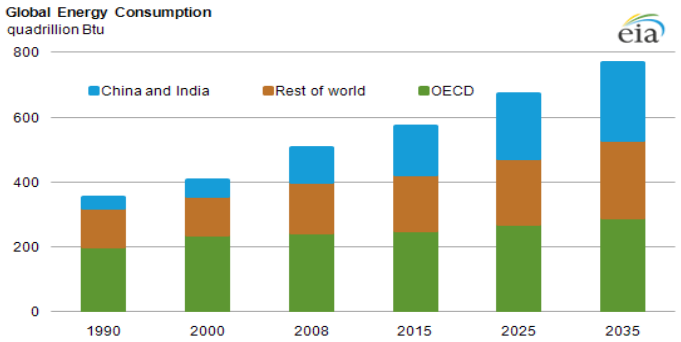
DRIVERS

China consumed 20.3% of the world's energy in 2010



DRIVERS

China and India account for half of the world increase in energy use over the next 25 years



Source: U.S. Energy Information Administration (EIA)

DRIVERS

General targets for carbon reduction and renewable energy

BY 2020,

1. China will reduce **40-45%** of carbon dioxide emission per unit of GDP.

2. **15%** of its energy come from non-fossil fuels (from 8.3% in 2009 to about 11% by 2015).

DRIVERS

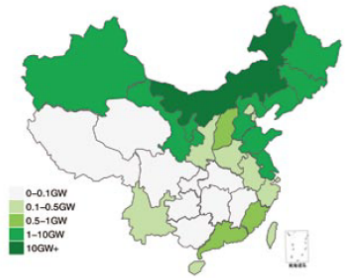
Rich wind power resources

Rank third in the world

Technically exploitable

onshore: 300 GW,

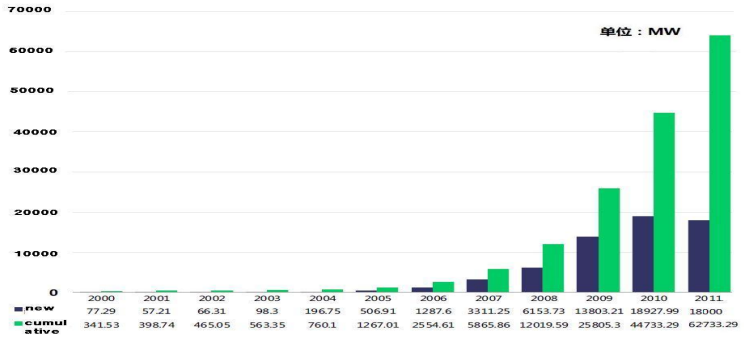
offshore resources: 700 GW



CURRENT DEVELOPMENT

Wind power capacity has grown dramatically

Growth rate of over 100% for five consecutive years (2006-2010)
Surpass the USA in 2010 and 2011, ranking the first in the world.

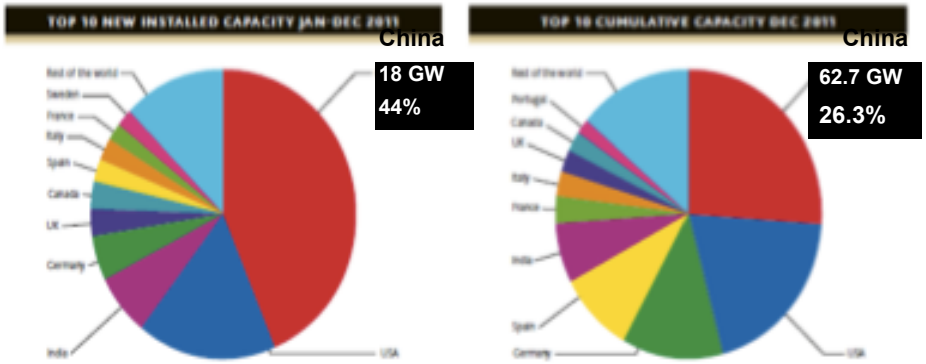


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
new	77.29	57.21	66.31	98.3	196.75	506.91	1287.6	3311.25	6153.73	13803.21	18927.99	18000
cumulative	341.53	398.74	465.05	563.35	760.1	1267.01	2554.61	5865.86	12019.59	25805.3	44733.29	62733.29

Source: CWEC , figures for 2000-2010 from China Wind Power Installed Capacity Statisics 2010 (in Chinese), figures for 2011 from GWEC, Global Wind Statistics 2011, 2012-02-07.

