

Hopkins Lecture 2008:

## Wind Power – one of many ways to a carbon-neutral future



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CEO/Director - Windflow Technology Ltd



## Outline



- Windflow Technology
- The Problem of Climate Change
- Use Economics
- The Solution
- Why Wind Power?



## Windflow Technology

- NZAX listed New Zealand company
- design, development & manufacture of utility size wind turbines
- based on experience since 1984 in California and UK

### MISSION:

to be a global leader in wind turbine technology innovation



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## Windflow Technology Ltd

- 2001
  - Windflow Technology IPO
- 2003
  - Built prototype at Gebbies Pass
  - CCC purchase electricity
- 2004
  - Prototype testing. Resolved issues with noise



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## Windflow Technology Ltd

- 2005

- Retrofitted with improved production model
- Resource consent to build 48.5 MW wind farm
- Floated NZ Windfarms Ltd

- 2006

- Manufactured and installed five turbines at Te Rere Hau
- NP Power and B&B join NZWL in TRH-JV



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## Windflow Technology Ltd

- 2007

- Set up new nacelle assembly facilities in Riccarton
- Wind Blades Ltd becomes wholly owned subsidiary
- Staff of approx 30



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## Windflow Technology Ltd

- 2008
  - Production of 5 turbines a month
  - Joint Venture formed (Wind Gears Ltd)
  - Mighty River Power opts to be second customer and 20% cornerstone
  - Staff of approx 50



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## Smaller and Smarter Windflow 500



- Provides electricity for approx 200 households
- Patented Torque Limiting Gearbox
- 2 bladed teetering rotor
- 500 kW synchronous generator

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## Designed For New Zealand:



- Lower cost over life of wind farm
- Reliable in high wind conditions
- Easy to transport and install
- Over 90% NZ content

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### NZ Made vs Imported Turbines

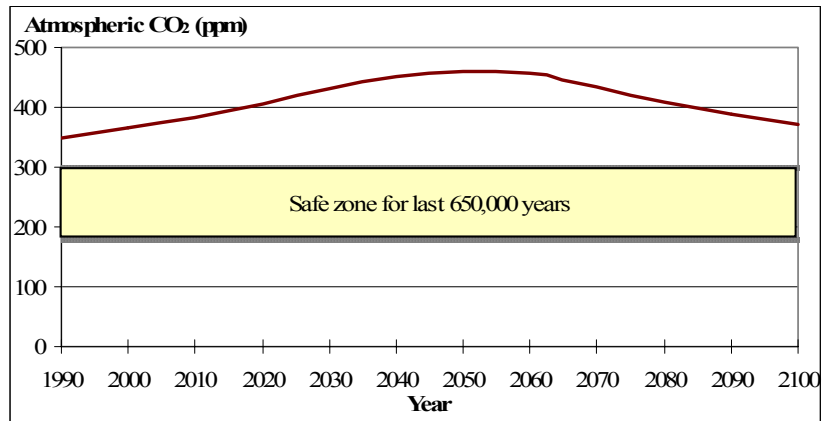
Comparative investment in New Zealand Economy

Based on a \$100 million Wind Farm Development



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## The Problem: Controlling Atmospheric CO<sub>2</sub> concentration



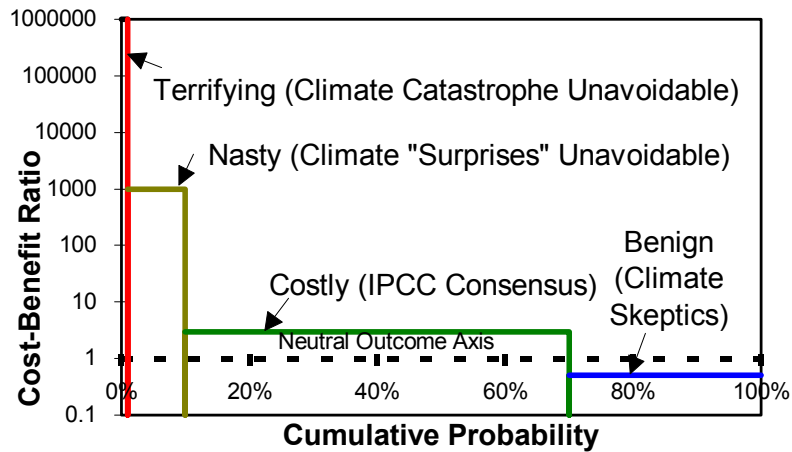
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## Inconvenient Truth – the Problem

The clip from Al Gore's Inconvenient Truth has been taken out from the original presentation in order to comply with copy rights.

