

# Wind energy

## Technology trends and applications in East Asia

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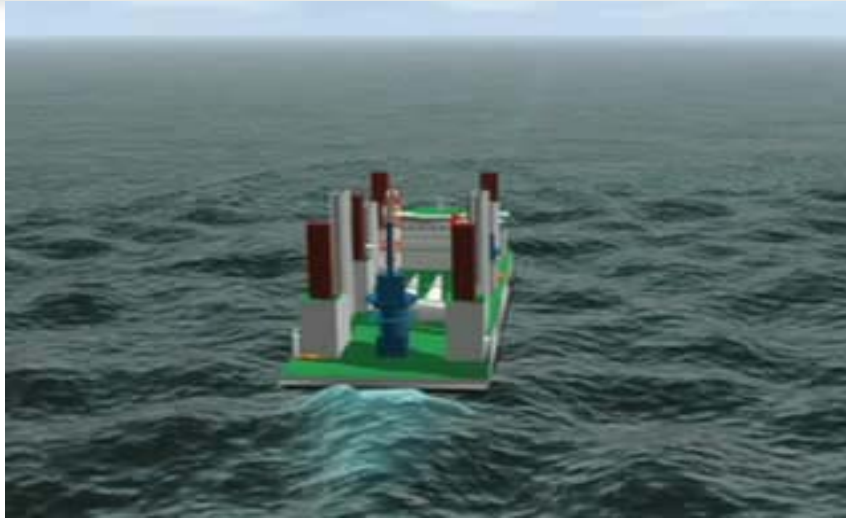


**East Asia Energy Futures**

**Vancouver, BC**

**November 4, 2003**

# Mayflower – Offshore turbine installation vessel



**North Hoyle Offshore Wind Farm, UK,  
60 MW**



**Shanhaiguan  
shipyard,  
Qinhuangdao  
China**

<http://www.mayflower-energy.com/index2.htm>

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- **Trends in wind energy technology**
  - **Turbine scale**
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# Trends in turbine scale (I)

