



# China low-temperature wind turbine design and its application

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# China low-temperature wind turbine design and its application



- Status of Wind Power Development
- Cold Climate in China
- Technical solutions , effect and problems
- Further actions



- In order to cope with climate change and reduce GHG emissions, the Chinese government put forward the strategic objective that "Non-fossil energy will represent 15% of the energy by 2020."
- The government also has the target to reduce carbon emissions "40% to 45% by 2020 per GDP compared to the level of 2005."
- To achieve the goals, Chinese government began implementing "The Renewable Energy Law " in 2005



## Status of Wind Power Development



By 2010, the newly installed capacity is 18.9 GW. The total installed capacity is 44.7GW. China has ranked on top in the world.

By the end of 2011, the installed capacity is above 60GW. The newly grid-connected wind power in 2011 is 15.85GW and accumulated amount is 47GW.

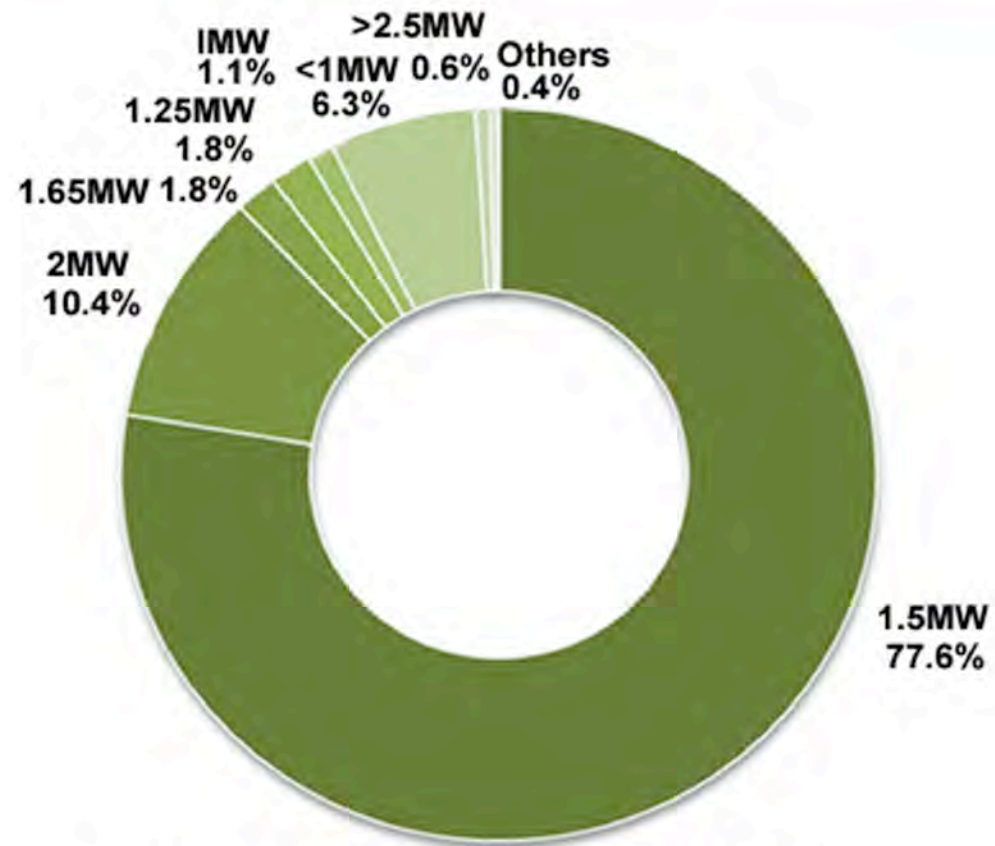






# Status of Wind Power Development





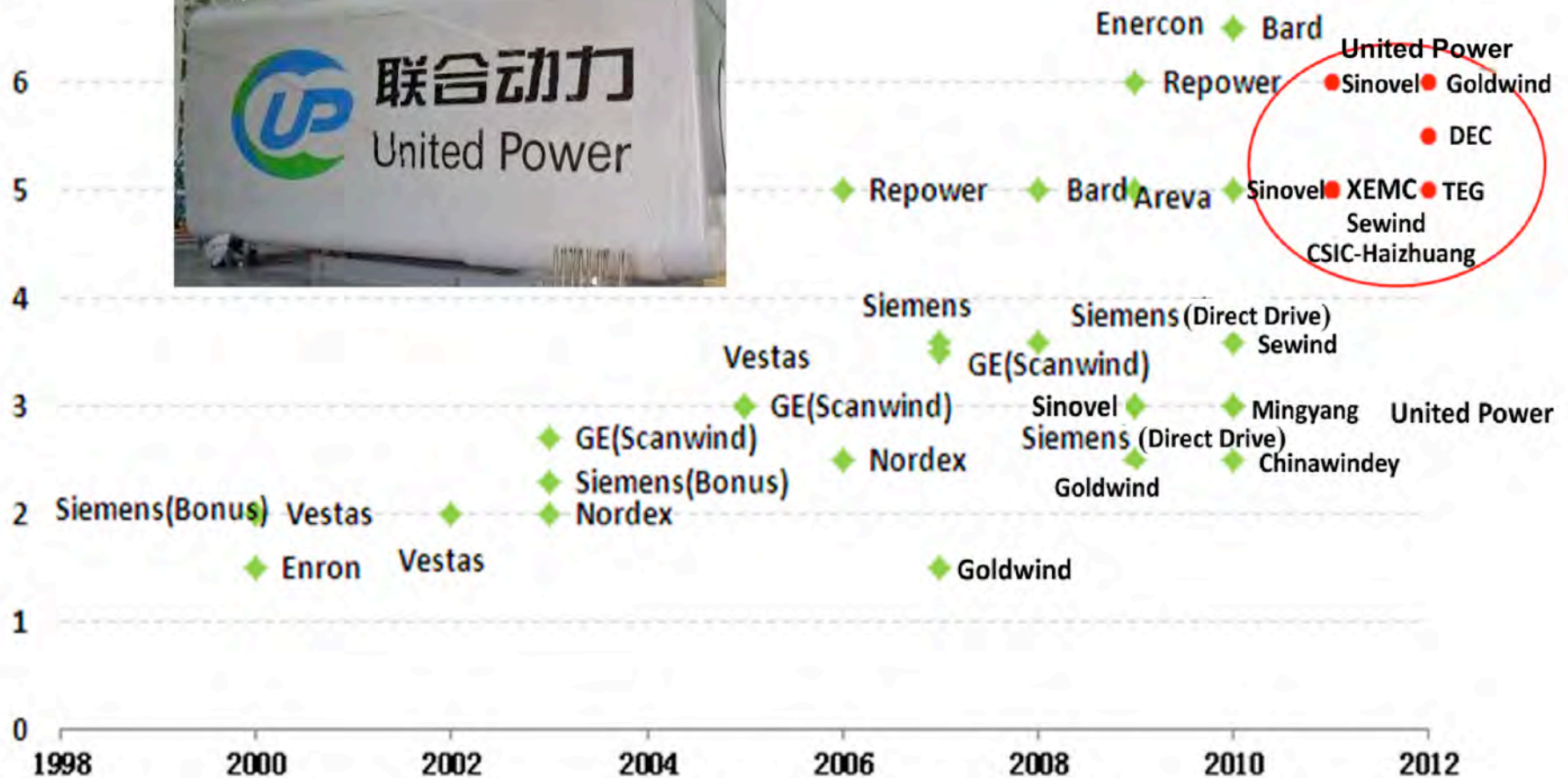
2010 Annual Installed Market Share  
by Capacity



