

# Energy & New Zealand Economy

**Basil Sharp**

**Energy Centre & Department of Economics**

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# Introduction

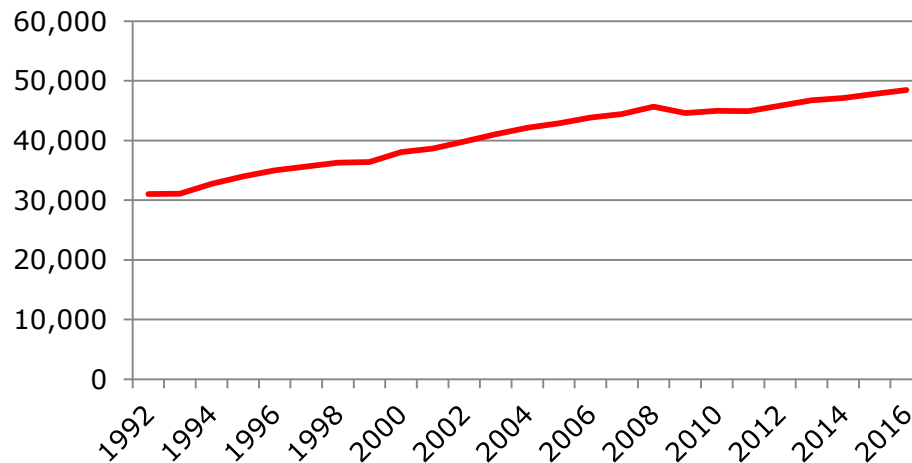
- Fundamental significance of energy
  - Production e.g. dairy products for export, requires energy
  - Consumption e.g. Cell phone requires energy
- Economics:
  - Market design – deliver low cost, low carbon & reliable
  - Technology – more efficient use, impacts both supply & demand
  - External impacts - fossil fuels: SO<sub>x</sub>, CO<sub>2</sub>, development; location of wind farms: visual, claims about noise; dams for hydro: fish passage, lost recreation; geothermal: reinjection; solar: production of panels;
  - Policy – ultimate aim of economic analysis is to assist with formation of policy:
    - Market & policy design
      - Carbon tax or ETS?
      - RET such as 90% renewable electricity by 2025?
      - market regulation?
      - Access & property rights?; etc....

# Outline

- Background
  - NZ Economic indicators – how are we doing?
- Energy & Economic growth
- Markets: electricity, oil & gas
  - Demand & supply
- Energy Development
- Energy Policy

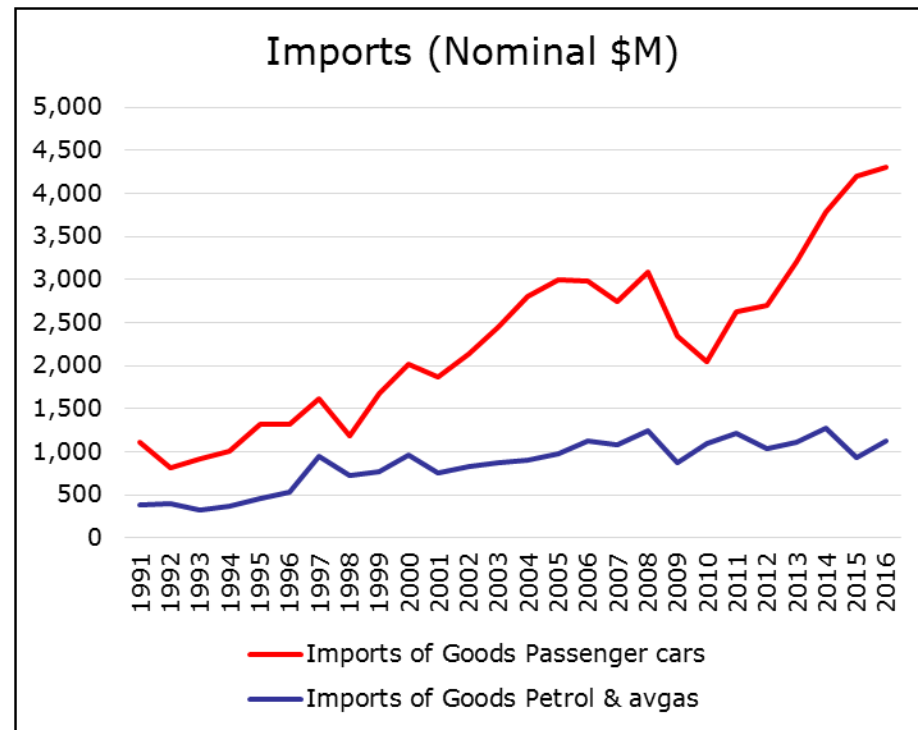
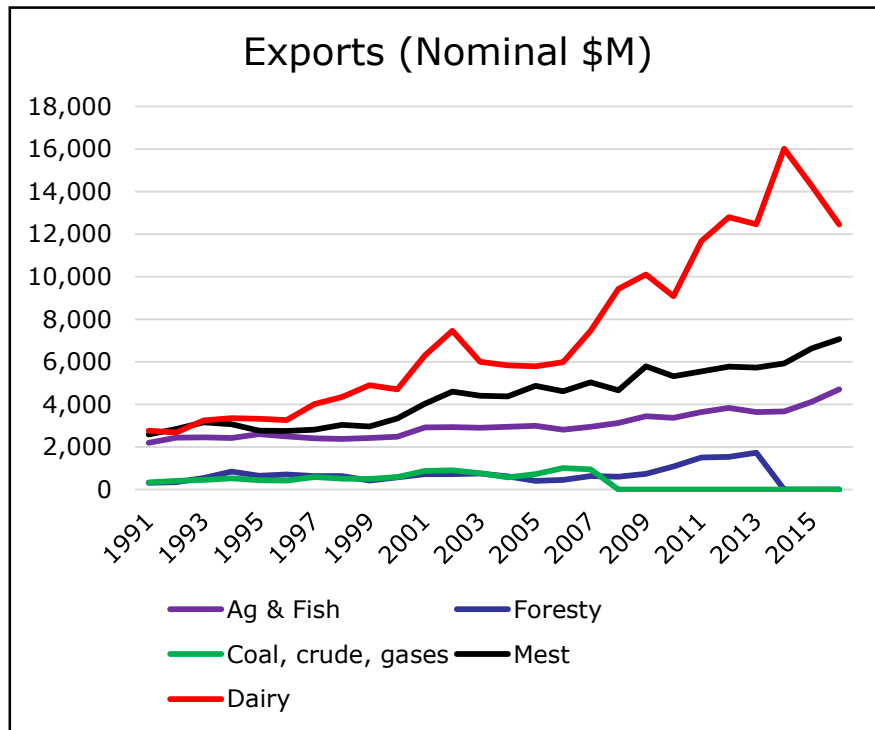
# Gross Domestic Product