2 MW [circa 2001]

**Bonus, Vestas, NEG Micon**



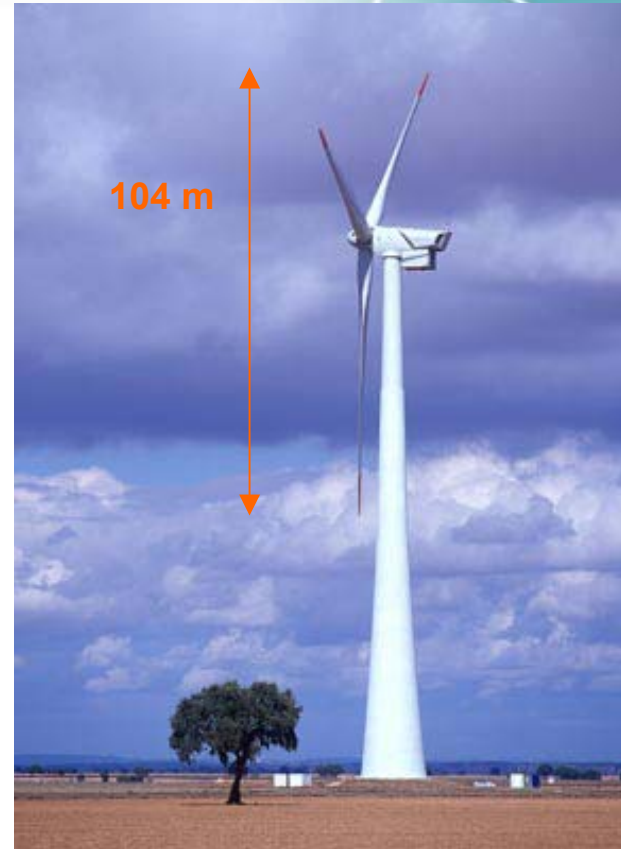


# Trends in turbine scale (II)

## Larger turbines

3.6 MW [Summer 2003]

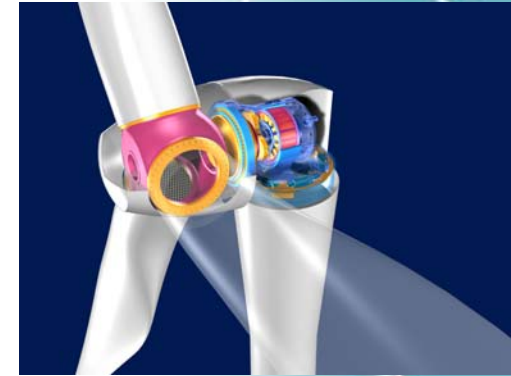
GE Wind – Iberdrola, Spain



# Trends in turbine scale (III)

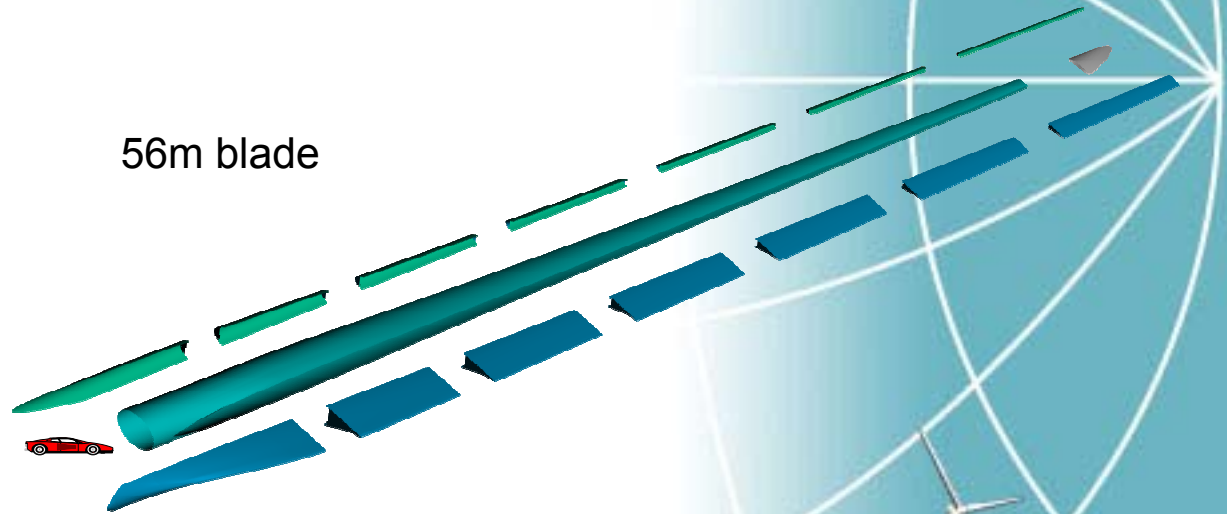
## Larger turbines

5 MW [Fall 2005]



Pfleiderer Multibrid

56m blade



# Plant size

## More turbines

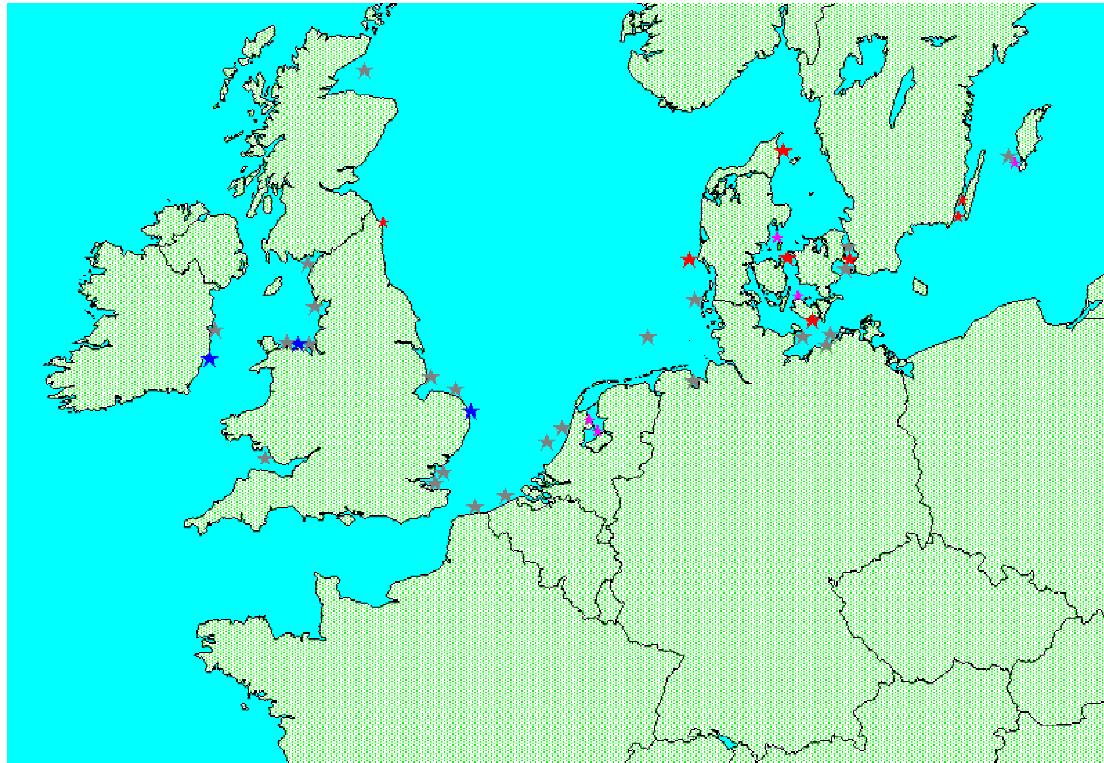


Stateline, Washington [399 x 660 kW = 263 MW]



