



A GL company



# Developments in Wind Energy

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Renewable Energy Experts  
worldwide



# Overview



- Some historical perspective
- The wind industry's international state of play
- Industry trends - growth, investment, internationalisation, mergers
- Major energy and manufacturing players
- The emergence of Asian firms
- The RET and its impact on the Australian market





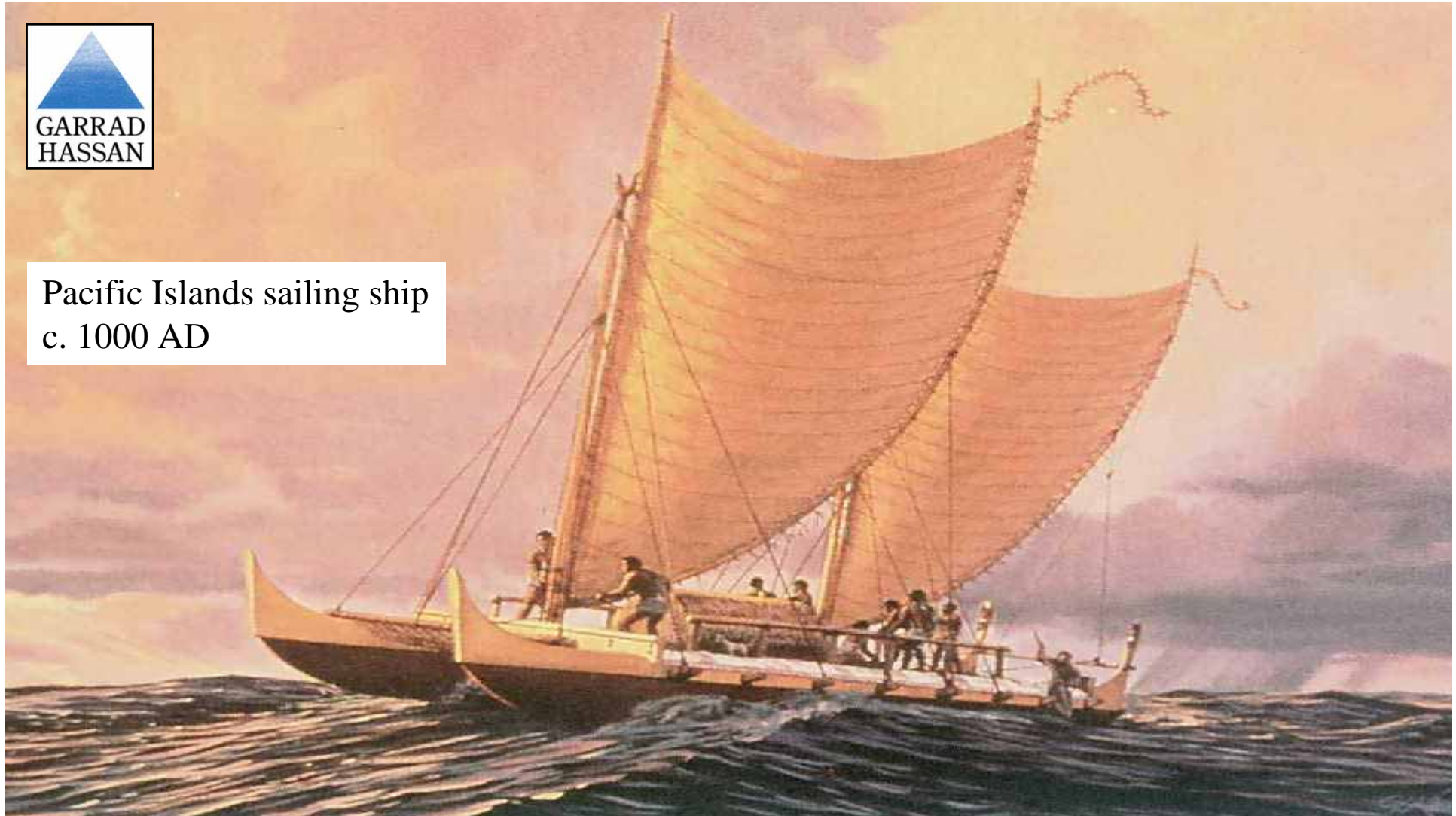
# History of Wind Turbines

- Wind one of oldest forms of power generation
- 1887- First conversion of wind to electrical power
- 1897- Pour La Cour (Denmark) built test turbines and trained wind engineers
- During and post WW2 wind turbines developed in Denmark
- Oil crisis of 70's spurred R&D in wind and other REs
- 1980s Danish Govt incentives to manufacturers & wind feed-in tariff
- Californian wind rush (1980 - 85)
- Nineties turbine size, hub height and efficiency increases
- 2000 increased access to offshore resources
- The last 30 years have seen modern turbine concept evolve significantly