**GDP/Capita (\$M 2009/10)**



$$\text{GDP} = C + I + G + (X - M)$$

# Value of Exports & Imports



# Exports/imports - % 2015

- Exports:

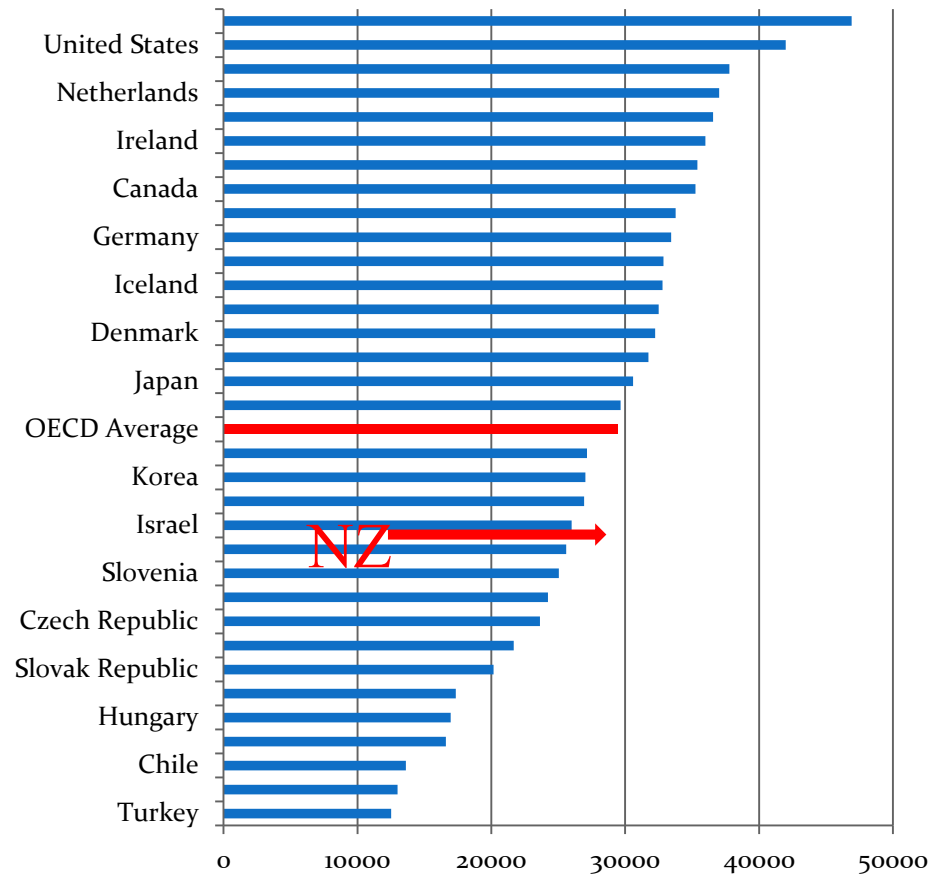
Dairy	24%
Meat	14%
Wood	7%

- Imports:

