PENNSTATE

1855

NEW ZEALAND WIND

Haoming (Steven) Ma

The Pennsylvania State University

CONTENT

- New Zealand Energy Overview
- Wind Energy History
- Turbine
- Te Uku Wind Farm
- The Future

PART I

- **New Zealand Energy Overview**
- Wind Energy History
- Turbine
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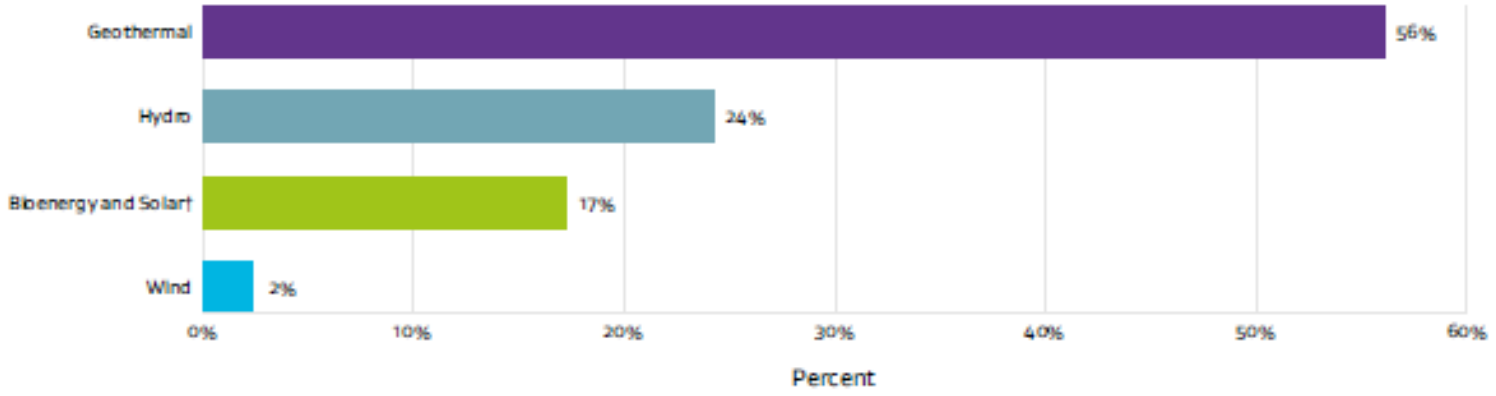
NEW ZEALAND ENERGY OVERVIEW

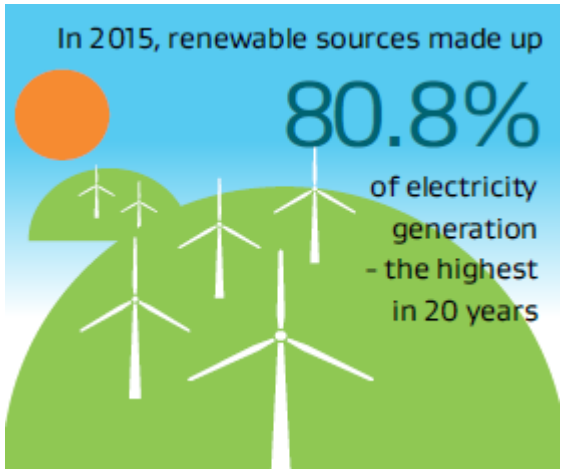
- In 2015
- Total Primary Energy Supply (TPES): 907 PJ = 0.86 QBTU = 0.8% USA Energy Consumption(97.42 QBTU)
- 81% Self-sufficiency
- Energy From: Oil 32%; Gas 21% Geothermal 22%
- Renewable contribute to 40.1%



NEW ZEALAND ENERGY OVERVIEW ELECTRICITY

- Total Generation: 42876 GWh = 1.05% USA Electricity Generation (4078000 GWh)
- Renewable : 80.8%
- Hydro: 56.7%
- Geothermal: 17.3%
- Wind: 5.4%
- Solar & Bioenergy: 1.4%