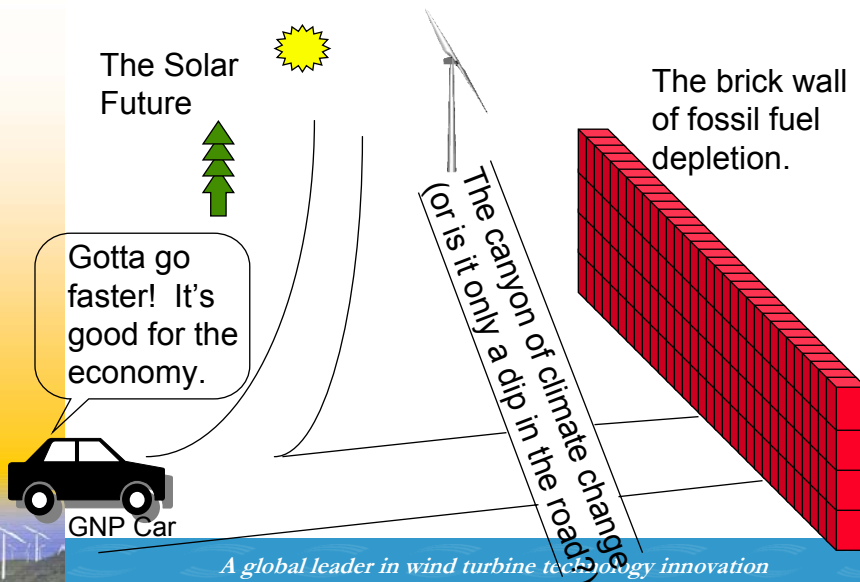
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# Atmospheric Carbon Dioxide 600 ppm by 2100: Possible Outcomes



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## How about a change of direction?



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## Basic Principle: It all comes down to Economics

- Al Gore pointed out fallacy of choice between economy and environment
- not dichotomy: environmentalism is simply long-term economics
- World's problems are about balance of resources and population (cf fruit flies)
- Economics = 'Resource Management'

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## Economic Efficiency should be a Common Goal

- Engineers, economists and environmentalists have as a common goal the maximisation of per-capita well-being for minimum cost
- The problem is that they all have different definitions of 'well-being' and 'cost'
- Can we converge on agreed costs and values?

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## Cost and Value

- To say that  
     “economists know the cost of everything and  
     the value of nothing”  
     **or**  
     “environmentalists know the value of everything  
     and the cost of nothing”  
     is to miss the point
- Both need to be weighed up when physical  
   resource decisions are made
- Money is just a unit for making comparisons,  
   ie doing the weighing

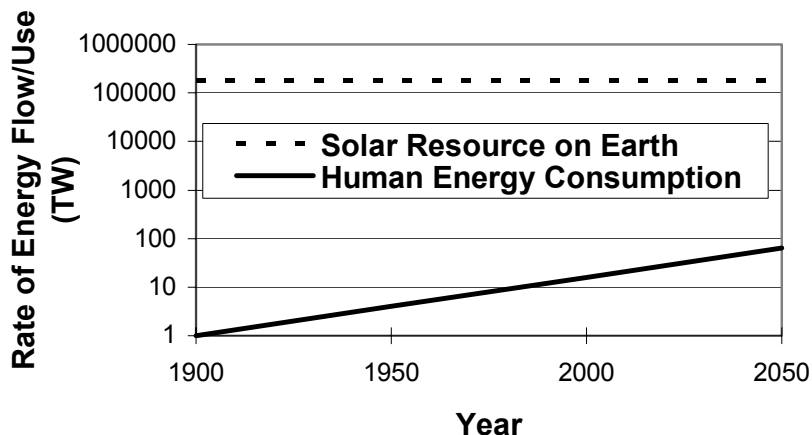
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## Engineers are resource managers