King Mountain, Texas [214 x  
1.3 MW = 278 MW]

# Offshore



red = (built Mm windturbines), purple=(built small windturbines),  
blue=(under construction), grey=(planned)

North America:  
Cape Cod, Mass  
Long Island, NY  
Hecate Strait, BC



# Evolution of scale (offshore)



Bockstigen  
(Sweden) 5 x  
550 kW = 2.75  
MW [1991]



Middelgrunden  
(Copenhagen) 20 x 2  
MW = 40 MW [1998]



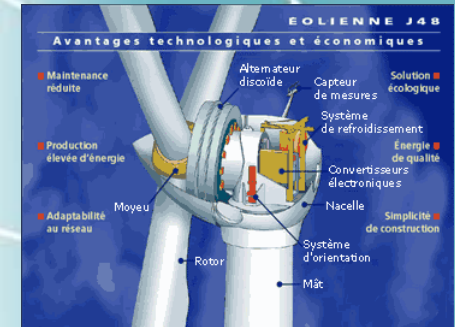
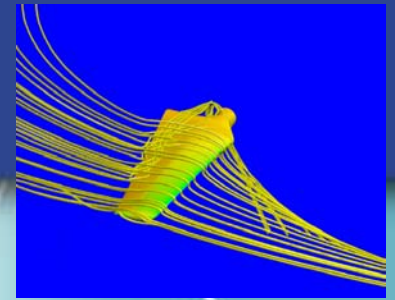
Nysted (Denmark) 72 x 2.2  
MW = 158.4 MW [2003]