NEW ZEALAND ENERGY OVERVIEW ELECTRICITY



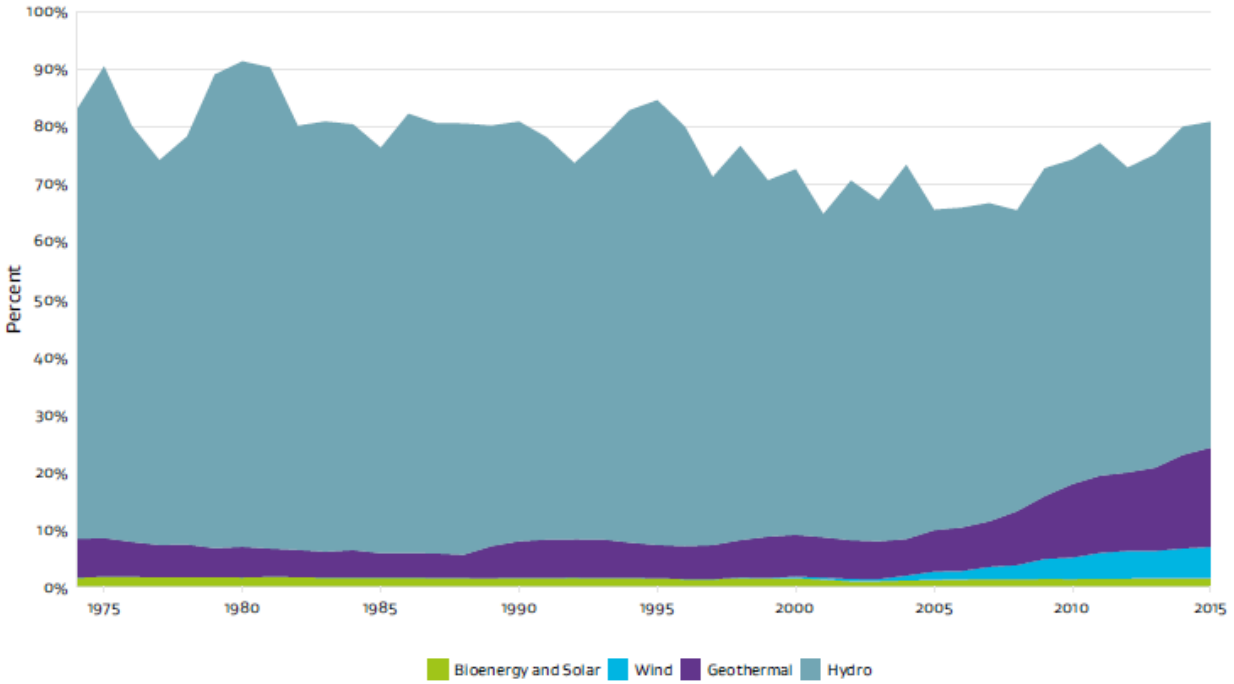
