Innovation pathways of the Chinese wind power industry

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Outline:

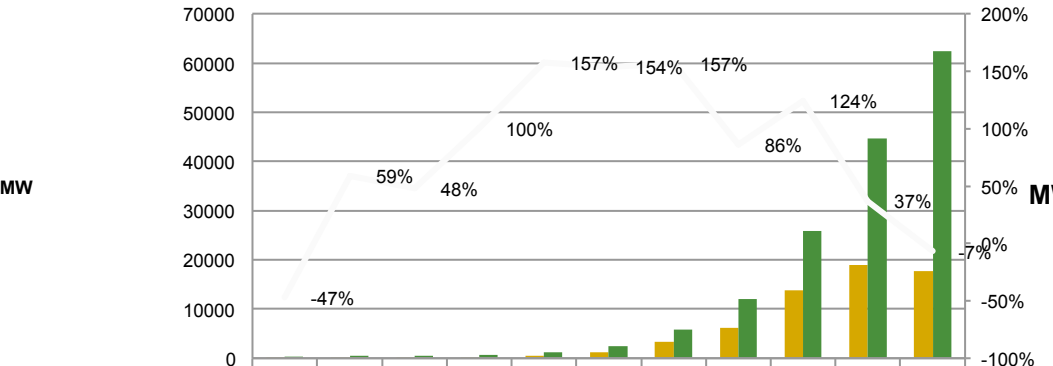
- **Research questions and methodology**
- **Background of China's wind energy sector**
- **A brief story of innovation process at HT**
- **Impacts of China's macro-level settings**
  - Market
  - Technology
  - Policy: Central and Local
- **China's innovation pathways**
- **Two more cases**
  - Goldwind – a lead wind manufacturer in China
  - Jiuquan wind farm base (Gansu Province)
- **Implications and discussions**

Research Questions

- "What" Question:

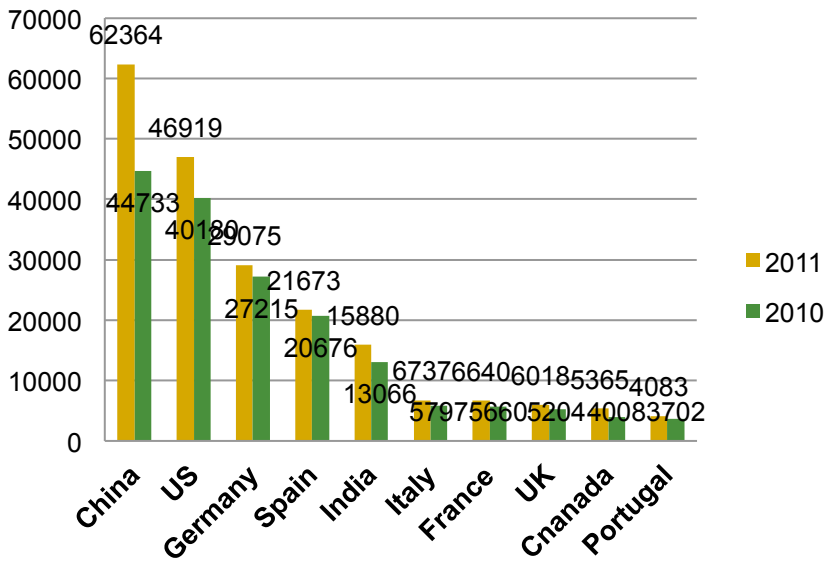
What is the innovation path in Chinese wind sector (if it has a different innovation path comparing to other countries)?

New Installed and Cumulative Capacity in China after 2000



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
new capacity	41.7	66.3	98.3	196.9	506.9	1287.6	3311.3	6153.7	13803.2	18928	17630.9
cumelative capacity	381.2	447.5	545.8	742.7	1249.6	2537.2	5848.6	12002.2	25805.4	44733.4	62364.3
growth rate	-47%	59%	48%	100%	157%	154%	157%	86%	124%	37%	-7%

Top 10 Countries by Cumulative Capacity



Research Questions

- "Why" Question:

What are the determinants of China wind energy innovation path?

China's innovation capacity / strategy of firms?

The specifics of China's market?

China's development strategy and policy support?

International knowledge transfer / innovation network?

Methodology / Data

- Snowball Interviews:
  - Two rounds of interviews, including:
    - Domestic wind manufacture firms
    - Wind farms
    - Local governments
    - Central government (NDRC)
    - Research institutes, experts (i.e. from Grid)
    - Foreign wind manufacture firm
- Policy analysis:
  - Summarize wind policies with trend analysis, including
    - 41 policies with regarding to Chinese wind development
    - 11 policies to encourage the wind industry to development, while 29 with regarding to FIT and renewable energy subsidy.

Goldwind

Gansu Jiuquan Windfarm

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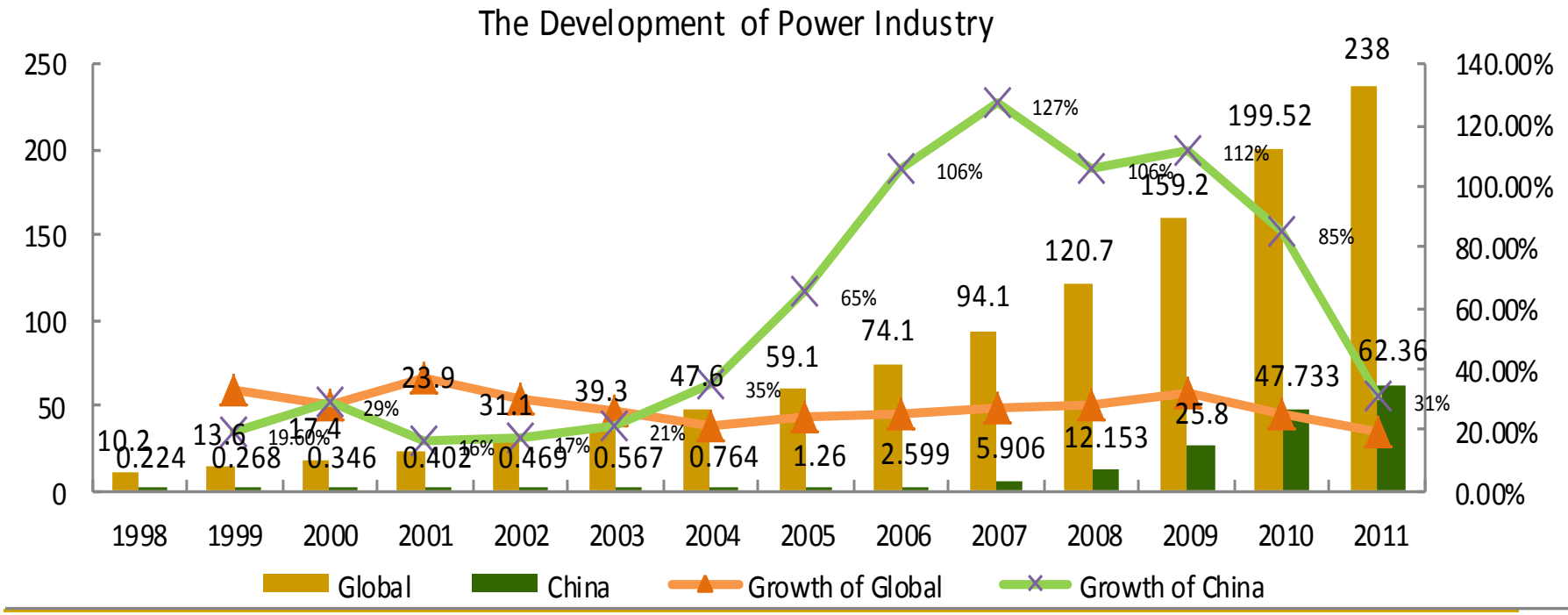
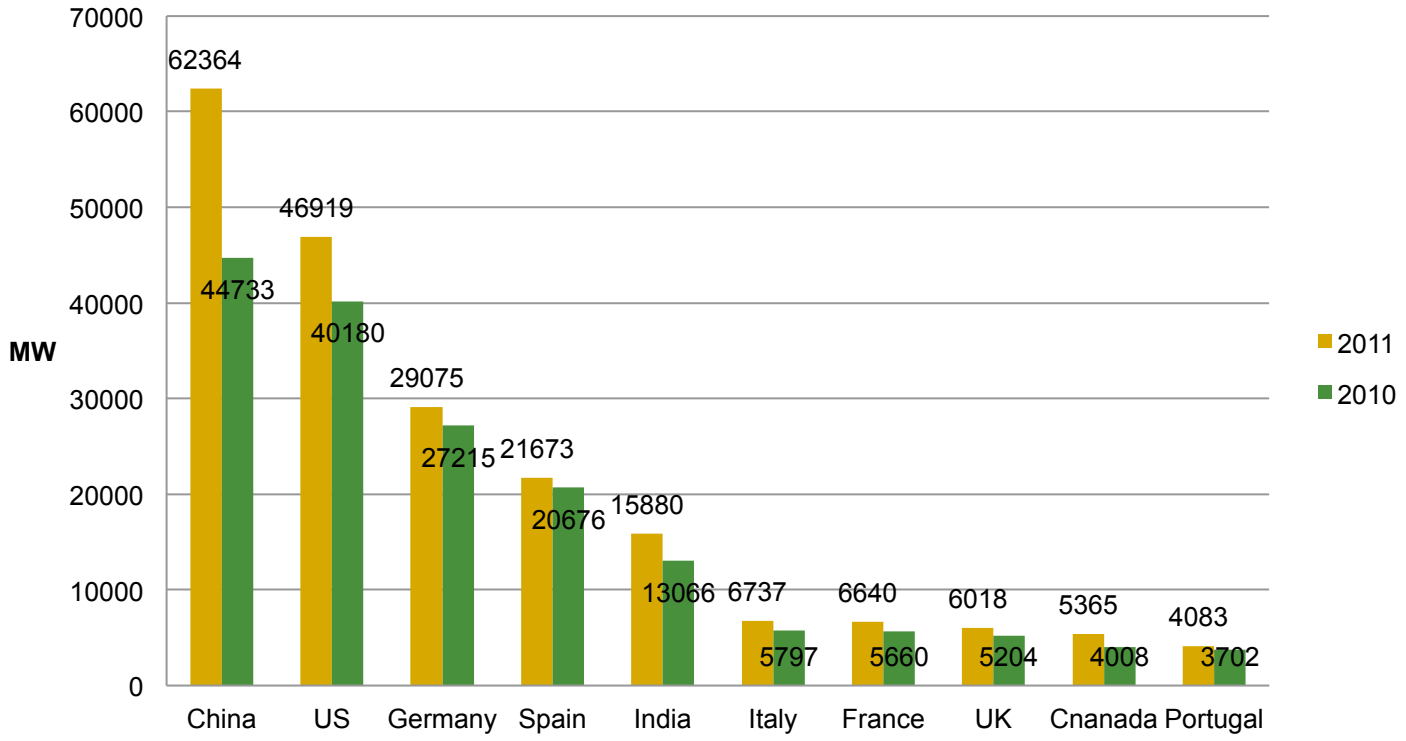
Background

- **Wind energy industry grows rapidly in both China and world-wide.**



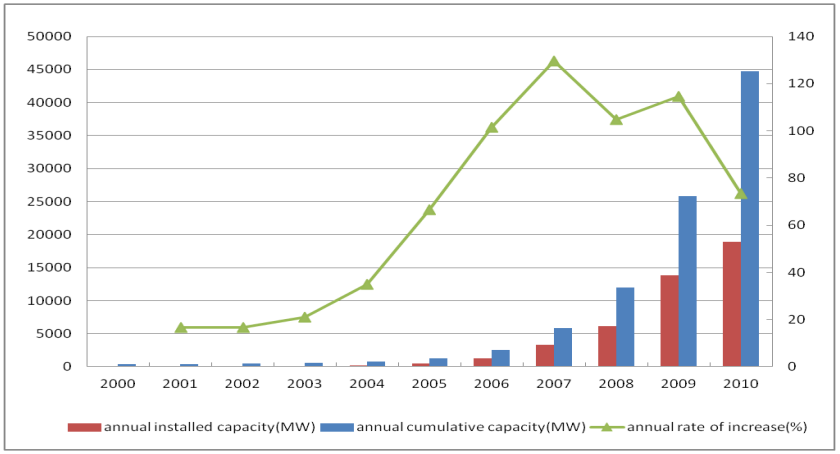
Background

- **Top 10 Countries by Cumulative Capacity**

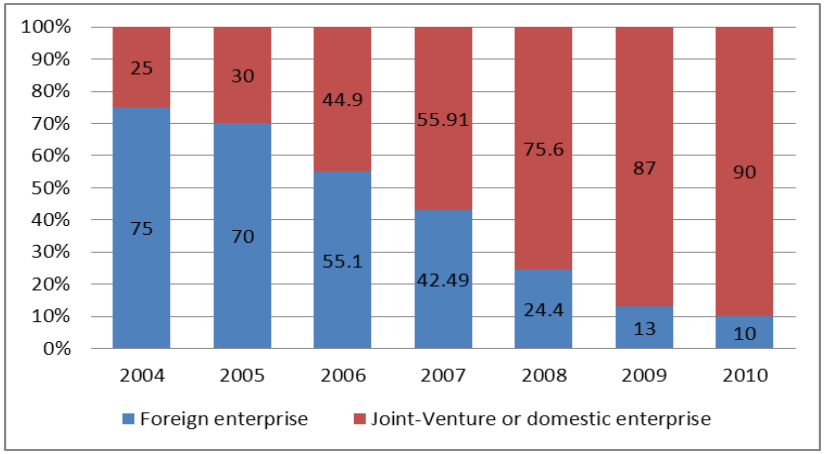


Background

- **Rapid growth of China wind turbine market**



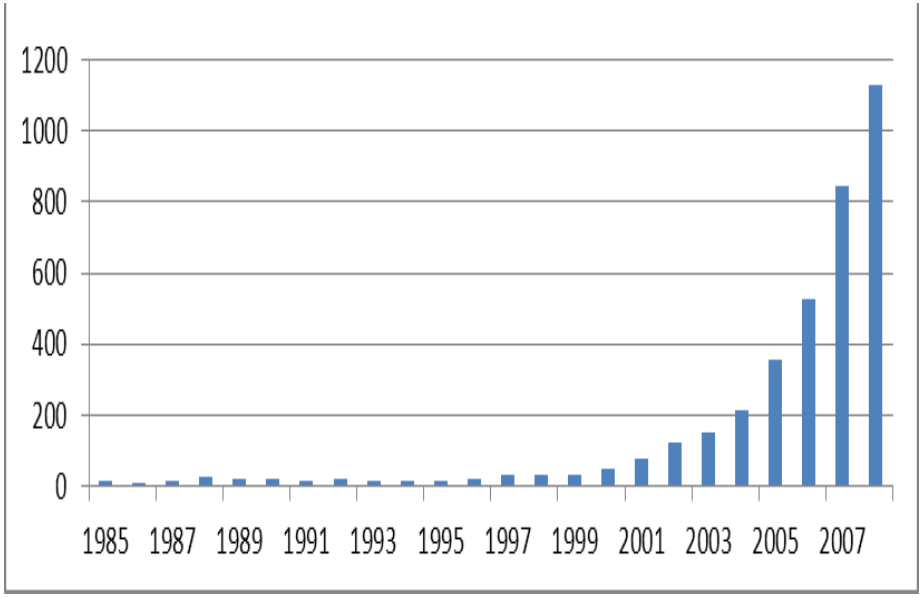
Boom of the market size
CWEA(2011)



