WIND – NEW ZEALAND'S ENERGY

new zealand wind energy association

Wind Energy in NZ

Presentation to The Energy Economics Summer School

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Contents

About NZWEA

- Established 1997
- An industry association
  - Promotes the development of wind as a reliable, sustainable, clean and commercially viable energy source
  - Policy & regulatory advocacy, public awareness and industry development
  - Represents around 40 companies:
    - Generators and developers
    - Turbine manufacturers, equipment suppliers, consultants
- Utility scale generation

Wind Energy, An Historical Perspective

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- Internationally
  - 500 to 900 A.D - used for pumping water
  - 1890's - pumping water and electricity
  - 1980's - first large scale wind farms
  - 1991 - first off shore wind farm
  - 2002 - first 3MW wind turbine
- New Zealand
  - 1970's - research commenced
  - 1980's - recognition of commercial opportunities
  - 1990's - first turbines and commercial deployment
  - 2004 - first grid connected wind farm

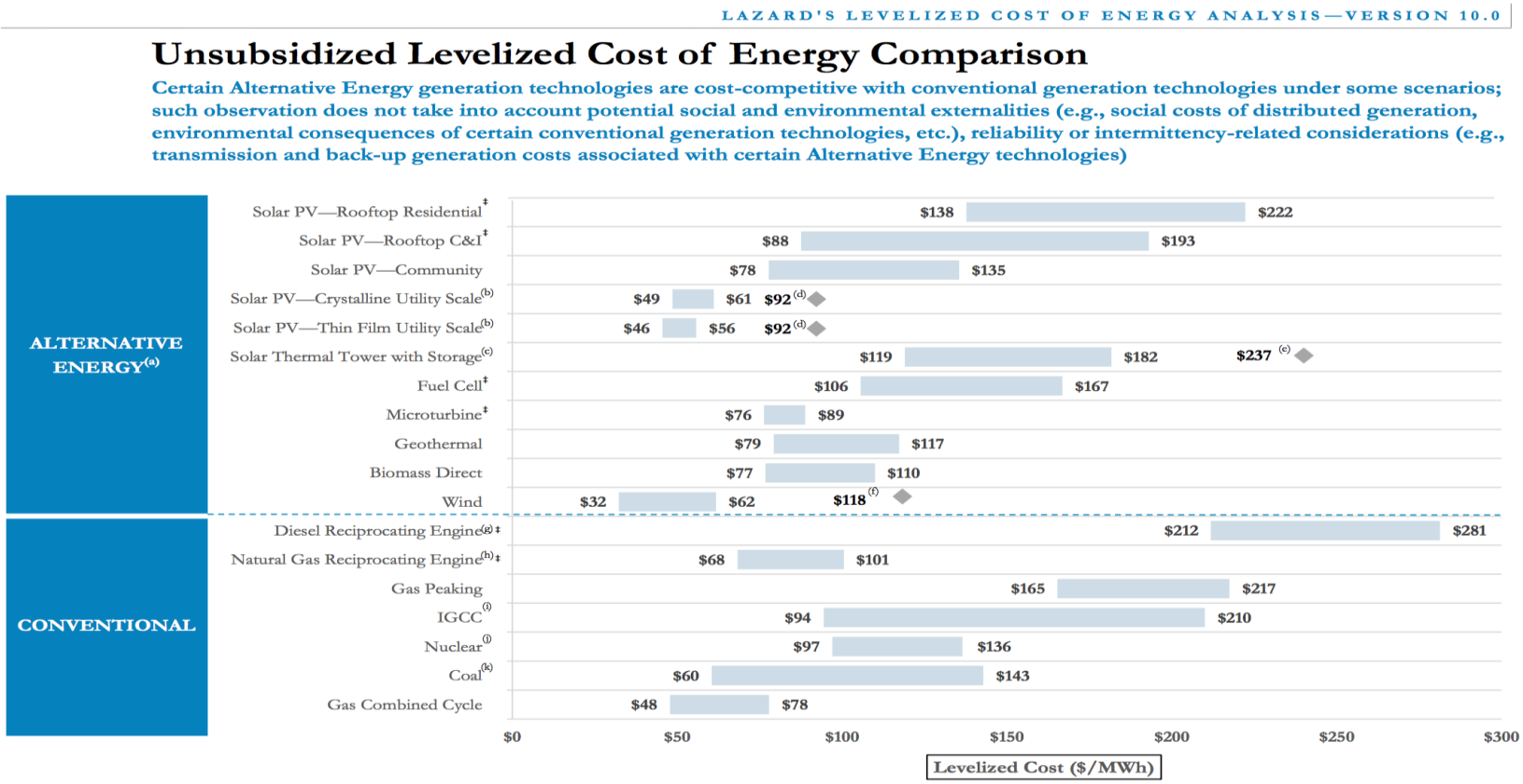
Why Wind?