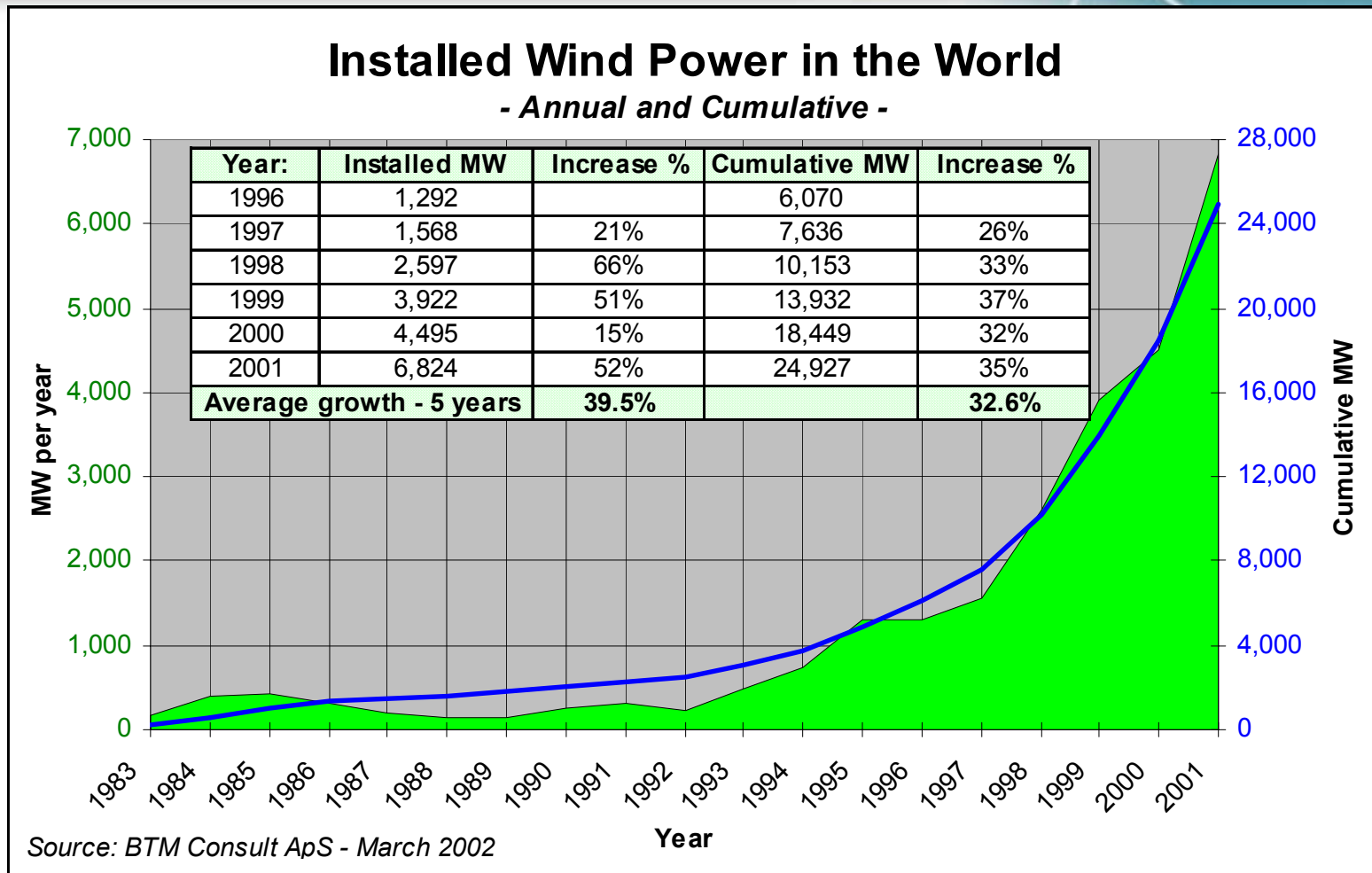
Arklow Banks (Ireland; visualization) – 144 x 3.6 MW =  
520 MW [2006]

# Other developments

- Direct drive/permanent magnet rotor
- Grid interconnection
  - AC reactive power and voltage stability
  - HVDC light
- Remote operation (e.g. satellite)
- Large blade design
- Preventive maintenance schemes
- Wind modelling
- Offshore foundations



# Markets – the World




# Ten largest markets – Installations (MW)


Country	1999	2000	2001	Share %	Cum. Share %
Germany	1,568	1,665	2,627	38.5%	38%
USA	477	165	1,635	24.0%	62%
Spain	932	1,024	1,050	15.4%	78%
Italy	80	147	276	4.0%	82%
India	43	169	236	3.5%	85%
Japan	38	74	217	3.2%	89%
Denmark	325	603	115	1.7%	90%
UK	24	63	107	1.6%	92%
Greece	103	116	84	1.2%	93%
P.R. China	43	13	75	1.1%	94%
<b>Total</b>	<b>3,633</b>	<b>4,039</b>	<b>6,422</b>		
Percent of World	92.6%	89.8%	94.1%		