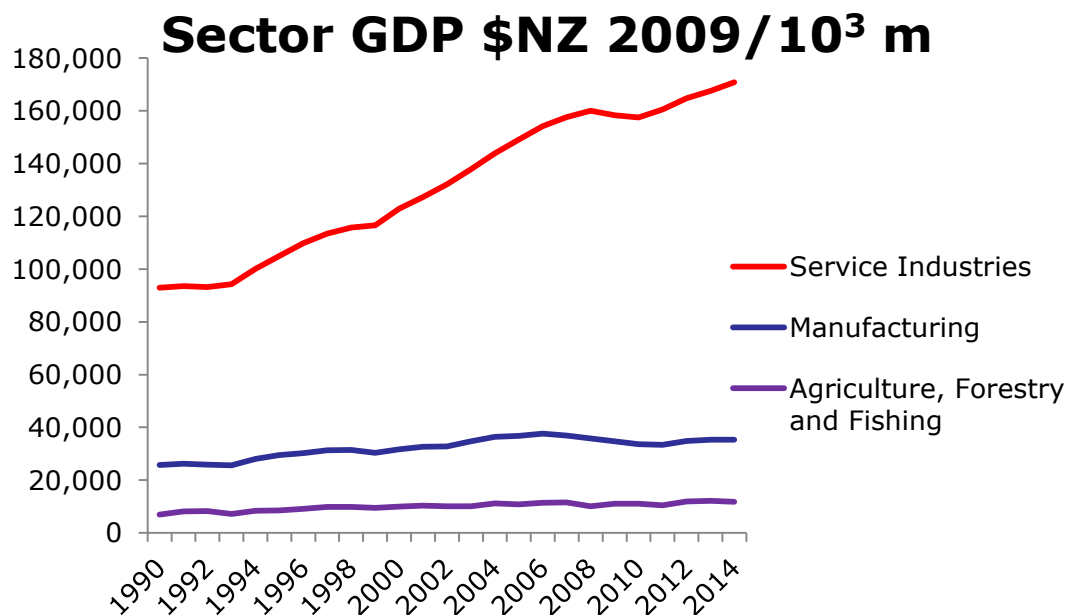
Machinery	14%
Vehicle parts	13%
Mineral fuels	10%