Pacific Islands sailing ship  
c. 1000 AD

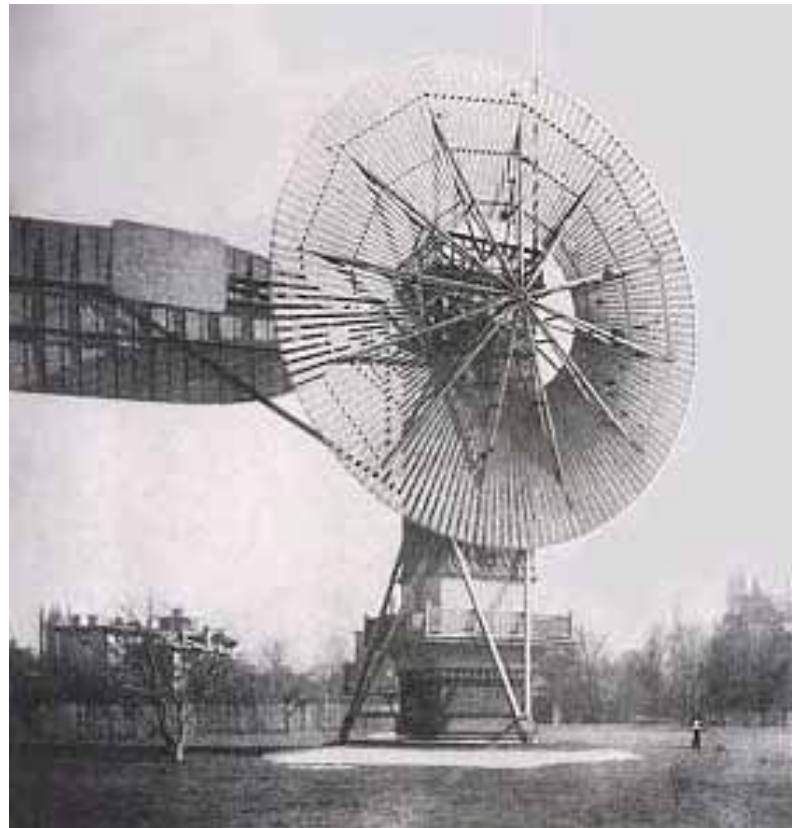




Mediterranean sail wing windmill, Crete



# Charles Brush Turbine (US - 1888)



~ 12 kW



# Paul La Cour Turbines (Denmark - 1897)





# California - 1980s - 50 kW





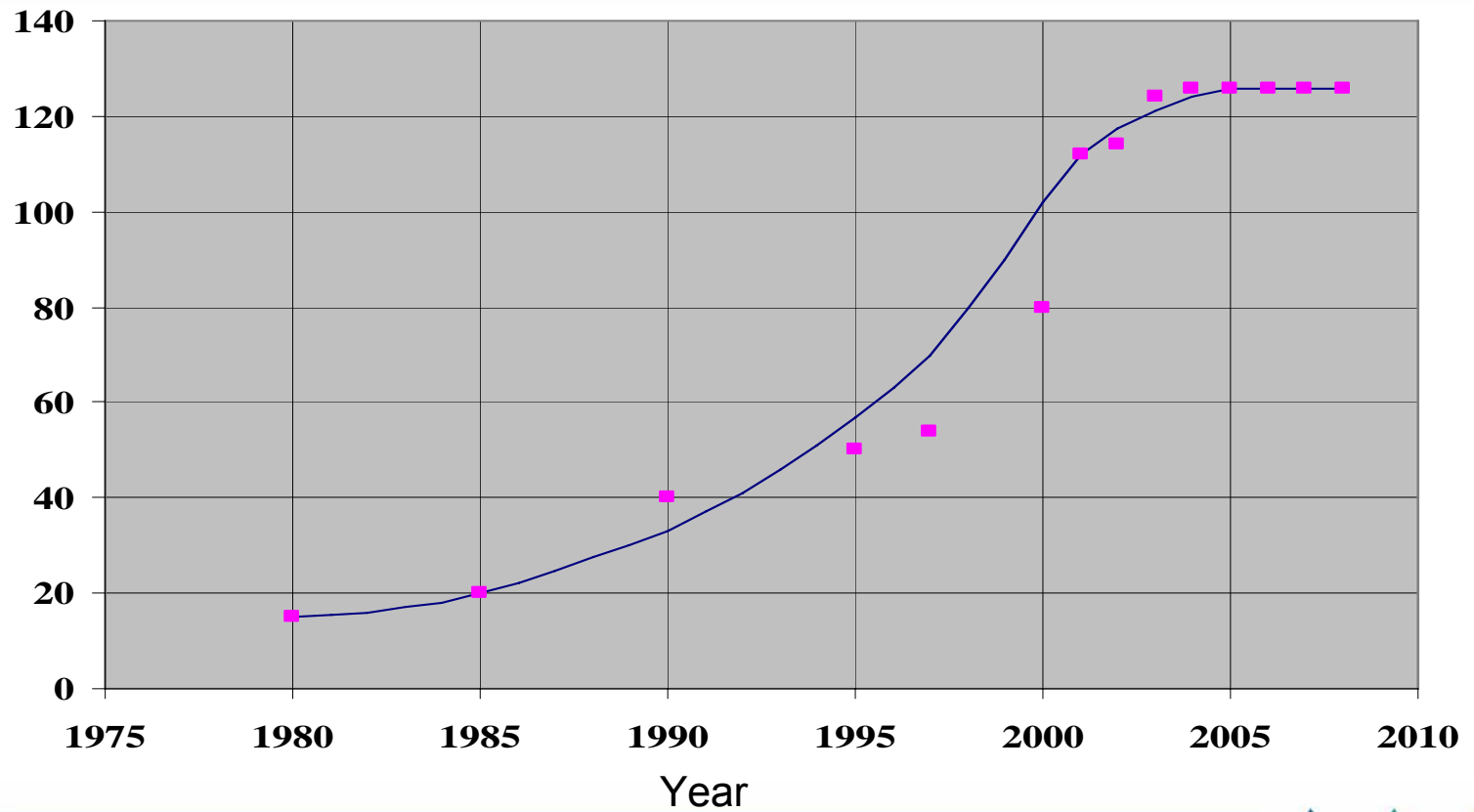
# Germany - 2008 Enercon - 6 MW





# Turbine Development

Rotor Diameter [m]



## Where are the Limits?

Onshore turbines must be  
easy to transport, install and be  
good neighbours



1980  
30 kW, dia 15m



2009  
6 MW, dia 127 m







# Key trends



- Turbines become much larger
- Fixed pitch, fixed speed operation replaced by variable pitch, variable speed
- New drive train concepts. e.g. direct drive
- Market dominated by turbines of 1.5 - 3 MW rating (80% 2008)
- Grid requirements and offshore market now major drivers of technology development





# Wind Turbines - Future



## Onshore

- Market dominated by turbines of 1.5 - 3 MW rating
- Rotor diameters up to 115 m diameter, nacelle height 120 m
- Expansion of onshore market for smaller turbines (few hundred kW rating)

## Offshore

- Further growth in size of offshore turbines
- Manufacturers are now considering turbines in the range of 7.5 - 10 MW
- Growth rates to slow