# Ten largest markets – growth rates (MW)


 Country	Accu. end 1998	Accu. end 1999	Accu. end 2000	Accu. end 2001	Growth rate 2000-2001 %	3 years average %
Germany	2,874	4,442	6,107	8,734	43.0%	44.8%
USA	2,141	2,445	2,610	4,245	62.6%	25.6%
Spain	880	1,812	2,836	3,550	25.2%	59.2%
Denmark	1,420	1,738	2,341	2,456	4.9%	20.0%
India	992	1,035	1,220	1,456	19.4%	13.6%
Italy	197	277	424	700	65.0%	52.5%
UK	338	362	425	525	23.5%	15.8%
Netherlands	379	433	473	523	10.6%	11.3%
P.R. China	200	262	352	406	15.4%	26.7%
Greece	55	158	274	358	30.7%	86.7%
Japan	30	68	142	357	152.1%	128.3%
<b>Total "Ten"</b>	<b>9,506</b>	<b>13,032</b>	<b>17,203</b>	<b>23,310</b>	<b>35.5%</b>	<b>34.8%</b>

# Regional distribution

	Installed MW 2000	Accu. MW 2000	Installed MW 2001	Accu. MW 2001	% of installed MW 2001
Total America	180	2,848	1,745	4,593	25.6%
Total Europe	3,893	13,630	4,527	17,812	66.3%
Total Asia	330	1,728	511	2,237	7.5%
Total OECD-Asia	21	70	41	111	0.6%
Total Africa	73	137	0	137	0.0%
Total other continents and areas:	0	37	0.6	38	0.0%
Annual MW installed capacity	4,495		6,824		
Cumulative MW installed in the world		18,450		24,927	

Asia is 9% of cumulative installed, 7.5% of growth

# Regional within Asia

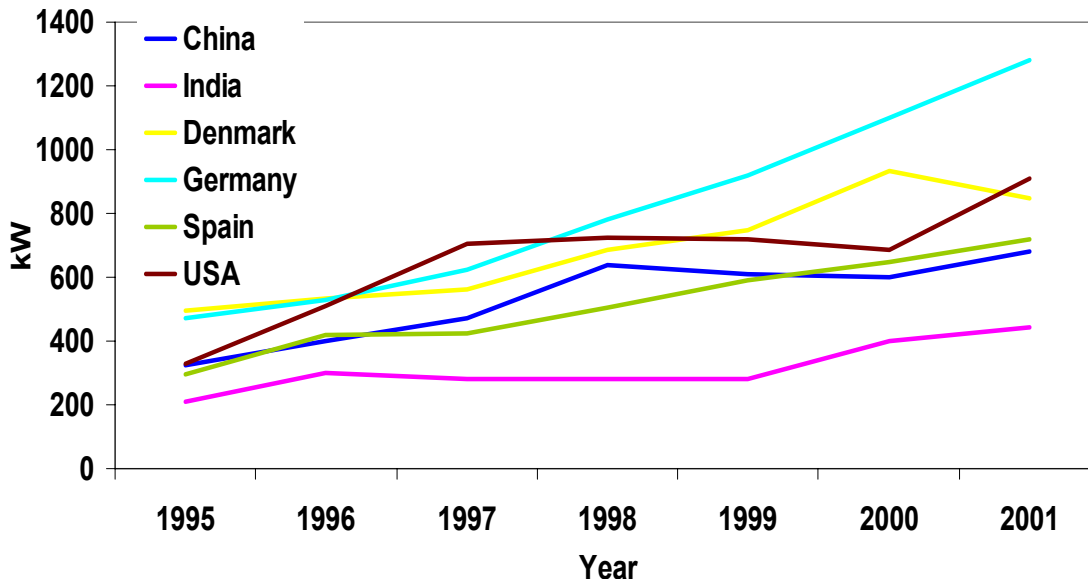
	Installed MW 2000	Accu. MW 2000	Installed MW 2001	Accu. MW 2001
P.R. China	84	352	54	406
India	169	1,220	236	1,456
Japan	74	142	217	357
Rest of Asian : Korea /Malaysia /Indonesia /Philippines / Taiwan /Thailand/ Vietnam etc.	3	15	3.7	18
<b>Total Asia</b>	<b>330</b>	<b>1,728</b>	<b>511</b>	<b>2,237</b>