# Status of Wind Power Development



(Unit: : MW)  
7







## Multi-MW wind turbines



Sinovel 6MW



Guodian United Power 6MW



Goldwind 2.5MW

At present, the main WEC type is 1.5–3MW, some 6MW machines has been produced for prototype, and the even bigger wind turbine is under development.



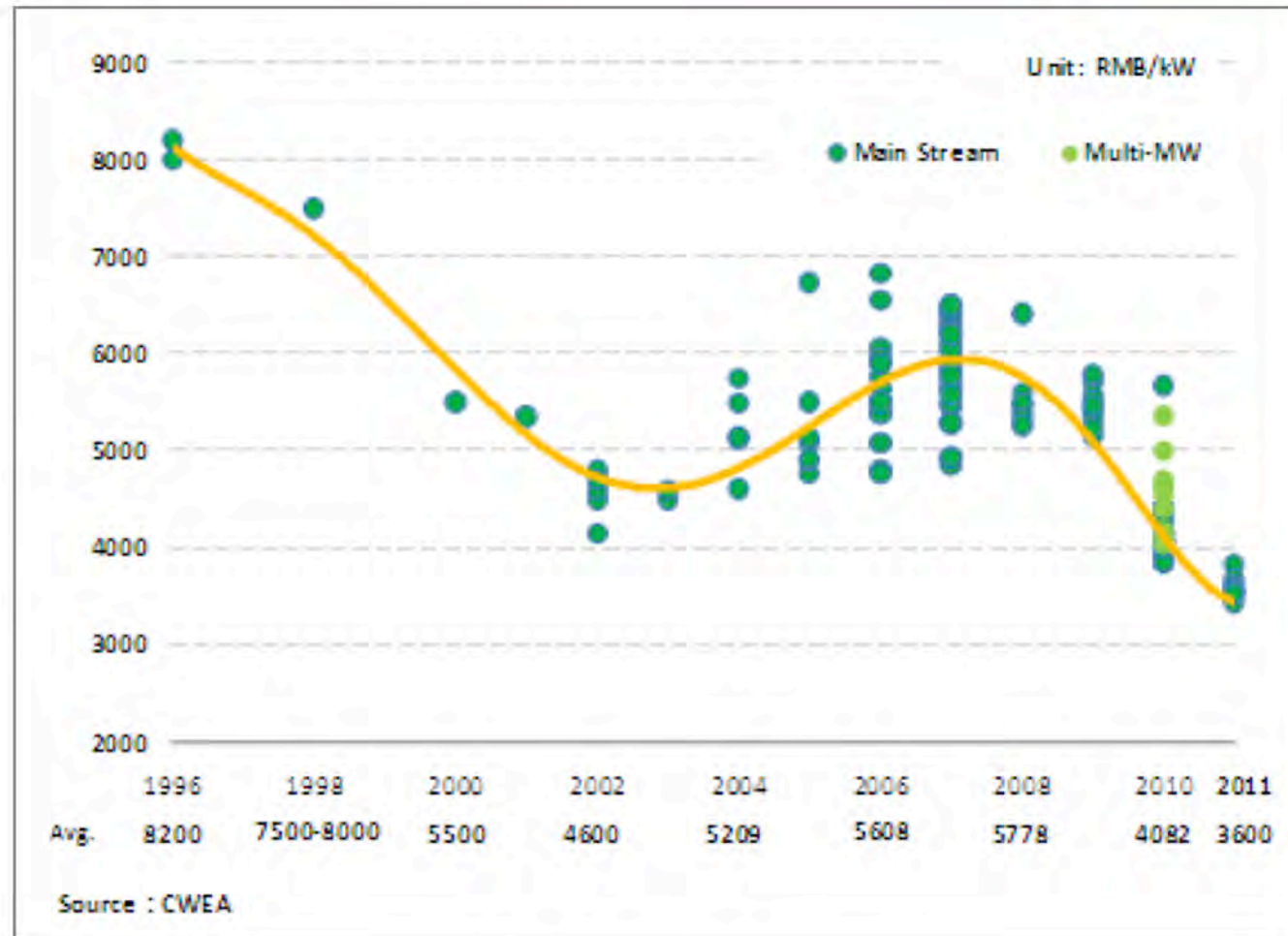


# Status of Wind Power Development



Pressure from Price

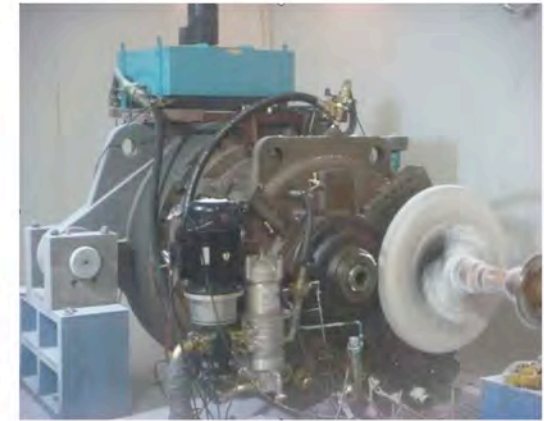
Unit: Yuan RMB/kW



Trend of WEC Price



## The ground test platform of WEC components







## WEC should support the grid!



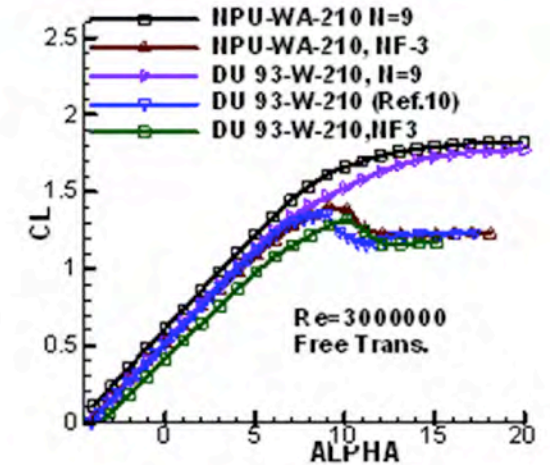
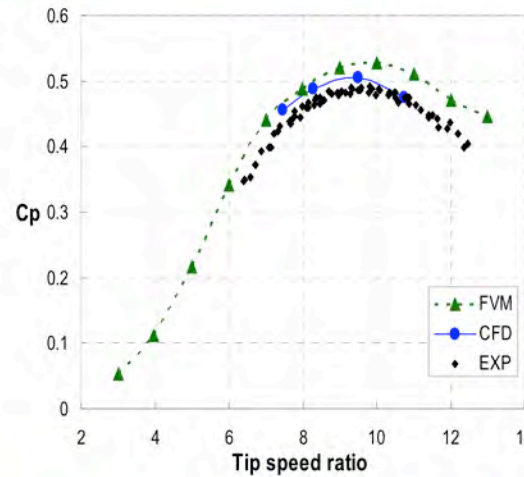
Low voltage ride-through (LVRT)



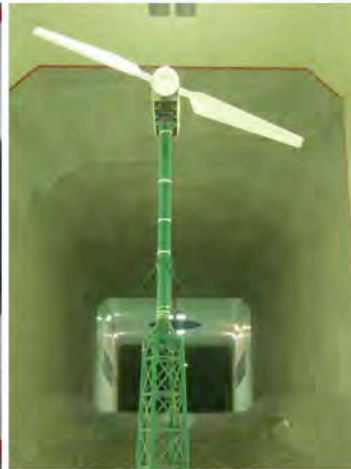


Basic Research(973 and 863 Program)

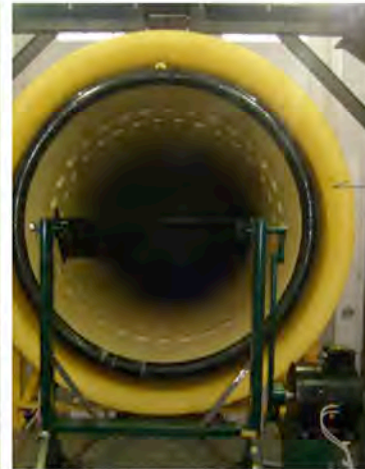
"Aerodynamics Basic Research for Large Scale WEC"