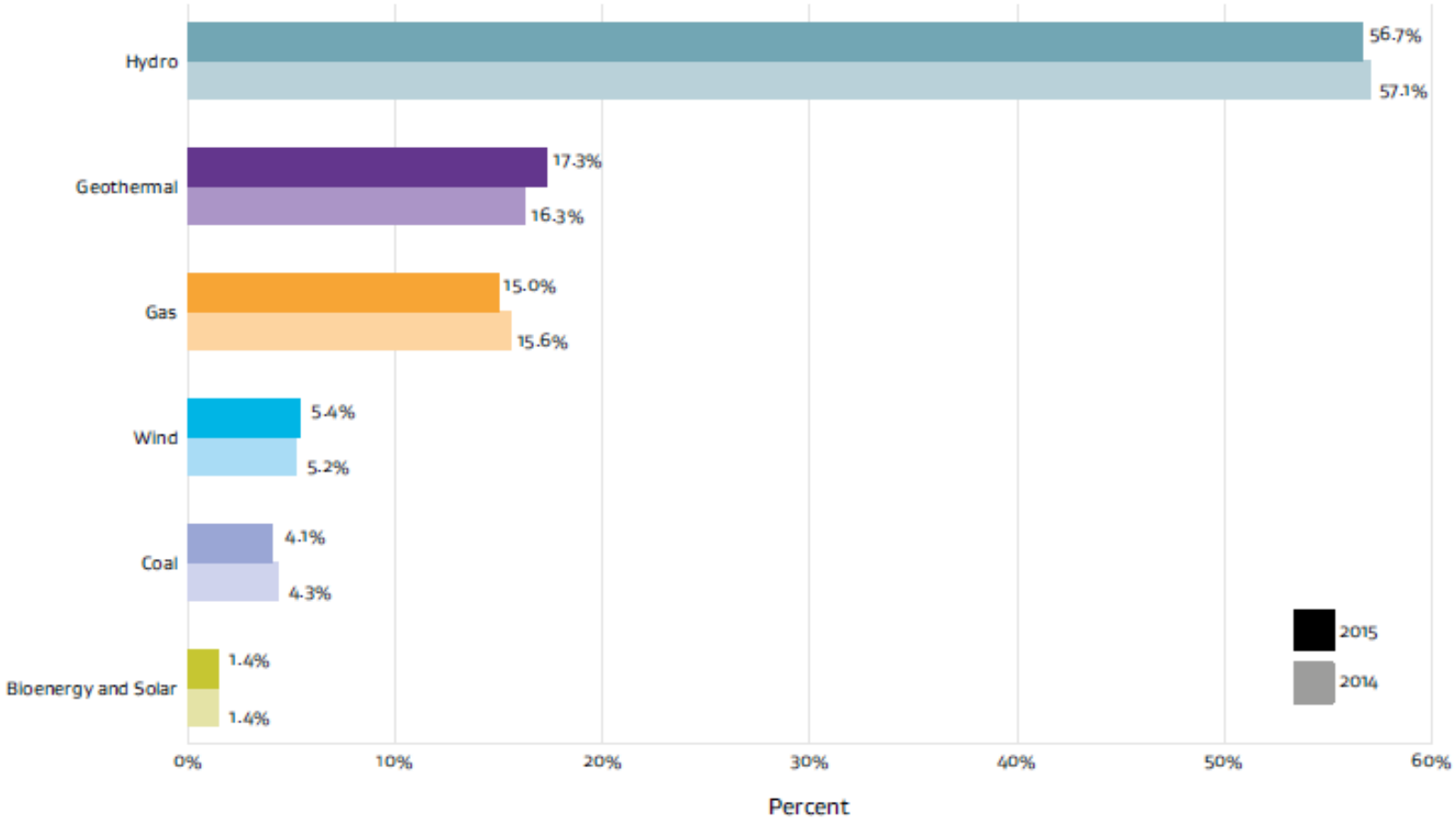
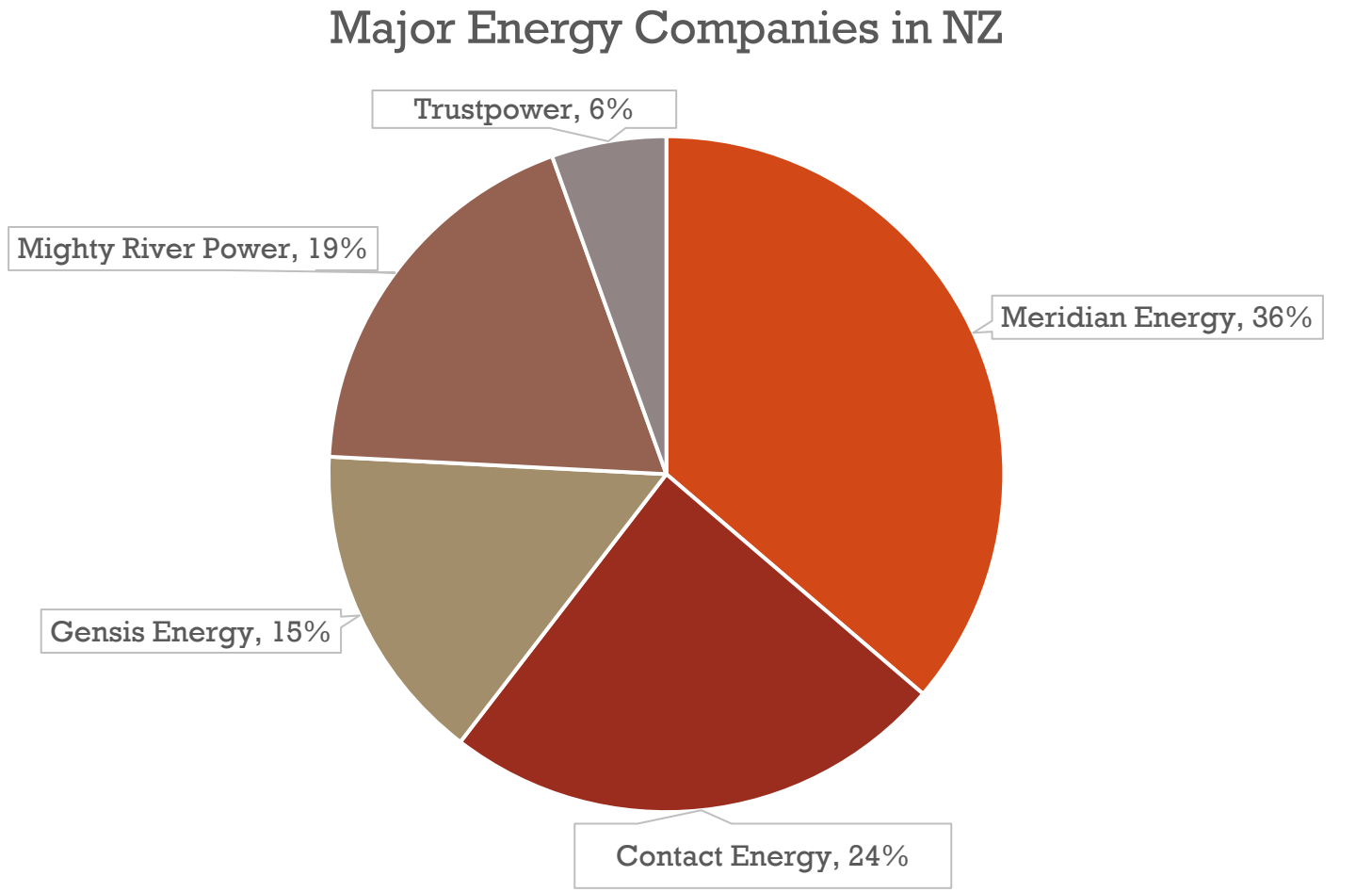


