The Development of Wind Industry in New Zealand

EGEE 497 Final Presentation
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Development of the wind industry

- New Zealand Vision
- New Zealand Electricity
- Wind Generation
- Diversity in Generation
- Handling Uncertainty and Variability
- Barriers
- NZ Wind Farms
- References

Vision

- Wind Energy to be 20% of NZ generation by 2035 with capacity 3.5 GW


White Hill wind farm, Southland


Tararua wind farm, Manawatu


West Wind wind farm, Wellington


Wind turbine blades being moved to site, Tararua wind farm

The transformers are warm," says Barbara Jackson, a Manawatu farmer. "The sheep like to snuggle up to them." The sheep also use the towers to shield themselves from driving wind and rain.

The New Zealand Electricity

- Total installed generation capacity: 10,539 MW
- Peak load 6,414 MW
- Electricity production (2014) 39.7 TWh
- Thermal plant (gas and coal) 20%
- Hydro generation 59%
- Geothermal generation 15%
- Wind generation 6%

Wind Generation

- New Zealand has good wind resources
  - NZ locates in the Southern Ocean between 34S and 47S
  - Capacity factor reach 45% in NZ and the global average is 24%
  - Researcher collected good quality wind data showing NZ have a world class wind resource
  - Distribution companies are eager to develop generation in their local areas
- Wind generation is scalable
- Distribution companies are eager to develop generation in their local
- The technology is straight forward to install
- Wind was profitable for lines companies

Domestic generation organization recognizing wind to be a potential future for of generation

Diversity in Generation

Enabling the system to respond and maintain supply even when there is a serious problem with one form of generation

- In February 2010, the HVDC system was shut down for over three hours

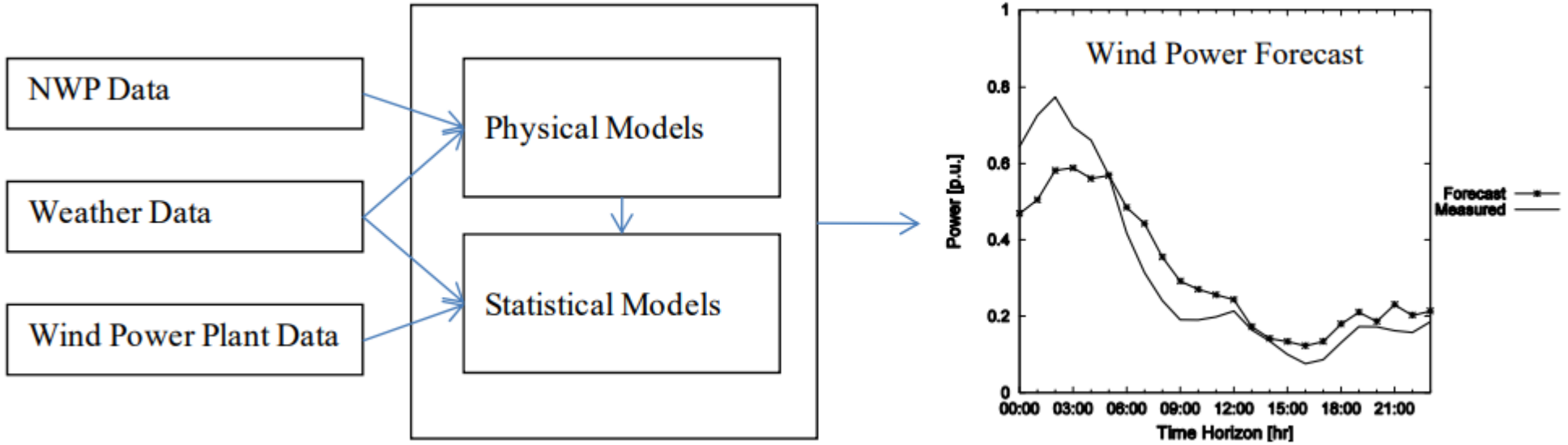
The outage coincided with a period when a number of North Island power stations were offline for maintenance.