CURRENT DEVELOPMENT

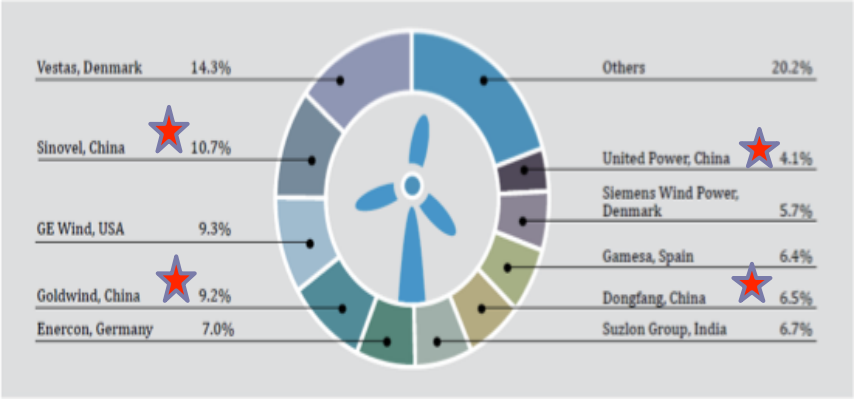
Installed capacity share in the world in 2011



Source: GWEC, Global Wind Statistics 2011, 2012-02-07.

CURRENT DEVELOPMENT

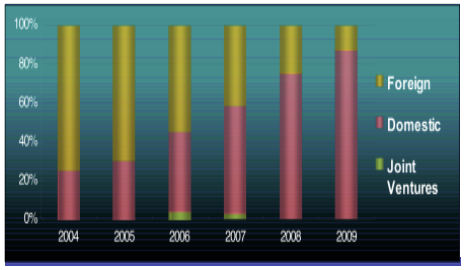
Four wind turbine manufacturers in the world Top 10 (2010)



Source: Renewables 2011 Global Status Report P39.

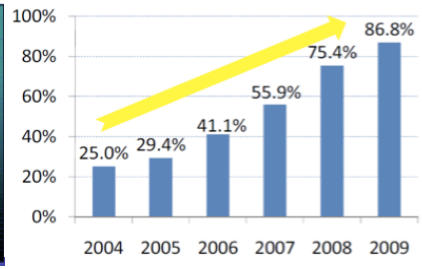
CURRENT DEVELOPMENT

Share of domestic producers in China's market: 2004 -2009



Segmentation among producers in China's market

Foreign companies' share: **70%** ((before 2005)
13% (in 2009).



Market share of the domestic producers: 2004 -2009

Source: China wind power development towards 2030- Feasibility study on wind power contribtution to 10% of power demand in China (Energy Foundation Research).

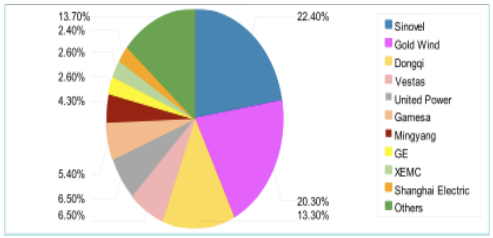
CURRENT DEVELOPMENT

Large Chinese companies dominate the domestic market

Overview

- There are more than 80 wind turbine producers in China.
- Domestic players has been focusing on meeting indigenous demand.