Figure F.4: Electricity Generation by Fuel Type, 2014 and 2015 Years



NEW ZEALAND ENERGY OVERVIEW ELECTRICITY



NON-RENEWABLE

FOSSIL FUELS
Includes coal, oil and natural gas. The energy comes from the fossilised remains of plants and animals from millions of years ago.

RENEWABLE

HYDRO ENERGY
Energy created by falling water

WIND ENERGY
Energy from the force of wind

GEOTHERMAL ENERGY
Energy from underground steam

SOLAR ENERGY
Energy from the sun

BIOENERGY
Fuel/Energy from waste materials

MARINE ENERGY
Energy from tidal movements and waves

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WIND ENERGY HISTORY

Windmill: Grinding

Wind Turbines: Electricity Generator

WIND ENERGY HISTORY

- 5000 B.C: Propel Boats along Nile River
- 200 B.C : Simple Wind Powered water Pump in China
- 11th Century: Windmills used for food production
- Dutch developed wind pumps to drain lakes in Rhine River Delta
- In USA, late 1800s and early 1900s, small wind electricity generator widely used
- 2000s federal government established incentives to renewable energy
- Denmark has roughly 40% of its energy supplied by wind

WIND ENERGY HISTORY

- First Turbine in NZ : 1993 Wellington
- NZ has 690MW install Capacity
- Tararua Wind Farm (TrustPower)
- Completed in 2007
- 134 turbines
- 161MW Install capacity
- 650 GWh

