China wind market is booming:

---- Growth not only on-shore but off-shore

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Manila, Philippine

The views expressed in this presentation are those of the presenter and do not necessarily represent those of the Asian Development Bank.
Contents

- International wind development outlook
- Wind power resources allocation
- Development status
- Update recent years
- National policy
- Potential for more depends on
- Outlook supply vs. demand forecast
International wind development outlook

**GLOBAL CUMULATIVE INSTALLED WIND CAPACITY (1996-2009)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>6,100</td>
</tr>
<tr>
<td>1997</td>
<td>7,600</td>
</tr>
<tr>
<td>1998</td>
<td>10,200</td>
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<tr>
<td>1999</td>
<td>13,600</td>
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<tr>
<td>2000</td>
<td>17,400</td>
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<tr>
<td>2001</td>
<td>23,500</td>
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<tr>
<td>2002</td>
<td>31,100</td>
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<tr>
<td>2003</td>
<td>39,431</td>
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<tr>
<td>2004</td>
<td>47,620</td>
</tr>
<tr>
<td>2005</td>
<td>59,091</td>
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<tr>
<td>2006</td>
<td>74,052</td>
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<tr>
<td>2007</td>
<td>93,835</td>
</tr>
<tr>
<td>2008</td>
<td>120,550</td>
</tr>
<tr>
<td>2009</td>
<td>157,899</td>
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</table>

**GLOBAL ANNUAL INSTALLED WIND CAPACITY (1996-2009)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>1,280</td>
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<td>1,530</td>
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<td>1998</td>
<td>2,520</td>
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<tr>
<td>1999</td>
<td>3,440</td>
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<tr>
<td>2000</td>
<td>3,760</td>
</tr>
<tr>
<td>2001</td>
<td>6,500</td>
</tr>
<tr>
<td>2002</td>
<td>7,270</td>
</tr>
<tr>
<td>2003</td>
<td>8,133</td>
</tr>
<tr>
<td>2004</td>
<td>8,207</td>
</tr>
<tr>
<td>2005</td>
<td>11,531</td>
</tr>
<tr>
<td>2006</td>
<td>15,244</td>
</tr>
<tr>
<td>2007</td>
<td>19,865</td>
</tr>
<tr>
<td>2008</td>
<td>26,282</td>
</tr>
<tr>
<td>2009</td>
<td>37,466</td>
</tr>
</tbody>
</table>
Accumulated wind power installation by Country

- USA: 35159 (22.3%)
- Germany: 25777 (16.3%)
- China: 25104 (15.9%)
- Spain: 19149 (12.1%)
- India: 10926 (6.9%)
- Italy: 4850 (3.1%)
- France: 4492 (2.8%)
- Portugal: 3535 (2.1%)
- Denmark: 3465 (2.0%)
- Other: 21391 (13.5%)
Newly added wind power in 2009

- China: 13000 (34.7%)
- USA: 9922 (26.5%)
- Spain: 2459 (6.6%)
- Germany: 1917 (5.1%)
- India: 1271 (3.4%)
- Italy: 1114 (3.0%)
- France: 1088 (2.9%)
- Canada: 950 (2.5%)
- Portugal: 673 (1.8%)
- Other: 3994 (10.7%)
- UK: 1077 (2.9%)
China wind power development

- Newly added
- Accumulated
There are discrepancy between different institutions for evaluation of wind power resource in methodology and results.

It still indicates that the wind resource in China is abundant.
# National Wind Power Resource

## Onshore Resource

- Theoretical reserves of more than 4,000GW above 10m height with technically exploitable reserve of 300GW. The practical development area is approximate 200,000 km².
- Based on current technology, over 50m level, it requires 3-5 MW wind turbine to cover 1km². With 200,000 km² development land area available in China, the total installed onshore wind capacity can probably reach 600~ 1,000GW.

## Offshore Resource

- According to the China Coastal Zone and Tideland Resource Investigation Report, the sea area of 0-20m off coastline is around 157,000 km².
- Assuming 10% to 20% of the total amount of sea surface used, the total offshore wind capacity can reach 100~200GW.