Source: BTM Consult

# Turbine sizes

Year	1999	2000	2001
Total MW supplied	4,021	4,548	7,056
Product (Size range)	% of total MW		
"Small WTGs" <500 kW	4.9%	1.8%	1.6%
"Main stream" 500-999 kW	68.3%	59.0%	47.8%
"MW-class" 1MW & up	26.8%	39.1%	50.6%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>



**Average  
size of  
installed  
turbine**

Source: BTM Consult



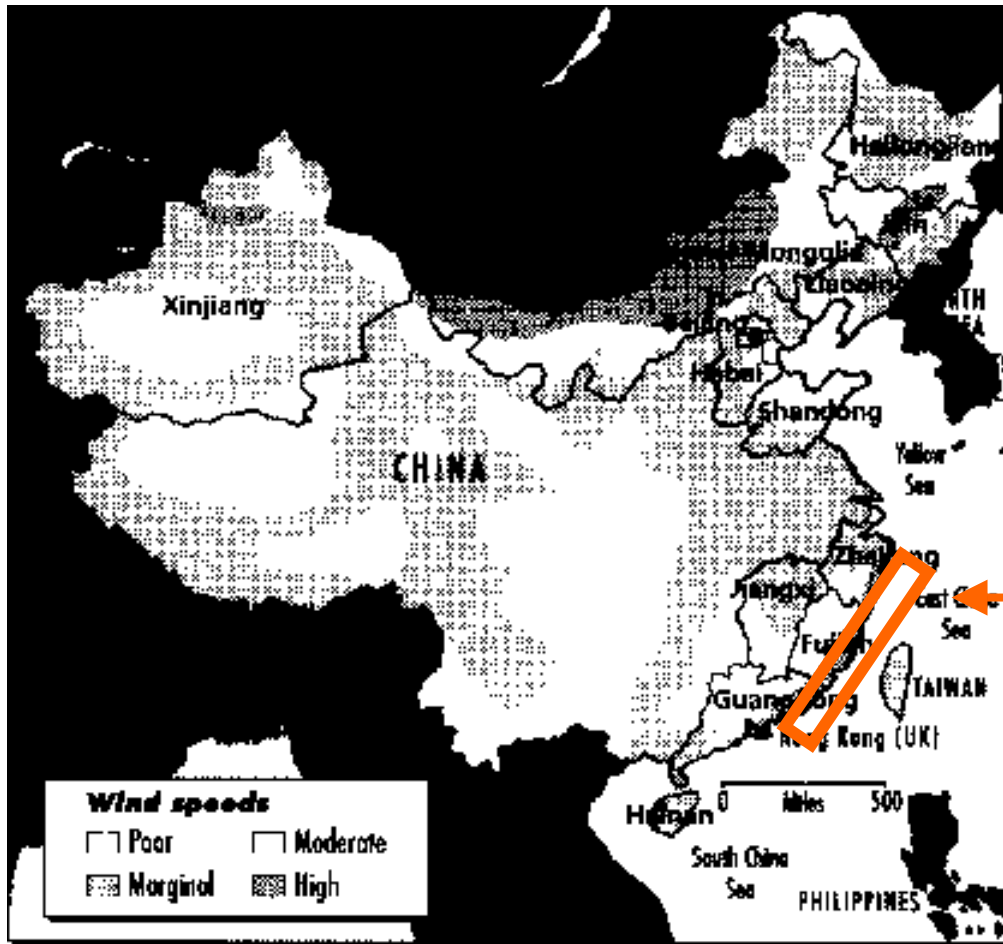
# Wind resources - China

- 253 GW on-land theoretical potential
- Best areas: the grasslands or deserts in northwest, northern and northeast of China, and coastal areas or islands in east and southeast China
- Best winds: coast and offshore islands