- Renewable - produces no greenhouse gases

	Tonnes C02-e per GWh
Coal	630
Gas	455
Geothermal	115

- Low investigation costs
- Cheapest form of new generation and scalable
- Consistent resource
  - Variable but seasonally reliable
  - Spatial diversity smooths output
- Synergies with hydro generation and NZ demand
- Strong public support

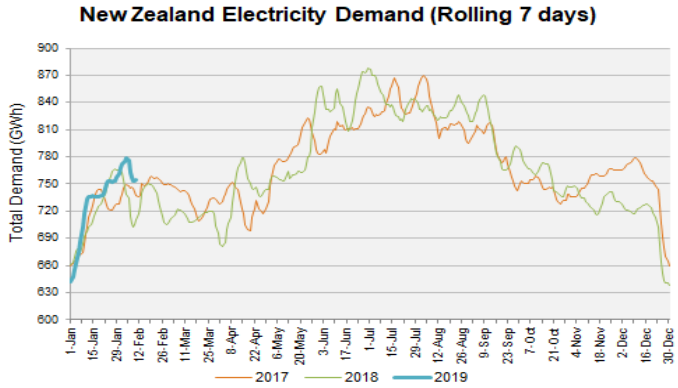
The Cost advantage of Wind



- Next NZ wind farm $60+ MWh
- Benefits from economies of scale and innovation

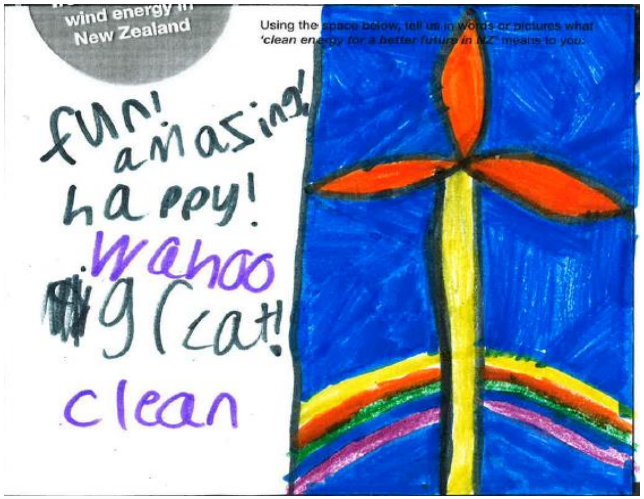
Wind Right for NZ Market

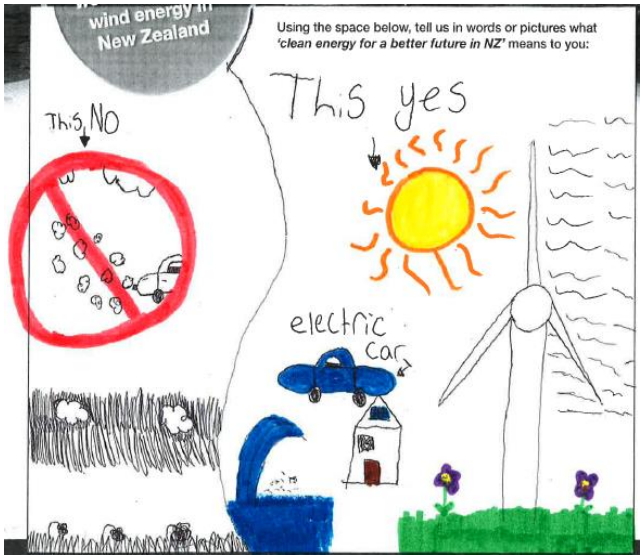
- All renewables positive but…
- Morning and evening demand peaks
- Plus higher winter demand profile
- Scale and spatial diversity key to managing wind's variability