Market shares of top 10 wind turbine companies in China , 2010



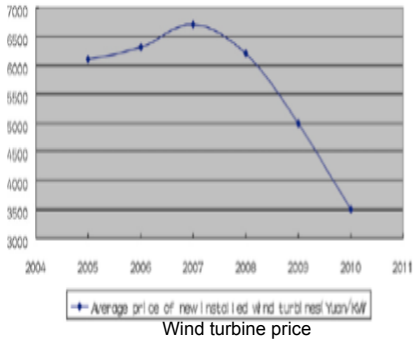
Source: China Wind Power Outlook 2010

China's wind power market has become very competitive with many large players looking to gain market share

CURRENT DEVELOPMENT

Average wind turbine cost has been declining

The localization of wind equipment has promoted the decline of wind turbine cost, and has accordingly reduced wind power development cost.

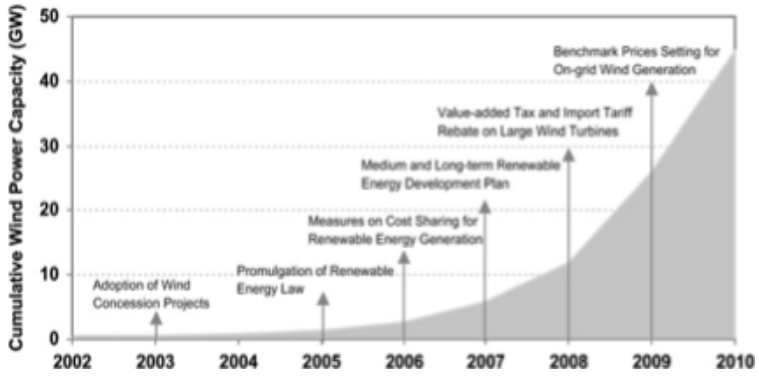


Wind turbine price

Source: J. Kang et al./ Renewable and Sustainable Energy Reviews 16(2012) P1911.

POLICY INSTRUMENTS

Laws, regulations and plans fow wind power development



POLICY INSTRUMENTS

Regulatory instruments

Mandatory purchase (2005)

Grid companies purchase all the electricity generated by registered wind farms.

Mandatory market share (MMS, 2007)
(Renewable portfolio standard, RPS)

The generation from non-hydro renewable resources:
1% by 2010 and **3% by 2020** of the total grid capacity.

For all investors that have installed capacity over **5 GW**,
non-hydro renewable: **3%** by **2010**
8% by **2020**.

POLICY INSTRUMENTS

Regulatory instruments

Local content requirements

The concess program: local content requirements
In 2003: 50%; in 2005: 70% ; in 2010: abolished.

Purpose: Reduce initial investment costs of wind farm constructions. (domestically made: estimated 30% decrease)