# How are we doing in OECD?

2010 GDP per capita



# Sector Level Contributions to GDP



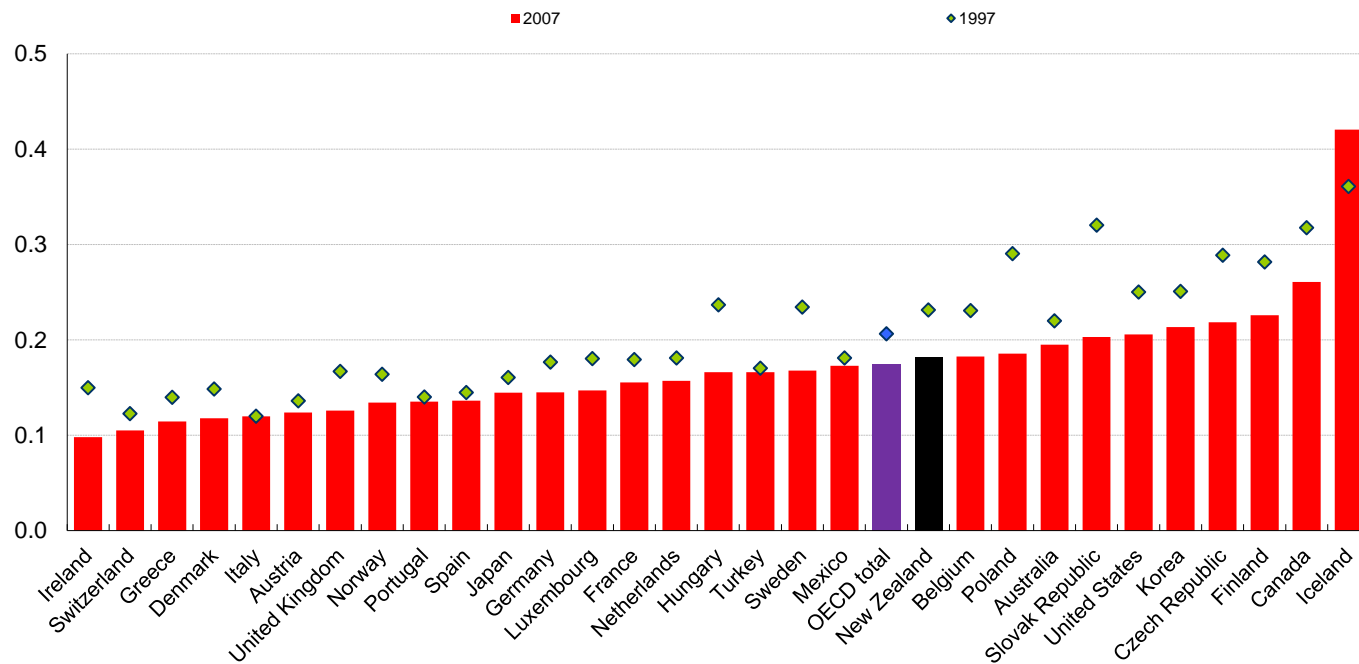
## Composition 2014

Primary ind.	7%
Goods producing ind.	20%
Service sector	65%



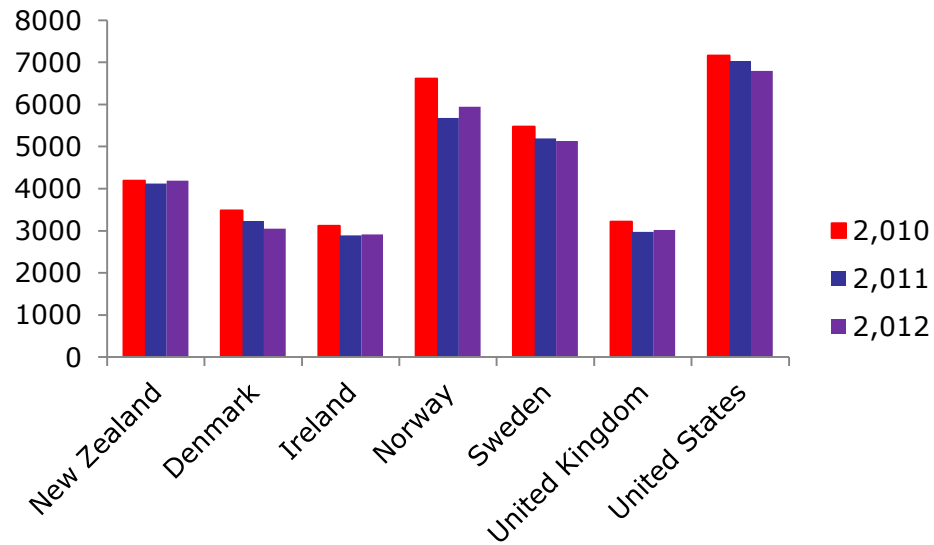
# Energy and GDP

## TOE per 1000 US\$GDP

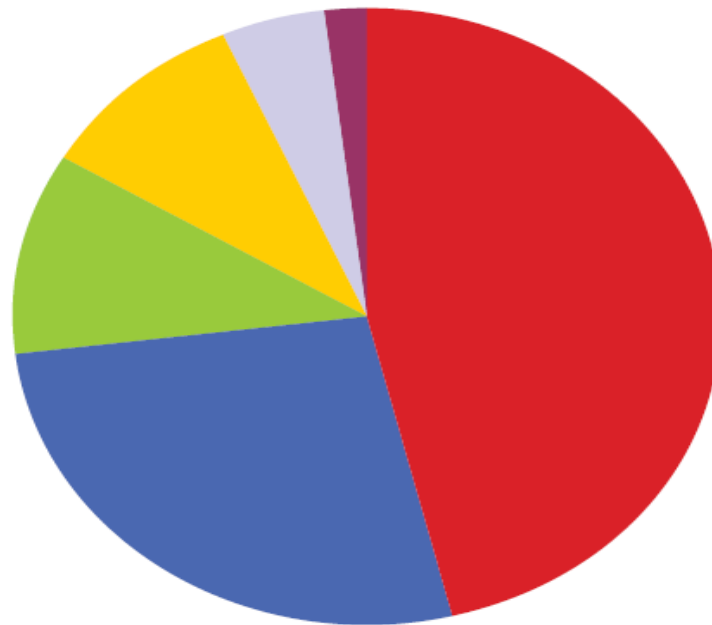


Note: TOE = Tonnes of oil equivalent 2000 US\$GDP