- *“A good engineer is someone who can do for  
   a dollar what any damn fool can do for two”*
- Climate change = economic problem →  
   economic solution
- Renewable energy suppliers = honest  
   beekeepers
- Stolen honey will always be cheaper
- Problem not lack of technical solutions

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## Abundant Solar Energy 10,000 x Human Use



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## The Technical Solutions

- 4 main forms on supply-side:
  - Wind power
  - Direct solar (heat, drying, solar thermal, PV)
  - Hydro power
  - Biofuels (wood, litter, alcohols, oils, methane)
- A million clever technologies on demand-side (energy services):
  - Plug-in hybrids + smart metering
  - CF lamps, bikes, buses, maglevs, sail-assistance

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## The Solution

- The polluter must pay to absorb greenhouse gases
- This will push everything in the right direction
- Simple, but not politically easy
- 250 years of energy infrastructure will gradually de-fossilise as a result

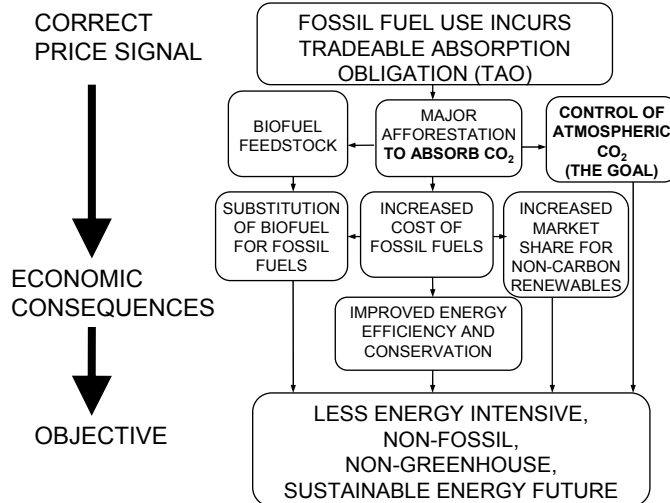
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## Tradeable Absorption Obligation (TAO)

- Equivalent to ETS with absorption credits
- Minimum economic instrument:
  - least-cost and durable, necessary if not sufficient
  - market stimulation should be considered **as well**, especially for start-up and while FCCC targets not “zero net”
- Directly addresses:
  - the problem of CO<sub>2</sub> accumulation
  - the economic source

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# The TAO pushes everything in the right direction



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## Land Use Implications

Large area required for absorption/biofuel feedstock, but:

- economically self-limiting
- increasing only during fossil-fuel transition
- steady when defossilized
- output at least 5 kW/ha
- present energy use 1 kW/ha ( = 2.2 kW/p x 0.47 p/ha)
- i.e. present energy use would require 20% of land
- logically necessary if we want to:
  - continue burning carbon-based fuels, and
  - control atmospheric concentrations of CO<sub>2</sub>

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## Land availability won't be a limit

Other renewable resources much more land-efficient:

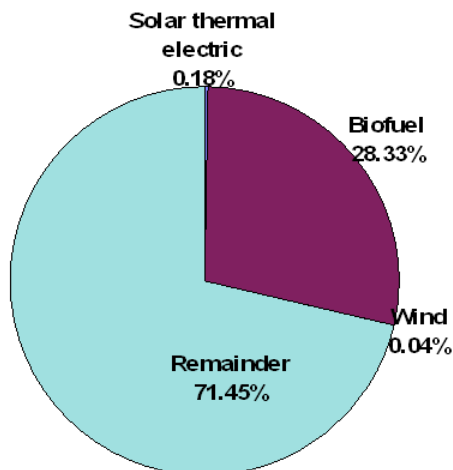
- wind power 1000-2000 kW/ha
- solar thermal 500 kW/ha
- hydro 50-100 kW/ha
- rooftop PV and solar hot water no land (infinite kW/ha)