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TURBINES

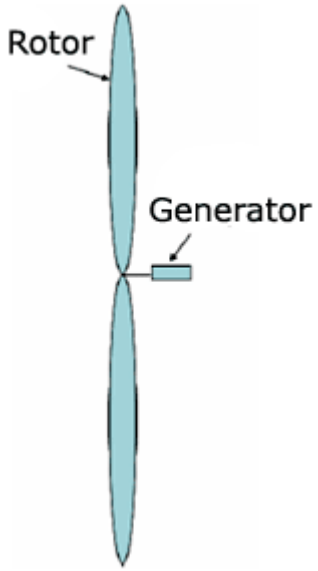
VS

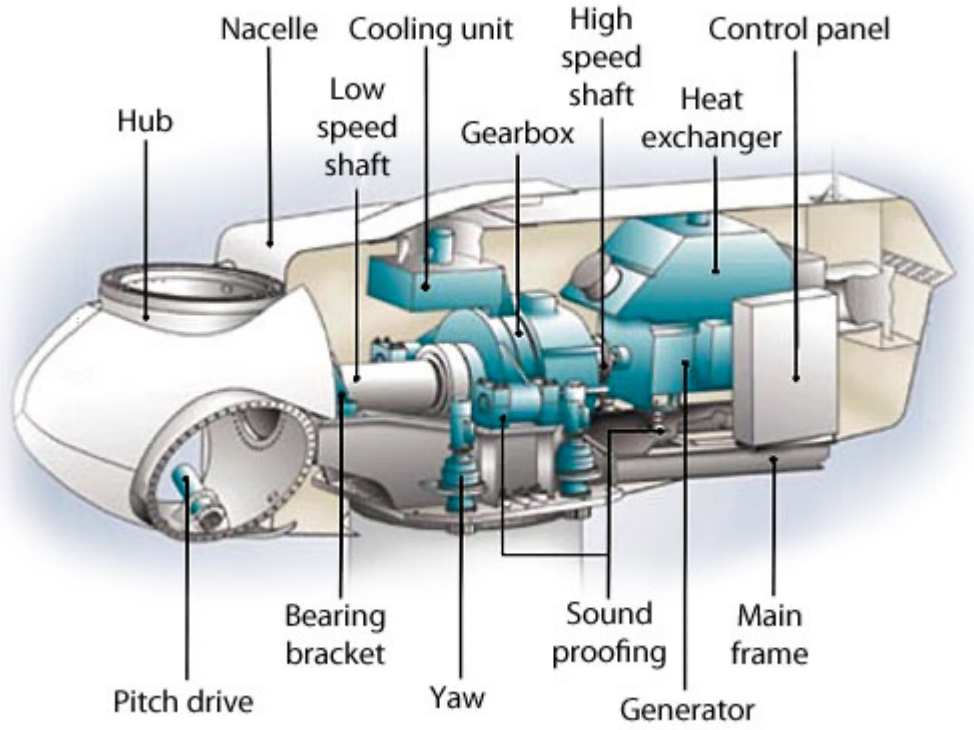
Vertical axis turbines

Horizontal axis turbines

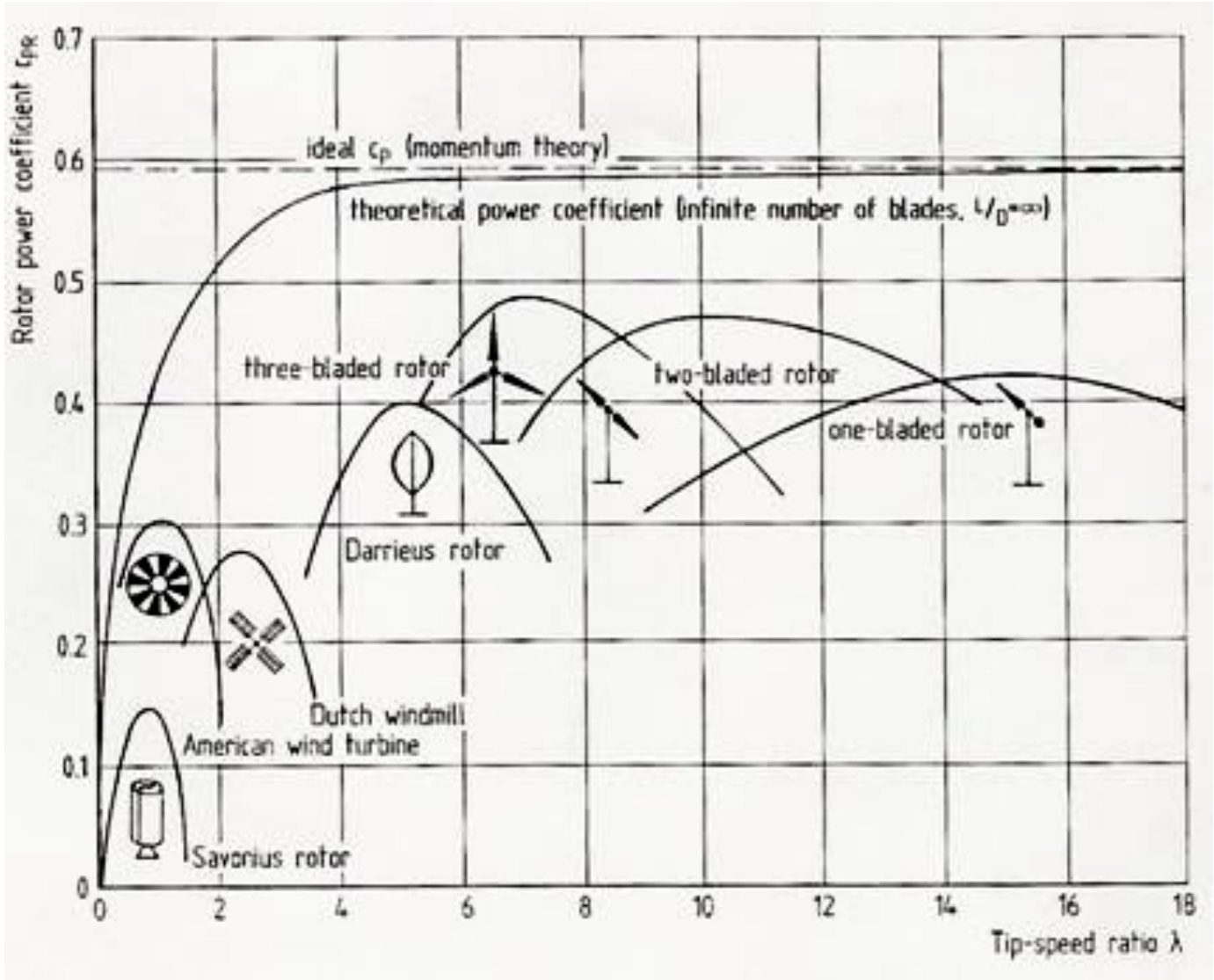
TURBINES

- Kinetic Energy to electricity





TURBINES


Rotor power coefficient c_{pR}
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ideal c_p (momentum theory)
theoretical power coefficient (infinite number of blades, $l/D=\infty$)
three-bladed rotor
two-bladed rotor
one-bladed rotor
Darrieus rotor
Dutch windmill
American wind turbine
Savonius rotor
0
2
4
6
8
10
12
14
16
18
Tip-speed ratio λ