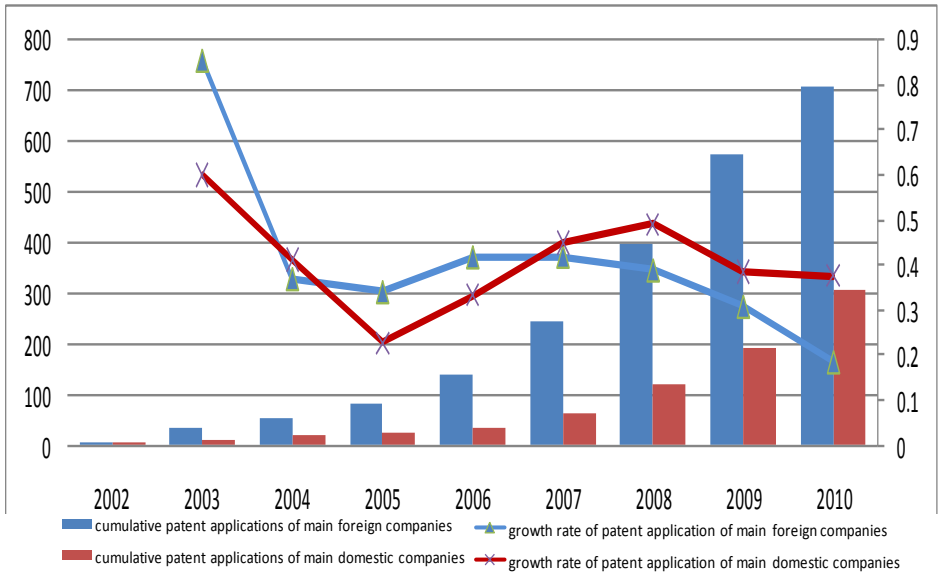
Rise of market share of domestic firms
Shi (2005, 2006, 2007, 2008, 2009), Li (2011)

Background

- **The growing number of patent applications in China**



Growing patent grants(cumulative)



Cumulative patent applications of main companies in China

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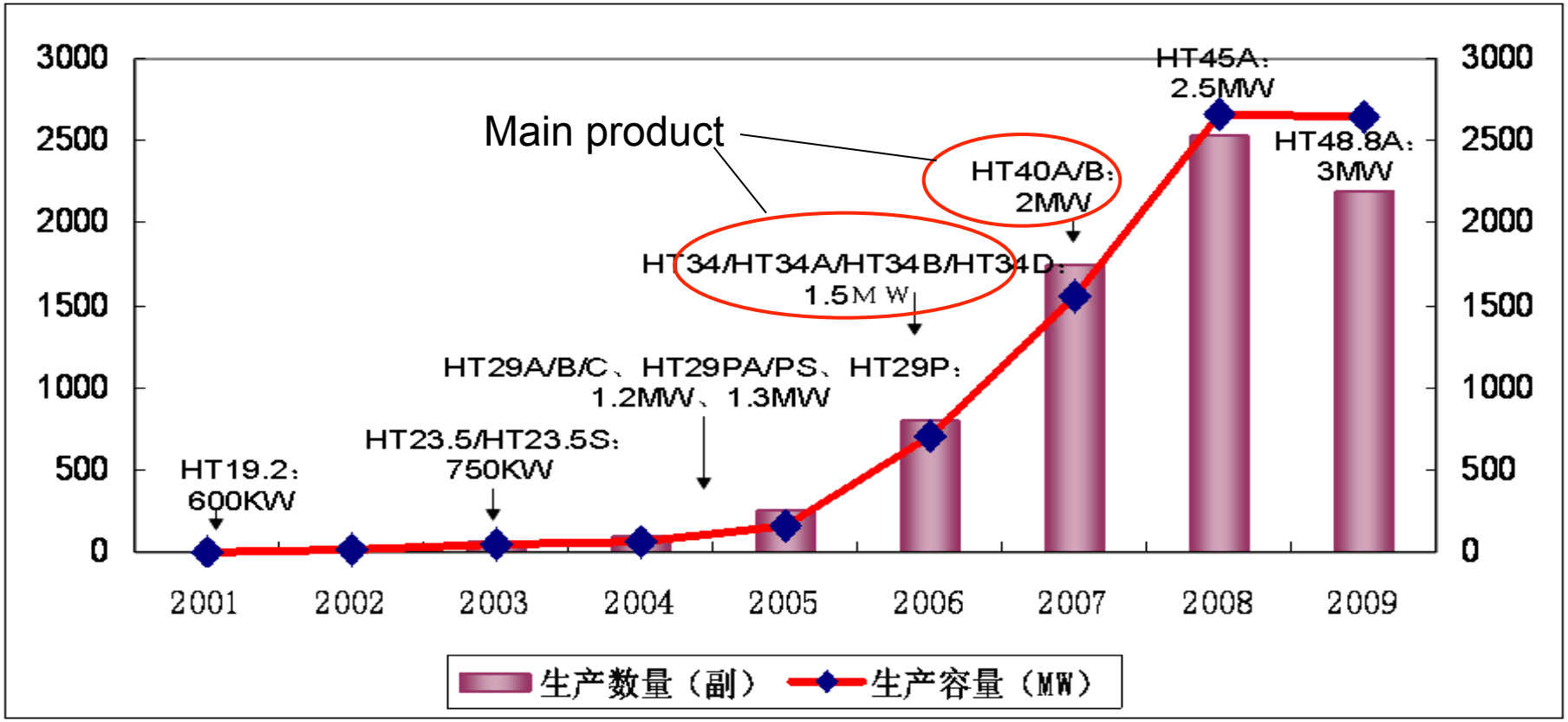
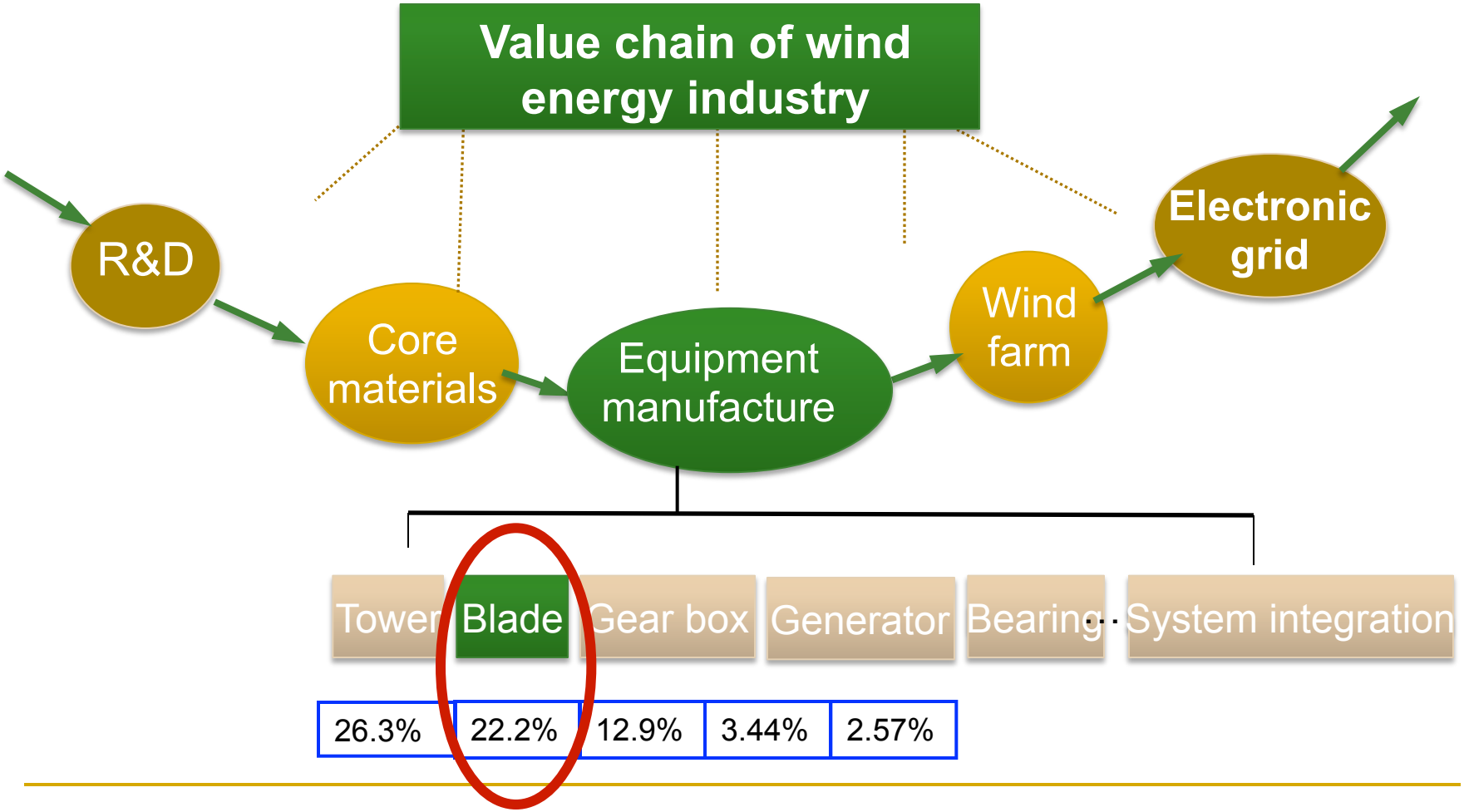
A story on HT

- Established in 2001
- The biggest wind turbine blade provider in China
- 40% market share in China
- Exportation to United States, Japan, South-Africa, etc.



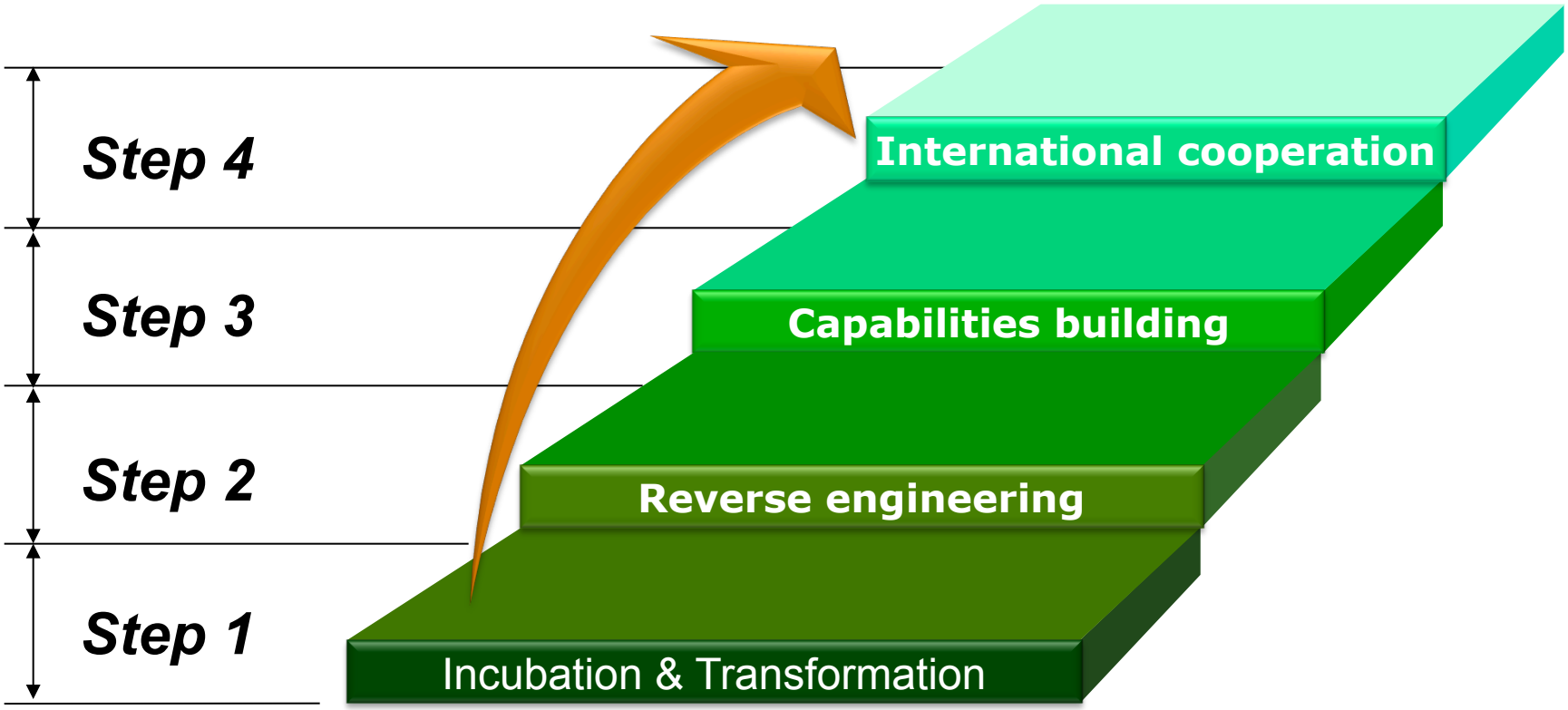
Blade is a key component of wind turbine system, accounting for 22.2% of the total cost



Blade: technology intensive and high quality requirements

- **large size: e.g. blade: 37.5m long, 5t weigh**
- **high precision: weight tolerance within 5%, gravity centre tolerance within 120 mm**
- **tough working condition (especially in China):**
  - Low extreme temperature：-30℃ (-50℃ in China)
  - Violent wind (sand storm in China)
  - Rain and snow (Acid rain in China)

Growth steps of HT



Step 1 Before 2000: Incubation & Transformation

From a military firm (soviet-union style) to a high-tech new venture

- **Parent company: an aviation propeller manufacturer**
- **Technological foundations inherited from parent company**
- **Technological experts transferred from parent company**
  - E.g. Chief engineer of HT: former R&D team leader and associate chief engineer of the parent company

Step 2 Before 2005: Start from R&D and imitation

- **Joint-venture with U.S. established in 2001**
- **Acquired the know-how of 600 kW blade through reverse engineering and learn-by-doing.**
- **Contribution for the industry: Low cost strategy**
  - No more monopoly of foreign companies
  - Significant price decrease from 1.3 million CNY to 0.5~0.8 million CNY per pair.