POLICY INSTRUMENTS

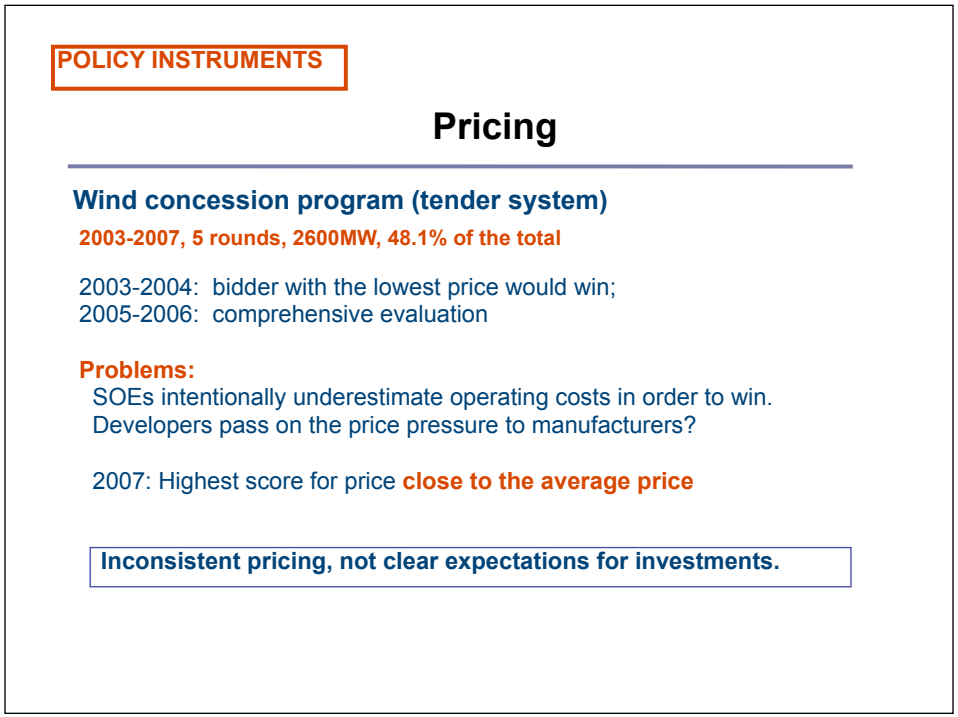
Economic instruments

Enterprise income tax (genaral: 33%)
Important high-tech enterprises: **15%**.

VAT: **8.5%** (general 15%)

Customs duties and VAT exempted for **imported parts and materials** that are components to a single wind power turbine of more than 1.5 MW power capacity.

Compensation for price difference = (wind power price) - (conventional energy power price) and extra **costs**
Through surcharges of price on end-users.


POLICY INSTRUMENTS
Pricing
Wind concession program (tender system)
2003-2007, 5 rounds, 2600MW, 48.1% of the total
2003-2004: bidder with the lowest price would win;
2005-2006: comprehensive evaluation
Problems:
SOEs intentionally underestimate operating costs in order to win.
Developers pass on the price pressure to manufacturers?
2007: Highest score for price close to the average price
Inconsistent pricing, not clear expectations for investments.

POLICY INSTRUMENTS

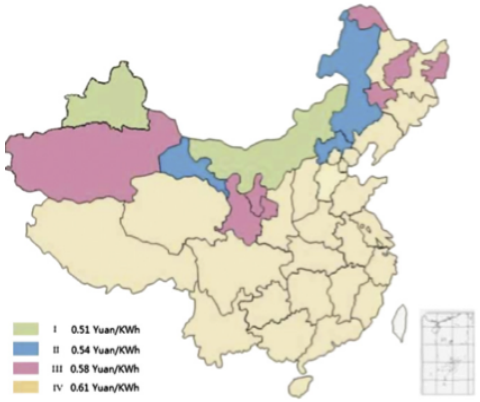
Pricing

Feed-in tariffs

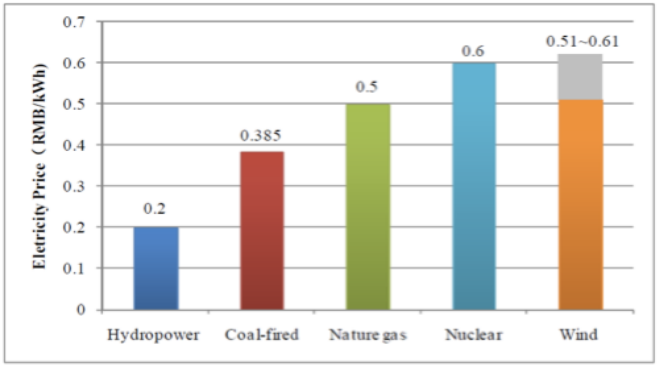
Most successful countries:
Germany, Denmark, Spain

- **China: Differentiated wind energy tariffs based on four wind energy zones in August 2009.**

Average coal-fired electricity rate: 0.34 yuan/kWh.