PART IV

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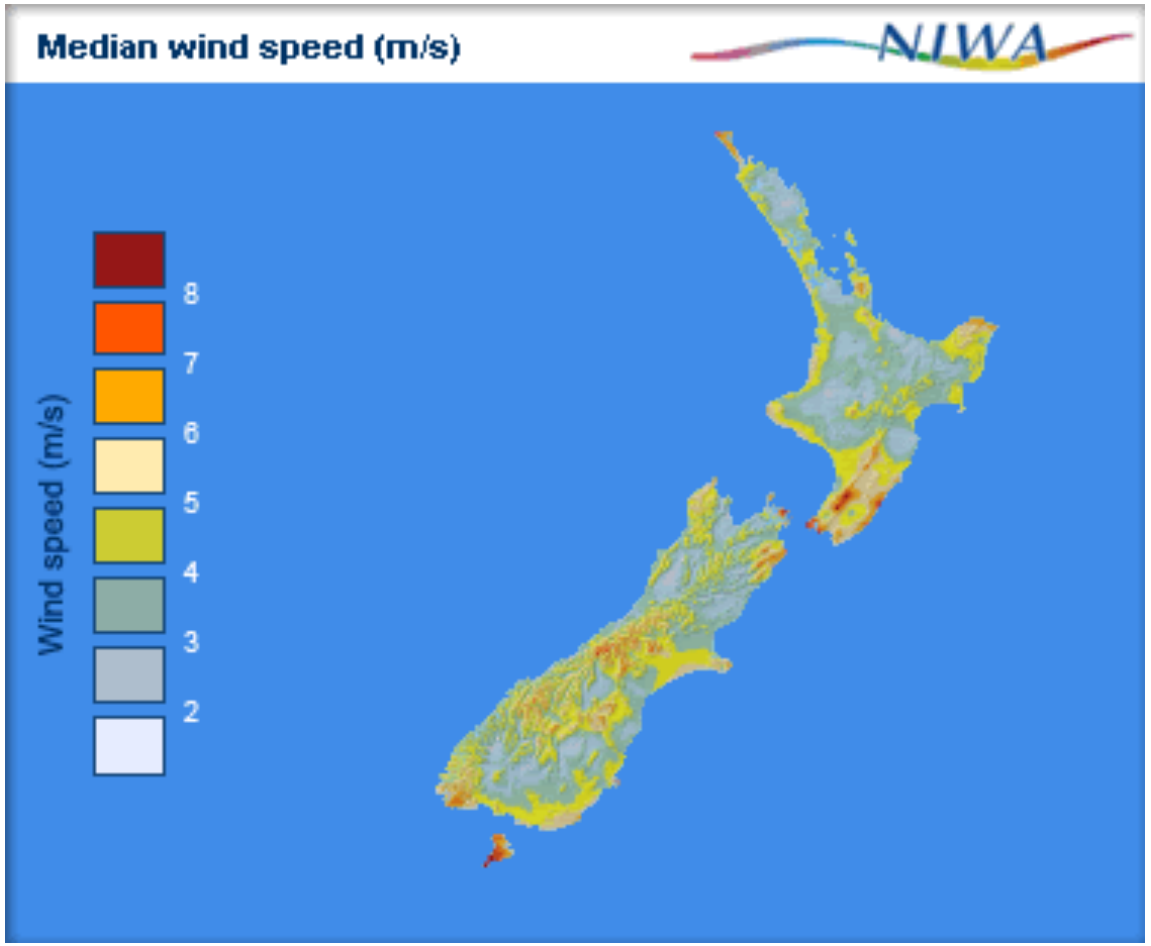
- **Te Uku Wind Farm**
- The Future

TE UKU WIND FARM



TE UKU WIND FARM

- Near Raglan
- Operated by Meridian Energy
- Capacity 64MW
- 28 turbines
- Cost 200 million
- Generate electricity for 28,000 homes