Step 3: Technology transfer and localization

- **Foreign company started to transfer their technology to Chinese company**
  - e.g. CTC transfer their blade design to HT
- **Technology transfer also enabled the boom of blade manufacturing companies, under the boomed market**
  - e.g. 2 blade companies to 70 companies
  - China's wind energy concession project since 2004
- **Competition caused the quality differentiation**
  - e.g. 50% basic material cost off by cultivating two major suppliers from Germany and China

Step 3: Technology transfer and localization

Strategy shift from cost leadership to technology differentiation

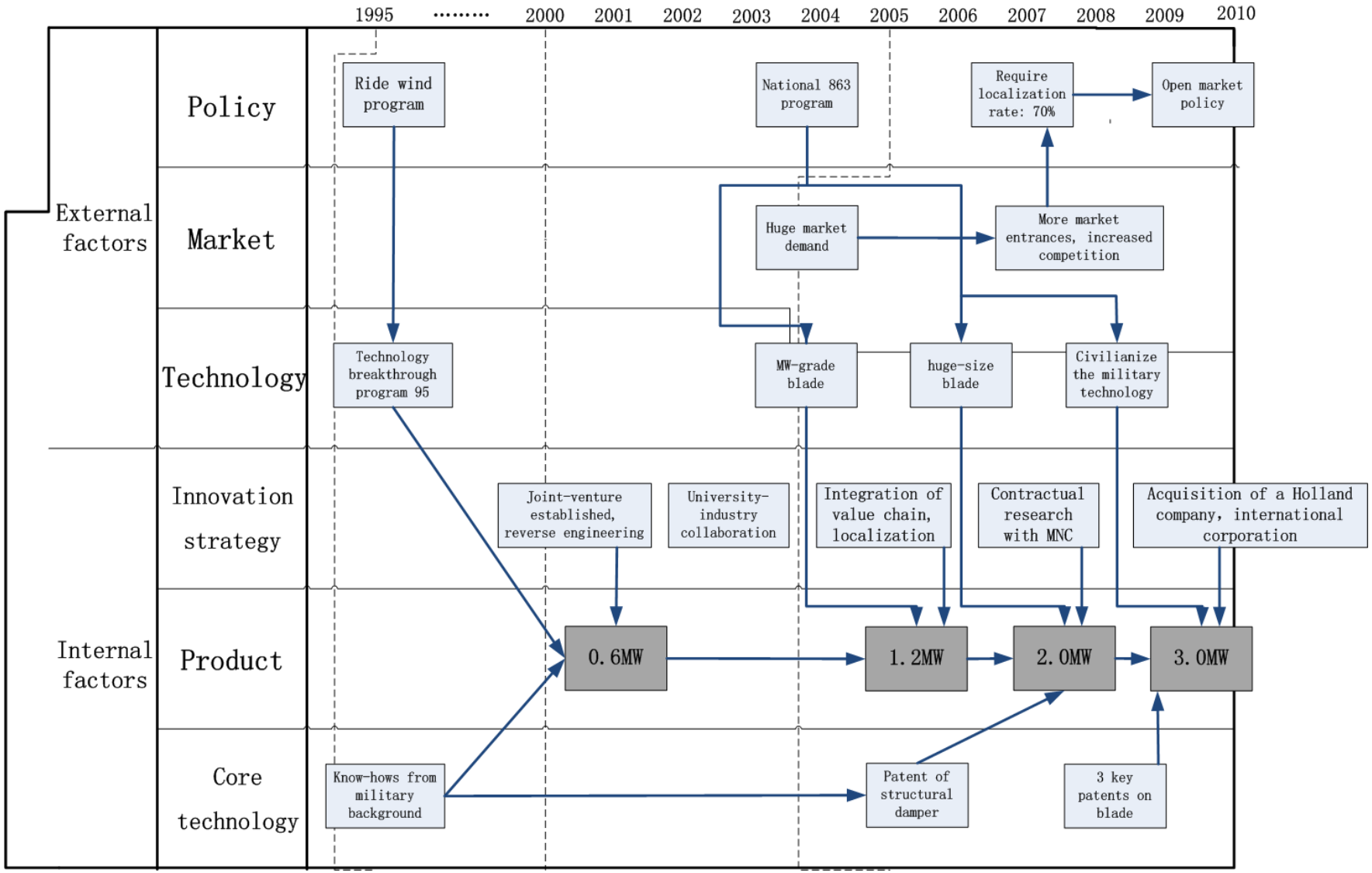
- **Technology improvement according to Chinese specific working conditions**
  - e.g. low extreme temperature decreased from -30℃ to -50℃
- **Technology breakthrough addressing the common problems of turbines**
  - e.g. patent of ”structural damper of wind turbine blade”
- **Vertical integration of the value chain**
  - e.g. 50% basic material cost off by cultivating two major suppliers from Germany and China

Step 4: international cooperation

From contractual research to acquisition

- **Contractual Research**
  - Partnership with a German company on MW blade research
  - Close partnership with a Holland company on blade design
- **Acquisition for stronger R&D**
  - Acquired the Holland company for blade design capability enhancement
- **M&A opportunities**
  - A world famous wind turbine manufacturer CTC from Netherland is approaching to HT, exploring the possibility of acquisition.

Technology roadmap of HT



WHY ?

- **HT transforms from a military firm to the biggest wind blade provider in China in less than 10 years.**
  - What are the key driven factors of the growth?
  - What are the roles of market, industrial technology and policy through the development process?

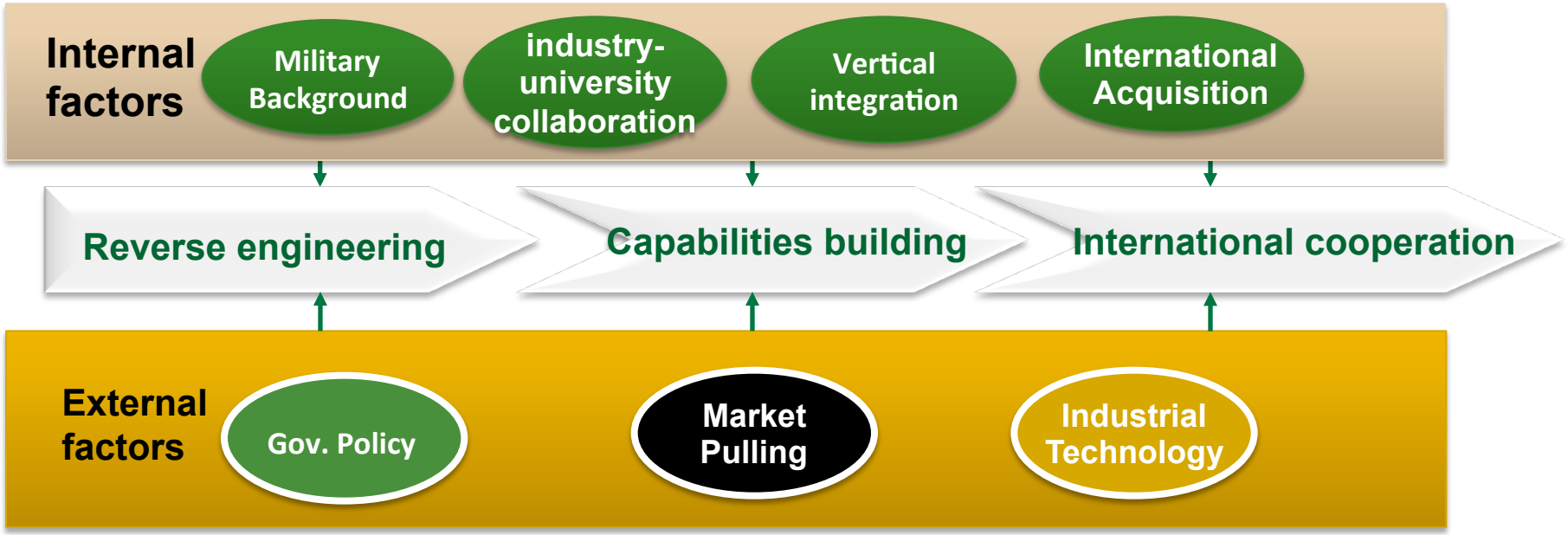
What are the key driven factors?

Baoding Huiyang aviation propeller factory

Cooperation with many universities, like Beihang university、North China electric power university

Vertical integration of key materials

The development of 750kw



21 national research projects and 3 provincial research projects

Long term technology cooperation with CTC

Determinants of the innovation path change

- Policy factors
  - For the long run: long-term stable national policy provides confidence both for core technology innovation and for deployment
  - For the short run: national standards and supportive policy packages provides incentive for firm innovation
- Demand factors
  - Domestic market exploration forms the solid motivation for innovation
  - Size of home market promote dominant technology
  - Quality requirement influence the competition capacity between domestic firms and international firms
  - International market exploration arise quality concern
- Related firms and networks
  - To extend the business both to upstream and downstream for cost management to increase competitiveness both locally and internationally
- Firm strategies
  - Internalization decision influences both domestic / export focus, and decree of acquisitions of other firms
  - Tech-oriented strategy vs. market oriented strategy have to be combined

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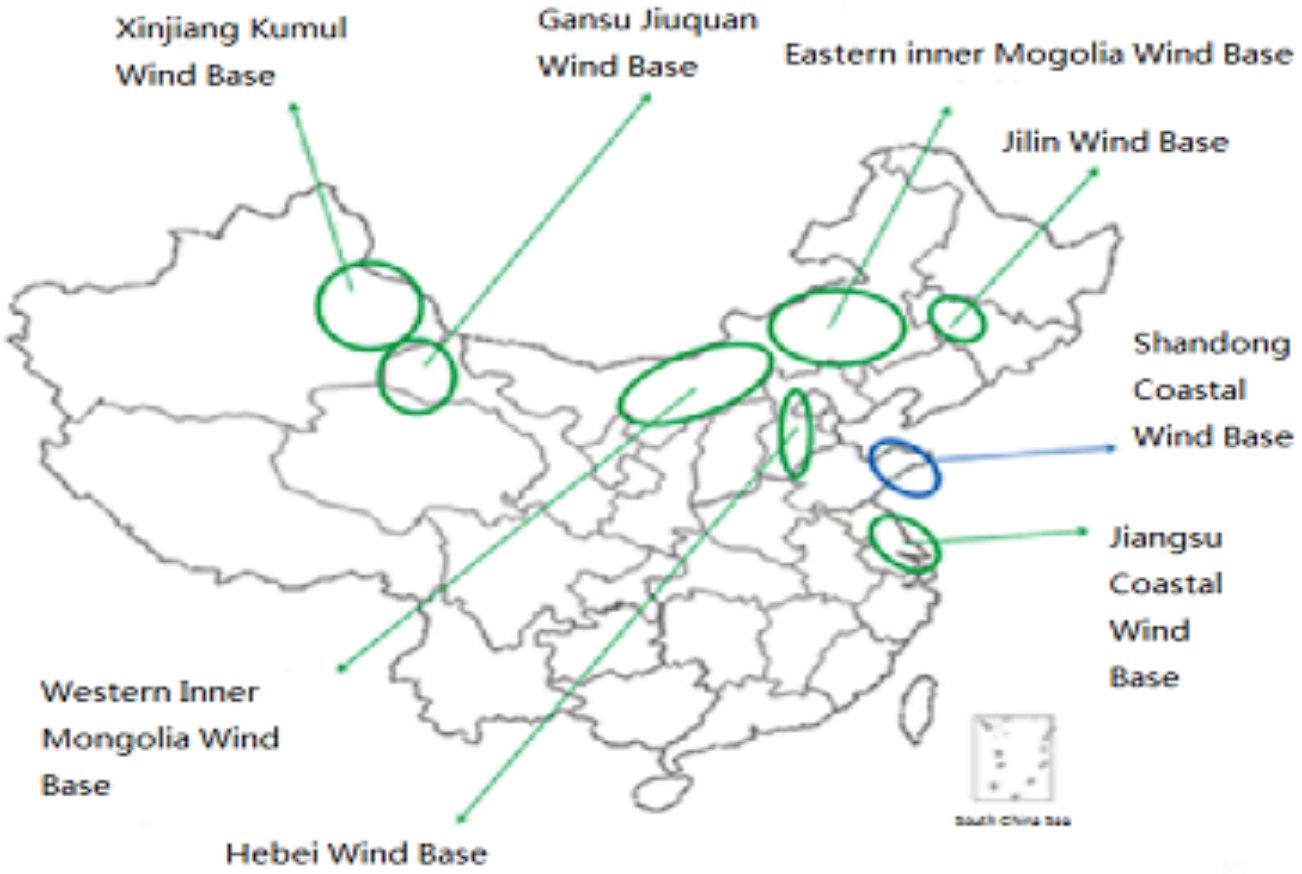
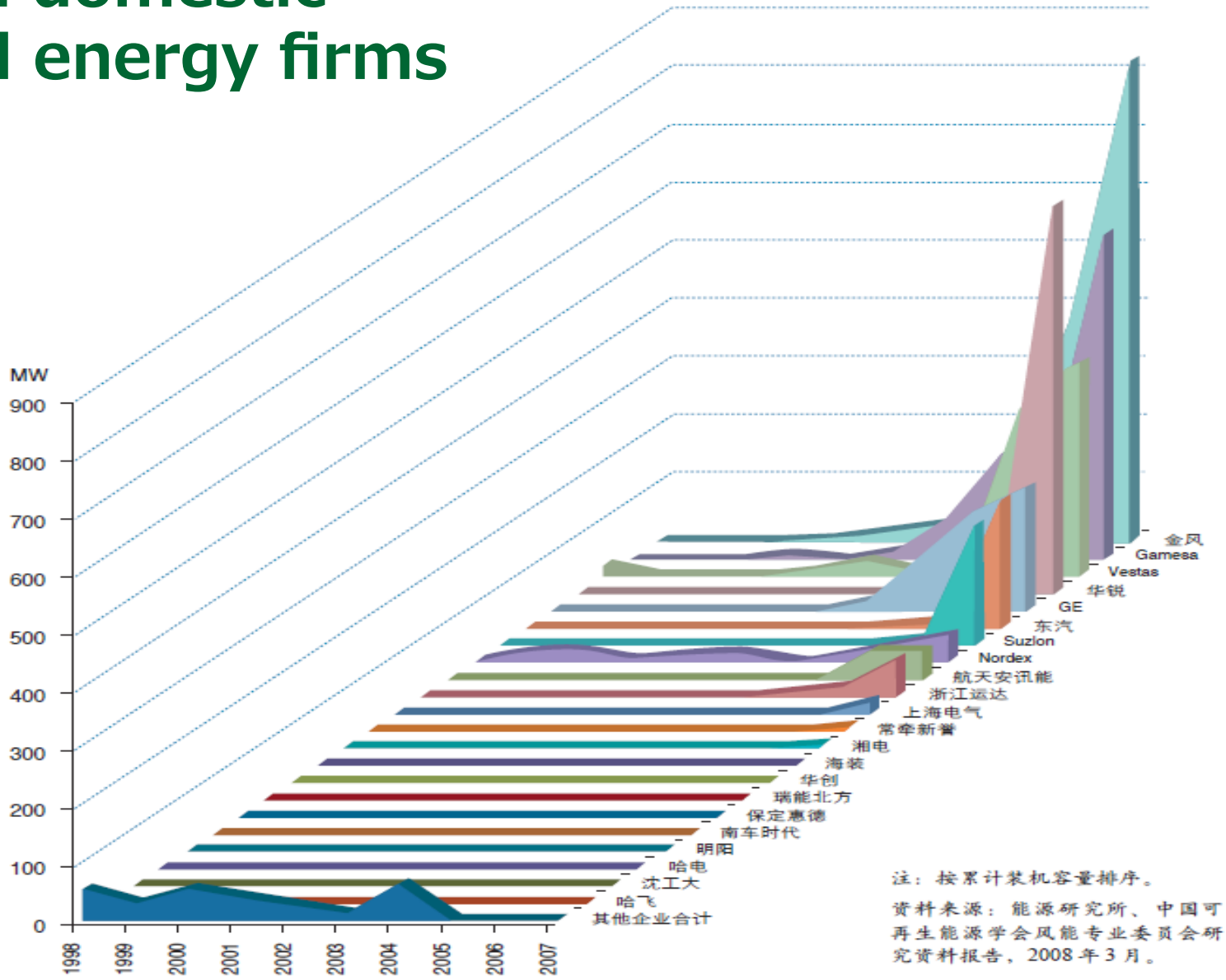
10 GW Level Wind Bases Distribution in China