NDRC regional divisions for wind power prices

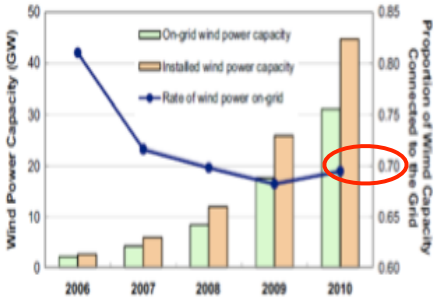


Electricity price of different power generation technology of China in 2007

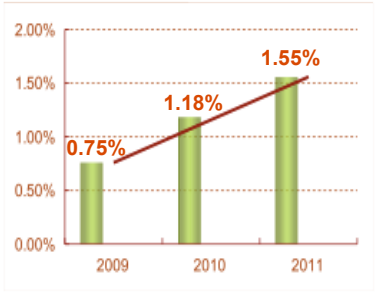
Source: China wind power development towards 2030 - Feasibility study on wind power contribtuion to 10% of power demand in China

POLICY OMISSION AND FAILURE

Low proportions of wind power grid-connection & generation



Proportion of wind capacity connected to the grid
Source: M. Yang et al. Reneable Energy 41 (2012) 145-151.



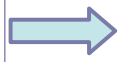
Proportion of wind power generation

POLICY OMISSION AND FAILURE

Inadequate financial incentives for grid companies and providers of backup generation

Grid companies

- should purchase all the electricity generated by registered wind farms.
- be responsible for the construction of transmission lines and the connection.



Fail to consider hidden system costs

- Wind-generated electricity cannot be reliably dispatched or perfectly forecasted.
- System operators need to plan for backup power, regulation services.

POLICY OMISSION AND FAILURE

Collaboration between local governments and large power enterprises

- **RPS**: large power enterprises with a total installed capacity of over 5 GW. (3%, 2010; 8%, 2020)

- Large SOEs have hastened to exploit China's wind power market, and hold more than 80%of the country's total installed capacity.

- Wind farms with a total installed capacity≥50 MW are subject to the approval of the NDRC, while smaller projects can be approved by local governments.

- Local governments split up large scale wind farms to keep each project < 50 MW capacity bypassing the need for NDRC permission ("49.5 MW" phenomenon).

POLICY OMISSION AND FAILURE

Wind farms can be built faster than transmission lines

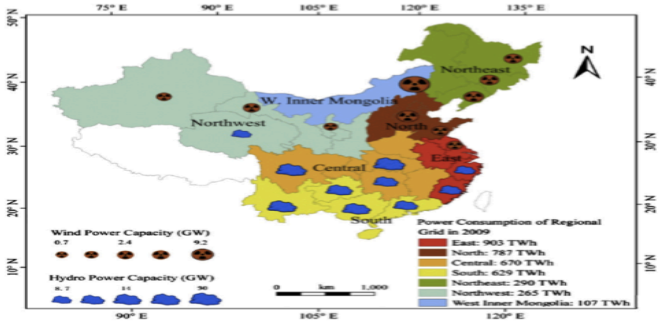
- **2-3 years needed only to get approval for new transmission capacity**
- **The construction of transmission lines takes a longer time than the construction of wind power plants.**

- Supporting documents include planning, land and environmental protection studies, approved feasibility documents

POLICY OMISSION AND FAILURE

No advance planning for long-distance transmission lines

The best wind sites in China are often located far from its main load centers. Long-distance transmission of wind generation becomes necessary.



Distribution of the 10 provinces holding the highest capacity of wind and hydro power as well as power consumptin of regional grid in 2009

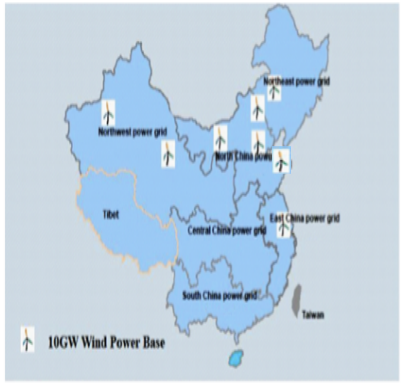
FUTURE DEVELOPMENT

Strong potential development in the future

In 2030:

- Electricity demand in China beyond 5000-6000 TWh
- Installed capacity of wind power will be **300 GW** in 2030, equal to **10% electricity demand** of the whole country in 2030.