# Energy use kg OE per capita



# NZ Total Energy by Fuel

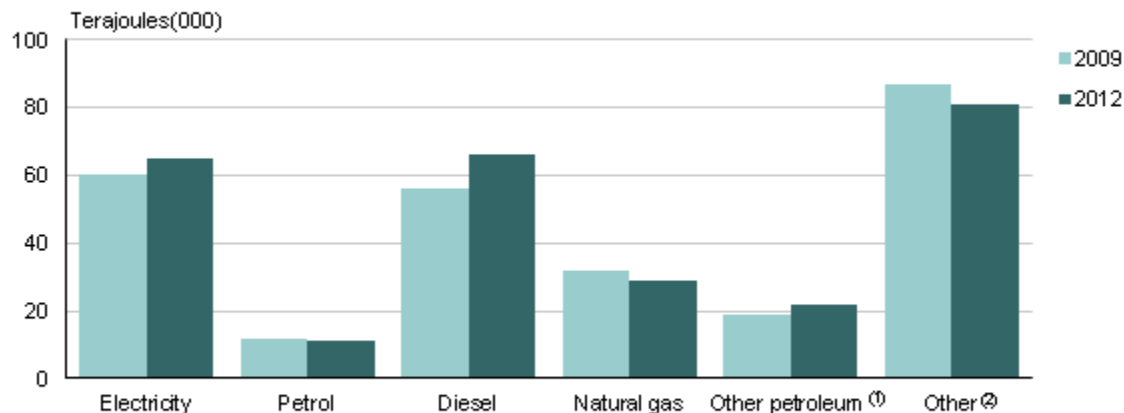


Note:  
Significance of oil & electricity  
Link to: imports & transport

- Oil 46.0%
- Electricity 27.0%
- Other Renewables 10.3%
- Gas 10.2%
- Coal 4.8%
- Geothermal Direct Use 1.8%

# Energy Use Industrial & Trade Sector

Industrial and trade sector energy use by energy type  
2009–12



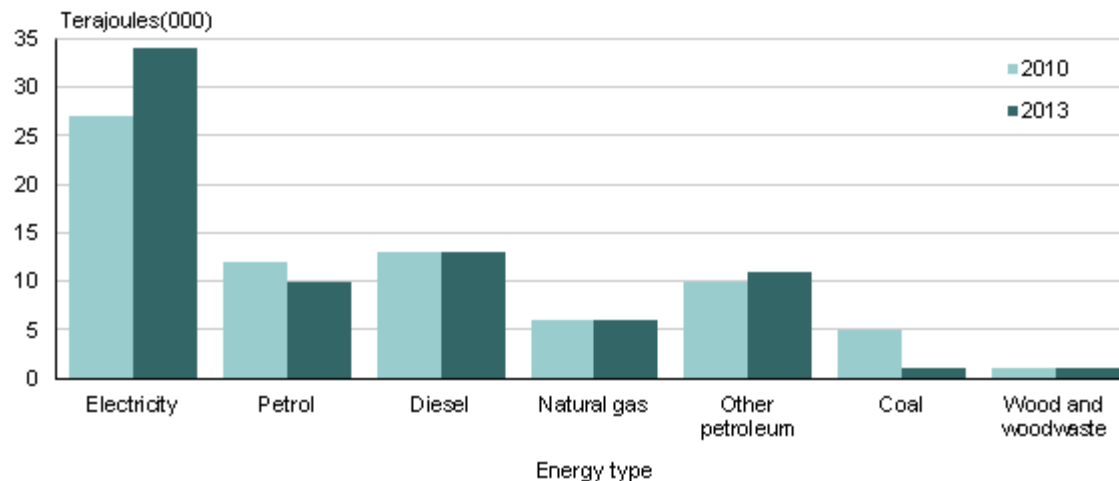