Main domestic wind energy firms



注：按累计装机容量排序。

资料来源：能源研究所、中国可再生能源学会风能专业委员会研究资料报告，2008年3月。

New Installed Capacity and Cumulative Capacity of Top 15 Manufacturers in China (MW)

Enterprise	Annual Production (2010)	Cumulative Production (2010)	Annual Production (2011)	Cumulative Production (2011)
Goldwind	3735	9078.85	3600	12678.9
Sinovel	4386	10038	2939	12977
United Power	1643	2435	2847	5282
Guangdong Mingyang	1050	1945.5	1177.5	3123
Dongfang Electric	2623.5	5952	946	6898
XEMC	507	1089	712.5	1801.5
Shanghai Electric	597.85	1073.35	708.1	1781.5
Vestas	892.1	2903.6	661.9	3565.5
China Creative Wind Energy	486	682.5	625.5	1308
CSR Zhuzhou	334.95	465.3	451.2	916.5
General Wind Power	210	1167	408.5	1575.5
CSIC Haizhuang Windpower	383.15	479.25	396	875.3
Zhengjiang Windey	129	723	375	1098
Gomasa	595.55	2424.3	361.6	2785.9
Envision	250.5	400.5	348	748.5
Total	17823.6	40857.15	16557.8	57415.1

Source: China Wind Energy Outlook 2012

Four Types of Wind Farm Operators in China

Type of wind farm operators	Key Operators
Central state-owned enterprises	Guodian Longyuan, China Datang, China Huaneng, China Huadian, China Power Investment, Guangdong Nuclear Power, National Offshore Oil, CECEP, Shenhua (Guohua), Three Gorges Corporation, China Resources, State Grid, Sinohydro, HydroChina et al.
Local state-owned enterprises	Beijing Jingneng, Tianjin Jinneng, Shanghai Shennneg, Shandong Luneng, Guangdong Yudean, Ningxia Electric Power, Hebei Construction & Investment (Suntien Green Energy), Fujian Energy, and Fujian Investment & Development et al.
Private or foreign enterprises	Heilongjiang Zhongyu, China Wind Power, Golden Concord, Shanxi Yunguang Wind Power, Wuhan Kaidi, Daoda Marine Heavy Industry, HKC New Energy, Honiton Energy, UPC et al.
Wind manufactures	Goldwind, Gomesa, Zhejiang Huayi (HEAG), Tianwei Group, Shandong Changxing, Universal Wind Energy, and XEMC

Main Wind Farm Enterprises

Explorer	Capacity (MW)	Market share (%)
Guodian Group	3860.5	21.9
Datang Group	2235.1	12.7
Huaneng Group	2229	12.6
Huadiang Group	1104	6.3
Guohua	1094.5	6.2
China Power Investment	866.3	4.9
China Resources	796.1	4.5
Guangdong Nuclear Power	527	3
Beijing Jingneng	372	2.1
Suntien	343.6	1.9
Others	4202.9	23.9
Total	17630.9	100

Top 10 Wind Farm Enterprises with largest new installed capacity in 2011

Explorer	Capacity (MW)	Market share (%)
Guodian Group	12861.3	20.6
Huaneng Group	8578	13.8
Datang Group	8007.1	12.8
Huadiang Group	3829.9	6.1
Guohua	3440.1	5.5
China Power Investment	2944.9	4.7
Guangdong Nuclear Power	2891.5	4.6
China Resources	1773.4	2.8
Beijing Jingneng	1686.3	2.7
Suntien	1278.6	2.1
Others	15073.4	24.2
Total	62364.2	100

Top 10 Wind Farm Enterprises with largest cumulative installed capacity in 2011

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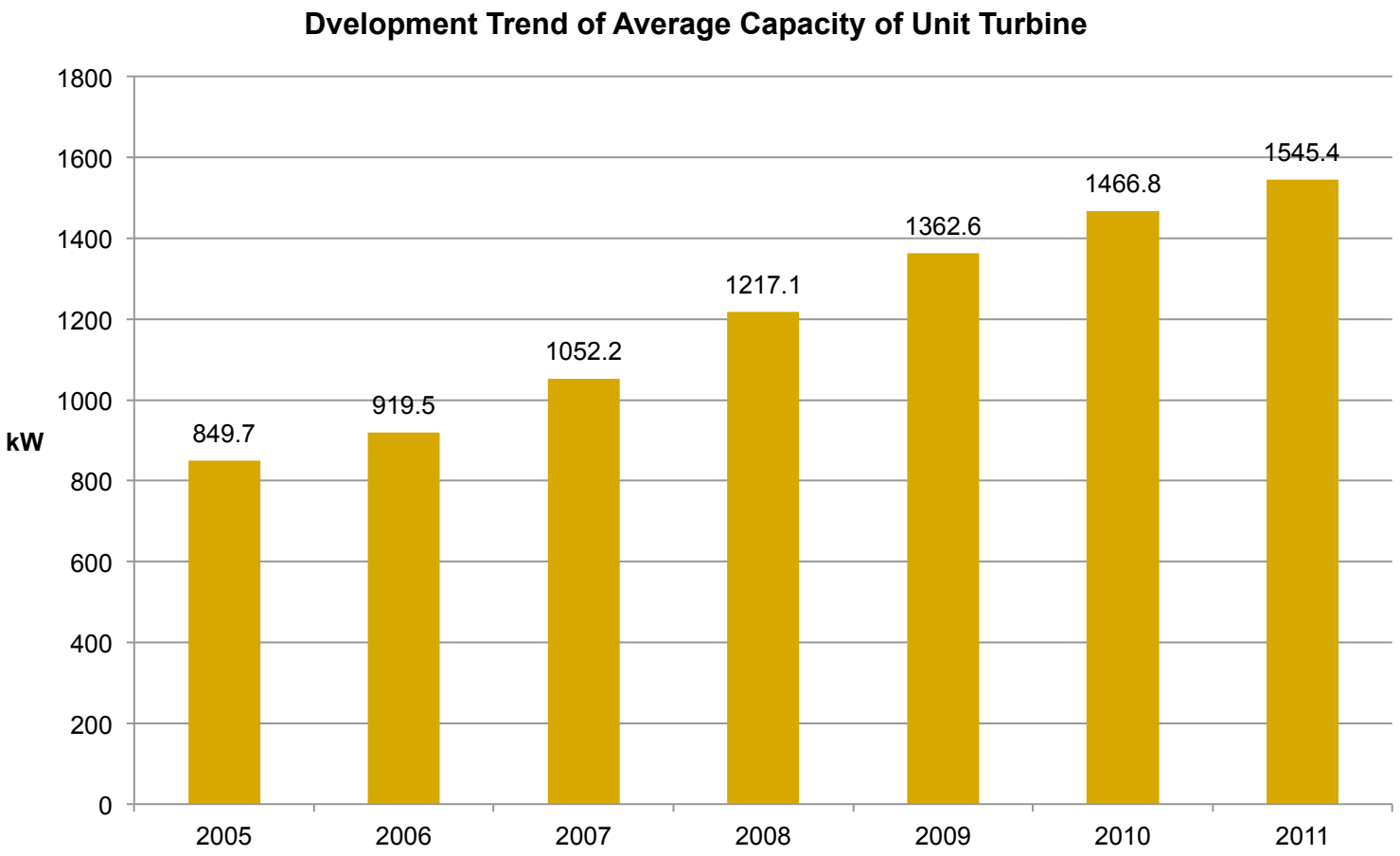
Technology: development Trend of Average Capacity of Unit Turbine



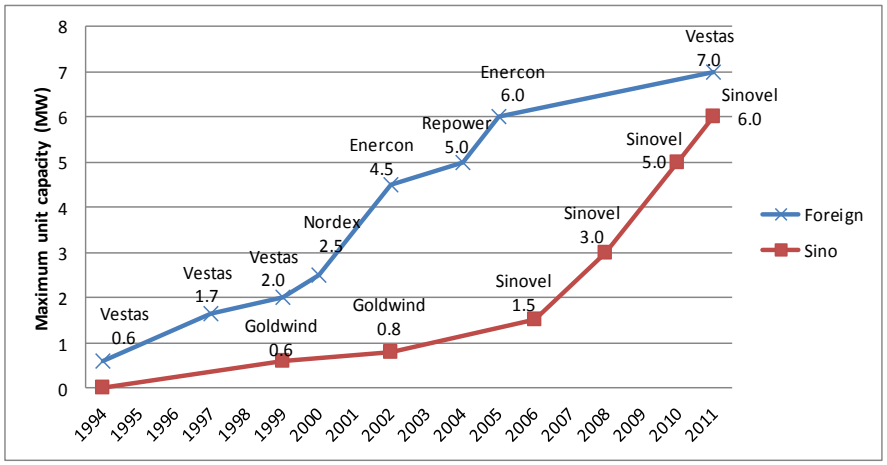
Source: China Wind Energy Outlook 2012

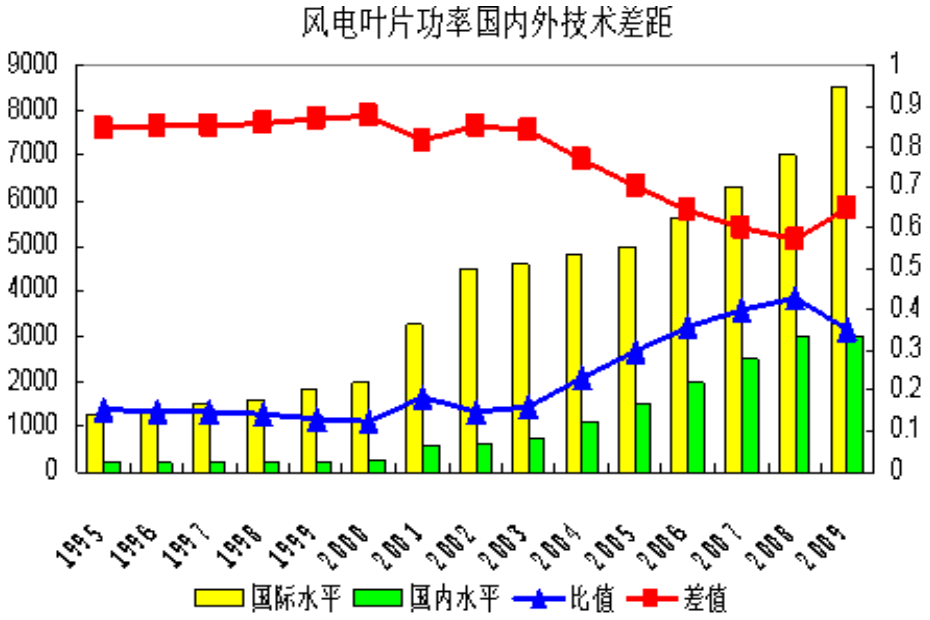
Technology 1: Technology advancement leading to cost decline

- The cost of wind turbine blade decreased by 50% in recent years.
- The price of wind turbine system has fallen 33.8% from 6800CNY/kWh to 4500CNY/kWh.
- The price of wind energy has fallen from 0.8.-1.20 CNY/ kWh in 2000 to 0.51-0.61CNY/kWh in 2010.