# World Wind Energy Market



- Industry is now over 25 years old
- Early turbine manufacturers Danish
- Soon followed by US, Dutch, English, German
- In recent years significant number of new entrants
- Industry has been 'globalised'
- Now manufacturers in Spain, India, Japan and China, etc.
- Manufacturing sector is undergoing a period of strong growth
- Wind industry both consolidating and expanding currently





# Market Drivers

- Global energy demand
- Energy security
- Climate Change
- Government policy has strongly influenced wind energy adoption and industry development
- RECs have created markets for RE in Australia & many other countries
- Price on CO<sub>2</sub> - carbon tax or tradable certificates
- Over 45 countries to date have RE market incentives
- Investment risk - carbon based generation now has high political, environmental and commercial risks
- Some countries have tied growth to local manufacturing (China, Canada, Spain, India)





# World Wind Energy Market Profile



## During 2008

- worldwide capacity of wind generation grew by 28% (average 27% last 5 yrs)
- capacity growth approx. 28 GW ( $\approx$  14,000 turbines)
- investment in wind energy  $\approx$  AUD\$ 60 billion

## Today

- total wind energy capacity installed globally  $\approx$  145 GW
- annual electricity generation  $\approx$  310 TWh
- wind turbines  $\approx$  128,000
- offshore: 1,500 MW (610 turbines)
- wind power accounts for 1.3% of global electricity
- CO<sub>2</sub> saving annually  $\approx$  160 million tonnes
- sector employs more than 400,000 in over 70 countries





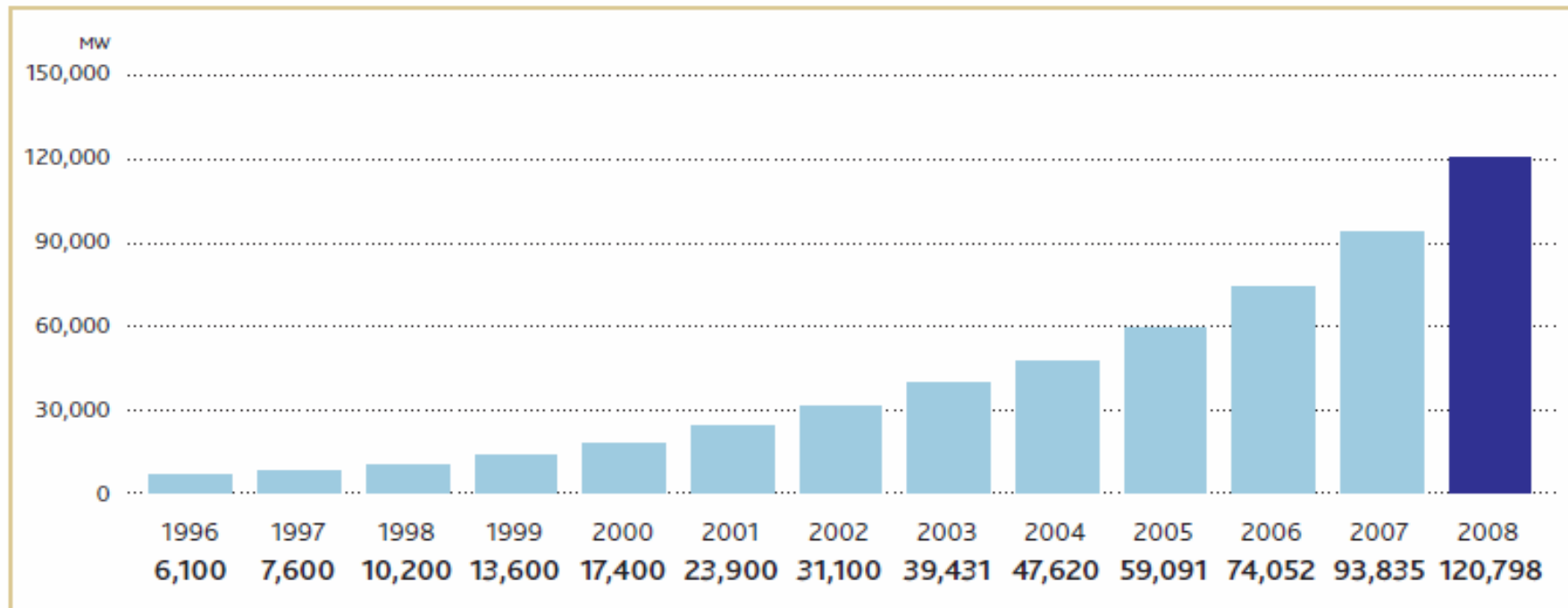
# Country Targets & Expectations

- Over 45 countries now have policy targets for renewable energy
  - New Zealand 90% by 2025
  - Germany- 30% by 2020
  - EU - 20% by 2020
  - Australia - 20% by 2020
- Some countries have significant targets for wind energy
  - China - 30 GW by 2020
  - UK - 14 GW (onshore) / 14 GW (offshore) by 2020
  - Spain - 20 GW by 2010
  - Japan - 3 GW by 2010
- 2020 wind market predictions
  - Germany - 45 GW (onshore) / 10 GW (offshore) - 25% of total
  - Spain - 40 GW (onshore) / 5 GW (offshore) - 30% of total
  - China - 100 GW