Fortunately, strong winds at the North Island wind farms during this time, and so the wind farms met the demand. West Wind near Wellington ran at approximately 75% of rated capacity and the wind farms in the Manawatu ran at around 50%

- Improving power quality in rural areas

Prior to White Hill's commissioning in 2007, the local network experienced fluctuations in voltage as load varied throughout the day

Handling Uncertainty and Variability



Handling Uncertainty and Variability

- The aggregation of wind farms reduce the forecast error because of smoothing effects
- The power generating units:
  - Peak units : hydropower plants and open cycle gas turbines
  - Mid-merit units: biomass and combined cycle gas turbines (CCGT)
  - Base load units: geothermal, coal fired plants
- The reserves units
  - Primary or frequency response: stabilizing the system frequency after a disturbance
  - Regulation reserve: restoring the frequency and interarea power exchanges
  - Tertiary or replacement reserve: restoring secondary reserve levels

Barriers

- In 1998 the government passed a new law

- Run the distribution network only or

- Become a retailer and or/generator.

The wind generation development ceased in 1998 to 2006 affecting the whole development of wind generation

- Geothermal development growth

Considerable number of expertise and government subsides

- The government concerned that the ability of delivering sufficient generation

In 2004 New Zealand suffered an electricity shortage caused by drought so they commissioned Gas fired generation plant (400 MW) in 2007

NZ Wind Farms

Proposed wind farms

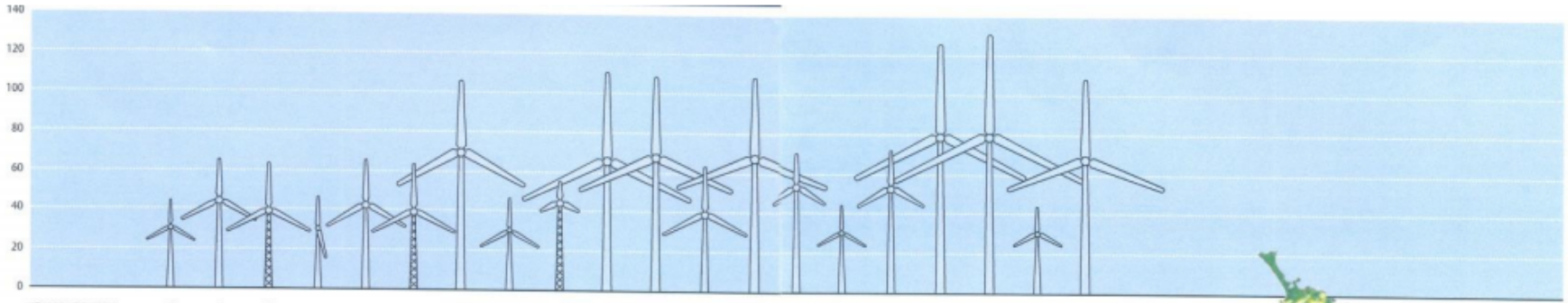
Site	Developer	Region	Status
Blueskin Bay	Local community project	Otago	Consent and environment court appeal declined
Pouto Forest	Meridian	Northland	Site under investigation
Ahipara Gumfields	Meridian	Northland	Site under investigation
Slopedown	Genesis Energy	Southland	Site under investigation
Cape Campbell	Mercury	Marlborough	Site under investigation
Mt Stalker	Waitaki Wind	Otago	Site under investigation