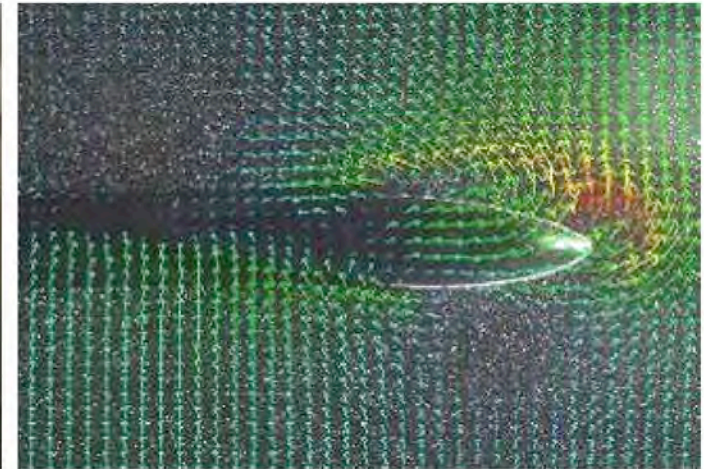
4mX3m  
wind tunnel



8mX6m/12 mX16m  
wind tunnel



Φ3.2m  
wind tunnel

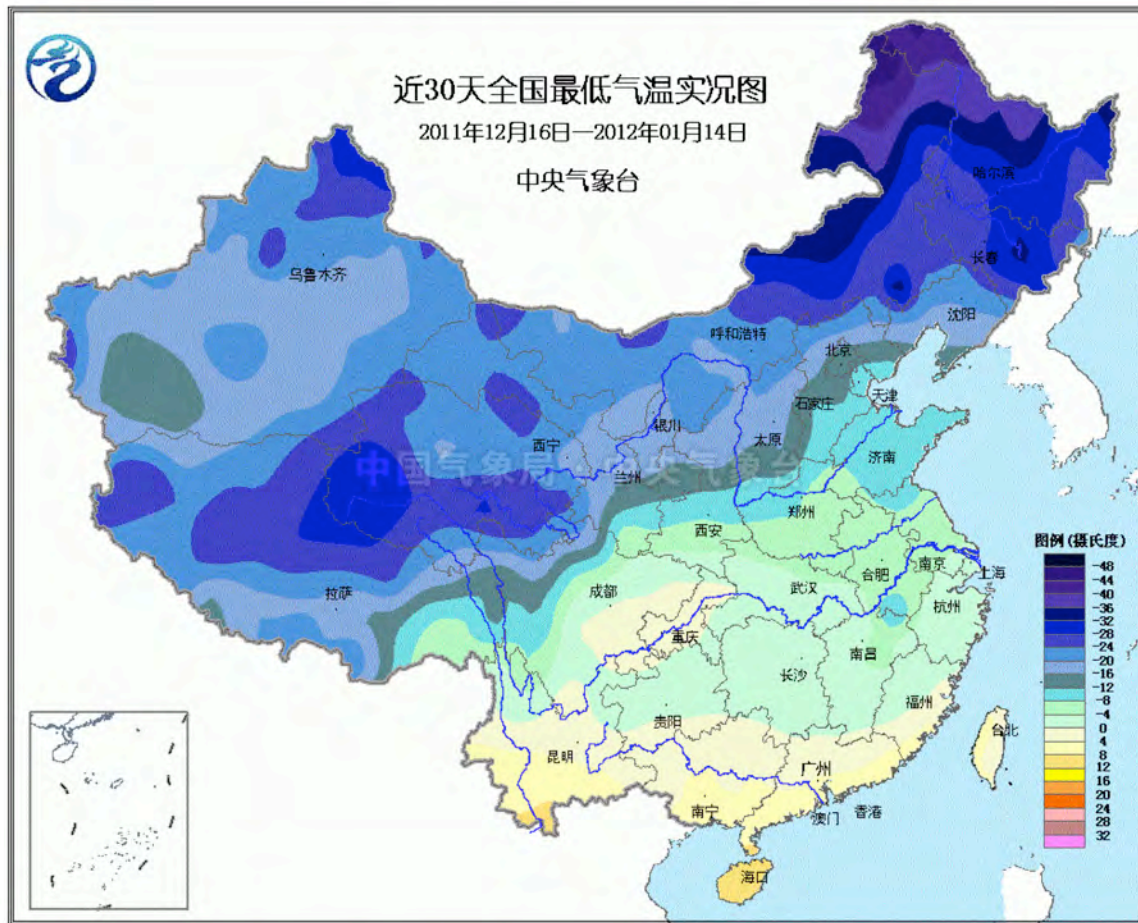


Numerical simulation





# Cold Climate in China

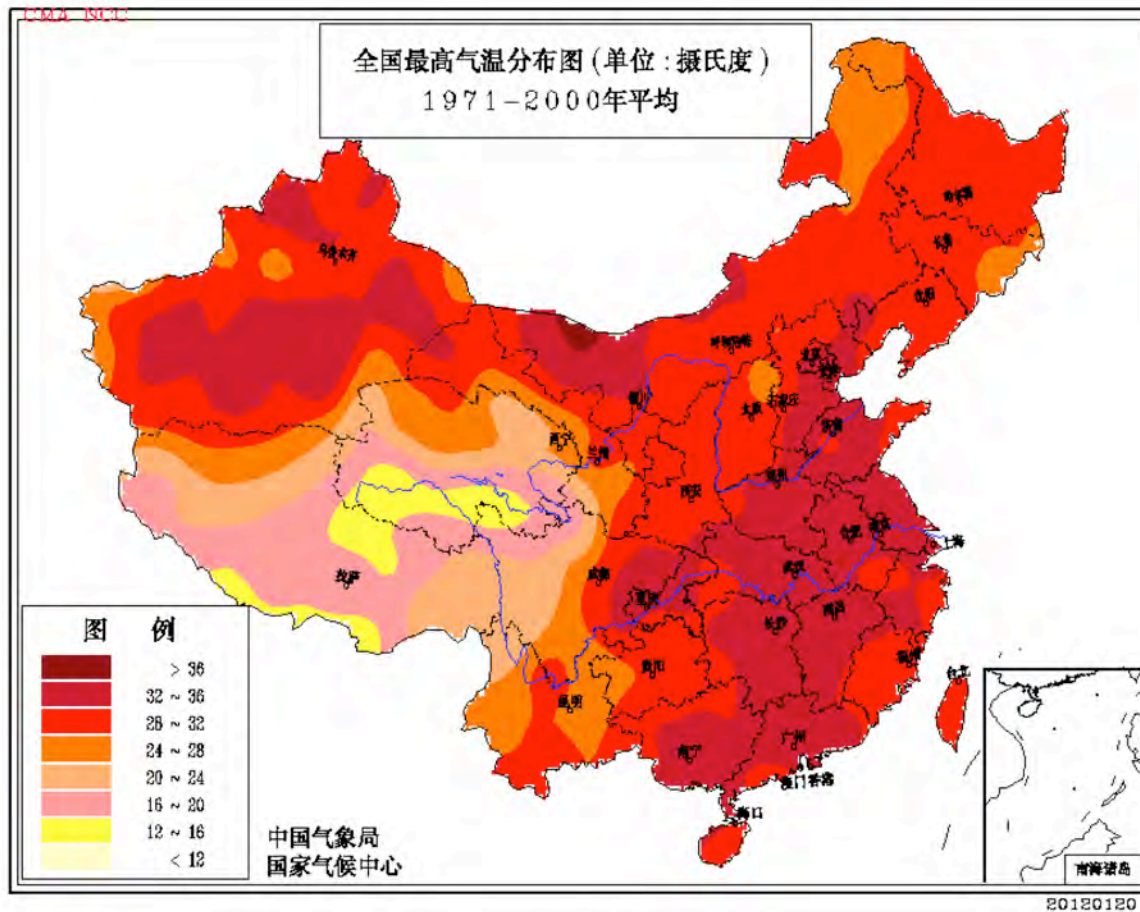


Most area of North China is Cold Climate for wind turbine!

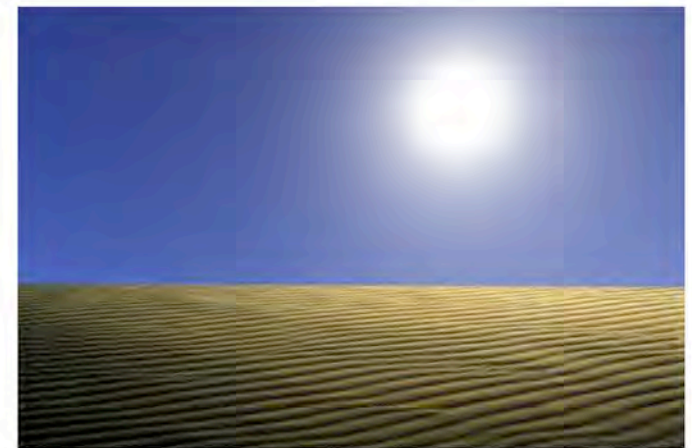




# Cold Climate in China



At the same time, some of these areas is also Hot Climate for wind turbine!