Above figures based on net land unavailable for other productive use

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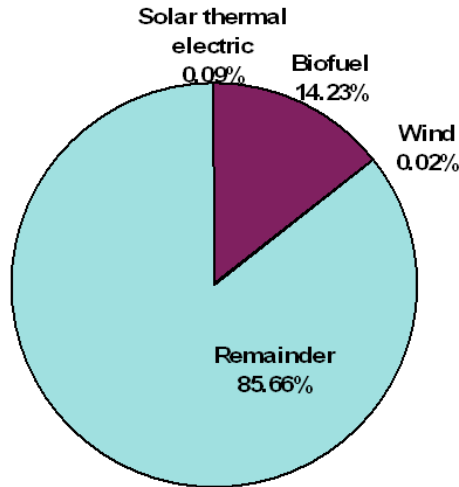
## The Big Three Renewables: Global Land Requirements

\* Excluding Antarctica



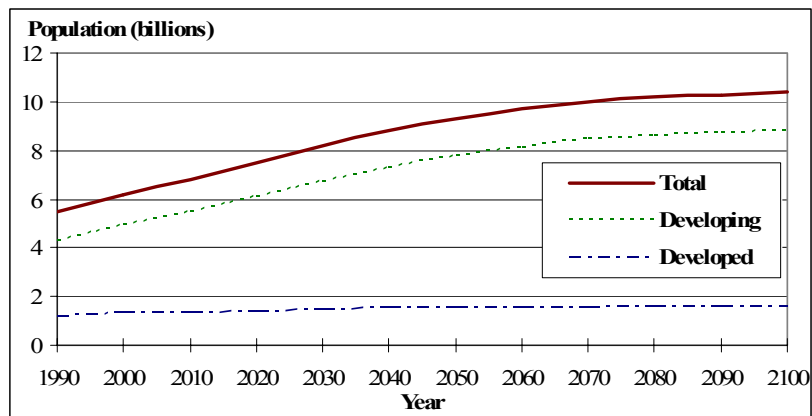
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## The Big Three Renewables: NZ Land Requirements



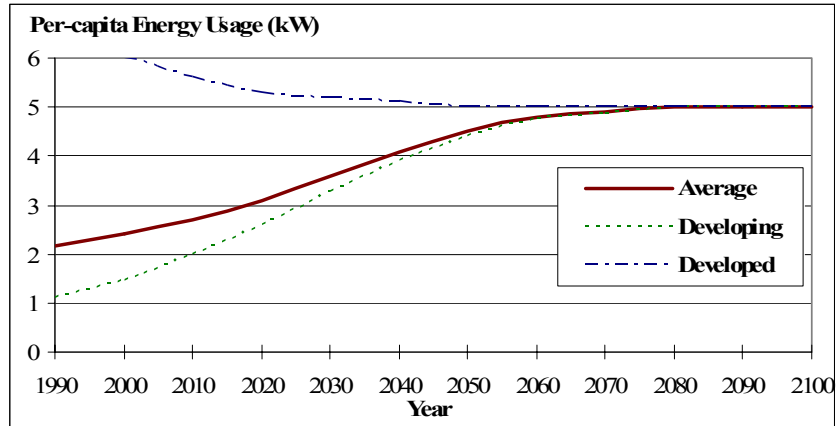
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## Population in the developing and developed world



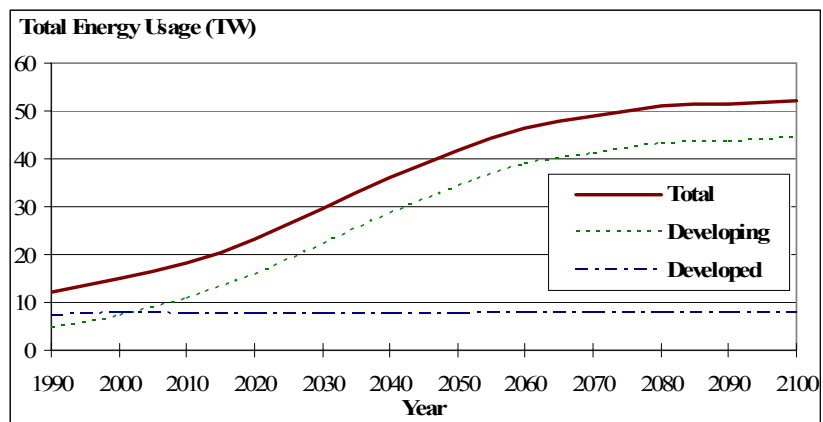
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## Energy per capita will contract, converge and plateau