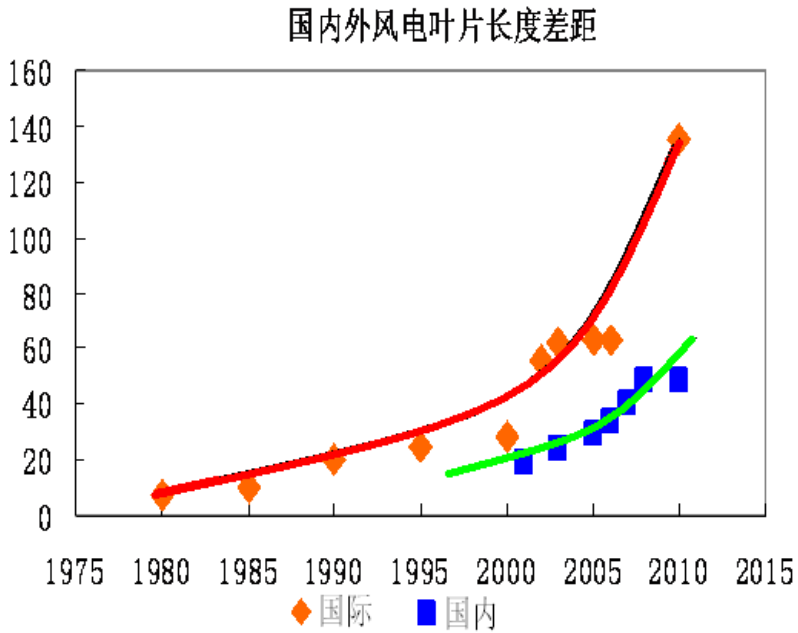
Technology 2: Narrowing technology gap

Spindle-shaped technology gap

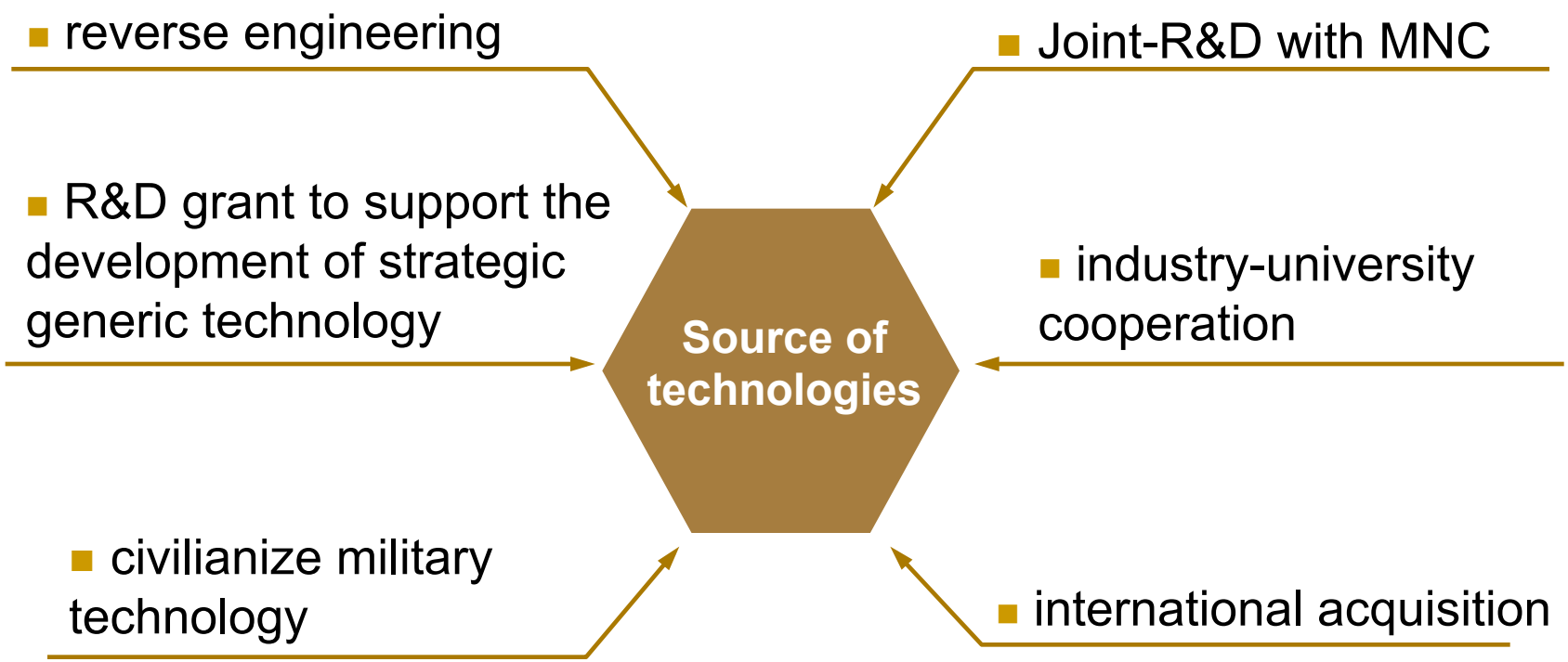




Length of Blade



Technology 3: diversified sources of innovation



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Policy combination in response to climate change in China (2001-2010)

Year	Innovation Policy	Industry Policy	Financial Policy	Environmental Policy	Energy Policy
2000	19%	6%	0%	61%	13%
2001	8%	0%	0%	84%	8%
2002	45%	3%	0%	42%	9%
2003	21%	0%	5%	51%	23%
2004	13%	0%	9%	52%	26%
2005	31%	12%	4%	35%	19%
2006	34%	0%	4%	42%	21%
2007	29%	2%	0%	41%	29%
2008	29%	6%	6%	3%	56%
2009	45%	8%	12%	8%	27%
2010	31%	10%	2%	16%	41%

Policy	Year	R&D	Manufacturing	Deployment	Localization	Remarks
The Regulation on Grid –connecting Operation in Wind Farm	1994			√		Regulatory measure
Regulations on Supporting Further Development of Wind Power	1999		√	√	√	Regulatory measure, Price supporting
The 10th Five-year plan for new and renewable energy	2001		√	√		Planning
Management Measure on Preparatory Work of Wind Power Concessions Projects	2003			√		Regulatory measure
Measures on Formulating Pre-report of Availability of Wind Farm	2003			√		Regulatory measure
Technological Regulation on Selection of Wind Farm Location	2003			√		Regulatory measure
Technological Regulation on Measurement and Assessment of Wind Resource	2003			√		Regulatory measure
Technological Regulation on Engineering Geological Detailed Investigation of Wind Farm	2003			√		Regulatory measure
Measures on Formulating Investment Estimation of Wind Farm Project	2003			√		Regulatory measure
National Technological Regulation on Assessment of Wind Resource	2004			√		Regulatory measure
Notification on Relevant Requirement Wind Power Construction Management	2005			√		Regulatory measure
Notification on Relevant Suggestion of Accelerating Localization of Wind Power Construction	2005	√	√		√	Planning & Subsidy
Interim Measures on Regulation of Land and Environment Protection Management in Wind Power Construction	2005			√		Regulation
Interim Measures on Special Fund Management for Development of Renewable Energy	2006	√				Subsidy
11th Five-year plan for renewable energy development	2008			√		Planning
Circular of the Ministry of Finance on the Adjustment of Import Tax Policies Governing the High Wind Power Generator Units and Their Key Parts and Raw Materials	2008	√	√			Tax rebating
Interim Measure of Management of Special Funds for Wind Power Industrialization	2008		√		√	Subsidy
NDRC Notification on Improving Price Policy of Grid-connected Wind Electricity	2009			√		Price supporting
NEB Interim Measure on Management of Offshore Wind Power Development	2010			√		Planning & Regulation
Views on Accelerating Smooth Development of Try to Wind Equipment Industry	2010	√	√		√	Planning

China's wind policy

- Stage 1
  - Macro-level policy: Economic development; Market mechanism; Imported production lines; Science and technology development;
- Stage 2
  - Macro-level policy: Imported technology; Joint ventures; Technology licensing; Technology improvement;
  - Sectorial policy: Climate policy priority
- Stage 3
  - Macro-level policy: Indigenous innovation; Commercial merger; WTO pressure;
  - Sectorial policy: Renewable energy law; Environmental protection;
- Stage 4
  - Macro-level policy: Quality of development; Indigenous innovation; Financial crisis;
  - Sectorial policy: Deployment.

China's wind policy

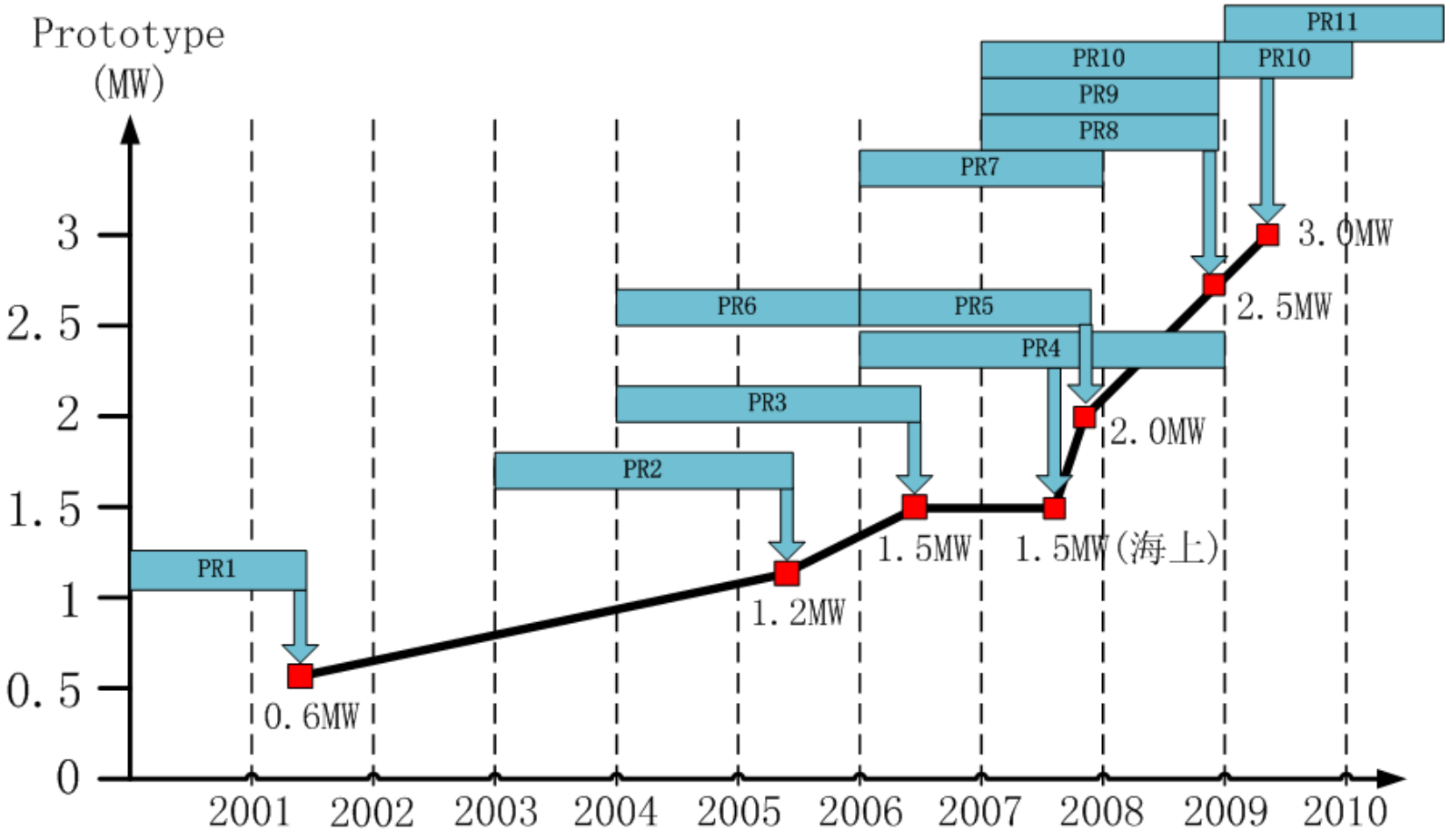
- First of all, energy policy and national strategy and planning set up the umbrella framework for all supportive policies.
  - Renewable Energy Law (REL) passed by the National People's Congress (NPC) in 2005, and revised in 2009, was the milestone representing China's effort in promoting the development of renewable energy in the long run.
- Market exploration policy and or deployment policy served as the most popular policy tools Chinese government adopted.
- R&D policy presents special feature in Chinese wind energy development.
- Localization policy scattered in 1990's and early 2000's. Yet, it has been cancelled all in 2009, which marked that Chinese market has been fully competitive.

Central government Policy 1: Government R&D subsidy on generic technologies (GT)

Code	Project period	the objective of R&D subsidy Government's subsidy on HT	prototype	Production ready
PR1	1995-2000	The GT of 600kw wind turbine system	0.6MW	2001.4
PR2	2003-2005	The GT of blade for MW-standard wind turbine	1.2MW	2005.5
PR3	2004-2006	The GT of blade for 1.3MW wind turbine	1.5MW	2006.5
PR4	2006-2009	The GT of blade (Onshore) for 1.3MW wind turbine 1.3MW	1.5MW (onshore)	2007.8
PR5	2006-2008	The GT of blade for 2.0MW wind turbine	2.0MW	2007.10
PR6	2004-2006	Huge-size wind turbine blade		
PR7	2006-2008	Monitor technology of wind turbine blade		
PR8	2007-2010	The technology of advanced wind turbine airfoil		
PR9	2007-2009	Mould of Huge-size wind turbine blade	2.5MW、3.0MW	2009.2
PR10	2007-2009	The GT of Blade for 2.5MW wind turbine		
PR11	2009-2011	The GT of Blade for 3.0MW wind turbine		

数据来源：HT公司

Government subsidy on GT stimulates the innovation capability of HT



Central government Policy 2: from market protection to open market policy

- **2003: localization rate(parts of wind turbine system) should be not less than 50%**
- **2007: localization rate(parts of wind turbine system) should be not less than 70%**
- **2010: repeal the regulation on localization rate. This implies that Chinese wind turbine providers are capable to compete with overseas companies, so that Chinese wind energy market can be open to foreign companies.**

Central government Policy 3: price policy

- **Non-regulated competition (before 1998):**
  - Very low price(0.3CNY/kWh), and no profit for sustainable growth
  - Strongly sponsored: Equipments aided by international foundation
- **Vicious competition(1998-2003)**
  - Dual-Price mechanism: regulated price (by regional government) and free market competition. Electricity price: 0.3-1.2CNY/kWh.
- **Rationalization(2004-2008)**
  - National level: biding price mechanism
  - Regional level: regulated price by regional government
- **Differentiation of on-grid price(2008-now)**
  - On-grid price was divided into 4 categories in view of regional diversity: 0.51CNY/kWh, 0.54CNY/kWh, 0.58CNY/kWh, 0.61CNY/kWh.