# Global Wind Capacity Growth (1996-2010)

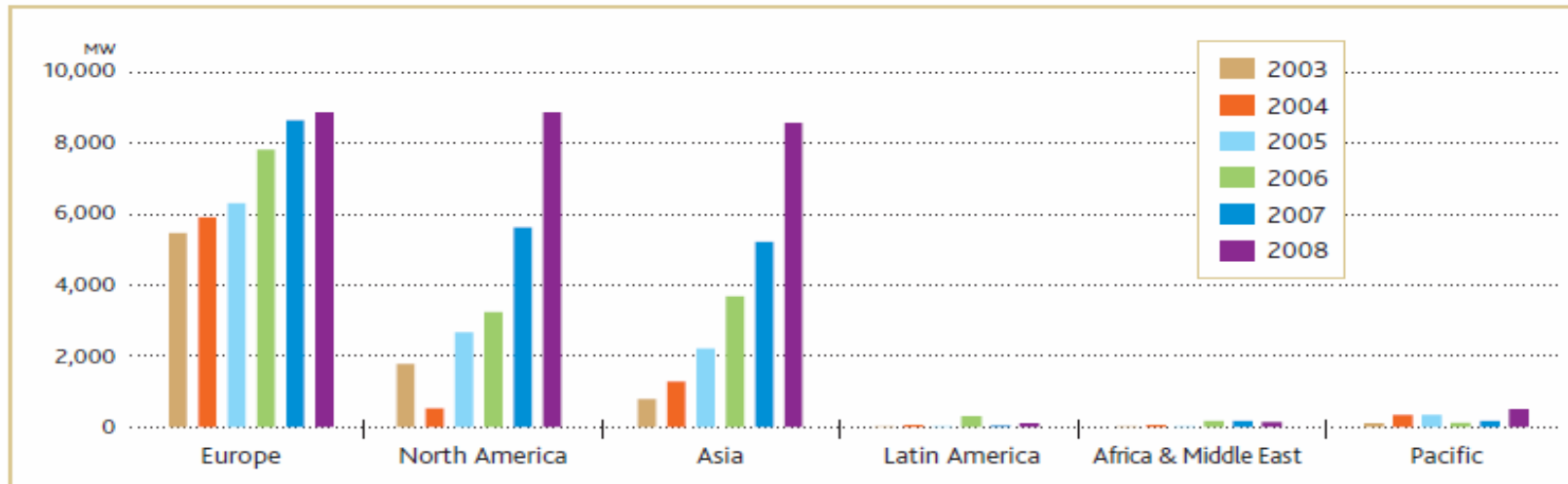


Source: GWEC, 'Global Wind 2008 Report'





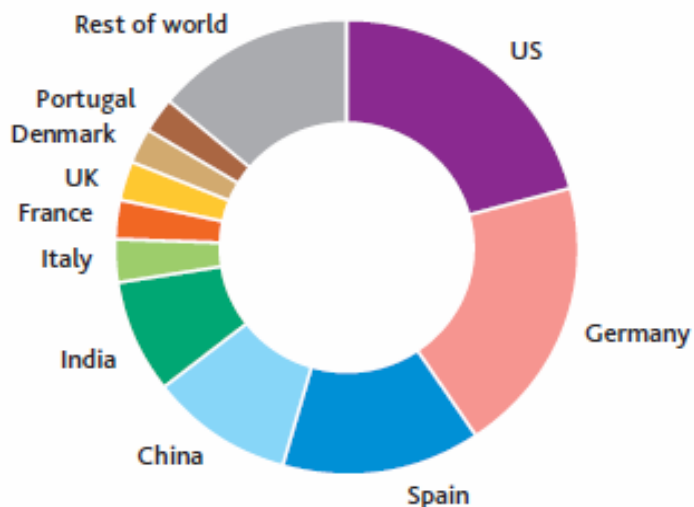
# Annual Wind Capacity Growth by Region (2003-2008)



Source: GWEC, 'Global Wind 2008 Report'



# Top 10 Countries- Total Wind Capacity (2008)



	GW	%
USA	25.2	20.8
Germany	23.9	19.8
Spain	16.6	13.9
China	12.2	10.1
India	9.6	8
Italy	3.7	3.1
France	3.4	2.8
UK	3.2	2.7
Denmark	3.2	2.6
Portugal	2.9	2.4
Rest of world	16.7	13.8
Total top 10	104.1	86.2
World total	120.8	100

Australia: Current capacity (2009)= 1476 MW

Source: 1) GWEC, 'Global Wind 2008 Report' 2) CEC, 'Wind Energy Fact Sheet', 2009





# Global Future for Wind



Worldwide by 2020 wind industry is expected to:

- grow to a capacity of approx. 700 GW
- supply 10-12 % of the world's electricity
- reduce CO<sub>2</sub> emissions by 1.5 billion tonnes/year
- involve annual global investment approx. €150 bn
- create over 2.2 million jobs
- Chinese market to surpass European markets
- Indian market to also grow substantially
- more governments to encourage RE sources
- global warming, energy security & price risk to drive uptake of wind energy
- wind energy will continue to become cheaper
- carbon based energy will continue to become more expensive





# Globalization of the Wind Industry



## Industry giants

- GE (US), Alstom (Fr), AREVA (Fr), MHI (Jpn), Siemens (DK), ABB (SUI), Acciona (Es)

## Major manufacturers (turbines & components)

- Vestas (DK), GE Wind (US), Gamesa (ES), Enercon (GE), Suzlon (India), Siemens (DK)

## Key HQs

- Denmark, Spain, Germany, US, Japan, India, China

## Historically strong industry base in Europe and North America

- Acciona (ES), Ecotecnica (ES), Gamesa (ES), Nordex (GE), REpower (Ge), Clipper (US)