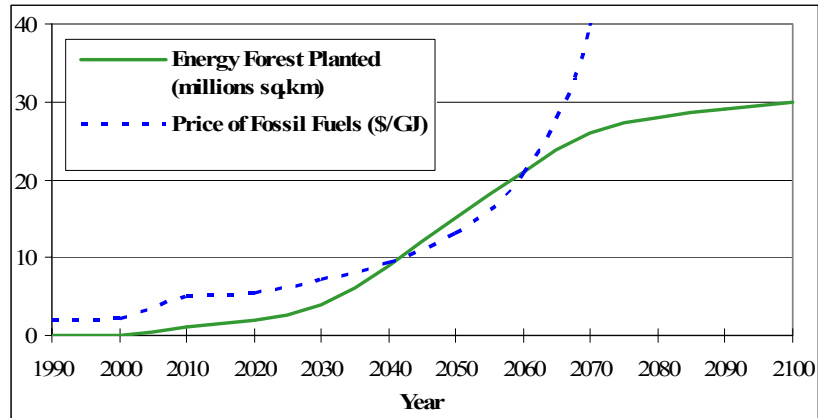
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## Total energy demand in the developed and developing world



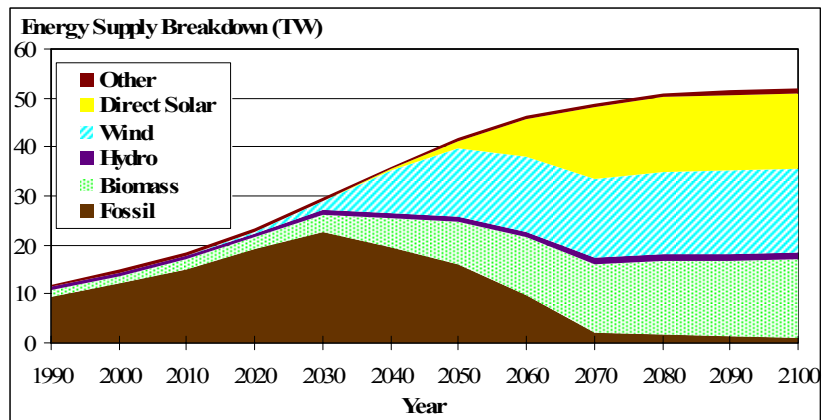
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## New afforestation and the price of fossil fuels



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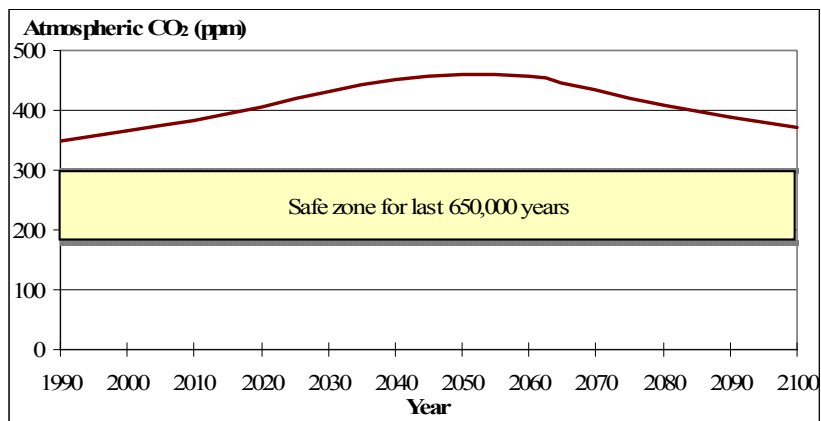
## Changing patterns of energy supply



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## Atmospheric CO<sub>2</sub> concentration



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## Summary of the Solution

- Polluter-pays to absorb (TAO) will:
  - avoid or minimise costs of climate change
  - achieve transition to sustainable energy future
- Everything is pushed in right direction and market forces will determine final mix
- NZ's ETS is on the right track