- Transpower on wind "a low cost source with stronger alignment with winter peaks"
- On solar " produces the least energy when NZ needs it most such as during cold, dark winter months"

Mostly, We Like Wind but…





- 76% of support for wind (EECA survey 2011)
- Increasing number of community wind initiatives
- Visual impacts and noise the main issues
- Challenge is for developers and operators to be good neighbours

Electricity Generation in NZ

Four Key Stages:

1900 - 80s: Hydro

1970s - 2000s: Thermal

1990s - 2020: Geothermal

2000s - 2030+ is Wind

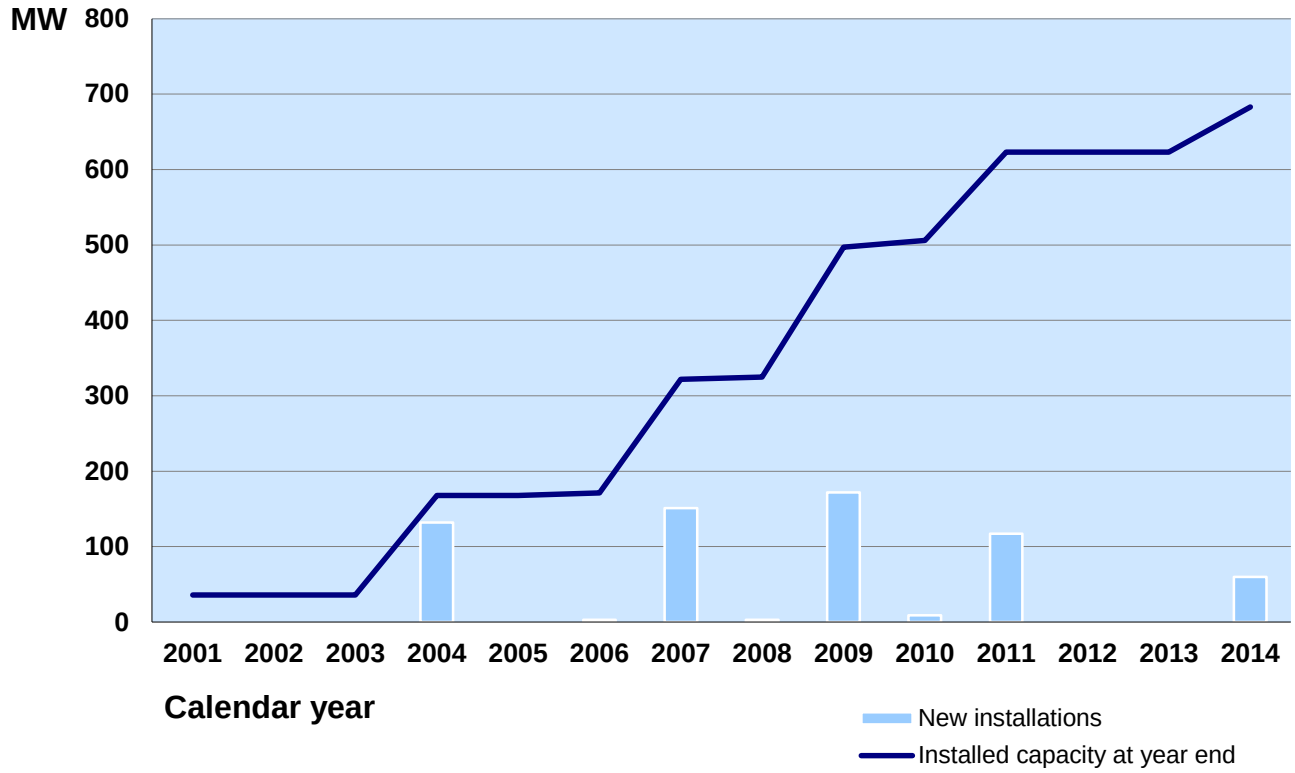
Trends in NZ

- Historic generation trends now in decline
  - 40% of gas produced in NZ
  - 50% of coal used for electricity generation
- NZ baseload – geothermal & combined cycle gas plants
- Renewables are increasing
  - 72% in 2000
  - 83% in 2017
  - potentially 90%+ 2035
- Thermal plant closures in 2015
  - Otahuhu 400MW
  - Southdown 130MW
- Future of TCC and Huntly?