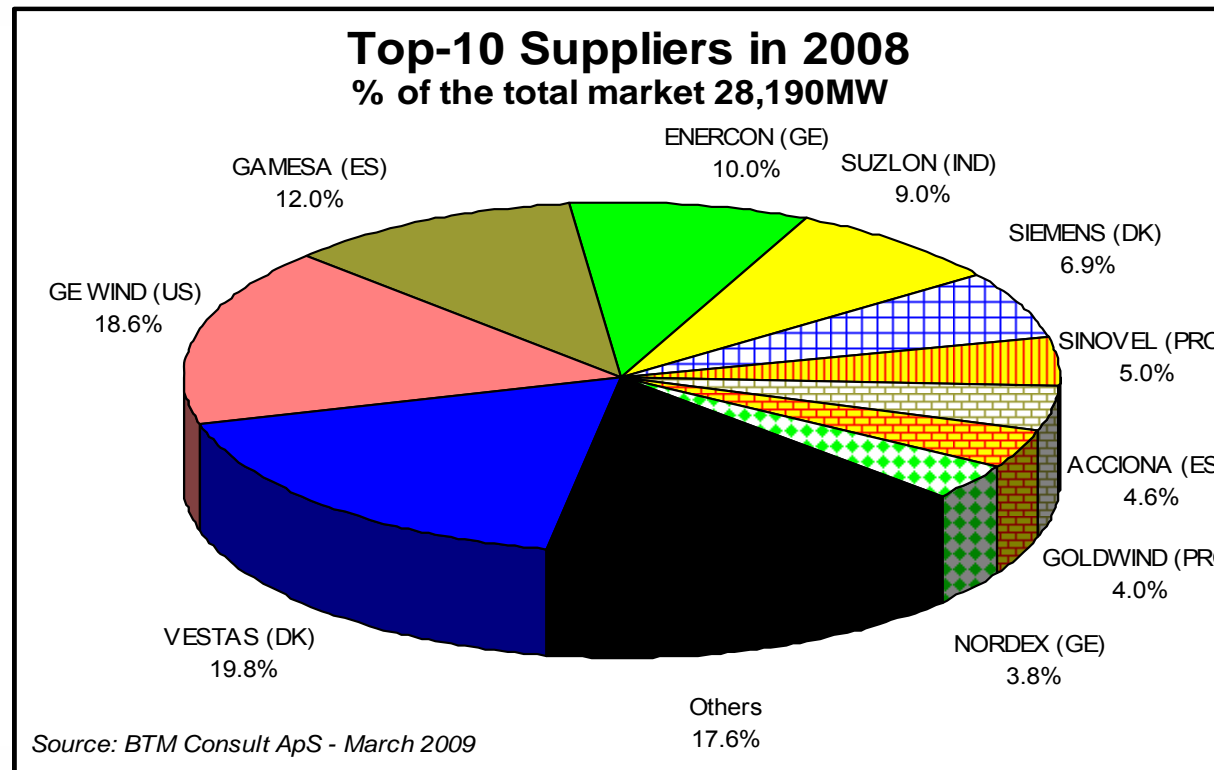
## Major production capacity developing in China and India

- Suzlon (Ind), Sinovel (PRC), Goldwind (PRC), Dongfang (PRC) + more

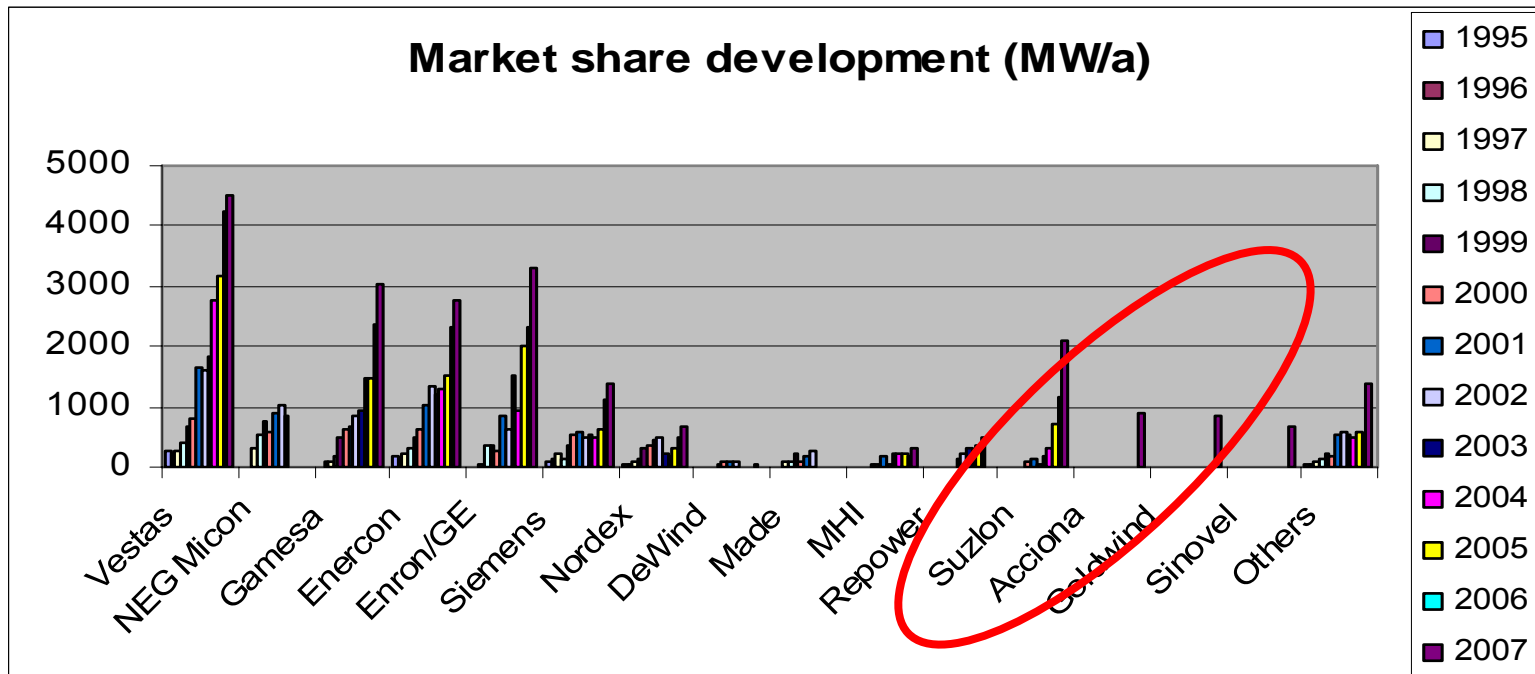
**Subsidiaries** - now in most major markets including Brazil, USA, UK, Canada, China, India



# Top ten manufacturers 2008



# Market shares MW/annum





# Mergers & Acquisitions

Company		Merger/Acquisition	
Germanischer Lloyd	Germany	Garrad Hassan	UK
Siemens	Germany	Bonus Energy	Denmark
DNV	Norway	Global Energy Concepts	US
GE	US	Enron Wind	US
GE	US	ScanWind	Norway
Alstom	France	Ecotecnia	Spain
Areva	France	Multibrid	Germany
Vestas	Denmark	NEG Micon	Denmark
STX Heavy Industries	South Korea	Harakosan Europe	Netherlands
Daewoo	South Korea	DeWind	US
Masdar	UAE	WinWinD	Finland
American Superconductor	US	Windtec	Germany
Suzlon Energy	India	REpower	Germany