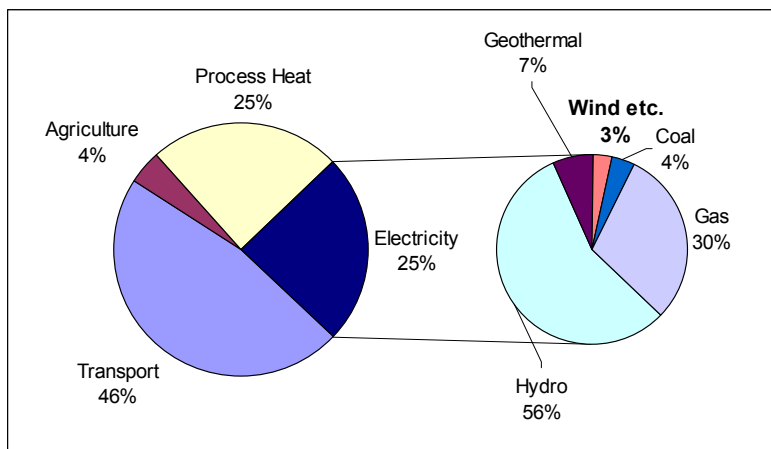
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## What role for Wind Power?

- Highest land-efficiency (other than roof-top solar) is fundamental
- Fastest growing form of power worldwide
- NZ is windiest country in the world
- Hydro and wind complement each other

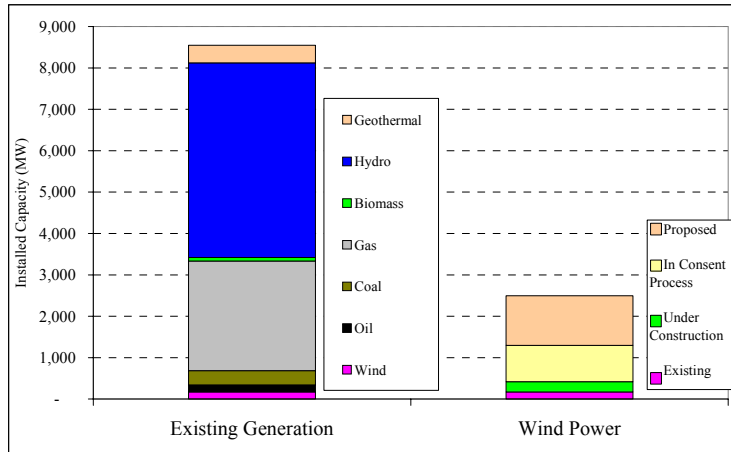
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## The Future of Wind Power in NZ: Current NZ energy mix



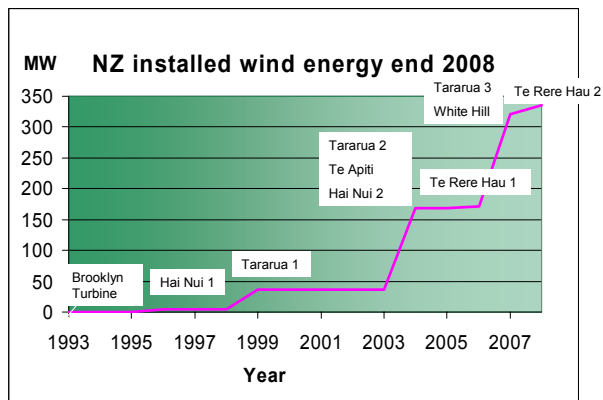
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# Growth Industry



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# NZ Wind Energy Growth



- Currently 322 MW installed in New Zealand
- Additional 2000 MW in consent process

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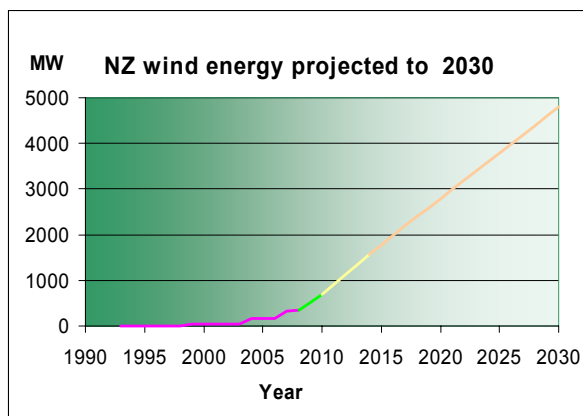
## Wind Farm Locations