1. Includes other petroleum products not captured elsewhere; eg fuel oil, LPG, aviation fuel.
2. Includes other fuels not captured elsewhere; eg coal, wood, steam, waste oil.

Source: Statistics New Zealand

~ 275,000 TJs in 2012  
75% of NZ total demand  
Electricity, diesel, coal  
66% sector demand

# Energy Use Services Sector

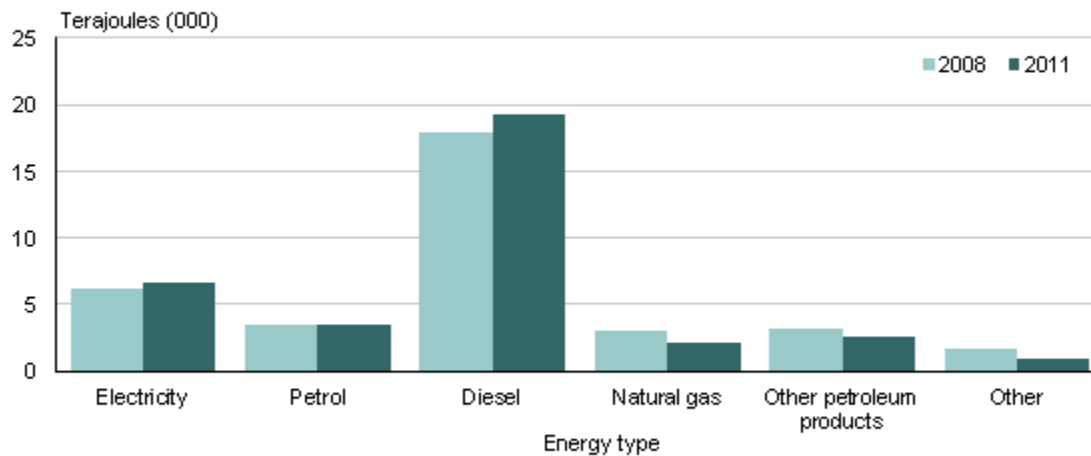
Services sector energy use by energy type  
2010 and 2013