NZ - Wind Generation Today

- 19 wind farms
- 690 MW generating capacity
- Around 6% of NZ's annual generation
- 2500MW consented
- Consent challenges with new technology
- Unlikely all will be built

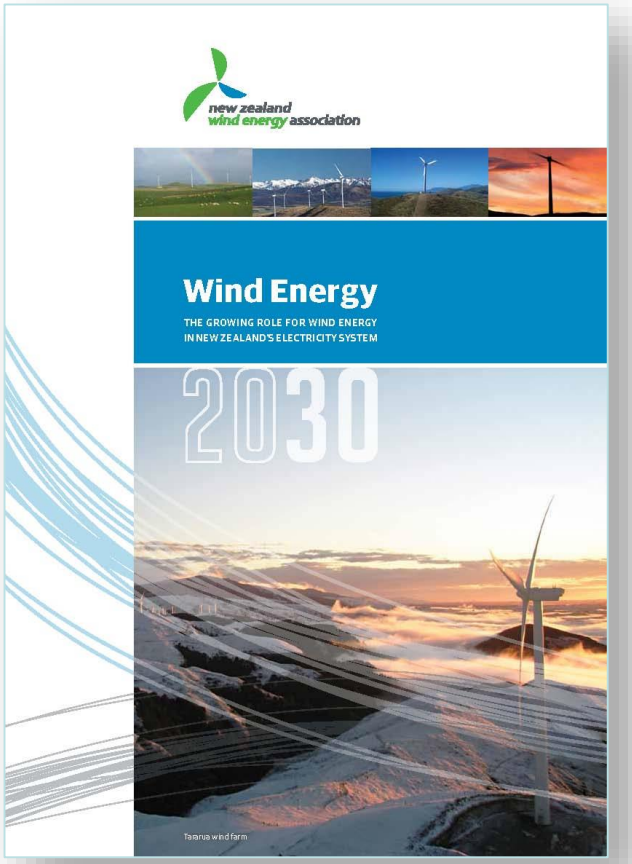
Wind Growth



- No major new development since 2014
- Market now talking about needing new capacity