Consented wind farms

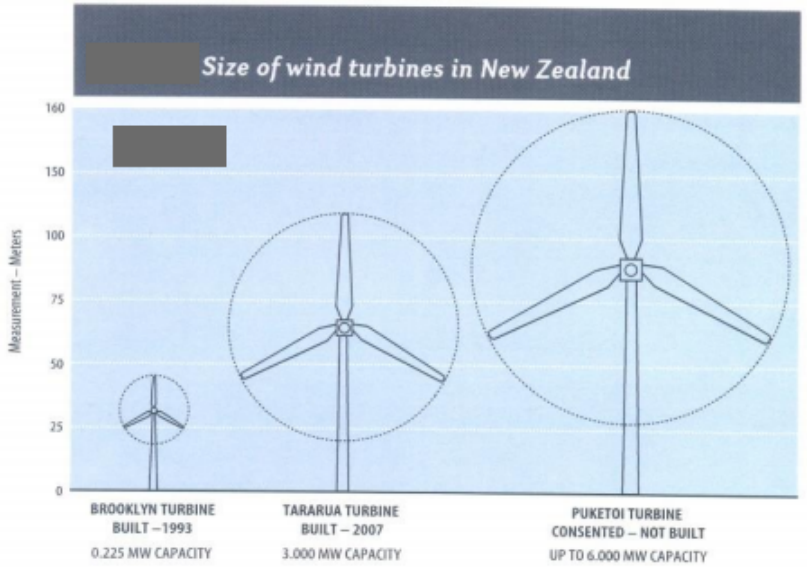
Site	Developer	Region	Capacity (MW)	RMA Application publicly notified
Waverley	Tilt Renewables	South Taranaki	130	July 2017
Castle Hill	Genesis Energy	Northern Wairarapa	800	August 2011
Mahinerangi (stage 2)	Tilt Renewables	Clutha	160	November 2009
Long Gully	Windflow	Wellington	upto 12.5	May 2009
Turitea	Mercury	Manawatu	upto 180	January 2009
Waitahora	Contact Energy	Southern Hawkes Bay	upto 156	September 2008
Central Wind	Meridian	Ruapehu & Rangatikei	upto 130	July 2008
Mt Cass	MainPower	Hurunui	upto 78	June 2008
Kaiwera Downs	Tilt Renewables	Gore	upto 240	November 2007
Taharoa	Taharoa C and PowerCoast	Kawhia	upto 54	December 2005
Hawkes Bay	Meridian	Hastings	upto 225	May 2005
Titiokura	Meridian	Hastings	upto 48	April 2005
Awhitu	Tilt Renewables	Franklin	upto 18	April 2004
Taumatatotara	Ventus	Waikato	upto 27	
Hurunui	Meridian Energy	Hurunui	upto 75.9	
Puketoi	Mercury	Tararua District	upto 318	