## Conclusion:

- Abundant wind power resource in China
- Great development potential
- A key constituent in future energy structure
Ranked second in the world by the accumulated installation with about 24-26 GW
Ranked the first by newly added with 12-14 GW a year
Regional distribution of turbines installation

- ~15.5GW installed (at 2Q2009)
- ~350 “projects” operating
- 2008 Ins. 5.9GW vs. 2007 3.3GW ↑82%
- 100% CAGR ’05-’08 means ave WTG >1yr ops
- 100% y-o-y growth is ongoing...

Source: Azure International, Google Earth
Development update - near-term activity

~ 650 sites represent ~45 GW of “imminent development”

...of which ~300 sites with 24 GW of orders outstanding

Source: Azure International, Google Earth
Development update - including long-term pipeline

- Future predicted by “long-term pipeline”
- ~1300 sites represent 210 GW of “Long-term cumulative Pipeline”

Source: Azure International, Google Earth
Development update - including long-term pipeline (6 wind bases)

Future may also be predicted by wind base planning

100GW achieved with no new “imminent development pipeline” as of today

6x10+ GW wind bases represent future pipeline

Jiuquan, Hami, IMAR E, IMAR W, Hebei N, Jiangsu

Coordinated grid development

Government selection of turbines/low price focus

China non signatory of Gov’t Procurement Agreement under WTO

Source: Azure International, Google Earth
Location of 6 wind power bases (over 10 GW of each)
Off-shore wind development status
----34 3 MW turbine installed in Shanghai
Current wind power policies

- Feed in tariff in 4 regions with each of them 0.51, 0.54, 0.58 and 0.61/kWh with a local special support
- VAT deduction of equipment cost (usually it is 17% of total investment)
- Income tax for 2 year free and 4 years half (normally it is 25% of net income)
Wind tariff in China
Wind tariff in China

**NDRC Approved Feed In Tariffs**

- Feed-in Tariff
- VAT

<table>
<thead>
<tr>
<th>Area</th>
<th>Feed-in Tariff (RMB/kWh)</th>
<th>VAT (RMB/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMAR West</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>Xinjiang</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>IMAR East</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>IMAR East2</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Hebei</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Gansu</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Ningxia</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Fujian</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Shandong</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>Liaoning</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Jilin</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Shanxi</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Henan</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Hebei South</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>Hubei</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

Ave net feed in tariff = RMB 0.53/kWh for 30k hrs

@ EUR 12/tce add RMB 0.10/kWh thru 2012

- On 9 Jun 07, 23 projects approved in 4 provinces
- On 3 Dec 07, 72 projects approved in 8 provinces
- On 10 Jan 08, Guangdong approved their fixed tariffs
- On 23 July 08, 48 projects approved in 10 provinces

143 projects in 14 provinces covered thus far represent over 85% of pipeline identified to date (100GW)

Source: Azure International
Cheaper manufacture in China

Established international and Established domestic companies each with potential for 2GW by the end of 2007

By 2009 each grouping could represent about 1/3 of the market, but “new entrants” will be challenged in acquiring market share

Expect consolidation within the next 3 years

WTG Manufacturer Company Groupings

- Established International
  Gamesa, GE, NCWA, Nordex, Suzlon, Vestas

- Established Domestic
  Sinovel, Dongfang, Goldwind, Windey, Changzhou, Huayi, Shanghai, Xiangdian

- New entrants
  24+ companies with tech or license agreements and detailed business plans for WTG manufacturing

Source: Azure International data
Future potential

All power needed by China to 2030 (7000 TWh ~ 3000 GW wind) could come from the wind resource based on reasonable geographical limitations and feed-in tariff of RMB 0.516/kW

Study by Michael B. McElroy (Harvard), Xi Lu, Chris P. Nielsen, Yuxuan Wang (Tsinghua)

Wind resource could provide 24,700 TWh of electricity annually, more than 7x current national consumption!