Vision: Wind Energy 20% by 2035

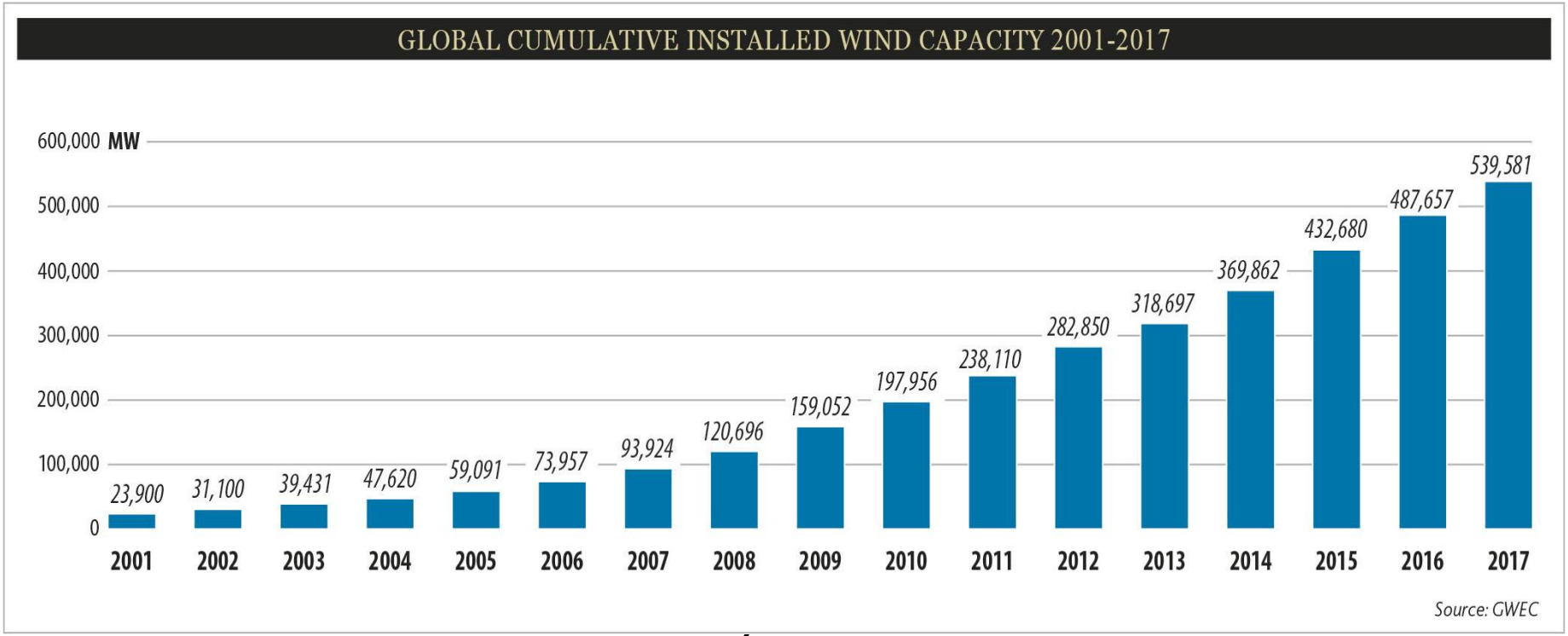
- **690MW now to 3100MW in 2035**
  - Requires 150MW / $300m investment p.a
- **20% wind energy**
  - NZ has excellent sites
  - Fits with the existing electricity system
  - Will deliver economic benefits
  - Wind can replace the majority of NZ's gas – fired baseload generation



International Trends

- The energy transition is gathering momentum
  - 53GW new capacity in 2017
  - Global capacity 540,000 MW
- Key growth markets - China, US and Germany
- Wind 17% of EU's generation capacity
  - 51% new EU generation was wind power
- Coal use in the US is the lowest since 1983
- Wind energy on track to supply 20% of US electricity by 2030
- Australia has 1,500 MW of new wind build
- The corporate imperative – renewable ppa's

Spectacular Global Growth

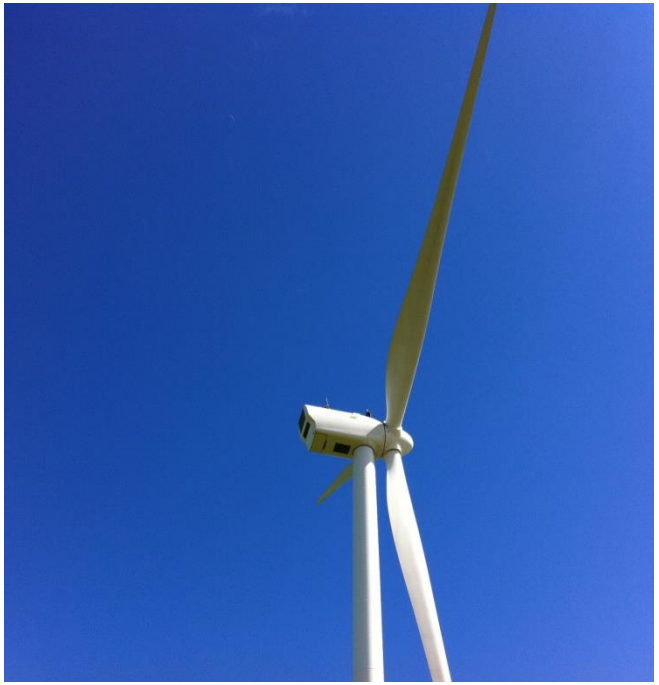


- 540GW = 60X NZ's total installed generation
- Forecast 790 - 880 GW by 2020
- 1,700 - 2,100 GW by 2030