75,000 TJs ~ 20%  
NZ business demand  
Electricity, petrol, &  
diesel > 75 % demand

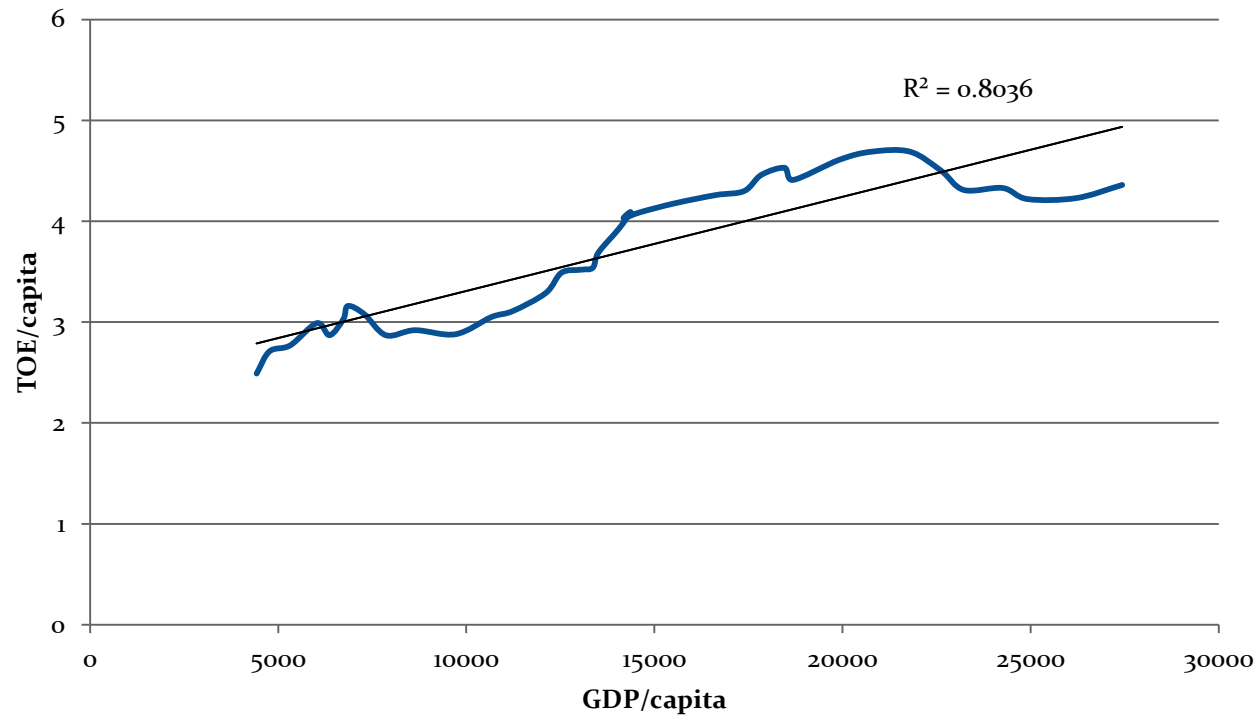
# Energy Use Primary Sector

Primary sector energy use by energy type  
2008 and 2011

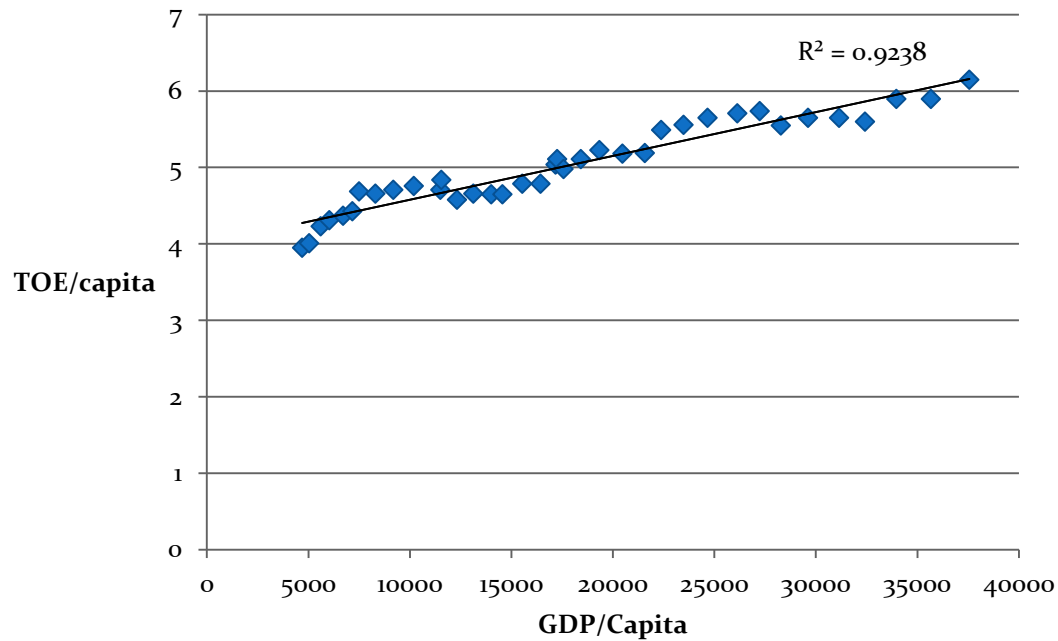


35,000 TJs  
~ 66% diesel

# Energy & Economic Growth, NZ



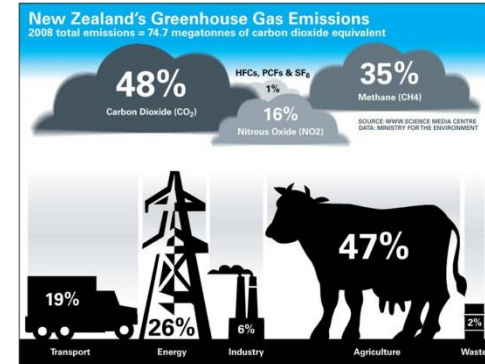
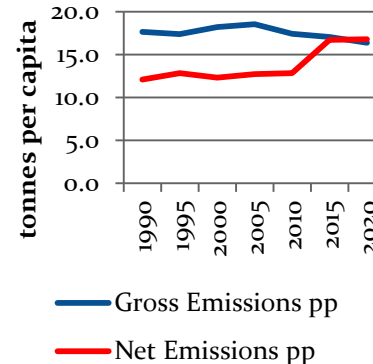
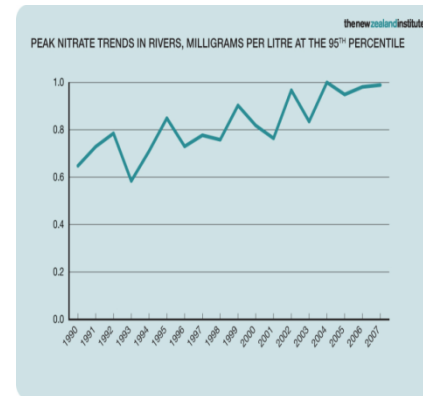
# Energy & Economic Growth, Australia





# Green Growth

- What GDP does not measure
  - Environmental degradation
  - Depletion of natural resources
  - Equity
- Origins: Bruntland's *Our Common Future* (1987) and earlier
  - A green economy maintains/improves wellbeing, within ecological constraints, more than just low GHG emissions
  - OECD, UNEP, World Bank