# Key Components



## Blades

- LM Glasfiber, SINOI, Abeking & Rasmussen Rotec, Vestas, Gamesa, Enercon, Siemens, GE Wind, Nordex, MHI, Suzlon & many more
- LM Glasfiber has approx. 30% of the market

## Gearboxes

- Winergy, Hansen, Moventas, Bosch Rexroth, MHI
- Winergy has 40% of the market - only MHI and Gamesa produce their own gearboxes

## Generators

- ABB, Weier, Siemens, Leroy Somer, Indar, Elin, Hitachi, Enercon, MHI

**Bearings** - Hoesch Rothe Erde, FAG, SKF

**Towers** - most towers are produced locally





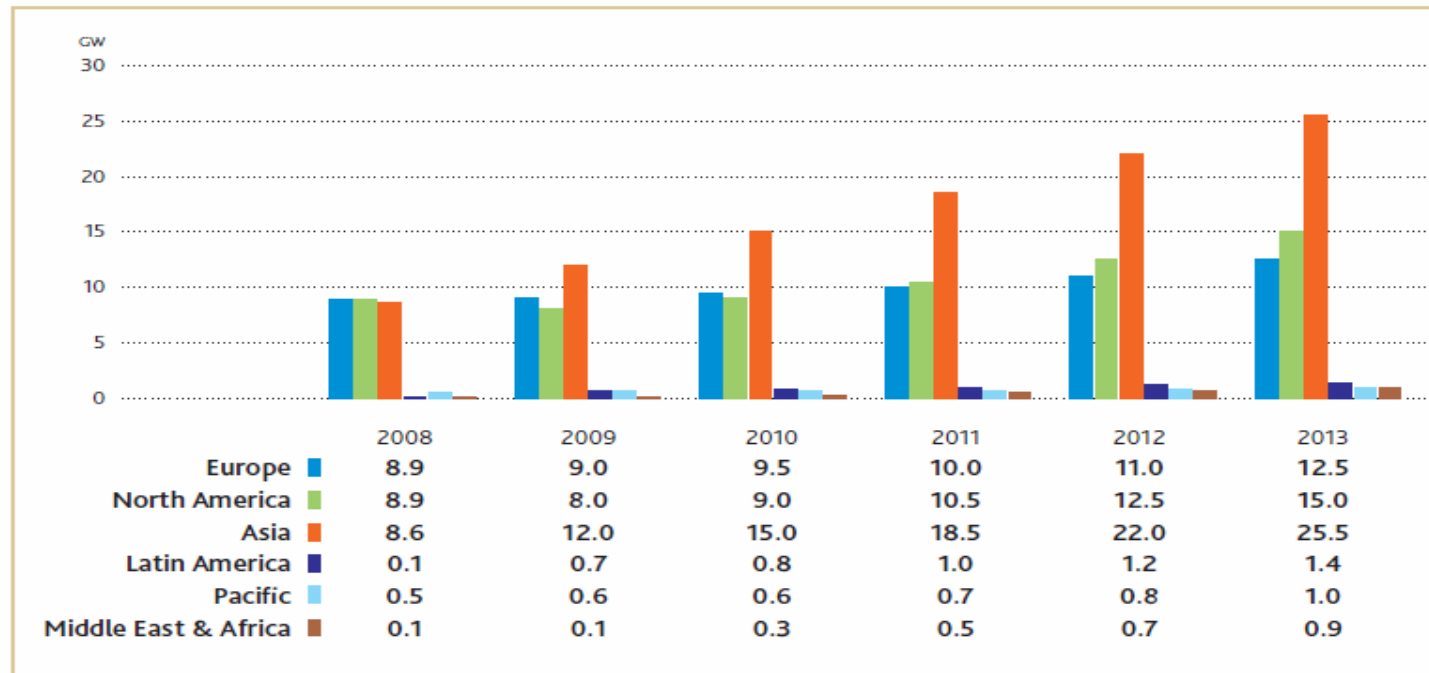
# The Emergence of Asian firms

- Asian wind farm developments expanding rapidly
- Installed 8.6 GW in 2008 (nearly a third of new global capacity)
- Region expected to dominate annual growth rates from 2009
- Annual installed capacity in Asia is predicted to triple over the next 5 years, approximately matching EU total capacity levels by 2013 with 120 GW
- Strong investment in the sector both in projects and energy infrastructure
- Strong domestic policies driving investment & supply chain development





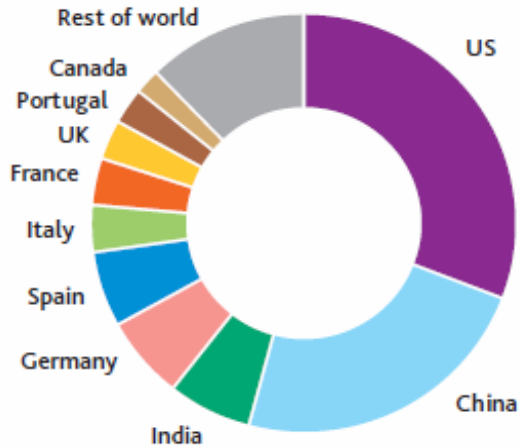
# Forecast Annual Capacity Growth by Region (to 2013)



Source: GWEC, 'Global Wind 2008 Report'



# Top 10 Countries- New Wind Capacity (2008)



	GW	%
USA	8.4	30.9
China	6.3	23.3
India	1.8	6.7
Germany	1.7	6.2
Spain	1.6	5.9
Italy	1	3.7
France	1	3.5
UK	0.8	3.1
Portugal	0.7	2.6
Canada	0.5	1.9
Rest of world	3.3	12.2
Total top 10	23.8	87.8
World total	27.1	100