A long way in a short time…

- 13 fold increase in capacity in 14 years
- 4 to 6 fold reduction in costs
- Ongoing innovation in blades and software

1993: 0.225MW
$13m/MW



2007: 3MW
$2m/MW

Improving performance

	3.0 MW	3.3 MW	3.45 MW	3.45/4.2 MW
Wind	• First Vestas 3 MW WTG	• Upgrade to 3.3 MW nominal rating • New rotors: 105m, 117m, 126m	• Upgrade to 3.45 MW nominal rating • New rotor: 136 m • Up to 3.6 MW Power Optimised Mode	• New rotor: 150 m • New segment: IEC T-class • Up to 4.2 MW Power Optimised Mode • Platform naming: 4MW
Tropical/strong wind				**V117-4.2 MW™**
High Wind	**V90-3.0 MW™**	**V105-3.3 MW™**	V105-**3.45 MW™**	V105-3.45 MW™
		V112-**3.3 MW™**	V112-**3.45 MW™**	V112-3.45 MW™
Medium Wind	**V112-3.0 MW™**	**V117-3.3 MW™**	V117-**3.45 MW™**	V117-3.45 MW™
		V126-3.3 MW™	V126-**3.45 MW™**	V126-3.45 MW™
Low wind			**V136-3.45 MW™**	V136-3.45 MW™ **V136-4.2 MW™** **V150-4.2 MW™**
Year of Announcement	**2010**	**2012/13**	**2015**	**2017**

NEW in 2017 4.2MW & 150 Rotor

Double digit AEP gains across wind classes

Up to **56%** AEP increase since 2010*

Environmental Impacts

- RMA key to the sustainable management natural and physical resources
- Construction Phase
  - Earthworks
  - Visual
  - Noise
  - Ecology
  - Transportation / traffic effects
- Operation Maintenance Effects
  - Visual and Landscape
  - Noise
  - Ecology
  - Productive land

Operational Challenges

- Health and safety
- Wind speed
- Maintenance windows
- Market and rules
- Landowner and stakeholder management
- Ensuring compliance with consents
- Changing regulatory environment impacting investment decisions
  - Transmission / distribution pricing

Addressing Climate Change

- Gross emissions in 2015 were 80 Mt C02-e
  - Increase of 24% since 1990
  - Energy sector 33 Mt (41%)
- Energy Sector
  - Transport 14 Mt
  - Manufacturing 5 Mt
  - Electricity generation 5 Mt (11%)
- Net emissions increased 64% since 1990
- Target 30% below 2005 by 2030 = savings of 20+ Mt p.a
- Cost without mitigations at $50/t = $1B+ p.a
- Zero Carbon Bill - Net zero by 2050 ?

The Opportunity

- Options are to buy or domestic mitigation
  - Mitigation = reduce emissions or LULUCF
  - Improving energy efficiency a given
- NZ's electricity generation opportunity
  - Already 83% renewable
  - Our hydro, wind and geothermal resources are unique
  - Significant capacity to increase renewable generation
- Leverage our renewable opportunities to:
  - Replace thermal fuels used in electricity generation
  - Electrify the light vehicle passenger
  - Replace thermal fuels used to provide industrial heat
- Focus and investment required

Domestic Wind

- Several types
  - horizontal – as per most windfarms
  - Vertical
  - Generally 5 kW or smaller
- Cost around $10k + per kW
- Difficult in urban areas
  - Wind turbulent, weak and erratic
- Require speed of 4.5m/second
- Tower mounting improves performance
- Best for rural areas with consistent wind speed
- Community wind has possibilities

A Way Forward

- Wind a key technology to decarbonise the NZ economy
- Big wind with spatial planning to improve variability
- Community and industrial solutions
  - Integrated with other technologies – solar and batteries
  - Promotes regional growth and support for wind
  - Utilises NZ's abundant resource
- Requires a change to planning instruments
  - Recognising the national importance of renewable
  - More directive standards
  - Differentiation for scale and impacts

Wind is Now…

From a science experiment 25 years ago wind offers an amazing opportunity