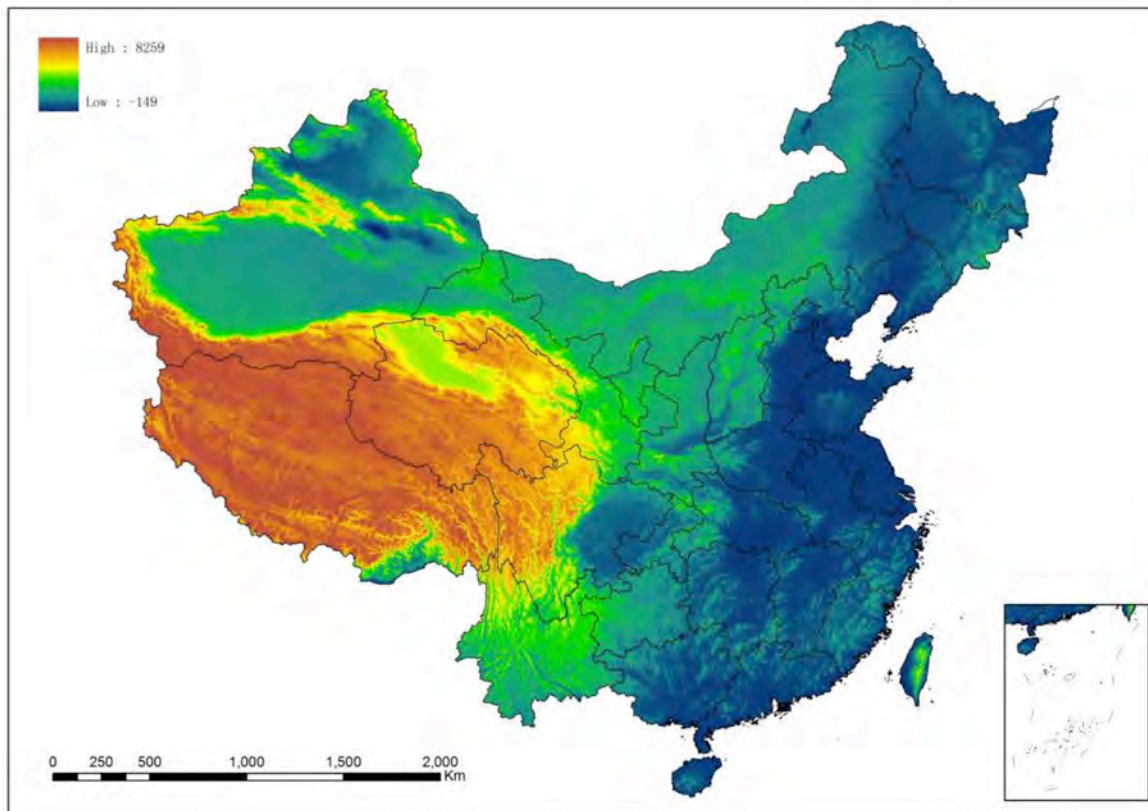


From: China Meteorological Administration





# Cold Climate in China



There are also sandstorms in these area every year!



From: China Meteorological Administration



# Cold Climate in China



Wind Turbines will be installed the area from the sea level from 0 to 4,000 meters!







## Technical solutions effect and problems



The environment of the wind parks is normally the combination of the above mentioned two factors or even more!

Not only Cold Climate..., but...

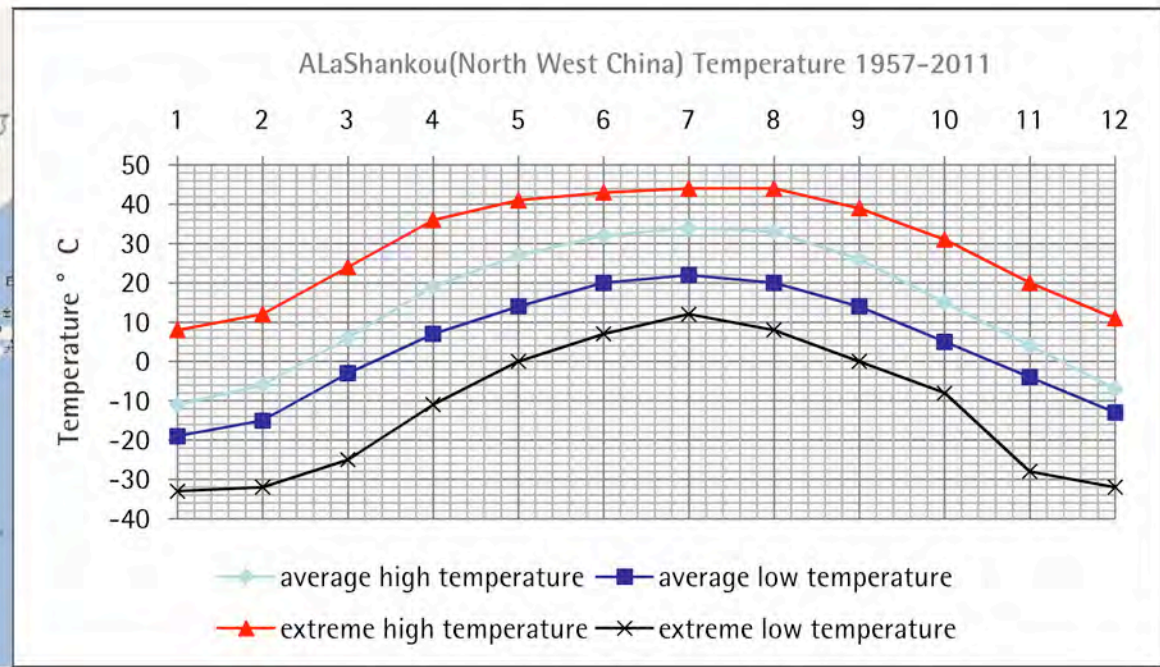






## North West China

- Cold Climate + Hot Climate + Sandstorm
- air density is  $1.401 \text{ kg/m}^3$  in winter, and  $1.088 \text{ kg/m}^3$  in summer



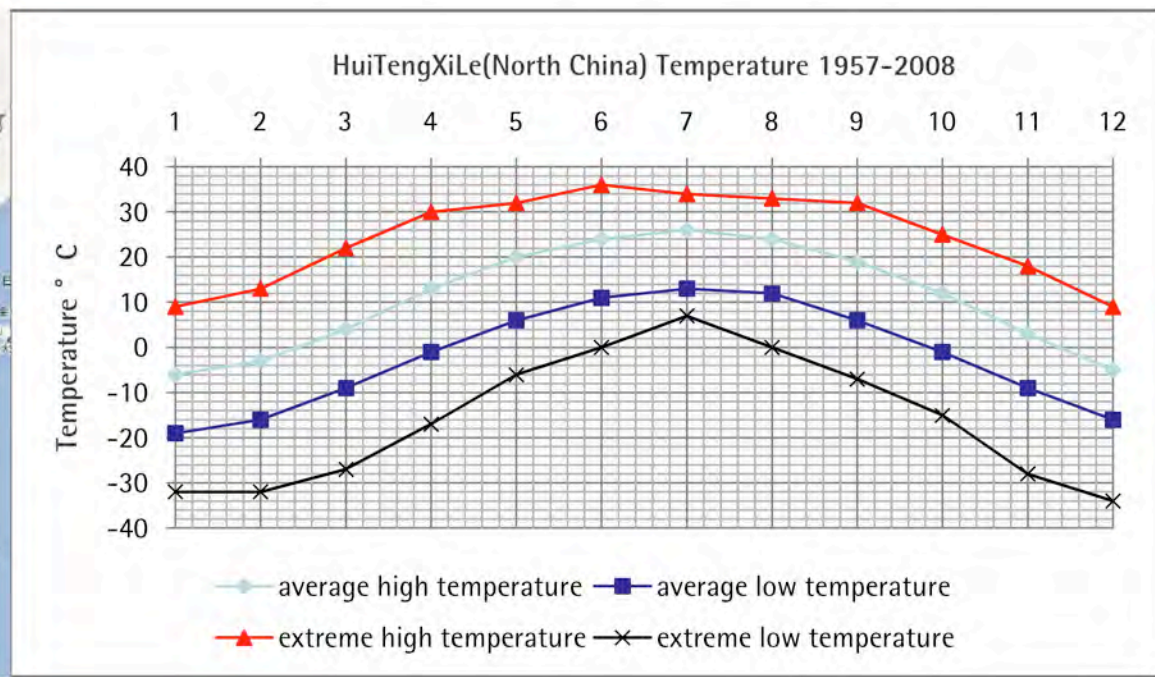


# Cold Climate in China



## North China

- Cold Climate + Sandstorm
- air density is  $1.102\text{kg/m}^3$  in winter, and  $0.902\text{kg/m}^3$  in summer