Australia: New capacity (2008)= 353 MW



## Leaders in Asia- China

- Doubled its total capacity in 2008 adding 6.3 GW (4<sup>th</sup> year straight)
- Total installed capacity 12.2 GW (2008)
- 314 Wind CDM projects in the pipeline (17,000 MW)
- Strong Government policy to diversify energy supply, invest in energy infrastructure and develop wind turbine supply chains
- 10 GW-Size Wind Base Program (6 locations planned → 60 GW)
- Expected to reach its 2020 target of 30 GW of wind energy by 2010 (10 years ahead of time)
- 75 turbine manufacturers (11 established, 64 new developers)
- Key companies - Sinovel, Goldwind, Dongfang Electric, Dalian Heavy Machinery, Baoding Huitang, Xi'an Weide Co.
- International firms - Vestas, Suzlon, GE, Gamesa, Repower





## Leaders in Asia- India

- Grew by 1.8 GW in 2008
- Total installed capacity 9.6 GW (2008)
- 270 Wind CDM projects in the pipeline (5,072MW)
- Relatively concentrated development regions, but changing fast
- Ten out of twenty-nine states have established renewable energy quotas of up to 10%
- Strong domestic manufacturing base
- Suzlon (5th largest turbine manufacturer in the world)
- Production facilities for many international firms including Enercon, REpower, Siemens, LM Glasfiber





## Other Developments in Asia

### Japan

- Grew by 346 MW to 1.9 GW in 2008
- Turbine manufacturers - Mitsubishi Heavy Industries, Fuji Heavy Industry, Japan Steel works, Komai Tekko

### Taiwan

- Grew by 81 MW to 358 MW in 2008
- Future focus on offshore wind farms

### South Korea

- Grew by 43 MW to 236 MW in 2008
- Turbine and component manufacturers - Unison, Hyosong, Doosan, Samsung Heavy Industries, Hyundai Heavy Industries, Daewoo



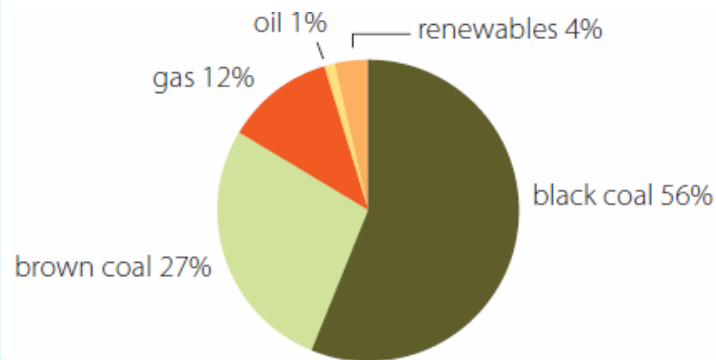


# Australian Energy Industry

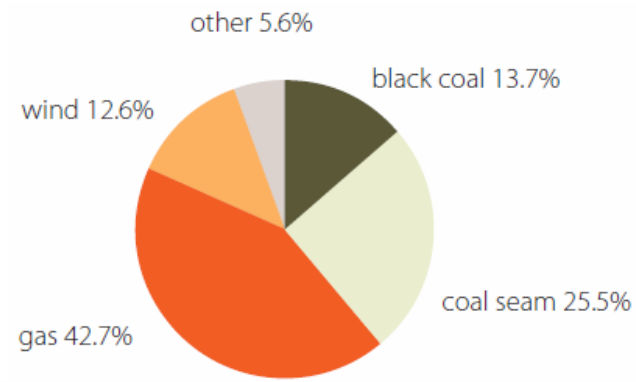
- 83 % of Australia's electricity currently produced from coal
- 10 electricity generation projects completed in 6 months to April 2009

Fuel	Projects	Capacity - MW	Expenditure - AUD\$m
Gas	6	1570	1626
Wind	2	250	530
Biomass	2	60	220

- 22 projects at advanced stage of development, totaling 4.8 GW



Current generation mix



Committed projects





# Australian Wind Industry

- The Australian wind energy industry is over 10 years old
- Currently no commercial turbine manufacturer in Australia (only towers- RPG, Keppel Prince, Haywards Engineering)
- Total operating capacity = 1,476 MW (August 2009)
- Generating 4,200 GWh/annum (3 m tonnes CO<sub>2</sub> saved)
- 47 operating wind farms, 834 operating turbines
- South Australia has the largest installed capacity- approx. 50%