Central government Policy 4: Tax Policy

- **Encouraging import(1997):** waive import tax on wind turbine system
- **Encouraging import(2001):** cut off 50% of value added tax in wind energy generation process to encourage the establishment of joint-ventures in China.
- **Protecting domestic suppliers(2005):** begin to impose import tax on wind turbine system.
- **Protecting domestic suppliers(2006):** waive import tax on production materials, in order to encourage the localization of wind turbine in China.
- **Free market competition(2008):** remove the regional authority on import tax rebate and give it to the national-level agencies.

Local Government Policy:

- **local resource endowment**
  - Land use guarantee the development needs of infrastructure construction in Chinese electric Valley
  - Establish the University Industry cooperation and increase the organizational interaction between wind energy firms related to Local industry development
  - Government procurement for Demonstration
- **Financial support**
  - Issued Chinese electric valley bonds
  - Strive for provincial and national level project to investment in local industry
  - Tax support

Local Government Policy : Different role

- **Financial Policy:**
  - renewable energy funds
  - small and medium-sized enterprise support funds
  - patents, technical standard and special funds
- **Project Support:**
  - various policies supports including innovation funds, electronic development funds, etc.
  - Give enterprises more preferential policies
- **Industrial Policy:**
  - Chinese Electronic Valley
  - tax policies
- **Land:** priority to get construction land

Local Government Policy

- **Cluster policy**: resources acquisition and industrial chain integration
  - Scientific Park formed, including high-tech zone wind energy industrial park, etc.
  - Enterprises, human resources, relevant fund support assembled and the companies in field of wind energy on SP have increased to 82 until 2011.
- **Innovation policy:** open innovation and technological innovation
  - Promote the innovation circumstances, R&D add up to 500 million in 2010.
  - Establish the wind energy equipment testing center in Chinese Electric Valley

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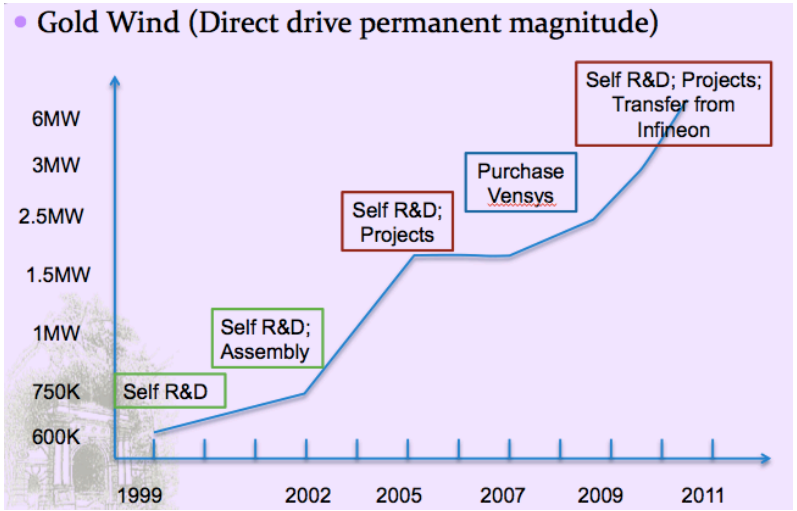
Innovation Paths in Chinese Wind Sector

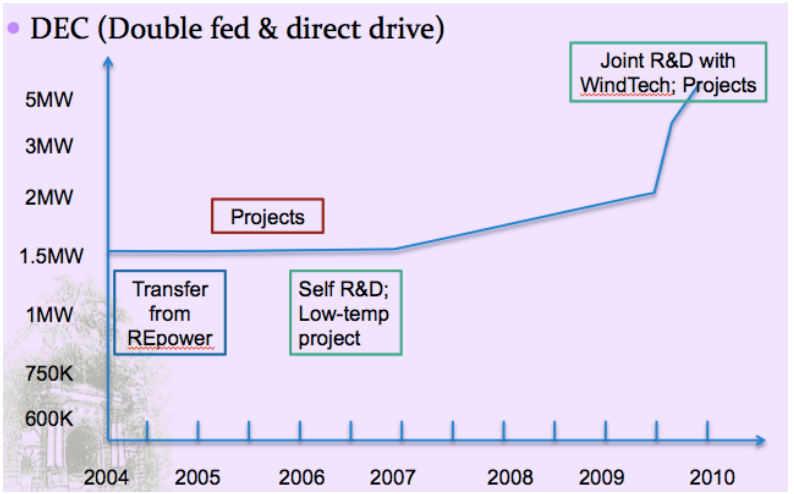
- For Core Technology – at Industry Level:

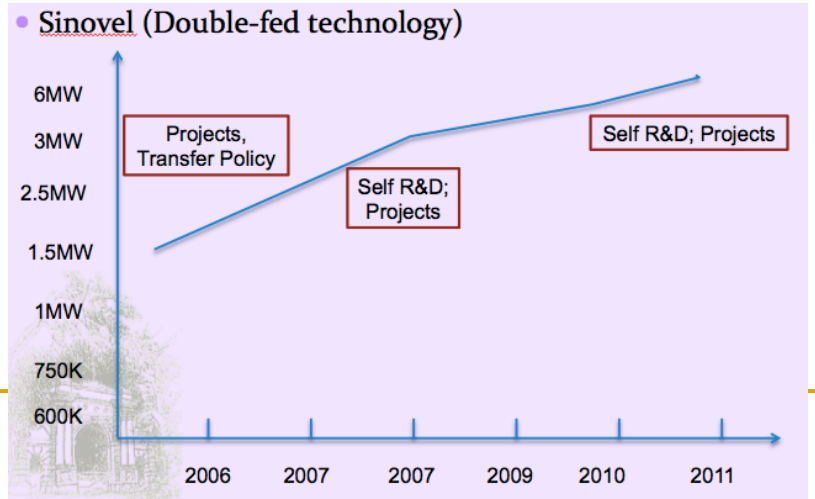
Stage	Technology Source	Technology Improvement	Supportive Policy	Leap-frogging
I: 1970-1995	Wind farm operation; Domestic R&D	55kW → 600kW	Basic R&D Policy	Y
II: 1996-2002	Imported production lines/technology; Imitation R&D	600kW → 2MW	Policy for Core Technology Development	Y
III:2003-2009	Joint venture; Collaborative R&D	1.2MW → 2.5MW	Policy for Deployment	Y
IV:2010-2012	Indigenous R&D; Globalized R&D	2.5 MW → 3MW, 5MW, 6MW	Policy for market mechanism design	N

Innovation Paths in Chinese Wind Sector

- For Core Technology – At Firm Level:

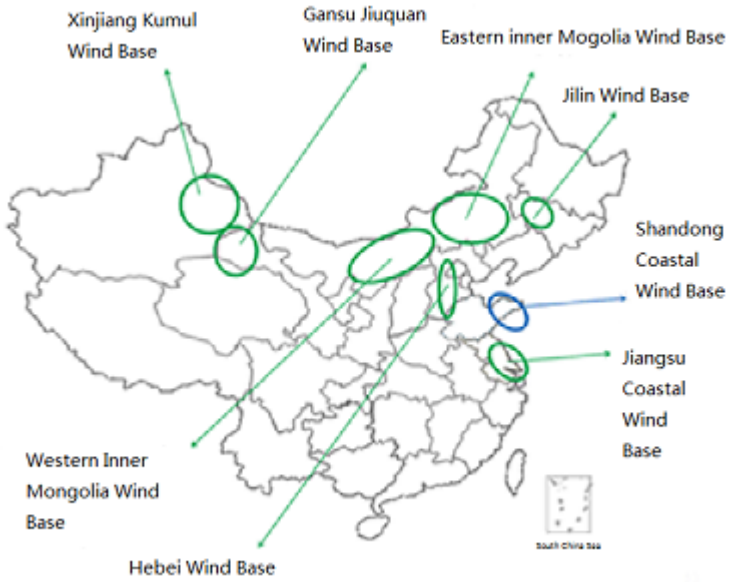






Innovation Paths in Chinese Wind Sector

- For Technology Deployment:
  - Large-scale deployment pattern → diversified deployment pattern w/ technological challenges
  - Key technological barriers exist together with wind electricity sale mechanism barriers
  - State-owned firms dominated wind farm operational market



China's wind innovation pathways

- Stage 1: wind farm operation and domestic R&D based innovation (1970s-1995)
- Stage 2: Imitation innovation based on imported technology import (1996-2002)
- Stage 3: Cooperative innovation based on collaborative design and joint venture (2003–2009)
- Stage 4: Indigenous innovation based on enterprise internationalization and R&D globalization (2010–present)

Stage 1: wind farm operation and domestic R&D based innovation (1970s-1995)

- Government supported public R&D activities and wind farms with foreign donated wind turbines.
- Chinese wind companies started to gain basic knowledge about wind energy.
- Chinese firms also clearly realized the technological gap.

Stage 2: Imitation innovation based on imported technology import (1996-2002)

- "Outline of New and Renewable Energy Development (1996–2010)":

the next target for Chinese wind energy industry was to import advanced technologies and equipment in order to absorb the technology and to develop domestic wind energy industry through localization.

- Chinese firms like Goldwind developed domestic wind energy industry technology licensing and domestic R&D.

the process of "importing technology, digestion, and absorption" became an ideal model to gain technology improvement for wind industry.

Stage 3: Cooperative innovation based on collaborative design and joint venture (2003–2009)

- the shortcomings of technology licensing reliance showed up:

  it became expensive and hard to obtain cutting edge technology licensing. In turn, market enlargement was limited.

- Domestic firms benefited from collaborative research or joint ventures and released new wind turbines of their own design soon.

Stage 4: Indigenous innovation based on enterprise internationalization and R&D globalization (2010–present)

- Leading domestic players gradually had the capacity to conduct indigenous R&D in each stage of the wind turbine lifecycle.
- Domestic firms gained core technologies and foreign markets share and speeded up their indigenous innovation capacity building through M&A to foreign R&D sectors or design companies.