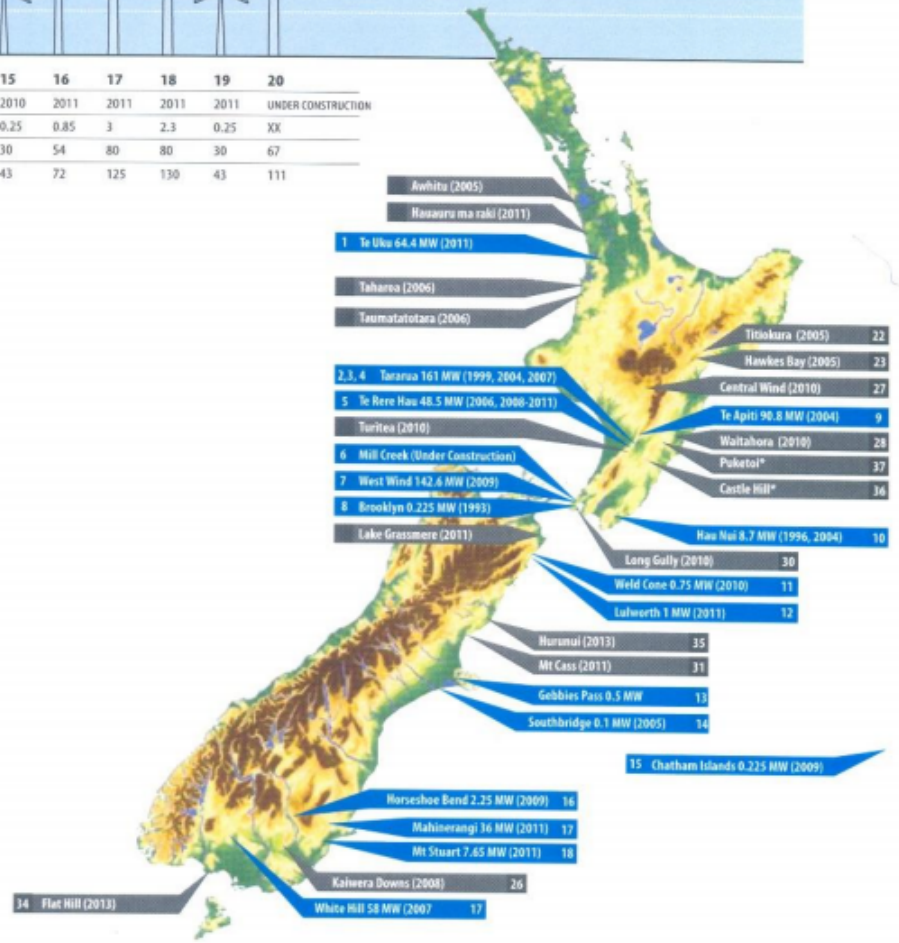
Operating & under construction

Wind Farm	Operator	Region	No. of Turbines	Capacity (MW)	Commission Date
Brooklyn	Meridian	Wellington	1	Turbine: 0.9 Farm: 0.9 Note: replaces original 0.25 MW turbine commissioned in 1993	2016
Flat Hill	Pioneer Energy	Bluff	8	Turbine: Farm: 6.8	2015
Mill Creek	Meridian	Wellington	26	Turbine: 2.3 Farm: 59.8	2014
Lake Grassmere	Energy3	Marlborough	1	Turbine: 0.66	2014
Lulworth	Energy3	Marlborough	4	Turbine: 0.25 Farm: 1.0	2011
Te Uku	Meridian	Waikato	28	Turbine: 2.3 Farm: 1.0	2011
Mahinerangi	TrustPower	Clutha	12	Turbine: 3.0 Farm: 36.0	2011
Mt Stuart	Pioneer Energy	Clutha	9	Turbine: 0.85 Farm: 7.65	2011
Weld Cone	Energy3	Marlborough	3	Turbine: 0.25 Farm: 0.75	2010
Chatham Islands	CBD Energy/ Chatham Islands Enterprise Trust	Chatham Islands	2	Turbine: 0.23 Farm: 0.46	2010
West Wind	Meridian	Wellington	62	Turbine: 2.3 Farm: 142.6	2009
Horseshoe Bend	Pioneer Energy	Central Otago	3	Turbine: 0.75 Farm: 2.25	2009
Tararua (Stage 3)	TrustPower	Manawatu	31	Turbine: 3.0 Farm: 93.0	2007
White Hill	Meridian	Southland	29	Turbine: 2.0 Farm: 58.0	2007
Te Rere Hau	NZ Windfarms	Manawatu	97	Turbine: 0.5 Farm: 48.5	2006, 2008-2011
Southbridge	Energy3	Canterbury	1	Turbine: 0.1 Farm: 0.1	2005
Hau Nui (Stage 2)	Genesis	Wairarapa	8	Turbine: 0.6 Farm: 4.8	2004
Tararua (Stage 2)	TrustPower	Manawatu	55	Turbine: 0.66 Farm: 36.3	2004
Te Apiti	Meridian	Manawatu	55	Turbine: 1.65 Farm: 90.8	2004
Gebbies Pass	Windflow	Canterbury	1	Turbine: 0.5 Farm: 0.5	2003
Tararua (Stage 1)	TrustPwer	Manawatu	48	Turbine: 0.66 Farm: 31.7	1999
Hau Nui (Stage 1)	Genesis	Wairarapa	7	Turbine: 0.55 Farm: 3.9	1996
Total			490		



NZ MAP LOCATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
YEAR OF INSTALLATION	1993	1996	1999	2003	2004	2004	2004	2005	2005	2007	2007	2009	2009	2010	2010	2011	2011	2011	2011	UNDER CONSTRUCTION
TURBINE CAPACITY (MW)	0.225	0.55	0.66	0.5	0.6	0.66	1.65	0.5	0.1	3	2	0.75	2.3	0.225	0.25	0.85	3	2.3	0.25	XX
TOWER HEIGHT (M)	31	46	40	30	43	40	70	30	45	65	67	40	67	55	30	54	80	80	30	67
TIP HEIGHT (M)	43.5	66	63.5	47	66	63.5	106	47	55	110	107	62	111	70	43	72	125	130	43	111





References

- http://www.windenergy.org.nz/wind-energy/nz-success
- http://www.windenergy.org.nz/wind-energy-case-studies
- http://www.windenergy.org.nz/store/doc/Farming_the_Wind_Case_Study.pdf
- http://www.windenergy.org.nz/store/doc/Improving_Electricity_Supply.pdf
- http://www.em6live.co.nz/PlanningRegion.aspx?planningregion=lni
- http://www.windenergy.org.nz/store/doc/Case-Study-on-the-Development-of-the-wind-industry-in-New-Zealand.pdf
- https://ac.els-cdn.com/S1364032111000700/1-s2.0-S1364032111000700-main.pdf?_tid=93471c15-1da5-43d2-86b1-1e72ae2444eb&acdnat=1524695118_7f70875046e7e165f2b00cf606728764


Mercury