TE UKU WIND FARM

TE UKU WIND FARM

TE UKU WIND FARM

- Start from Oct 2010 to Nov 2011
- Onshore
- Site Area: 2km^2
- Average Site Elevation: 500m
- Turbine type: Siemens SWT 2.3-101
- Hub height: 80m (262ft)
- Rated Wind speed: 9-56 mph (4-25 m/s)
- Pay back period: about 20 years

TE UKU WIND FARM

- Each turbine 130.5m high
- Tower formed in 3 sections
- 318 metric tons
- Cut-in & Cut-out Speed range: 12.5-25 m/s
- Tower were built in Korea
- Turbines were built in Denmark

TE UKU WIND FARM

- Environmental Issues:
- Used to be sheep and cattle farm
- 40,000 native plants were planted in two wetland near wind farm to improve the water quality
- Not too many birds
- 26 km road were built to transport turbines

PART V

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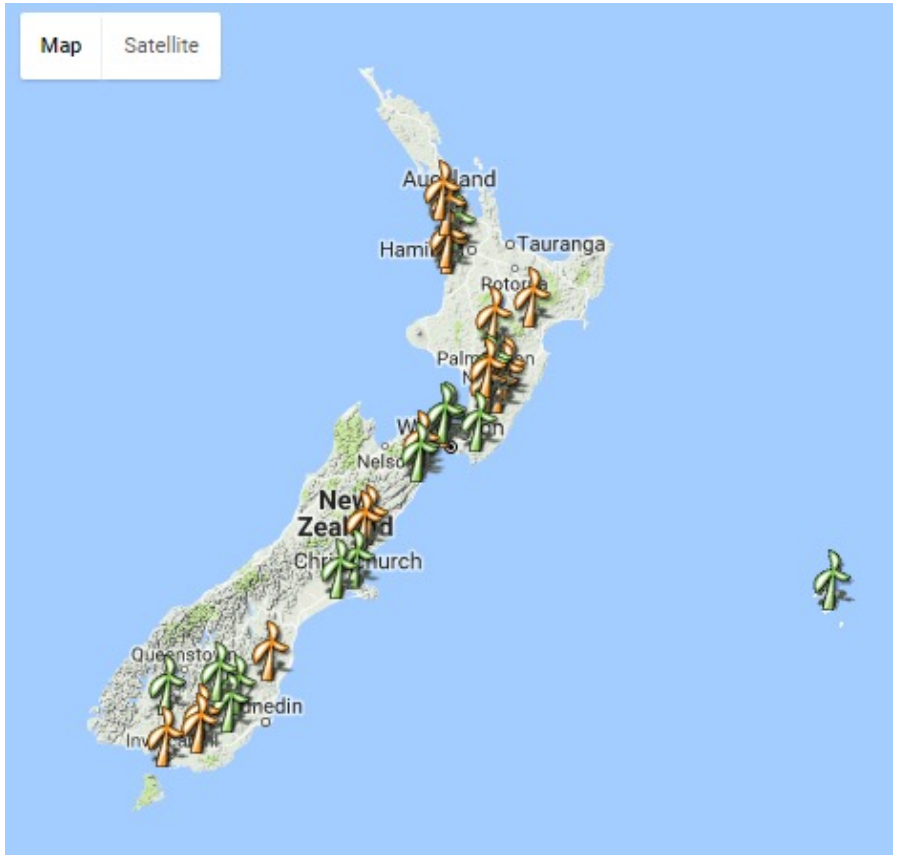
THE FUTURE

- Total 19 Wind Farms operating or under construction
- Most of them is onshore wind resource
- Life cycle emissions: 1% of thermal plant
- Wind Energy will growth and having larger contribution to electricity generation
- Wind Energy has much more development space compare to Hydro and Geothermal

Wind farms that are operating or under construction

Wind farms that have been consented and those that are proposed but have not yet achieved consent



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- Thanks to Dr. Derek Elsworth and his wife Susan
- This class not only brought me the different travel experience, but also make me known a lot of things that I cannot learn during the lecture.
- Connecting the knowledge in textbook with real application in industry
- Thanks to everyone.
- This is the most valuable class I had

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