New installed capacity target:
100 - 150 GW in 2020.



The **eight 10 GW** wind power bases being built in seven provinces

Furthermore, the international institutes have also envisaged an optimistic blueprint for the wind power development of China in 2030.

They thought that the wind power should play an important role in the power sector,

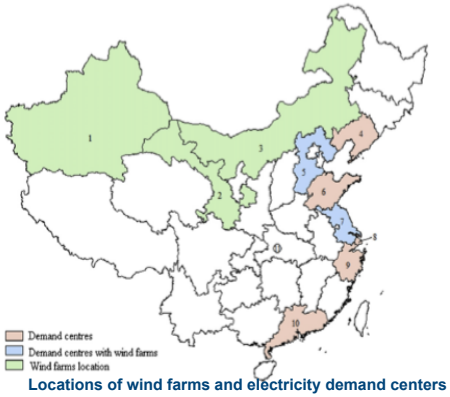
CHALLENGES

Existing power grid infrastucture sufficient?

Wind farms far away from the load centers. (investment)

Grid safety:
Example: *In Feb. and April (2011), three large-scale wind power drop-off accidents* **(additonal regulation capacity)**

Barriers for interconnection between provincial and regional grids.



Locations of wind farms and electricity demand centers
Source: X.Li et al./Energy 37 (2012) 51-60

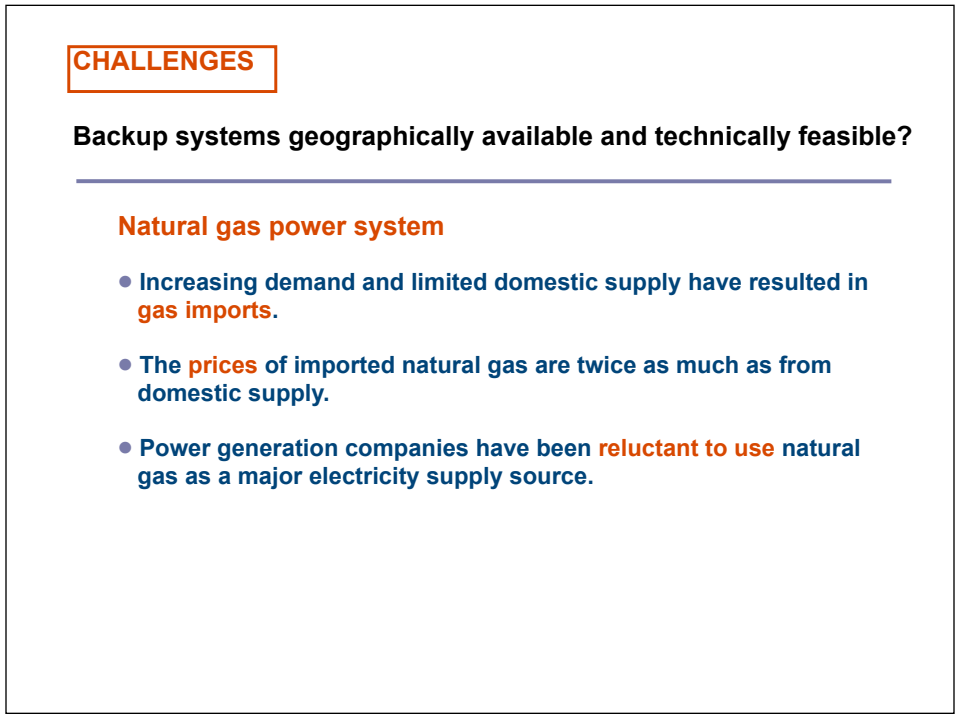
CHALLENGES

Backup systems geographically available and technically feasible?

Hydropower system

- When electricity output from wind farms fluctuates, the hydropower plants could be used to provide auxiliary supply to the electicity output.
- Not appropriate in specific areas due to mismatch in spatial distributions.