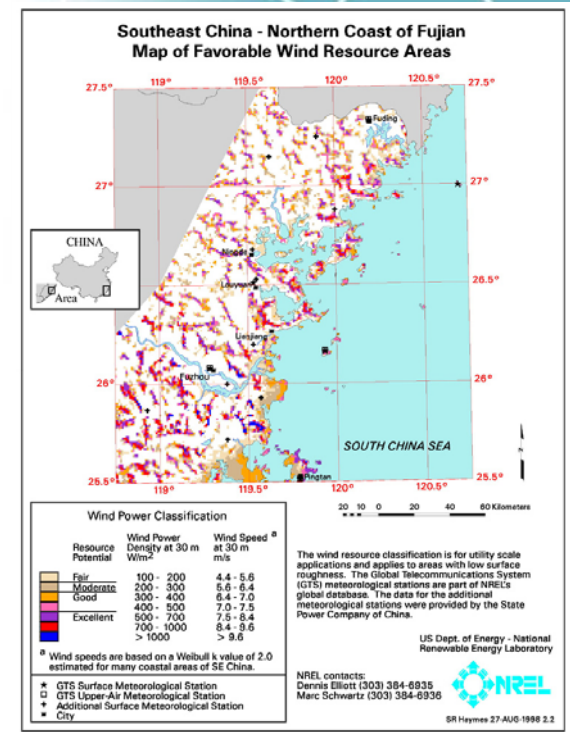
List of Provinces Abundant of wind Energy Resources

Provinces	Capacity(10,000KW)	Provinces	Capacity (10,000KW)
Inner Mongolia	6178	Shangdong	394
Xinjiang	3433	Jiangxi	293
Heilongjiang	1723	Jiangxu	238
Ganxu	1143	Guangdong	195
Jilin	638	Zhejiang	164
Hebei	612	Fujian	137
Lianning	606	Hainan	64

# Wind resources - China



750 GW of offshore potential [?]\*



(\* ) [http://www.nrel.gov/china/pdfs/re\\_forum/china\\_wind\\_energy\\_resource.pdf](http://www.nrel.gov/china/pdfs/re_forum/china_wind_energy_resource.pdf)



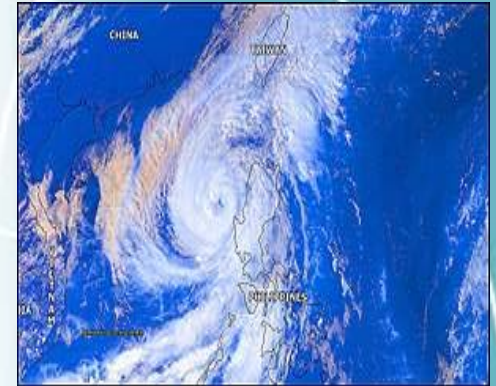
# East Asia – market

- China
  - the “holy grail”
  - energy prices very low
  - political drivers for energy
  - grid infrastructure weak or absent in many high-wind areas
  - needs 2 or more years before market will “take off”
- (South) Korea
  - wind is scarce on land (e.g. Jeju Island)
  - excellent infrastructure
  - excellent feed-in tariff (~\$US\$90/Mwh)
  - offshore possibility



# East Asia – market

- Taiwan
  - upcoming market, now very small
  - very good winds (but sometimes too good)
- Phillipines
  - good winds (also typhoon risk)
  - good grid locations
  - unreliable legal structure; corruption
  - promising for the future





# Manufacturing potential

- Most manufacturing now in Western EU, but is shifting to low-production cost areas [Brazil, Poland]
- World-class blade plants at tidewater (900 man-hours/blade)
- Rolled steel for towers
- Ancillary equipment (electronics, vessels)



# Conclusions

- Wind resources are available
- Infrastructure and business environment is variable
- Potential for offshore development
- Potential to “leap-frog” to latest technology
- Manufacturing potential for world market