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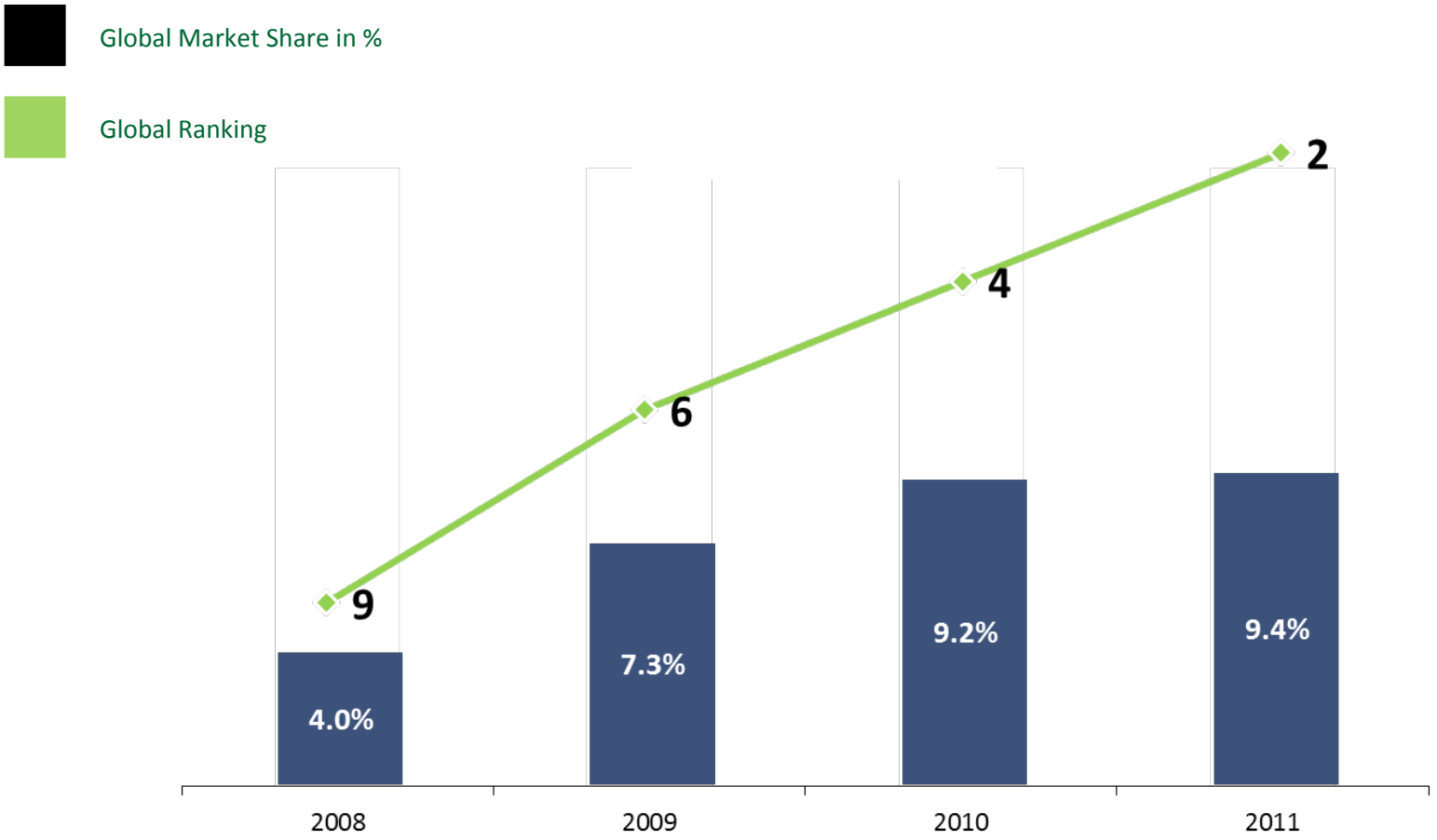
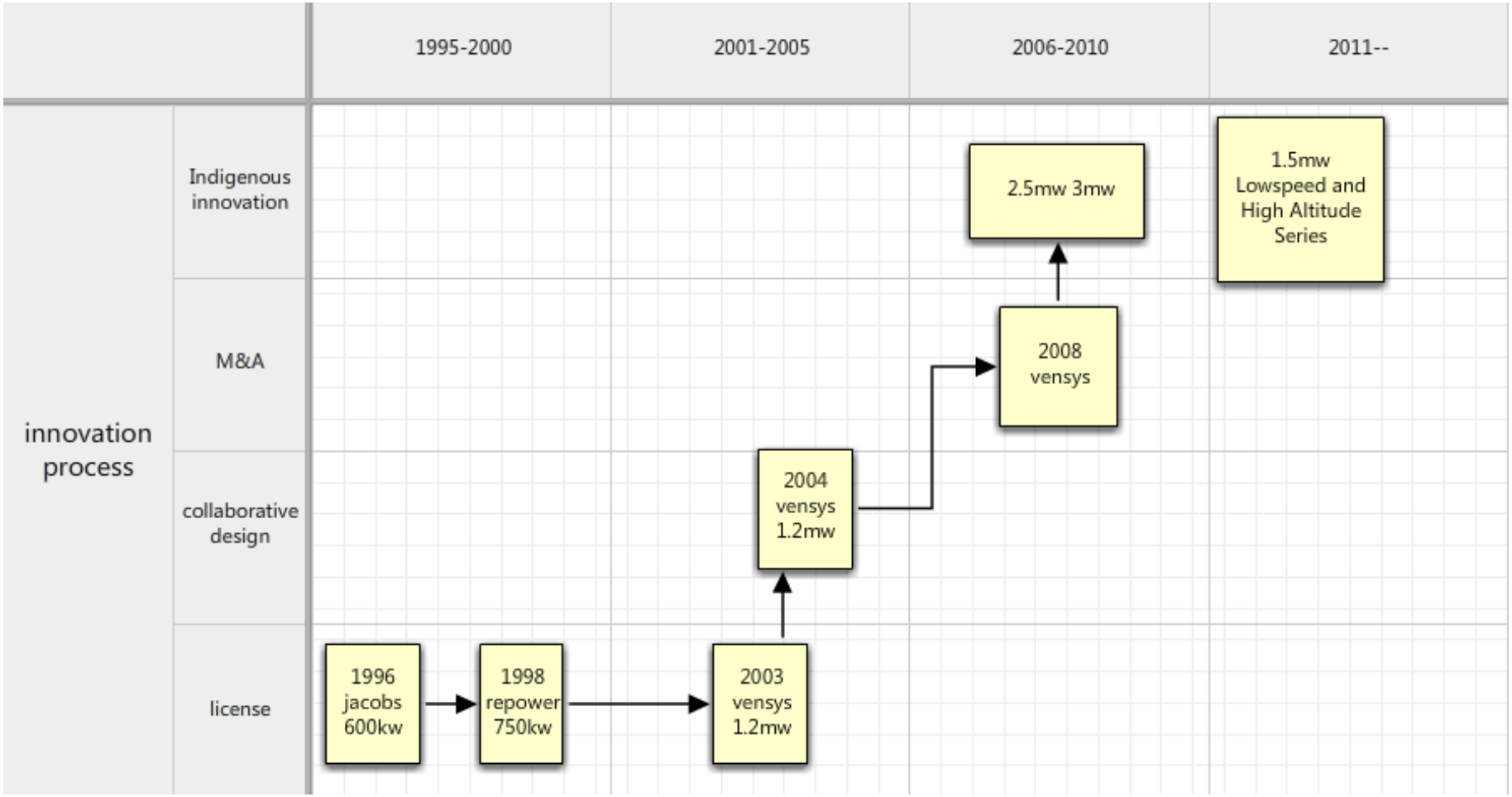
Goldwind – a lead wind manufacturer in China

- Established in 1998
- One of the earliest wind energy cooperation in China
- The largest manufacturer of wind turbines in China and the second largest globally
- The world's largest manufacturer of Permanent Magnet Direct Drive (PMDD) wind turbines

Goldwind


Global Market Share in %
Global Ranking
9
6
4
2
4.0%
7.3%
9.2%
9.4%
2008
2009
2010
2011

Goldwind innovation process



Stage 1: Imitative innovation based on technology importation

- In 1997, licensed the 600 kW wind turbines from Jacobs. Soon after, obtained a license from REpower for its 750 kW turbine.
- Through mutual communication and hand-by-hand teaching process, Goldwind improved its technology capability greatly and successfully produced turbines of 600 kW and 750 kW in 1999 and 2001 respectively.

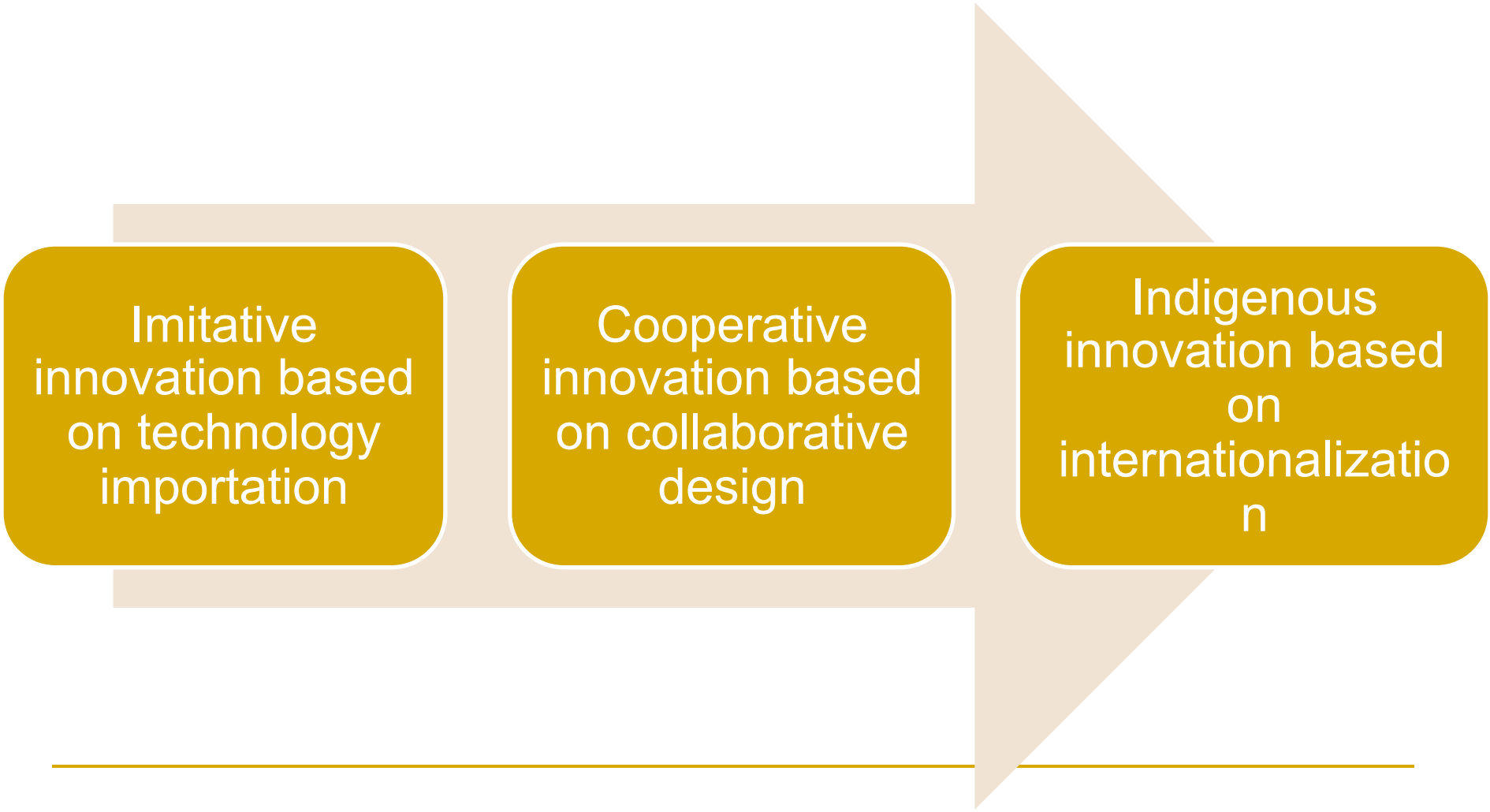
Stage 2: Cooperative innovation based on collaborative design

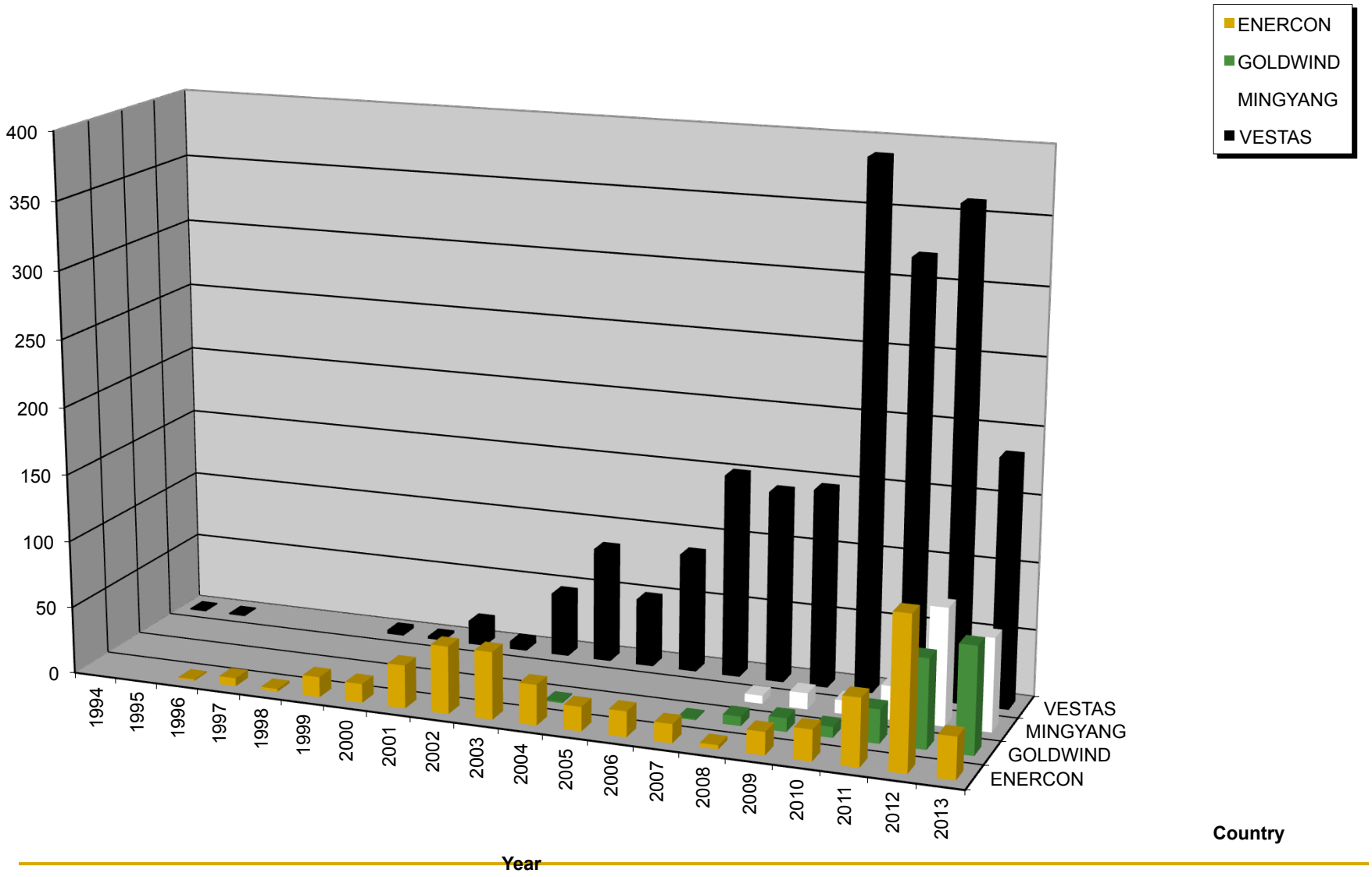
- In 2003, Goldwind embarked on the collaborative design of 1.2MW magneto electric direct-drive wind turbines with Vensys.

Stage 3: Indigenous innovation based on internationalization

- Goldwind learned a lot from the collaboration and improved the magneto electric direct-drive technology to produce 1.5MW（2007）, 2.5MW (2009) and 3.0 MW(2009) turbines independently.
- Goldwind continued its internalization process by purchasing Vensys in 2008.