# Key Projects - Australia





# Key Projects - Australia





# The RET and its Impact on the Australian Market

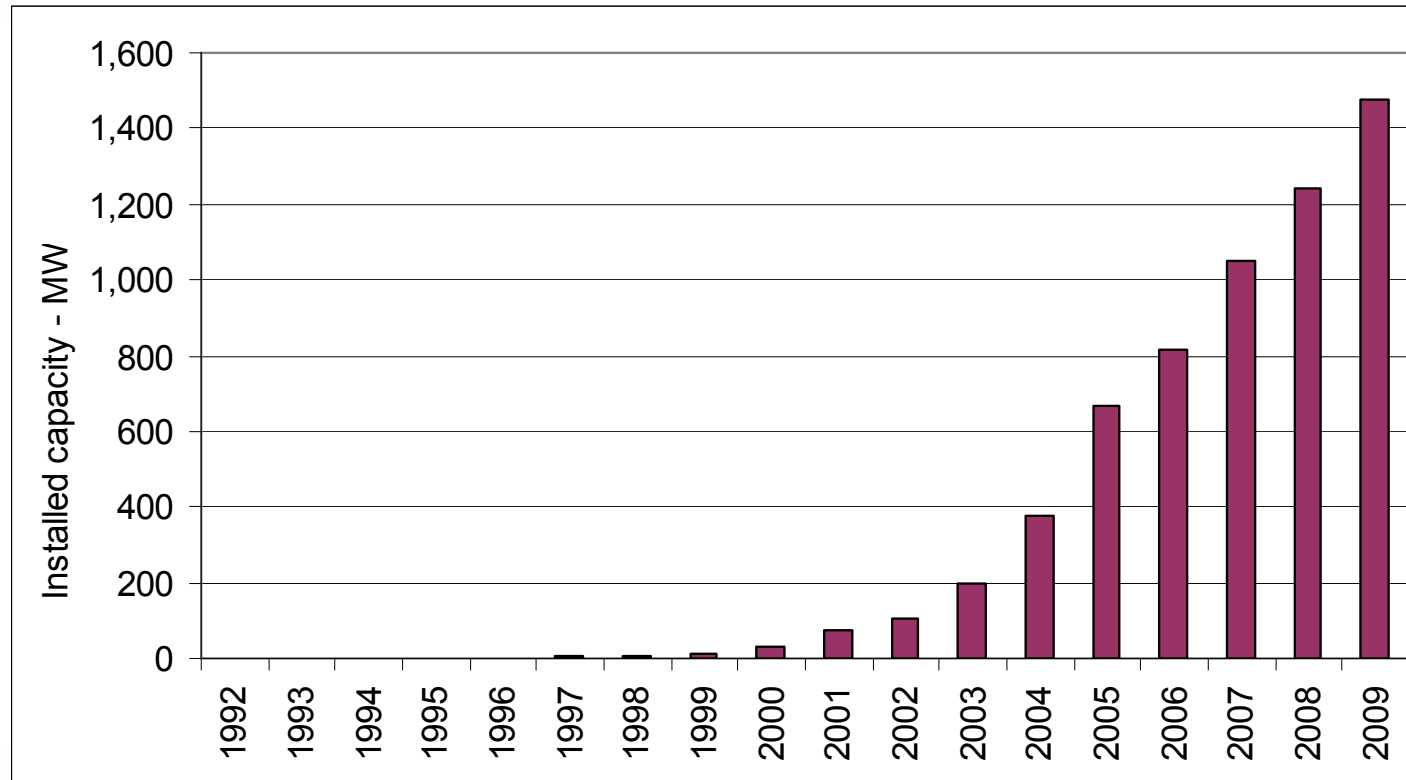


- Adoption of wind energy has been policy dependent
- Climate Change is now a major driver
- Early investments driven by MRET, VRET, Green Power
- Substantial investments were made in anticipation of the expanded RET legislation, commencing 2010 (20% by 2020, 45000 GWh)
- New capacity installed in 2008 = 482 MW (58% growth)
- Over AUD\$ 2 billion in capital investment
- Australia's strongest growth to date
- Wind currently represents approx 1.3% national electricity supply



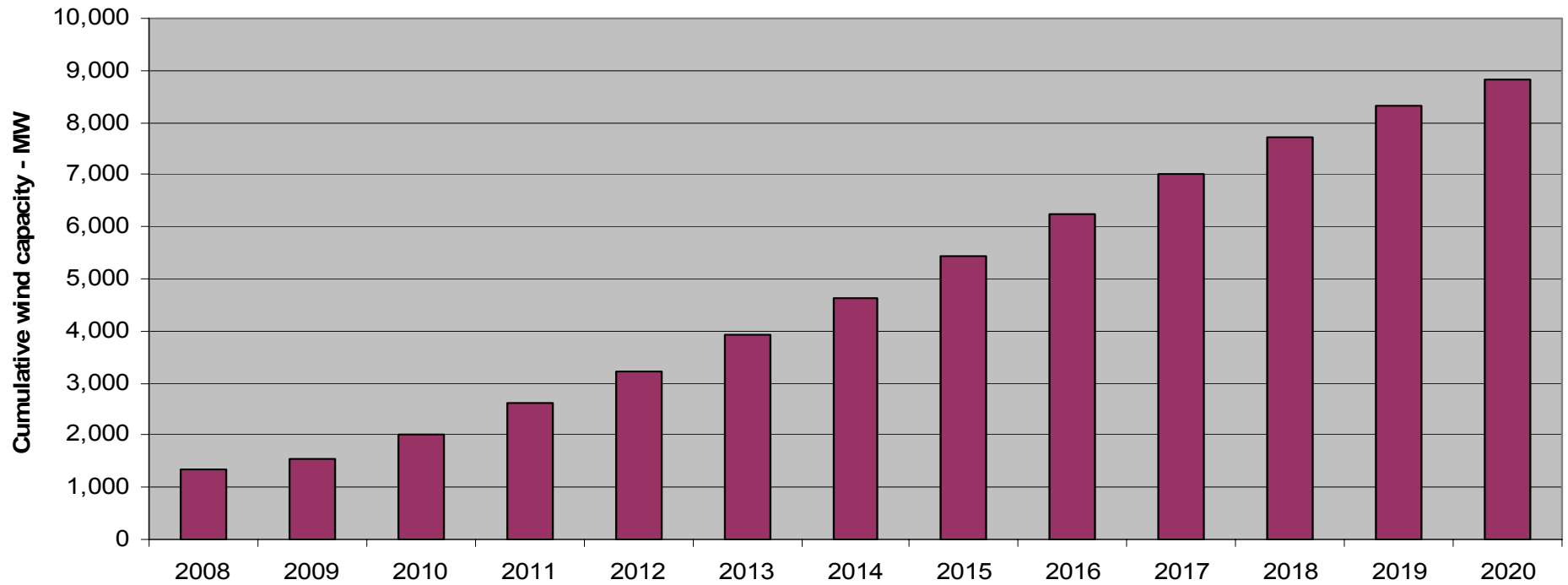


# Installed Capacity - Australia





### Total wind farm capacity





# The Future of Wind in Australia

- Currently almost 6,000 MW of large-scale wind farm projects proposed around the country, many have already received planning permission
- Wind energy is currently the 2<sup>nd</sup> cheapest renewable energy resource (after solar hot water)
- Wind expected to account for a substantial proportion of expanded RET target of 20% RE by 2020
- Estimates suggest by 2020 wind power in Australia will account for:
  - 9,000 MW capacity
  - 26,000 GWh/yr generation
  - AUD \$20 billion in investment over next 10 years





Thank you