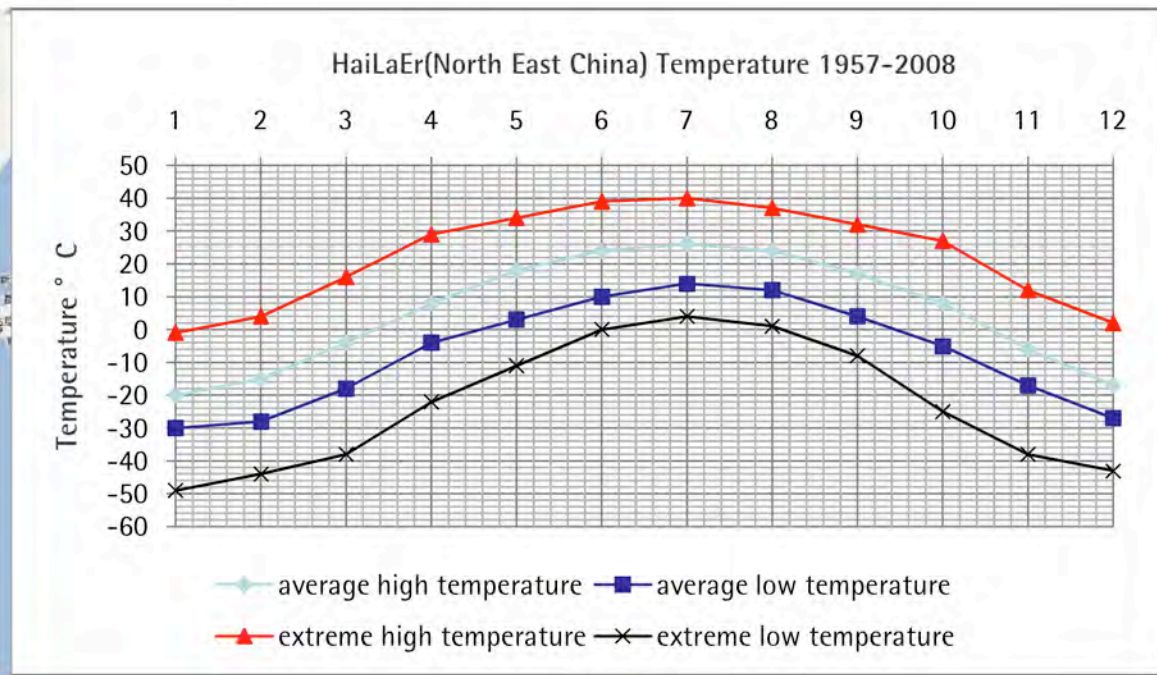






## North East China

- Cold Climate
- air density is  $1.349\text{kg/m}^3$  in winter, and  $1.065\text{kg/m}^3$  in summer







Technical solutions  
effect and problems



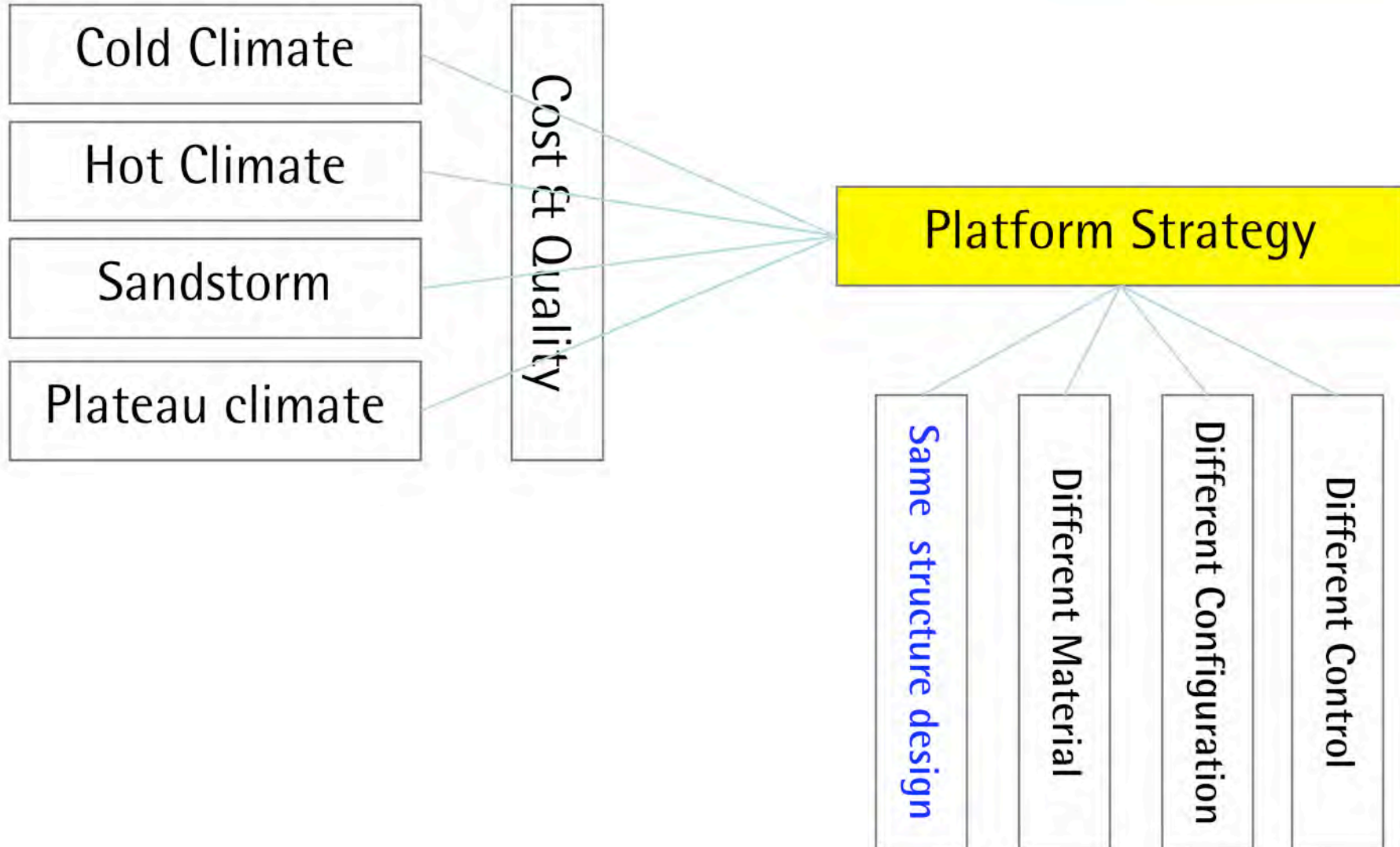
The environment of the wind parks is normally the combination of the above mentioned two factors or even more!