Three stages of accumulating its innovation capacity




ENERCON
GOLDWIND
MINGYANG
VESTAS
400
350
300
250
200
150
100
50
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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2007
2008
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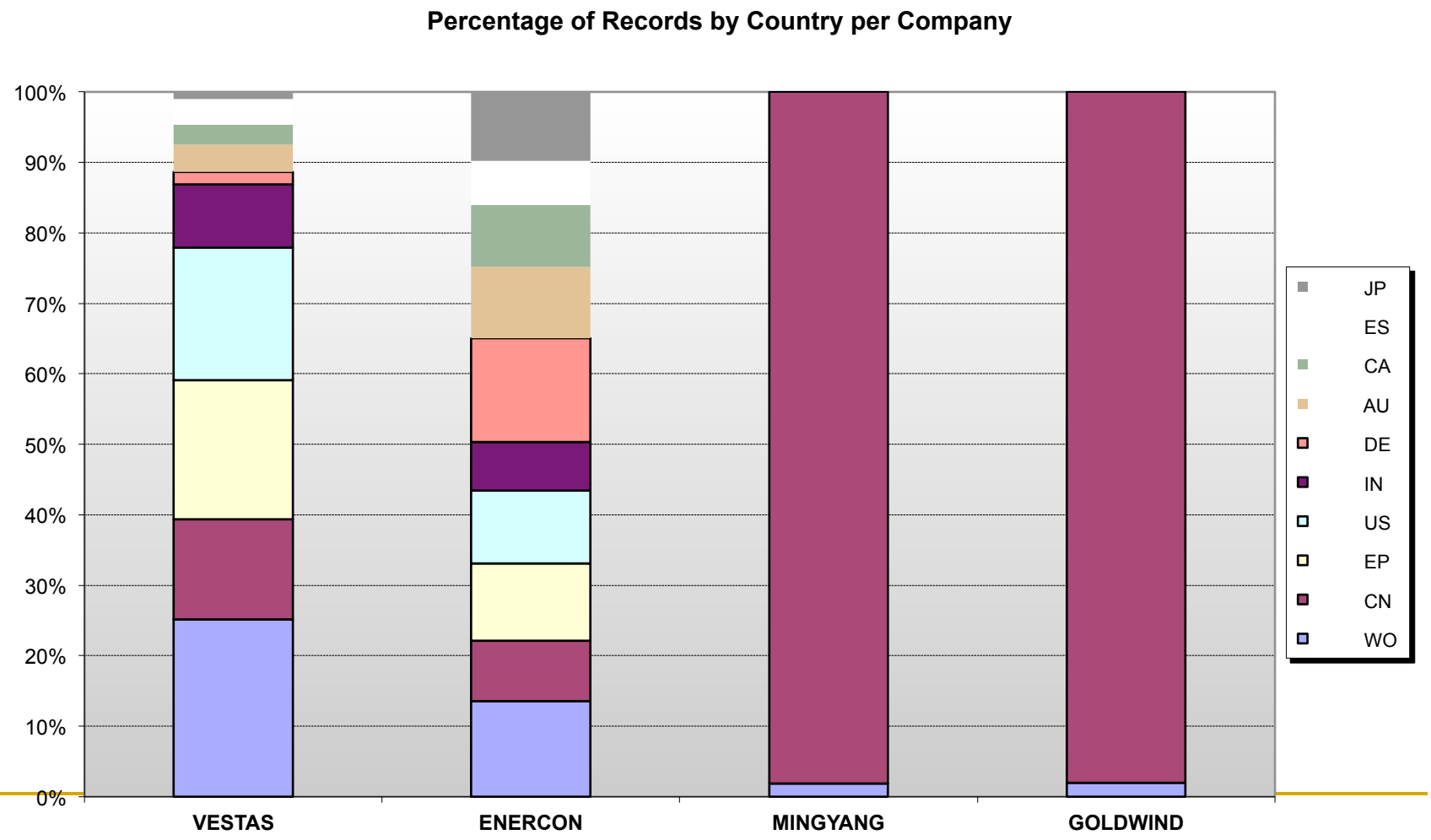
2010
2011
2012
2013
VESTAS
MINGYANG
GOLDWIND
ENERCON
Year
Country


Percentage of Records by Country per Company
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
VESTAS
ENERCON
MINGYANG
GOLDWIND
JP
ES
CA
AU
DE
IN
US
EP
CN
WO

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Jiuquan Wind Farm Construction – the large-scale deployment project in China

- Located in northwest of China, Gansu province
- with potential wind resource of 210 GW and available storage of 82GW at present.
- geographically and climatological appropriate for large-scale, concentrated wind farm construction.
- the first wind base over 10 GW being constructed among the seven state planned wind bases.

Technological difficulties in Jiuquan wind base

- the electricity storage and transmission: transmission lines were far from enough.
- Wind resource prediction technology is greatly needed while no existing technology could be borrowed.
- Off-grid accident happened because of not matured Low Voltage Ride Through (LVRT) technology.

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Implication 1
for Chinese Innovation Path Formation

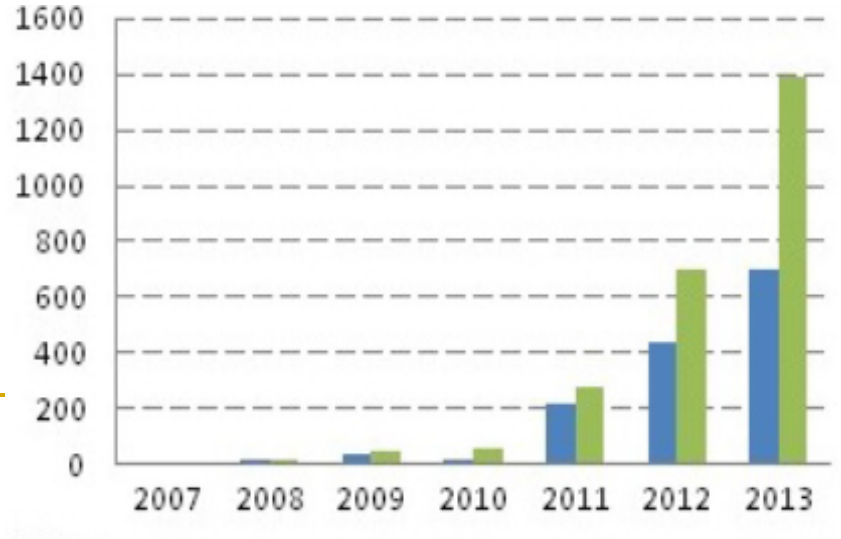
- Policy framework:
  - They do matter, especially those long-term strategic policy setting, such as the Renewable Energy Law
  - Policy shift from industrial policy to deployment policy, then, to market mechanism design policy, i.e. FIT
  - Policy learning process, especially on how to compliance with WTO rules
- Central government policies as signal and regulation
  - Start, enhance, adjustment and regulation.
  - Promote the development of wind industry at first, while make the regulation policy along with the industry saturation
- Local policies as Entrepreneurs based on resource endowment
  - Integration of effective resources: Land, financial,…
  - Further development of international industrial cluster
  - Establishment of financial platform

Implication 2
for Chinese Innovation Path Formation

- Technology Capacity Building:
  - Three ways to gain core technology, with product quality and service quality essential factors for success:
    - Domestic R&D only
    - Imported Technology + Domestic R&D
    - Imported technology only
  - Innovation capability building is essential for local firms
    - Network for information acquisition
    - Market sensitive
    - Technology source identification
    - Advantageous resource integration
    - Interaction with local government
    - Efficient process management

Implication 3
for Chinese Innovation Path Formation

- Competitiveness / Collaboration:
  - Chinese wind sector started domestically, began to export in recent years; Price strategy is not the only factor in bid-winning both in and out China
  - Globalized R&D emphasized localization as well as international collaboration. Both the local headquarter and the foreign R&D branch would be affected



Implication 3
for Chinese Innovation Path Formation

- Competitiveness / Collaboration:
  - Globalized value chain and Comparative advantages in different country
  - Globalization promotes the transnational division of the production and global labor division system.
  - The development of China's industry benefit from global market, while impeded by trade protectionism
  - Eliminate international technological barriers and promote knowledge transfer in new energy areas; in particular, reduce international patent licensing fee to developing countries

Recent facts and some thoughts:

- Industry growth: reaches a plateau or even a setback
- Policies: turning from a “mission-oriented government push” to a more diversified and “multi-poles” policies
  - Conflicts become more prominent between major players: central government & locals / national grid and local governments / central gov. vs. major firms
  - Central vs. locals: (i) de-centralized wind parks are encouraged by central gov. in recent national plans, but local ones have different thoughts; (ii) “market should be emphasized” before building more wind farms vs. continuous local subsidies to promote wind manufacturers and wind farms anyway;
  - Grid vs. locals: long-term power transmission is not technically and politically feasible; large wind parks;
  - Central vs. firms: mission-oriented R&D pointing to offshore wind parks, but firms (tender winners) are reluctant to set off
- Innovation paths: go on working with imported technology sources, with a few exceptions (Chinese specific techs)
  - Grid-connection and long-distance power transmission technologies that are bounded to large wind farms;
  - Gold-wind non-gearbox wind turbine: accounts for 90% of Chinese exports
- Innovation capabilities: Low-cost innovating strategy still goes on, so called “bottom of the pyramid” innovations

Discussions for comparative and future study

- Different strategies to gain the “core technology”
  - Is self-R&D the only way to gain the core technology?
  - Will technology transfer, licensing, commercial merger really help the core technology capacity building?
  - Does market expansion help to gain core technology?
- What are the roles of policy package on the sector development
  - Similarity of policy packages among regions (i.e. long-term supportive policy)
  - Differences in similar policy packages (i.e. different effort of R&D policy at different periods)
- What makes the “dominant” design happen?
  - Long-term stable national policy?
  - Quick market exploration?
  - Random factors?

Future works (working papers)

- Diverging paths to convergence? Wind energy innovation in advanced and emerging economies by Rasmus Lema, Zhou Yuan, and Ankur Chaudhary
- Policy instrument selection and the innovation system analysis – Comparing wind energy technology development in Europe, India and China by Yixin Dai, Johan Nordensvärd, Ankita Narain
- Patent analysis for technology trajectories and firm strategies: a comparative study of wind manufacturers between China, India and Europe by ZHOU Yuan, LI Xin, Rasmus Lema, Frauke Urban
- … …

Thank you !

Research projects

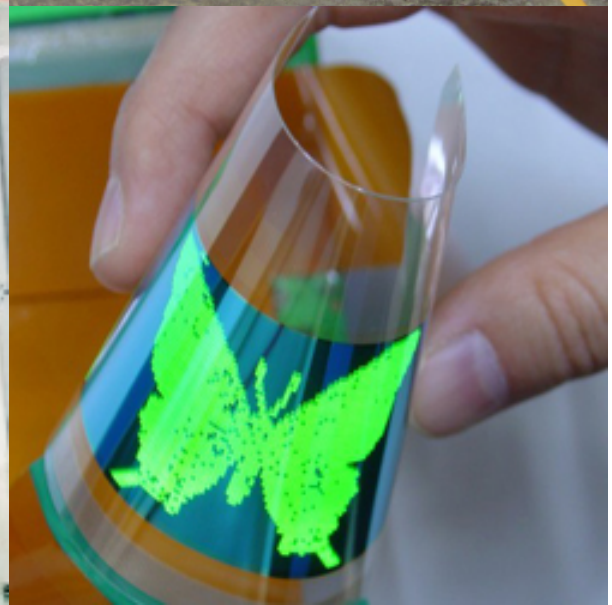
- Chairing -- NSFC Youth Project 2012:
  - Government-Funded Demonstration Project – Case Studies of the Emergence of New Energy and New Energy Vehicle Industries
- Chairing -- MOE Social Sci. Project 2011:
  - Roadmapping the emergence of clean coal technologies: Dimethyl Ether (DME) and coal-based oil, Carbon capture and storage (CCS), clean coal burning tech;
- Euro-China-India Comparative Study 2011:
  - Tech Trajectories on Wind Energy & Electric Vehicle Industries

Pure Electric Vehicles

Wind energy in Gansu province

Research projects

- Euro Framework 7 Project:
  - High value engineering network – international collaborations on innovation and manufacturing
- China Academy of Engineering's key project:
  - Emerging industries in China



Research Projects

- NSFC Major Project 2012: Decision Making Models of Chinese Public Policy Making – An Analysis on the Evolutional Path
  - M1: Decision making models: rational model, organizational model, bureaucratic model → but which one suits modern China?
  - M2: Policy process: Scenario setting, policy making, policy evaluation, policy revising;
  - M3: Decision making in national technology programme – 863 & 973
  - M4: Decision making in Chinese low-carbon industries – new energy, new energy vehicle, environmental sectors;
  - M5: Decision making in national education system;
  - M6: Decision making for contingencies: natural disasters, political issues, scandals, etc;

A brief introduction of CIEDS

- Major projects
- Key events

A brief introduction of CIEDS

中国工程科技发展战略研究院
Chinese Institute of Engineering Development Strategies

1

Urbanization Strategies of China

2

Mineral Resources

3

Environmental Concerns and Local Development

4

Strategic Emerging Industries

A brief introduction of CIEDS

中国工程院 Chinese Academy of Engineering 清华大学

中国工程科技发展战略研究院

Chinese Institute of Engineering Development Strategies

Urbanization Strategies of China

The project aims to analyze the current situations, characters and trends of Chinese urbanization, and to identify new modes for Chinese urbanization strategies, through probing into national specifics and bringing inspiration from global insights. It also attempts to enquire into key urbanization issues in China and the underlying concerns about engineering and innovation, in order to offer strategic advice to national policy makers.

Project Leader: Xu Kuangdi (CAE member)

A brief introduction of CIEDS

中国工程院 Chinese Academy of Engineering 清华大学

中国工程科技发展战略研究院

Chinese Institute of Engineering Development Strategies

Mineral Resources

The project draws on the pervious findings of CAE's research, and addresses new issues that are emerging in recent years. It focuses on the following areas in the spirit of sustainable development: domestic supply and demand and situation of global resources, roadmap planning and goal-setting, and the development of strategic countermeasures and a guarantee mechanism.

Project Leader: Wang Dianzuo (CAE member)

A brief introduction of CIEDS

中国工程科技发展战略研究院
Chinese Institute of Engineering Development Strategies

Environmental Concerns and Local Development

The project centers on pollution remediation in Huaihe region and explores the inter-dependent relationship between the regional environment and economic and social development, in order to seek a sustainable development path for the region and guarantee the sound implementation of the South-to-North Water Diversion Project.

Project Leader: Shen Guofang (CAE member)

A brief introduction of CIEDS

中国工程科技发展战略研究院
Chinese Institute of Engineering Development Strategies

Strategic Emerging Industries

The project explores through theoretical and empirical researches the definition, characteristics, patterns, trends, core technology, technology roadmap and policy-making of emerging industries. It focuses on the following topics: the prerequisites, positions and roles and development trends of strategic emerging industries, the situations of emerging industries in world's major countries, national strategies, the cultivation and development of emerging industries during and after the 13th "five-year plan" period, and the design and construction of relevant data-base.

Project Leader: Wu Hequan (CAE member)

A brief introduction of CIEDS

中国工程科技发展战略研究院
Chinese Institute of Engineering Development Strategies

January 6, 2012 –
Chinese Vice Premier Li Keqiang listened to the work report of the launch of the four CIEDS projects and addressed the meeting.