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# History and Potential of Wind Power Development in New Zealand



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# New Zealand Renewable Energy Background

- One of the earliest adopters of alternative energy technologies
  - Geothermal and Hydroelectricity
- Currently achieved a level of 60% total electricity generation from renewable sources
  - $\frac{1}{3}$  of total consumption from renewables
  - Pursuing a target of 95% by the year 2025
- Principal energy source has been Hydroelectricity
  - Power Generation from Southern Island
  - Consumption growth on North Island
- Geothermal springs have powered generators since the 1950's
- Energy use has doubled every 22 years over the past century
  - Dwindling gas reserves has led to the pressure of removing carbon dioxide emissions, and power crises caused by fluctuating hydro lake levels



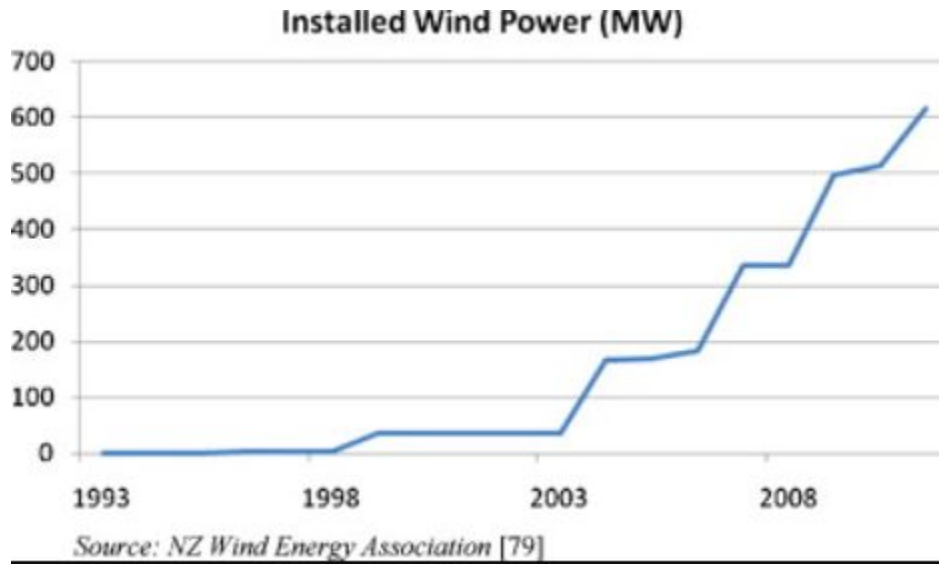
# Introduction to Wind Energy

- **How Wind Energy works**
  - **Flow of wind turns turbine blades, which are connected to generators that convert the energy into electricity**
  - **Increase in wind speed = increase in blade speed = increase in electricity generation**
  - **Electricity is generated between a specific range of high and low wind speeds, which shuts down when wind exceeds turbine's maximum level**
  - **Maximum output is determined by blade size**
- **Turbine size ranges from 1 kW to 7 MW (Europe Offshore)**
- **Largest capacity wind turbines in New Zealand are 3 MW (Tararua and Mahinerangi)**



# Background of Wind Energy in New Zealand

- Well endowed with wind potential by virtue of its location and topography
  - Region of strong westerly winds known as the “Roaring Forties”
  - Wind energy accessible through existence of central mountain ranges and long coastline with sea breezes
  - High country site winds tend to be more consistent than coastline winds
- Attracted attention in 1970’s, specifically 1974 with the establishment of the Wind Energy Task Force
  - Led to low international oil prices
  - Took 20 years to develop first commercial wind turbine (226 kW) in Wellington
    - Test site chosen due to strong winds
    - Operated continuously for 15 years before repair
  - Larger scale capacity commencing from 2003



- **The graph shown above displays the installed wind power capacity of New Zealand**
  - **As shown, capacity was expected to reach 615 MW by the year 2011 with the completion of a new plant**

# Current Wind Energy in New Zealand

- **19 fully operational wind farms**
  - **Combined installed capacity of 690 MW**
  - **Generate same amount of electricity as 300,000 kiwi homes use in a year**
- **Approximately 2,500 MW of wind generation consented in New Zealand**
  - **Developers consistently exploring new sites across the country**
  - **Not all consented wind generation will be constructed**



- **Green turbine-** represents wind farms under construction
- **Orange turbine -** represents consented/proposed that have not yet been built