The design of wind turbine suitable for all of these areas is a great challenge for the manufacturer in China.





# Technical solutions effect and problems







# Technical solutions effect and problems



## Loads

- Winter and Summer – big difference

	wind park	altitude (m)	low temperature	air density winter	high temperature	air density summer	density difference
North West China	A La Shankou	300	-30° C	1.401	40° C	1.088	129%
North China	Hui TengXiLe	2100	-26° C	1.102	30° C	0.902	122%
North East China	Hai LaEr	612	-30° C	1.349	35° C	1.065	127%

In China the cold area is in high altitude region, this compensate somewhat the increase of air density because of low temperature. But it is not always the case! Capability to design blade is very important!

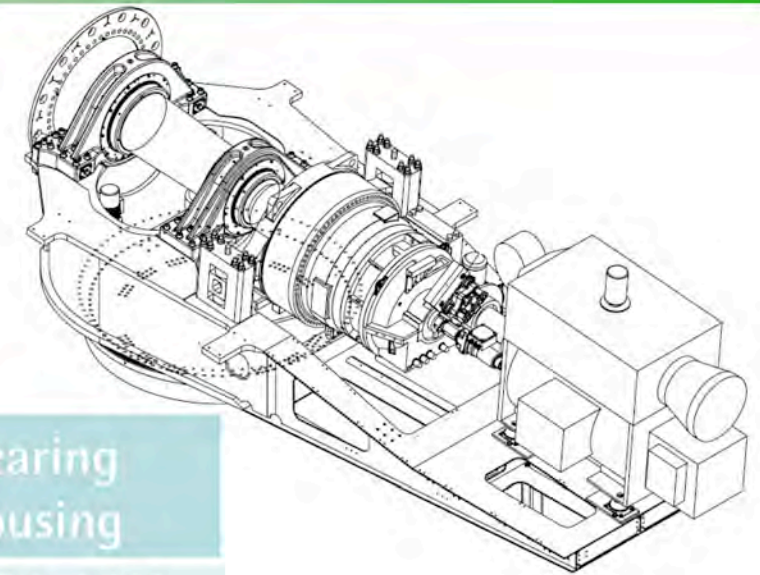


# Technical solutions effect and problems



## Material

- deep cooperation wind suppliers
- deep cooperation with certification body



Component	Hub	Main Frame	Bearing Housing
Normal Climate	QT400-18AL	Q345D	QT400-18AL
Cold Climate	QT400-18AL (impact test 12J at -40° C)	Q345E	QT400-18AL (impact test 12J at -40° C)





## Technical solutions effect and problems



### Components

- All the components must be cold climate
- Cold climate test at the suppliers
- Gearbox cold climate start up test,  
generator cold climate test
- Control System, Pitch System...

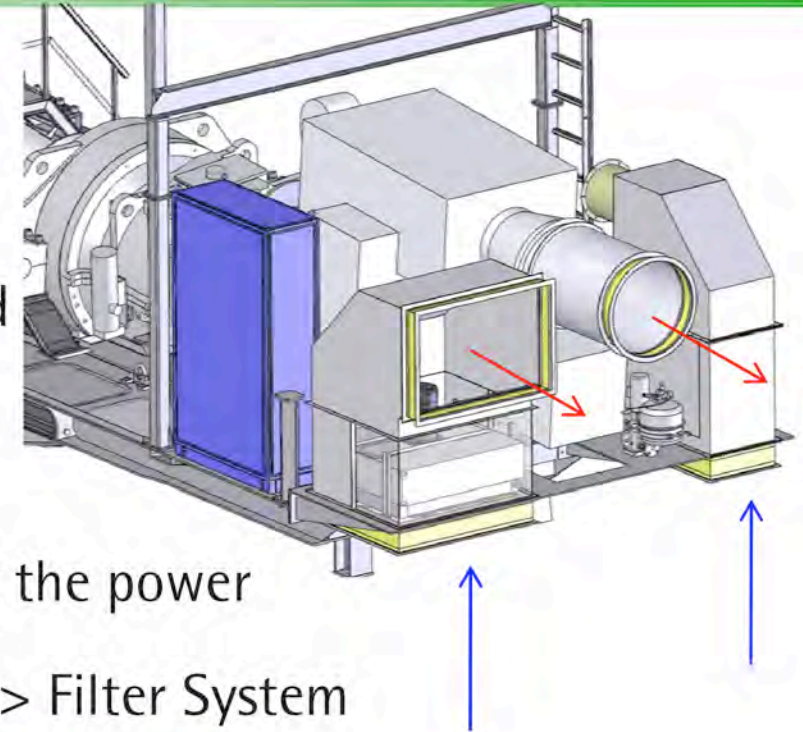
Integrated Development is the solution, because 50% "know-how" is at supplier!