- Generator/retailers
- Wind farm developers
- Lines companies
- Councils
- Others

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## Future NZ Wind Energy Growth



Approximately 200 MW estimated to be installed a year  
(100% of demand growth in most years)

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## Electricity Security

Don't believe propaganda – reality is:

- wind speeds predictable day-ahead
- wind farms provide smooth output
- wind enhances dry-year security
  - more reliable on a monthly or annual basis
  - “firm capacity” argument irrelevant in dry year
  - storage options will include plug-in EV's/hybrids
- hydro provides short-term storage
- extra hydro capacity a cheap option 10 years hence

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## Cost of Electricity

Don't believe the propaganda – the reality is:

- no shortage of windy hills in NZ
- large 3-bladed turbines are fundamentally more expensive
  - if Newton's Laws and square-cube law said otherwise, Windflow would build large 3-bladers

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## Economic - smaller and smarter turbines

- Windflow 500 smarter than other turbines
  - Lower weight/kW = lower cost overall/kWh
- Larger projects/large turbines can be more expensive
  - Logistics, cranes, road/bridge upgrades, etc
- Multi-megawatt turbines well-suited for wind farms in the seas around Europe

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## Transport and Installation

	500 kW	2 MW
<b>Transport</b>	Standard trucks (5/MW)	Oversize truck/trailers, (>5/MW) + pilot vehicles
<b>Closures</b>	None	Possible
<b>Earthworks</b>	1 unit/MW	2 units/MW
<b>Roads</b>	5 m wide	10 m wide
<b>Craneage</b>	Common 80 tonne crane	400 tonne crane

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## Wind power: are there any negatives?

Visual impact is subjective:

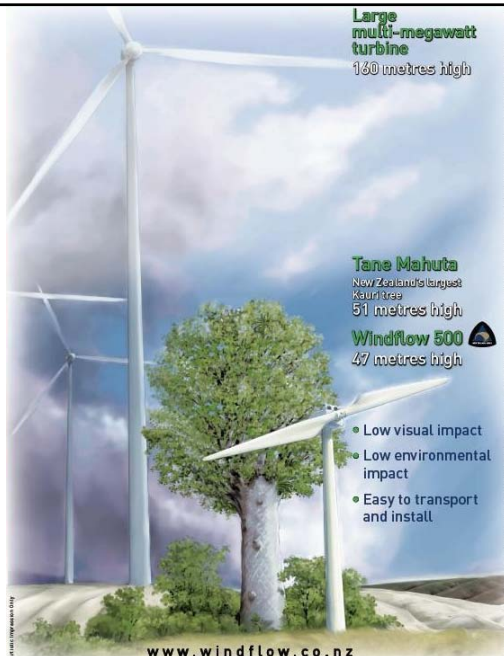
*“There are few merrier spectacles than that of many windmills bickering together in a breeze over a woody country, their halting alacrity of movement, their pleasant business of making bread all day with uncouth gesticulations, their air gigantically human, as of a creature half alive, put a spirit of romance into the tame landscape.”*

Robert Louis Stevenson

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## Within Nature's Frame



**Large multi-megawatt turbine**  
130 metres high

**Tane Mahuta**  
New Zealand's largest Kauri tree  
51 metres high

**Windflow 500**  
47 metres high

- Low visual impact
- Low environmental impact
- Easy to transport and install

[www.windflow.co.nz](http://www.windflow.co.nz)

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## Visual Impact to Scale



The R33 wind farm option showing 83 turbines measuring 47m at the highest tip point and 33m rotor diameter. Photo taken from near Reeves Road corner, Omihi (5km from site) at 8.05am on 16 April 2007.



The R90 wind farm option showing 26 turbines measuring 125m at the highest tip point and 90m rotor diameter. Photo taken from near Reeves Road corner, Omihi (5km from site) at 8.05am on 16 April 2007.

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## Conclusions

- Climate change must be addressed
- Emissions trading with absorption credits will push everything in the right direction
- Wind power has a BIG future in New Zealand but ...
- BIGGER is not necessarily better
- Most years wind power will be 100% of new generation
- Good option for NZ ....
- especially when done the Windflow way.

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# Questions

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