# Current Wind Farms in New Zealand

Wind Farm	Operator	Region	No. of Turbines	Capacity (MW)	Commission Date
<b><u>Brooklyn</u></b>	Meridian	Wellington	1	Turbine: 0.9 Farm: 0.9 Note: replaces original 0.23 MW turbine commissioned in 1993	2016
<b><u>Flat Hill</u></b>	Pioneer Energy	Bluff	8	Turbine: Farm: 6.8	2015
<b><u>Mill Creek</u></b>	Meridian	Wellington	26	Turbine: 2.3 Farm: 59.8	2014
<b><u>Lake Grassmere</u></b>	Energy3	Marlborough	1	Turbine: 0.66	2014
<b><u>Lulworth</u></b>	Energy3	Marlborough	4	Turbine: 0.25 Farm: 1.0	2011
<b><u>Te Uku</u></b>	Meridian	Waikato	28	Turbine: 2.3 Farm: 64.4	2011

<b><u>Mahinerangi</u></b>	Tilt Renewables	Clutha	12	Turbine: 3.0 Farm: 36.0	2011
<b><u>Mt Stuart</u></b>	Pioneer Energy	Clutha	9	Turbine: 0.85 Farm: 7.65	2011
<b><u>Weld Cone</u></b>	Energy3	Marlborough	3	Turbine: 0.25 Farm: 0.75	2010
<b><u>Chatham Islands</u></b>	CBD Energy/ Chatham Islands Enterprise Trust	Chatham Islands	2	Turbine: 0.23 Farm: 0.46	2010
<b><u>West Wind</u></b>	Meridian	Wellington	62	Turbine: 2.3 Farm: 142.6	2009
<b><u>Horseshoe Bend</u></b>	Pioneer Energy	Central Otago	3	Turbine: 0.75 Farm: 2.25	2009
<b><u>Tararua (Stage 3)</u></b>	Tilt Renewables	Manawatu	31	Turbine: 3.0 Farm: 93.0	2007
<b><u>White Hill</u></b>	Meridian	Southland	29	Turbine: 2.0 Farm: 58.0	2007

## Current Wind Farms in New Zealand

<b><u>Te Rere Hau</u></b>	NZ Windfarms	Manawatu	97	Turbine: 0.5 Farm: 48.5	2006, 2008-2011
<b><u>Southbridge</u></b>	Energy3	Canterbury	1	Turbine: 0.1 Farm: 0.1	2005
<b><u>Hau Nui</u></b> (Stage 2)	Genesis	Wairarapa	8	Turbine: 0.6 Farm: 4.8	2004
<b><u>Tararua</u></b> (Stage 2)	Tilt Renewables	Manawatu	55	Turbine: 0.66 Farm: 36.3	2004
<b><u>Te Apiti</u></b>	Meridian	Manawatu	55	Turbine: 1.65 Farm: 90.8	2004
<b><u>Tararua</u></b> (Stage 1)	Tilt Renewables	Manawatu	48	Turbine: 0.66 Farm: 31.7	1999
<b><u>Hau Nui</u></b> (Stage 1)	Genesis	Wairarapa	7	Turbine: 0.55 Farm: 3.9	1996
<b>Total all wind farms</b>			<b>490</b>	<b>690</b>	



# Pros and Cons of Wind Energy Implementation

- **Pros**

- Windswept landscape creates one of the best wind resources in the world
- No production of greenhouse gas emissions
  - Generate Electricity
  - Easy to move
- Fast-to-build infrastructure
- No effect on health
- Popular amongst New Zealanders, in which  $\frac{3}{4}$  support wind farms
- Long term stability
  - More stable than hydroelectric generation, which is less stable during dry periods
- Wind farms make New Zealand less vulnerable to power shortages
- Power companies benefit from carbon credits granted for the reduction of carbon dioxide emissions

- **Cons**

- Objection of local community
  - Noise
  - Visual appearance of the wind farm on prominent ridgelines
    - Stricter building codes for farms and noise standards have made wind-powered generation quieter

# Future Development and Potential of Wind Energy

- Large potential for wind to generate greater than the current 5% produced now
- As the construction of wind farms is low and there exists a close fit between wind and hydro generation, more wind farms are likely to be built with increasing energy demand
- Small Wind Turbines are essential as a part of a stand-alone power system
  - There do exist some potential issues
    - Vibration Problems
    - Getting consent for masts in built-up areas
    - Wind shielding from neighboring properties
    - Difference in value of imported and exported electricity
      - Unlikely to be used in urban settings

# Final Thoughts

- As shown, the pros outweigh the cons with the implementation of wind energy systems in New Zealand
- With the increase of developing wind technologies and lowered prices, the future of wind energy development in New Zealand is bright
  - There exist a large amount of developing wind projects currently being consented throughout the country, which will be implemented in the future



# References

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