QUICK RESPONSE



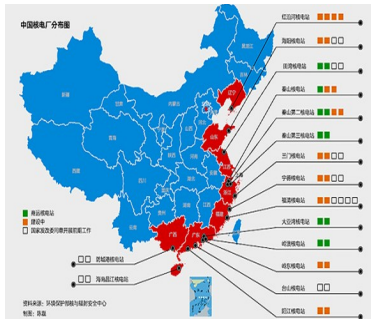
Although several agreements have been made between China and Russia, Turkmenistan and other supply countries to guarantee natural gas supply.

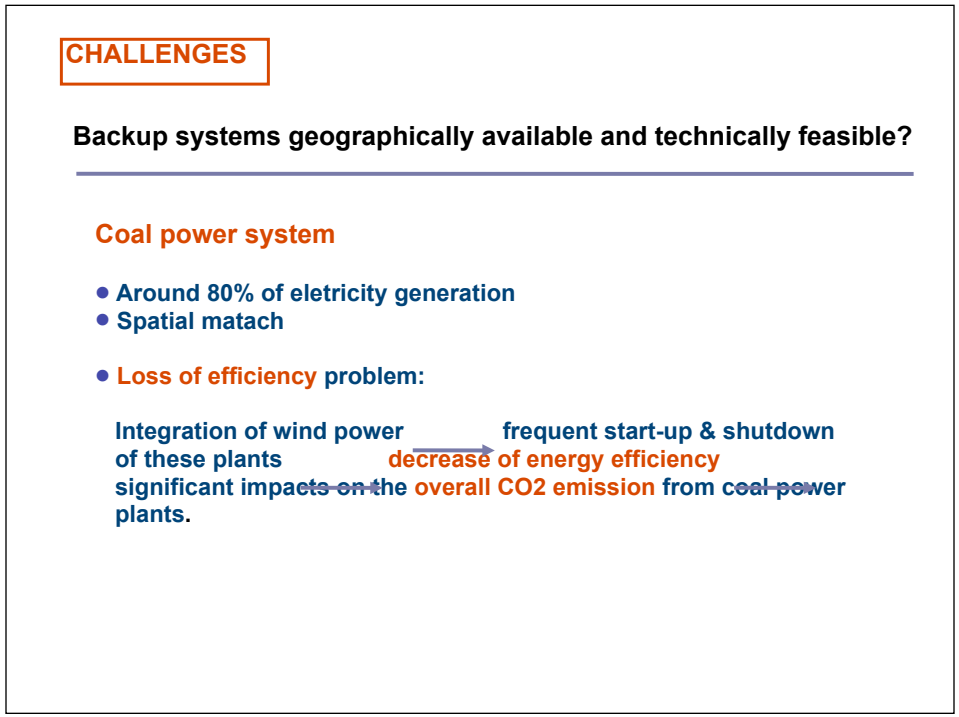
CHALLENGES

Backup systems geographically available and technically feasible?

Nuclear power system

- Important technology in diversifying the future power generation mix in China.
- Mismatch in spatial location.
- Incapable in ramping ups and downs quickly.





For example, White found that a 2% energy efficiency loss would result in a 150 g CO2 emission growth per kWh electricity output for a coal-fired boiler.

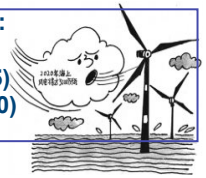
FUTURE PROSPECTS

- **Ultra high voltage (UHV) transmission**
  - **42.8 billion yuan** (US$6.3 billion) would be directly invested in wind integration related grid construction.
  - Accommodate up to 90 and 150 GW of wind power by 2015 and 2020, respectively.
- **Application of offgrid wind power:** direct use of wind power
- **Development of offshore wind power**: significant potential, location close to demand centers, consistent wind resources.

The first offshore wind farm was constructed at Shanghai Dongda bridge in 2009. Many offshore wind farms have been planned for the next decades.

Total capacity:

15.1 GW (2015)
32.8 GW (2020)



THANK YOU

Q & A