Doubling power use in China to 2020 (792 GW) if all done with wind would require ~ 1680 GW

Floor in place - RPS - powerful driver of sector but other factors at work

unprecedented thermal/hydro cap. Expansion (+100GW in 2007 alone / cum cap forecast at 1,575 GW by 2020*)

2010F overall power gen capacity 840GW at 3% implies 25GW of non-hydro renewables; with 60% cap from companies >5GW = 15GW mandated by 2010

2020F overall power gen capacity 1575GW at 8% implies 126GW of non-hydro renewables; with 60% cap from companies >5GW = 77GW mandated by 2020
## Major suppliers in China

<table>
<thead>
<tr>
<th>Domestic Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Gold Wind (Xin Jiang Urumchi)</td>
</tr>
<tr>
<td>▪ Sinovel Wind (Liao Ning Da Lian)</td>
</tr>
<tr>
<td>▪ Dong Fang Electric (Si Chuan Mian Zhu)</td>
</tr>
<tr>
<td>▪ United Power (Guodian and others)</td>
</tr>
<tr>
<td>▪ Ming Yang Electric (Guang Dong Zhong Shan)</td>
</tr>
<tr>
<td>▪ Hara XEMC Wind Power (Hu Nan Xiang Tan)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foreign Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamesa, Vestas, GE, Suzlon, RE Power, Acciona, Nordex, SKF, FAG, LM, XREB</td>
</tr>
</tbody>
</table>

There are currently more than 40 wind turbine generator manufacturers in China, including 4 foreign-invested enterprises, 7 joint-venture companies and over 20 domestic manufacturers.
Top 10 of the manufactures

- Shanghai: 2.00%
- Gamesa: 2.02%
- Xiangdian: 3.31%
- Vestas: 4.41%
- Mingyang: 5.46%
- United: 5.61%
- Easten: 14.67%
- Other: 14.78%
- Sinoval: 25.51%
- Goldwind: 19.87%
Scale-up Onshore Wind Bases
- Northeast and Northwest (Gansu, Xinjiang, Inner Mongolia)
- Wind speed >8.0 m/s

Pilot Intertidal Offshore
- Equivalent to “Tantu” wind speeds – perhaps 6.0-7.0 m/s
- Mostly Jiangsu, Shanghai and Shandong coast

Initiate Medium-Deep Water Offshore
- Higher wind speeds than inter-tidal area – but very limited measurements
- Fujian, Zhejiang, Guandong, Shandong, Jiangsu and Shanghai
Distinguishing the three main resource types is important

**Onshore Wind**
- Highest wind speeds
- Lowest cost
- Extensive local experience
- High potential in China
- Measures to improve capacity factor are key to cost efficiency.
- No global experience on planned 4-10 GW-scale wind bases
- Serious wake issue with large scale installations
- Grid planning and micro-siting of turbines key to success.

**Offshore – Intertidal**
- Muddy tidal flat area
- Potential attractive from a cost perspective
- Virtually no international experience in constructing wind-farms on tidal flats.
- Potentially quite attractive given proximity to load centers – reducing transmission costs
- Foundation construction and turbine erection methods have to be developed to minimize costs.

**Offshore – Medium to Deep Water**
- Likely to be most expensive (at least twice the price of on-shore)
- Significant international experience to develop upon.
- High costs of construction and maintenance – large capacity wind turbine (> 3 MW) will reduce costs.
- Uncertainties/risks of foundation construction
- Typhoon risk may be high in south China

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**Diagram:**
- **Onshore**
  - "TANTU" reclaimed land zone
- **Offshore**
  - Intertidal zone
  - Medium to deep water offshore
  - Typhoon risk may be high in south China
  - Low tide level
  - High tide level
  - Dike

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Special case in Jiangsu
Special case in Jiangsu
Future projection

- About 4 projects to be announced for bidding with 200-300 MW of total installation about 1000 MW
- Mainly in the inter-tidal area, such as Jiangsu, which with about 8 to 10 GW of inter-tidal wind power potential
- Followed by Zhejiang, Shanghai, Shandong, Fujian and Guangdong area, with total of installation by 2020 will be about 10 GW or more
Lessons to be learnt

 Localization and market scale are the key measures for reducing the cost

- Turbines price down to 5000 RMB Yuan in 2009 from 7000 RMB Yuan in 2007
- Market scale from 50 MW in early 2000 to about 14 GW by 2009

International cooperation is very important both for innovation and quality control

- All most of the large manufactures come to China already, including Vestas and GW
- GW and other have set up their R&D center in China
Thank You!

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