## Cooling System

- standard wind turbine  
be afraid of hot in summer and afraid of cold  
in winter.
- High altitude => low air density => lower  
cooling capacity => larger air cooler or limit the power
- Sandstorm => Sealing of the Nacelle Cover => Filter System



altitude dependent specific  
cooling capacity

0m 2.2 kW/K

800m 2.0 kW/K

2000m 1.6 kW/K





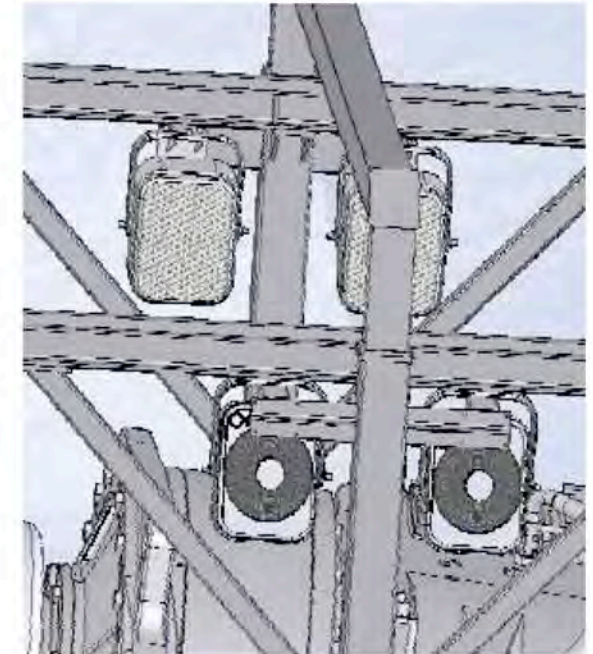
# Technical solutions effect and problems



## Heating System

- standard wind turbine  
be afraid of hot in summer and afraid of cold in winter.
- EFFICIENT COLD START UP
  - => distributed heating equipments  
oil sump heating, heating jackets or hoses,  
winding heating
  - => Supporting fan heating  
commissioning and maintenance(important)
  - => good nacelle cover thermal isolation

The time for Cold Start Up has big influence on productivity, so that it is a important parameter for Customer Satisfaction





# Technical solutions effect and problems



## Sensors

- ICE Detecting Sensor
- Cold Climate Wind Speed Sensor and Wind Direction Sensor
- Redundancy for wind Speed Sensor
- Plastic or Metal
- DEEP cooperation with supplier (Technology, Cost and Quality)



Working Sensors is the precondition for load assumptions!





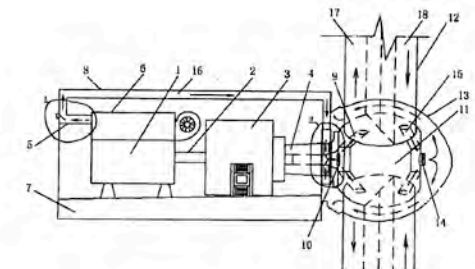
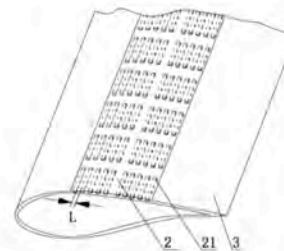
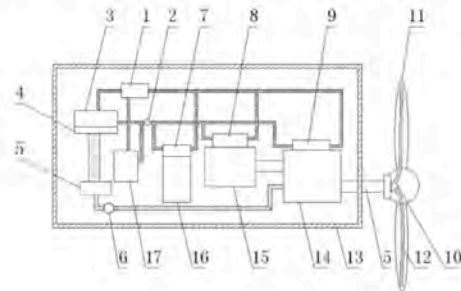
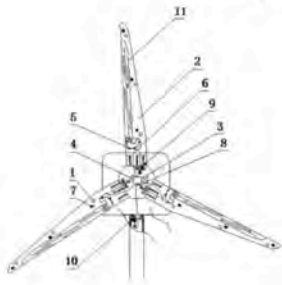


# Technical solutions effect and problems



## ICE

- Expensive Task
- Experience
  - new blade has less ice than old one
    - => smooth?
    - => clean?
    - => maintained?
- Ideas and Reality
  - solutions, some patents, less industrial use





# Technical solutions effect and problems



## Effect and problems

- newly installed wind turbines shows good availability
- cooling system works also well in summer
- cold start up works well, but time is relative long => productivity
- duty blade or sandstorm => ice on the blade







## Technical solutions effect and problems



### Effect and problems

- far from residential area => bad maintenance condition
- far from consumer => relative weak grid => grid connection  
=> more cold start up
- cost pressure / technology => active de-ice system is not widely used  
=> productivity





## Further Action



The Optimization should go further!

- intelligent Control (big air density difference, cold climate and hot climate)
- better maintenance
- cheaper de-ice system
- all kinds of measurement
- cooling system for hub because of also hot climate
- ...
- ...

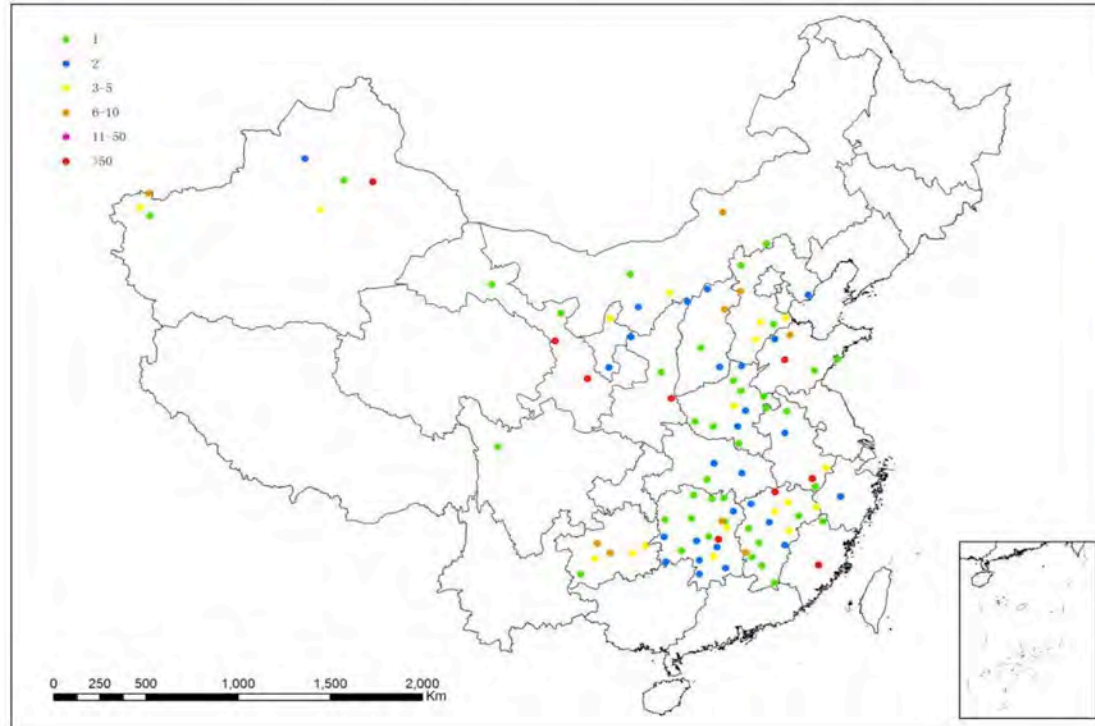




## Further Action



### Ice Rain: Cold Climate in Normal Climate





*Thank you for your attention!*