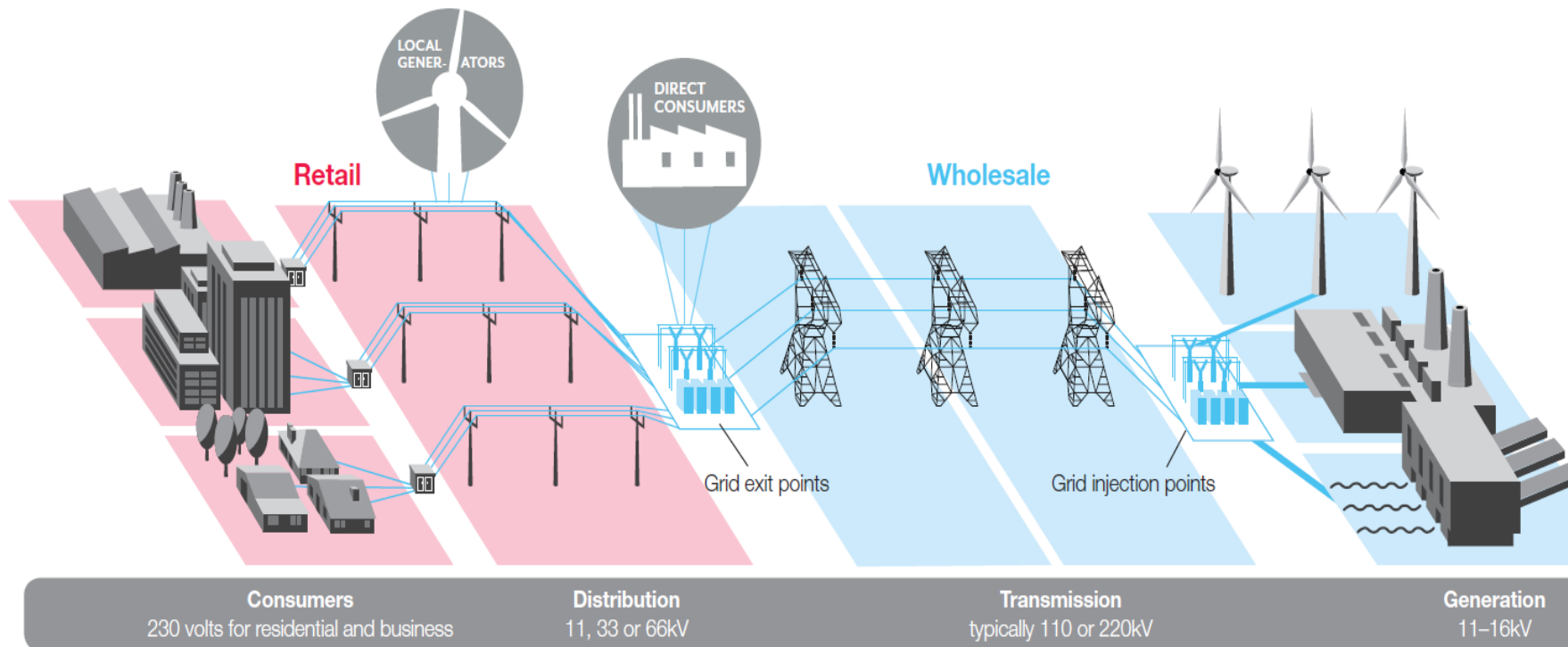
# Economic Reforms: Light handed regulation

- NZ transitioned from economy dominated by large government departments to an economy in which markets play a key role in resource allocation subject to regulations & government oversight.
- In the case of electricity: progression was from centralised production and price setting to a more competitive framework within a regulatory framework.

## Example: Electricity Sector

- Before 1987: large government agencies, 95% electricity, prices controlled, poor investment performance
- SOE Act 1986, ECNZ set up as for profit
- Transpower & Contact Energy spun out of ECNZ mid 1990s
- Contact privatised 1999, ECNZ split into 3 generating SOEs
- By 2014 SOEs partially privatised – Crown owns 51% shares
- Commerce Commission & Electricity Authority oversight.

# New Zealand Electricity Market

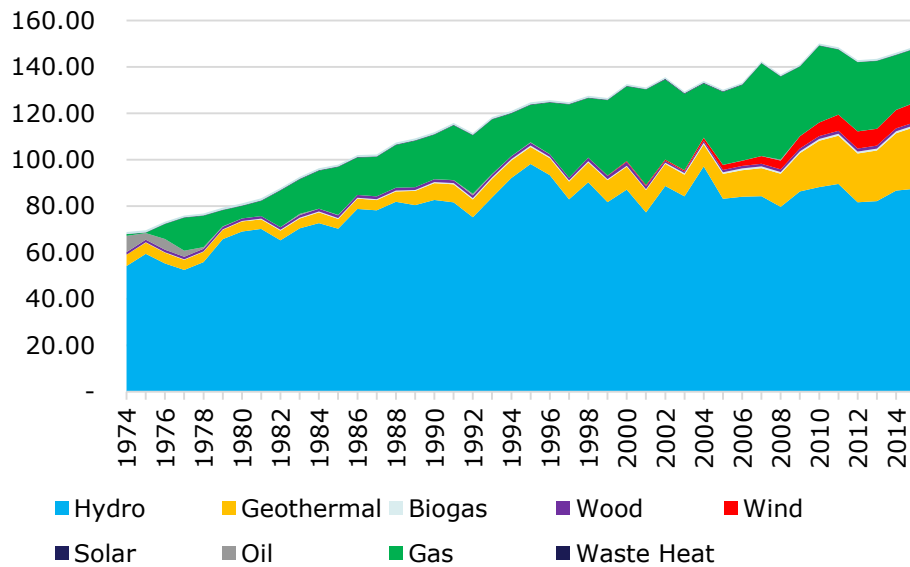


# Three pillars of Reform

- Market design
  - Clear well-defined property rights
    - Land owners & developer can contract with high degree of certainty, lower risk
  - Competitive market
    - Price discovery across competing sources
  - Regulatory oversight
    - Electricity Authority, Commerce Commission, regional govt.
    - Consent process, fiscal regime & resource pricing
- Environmental/resource management
  - Control for & manage impacts associated with development eg. Re-injection, monitoring temperature/pressure et.
- Climate change
  - Emissions Trading Scheme

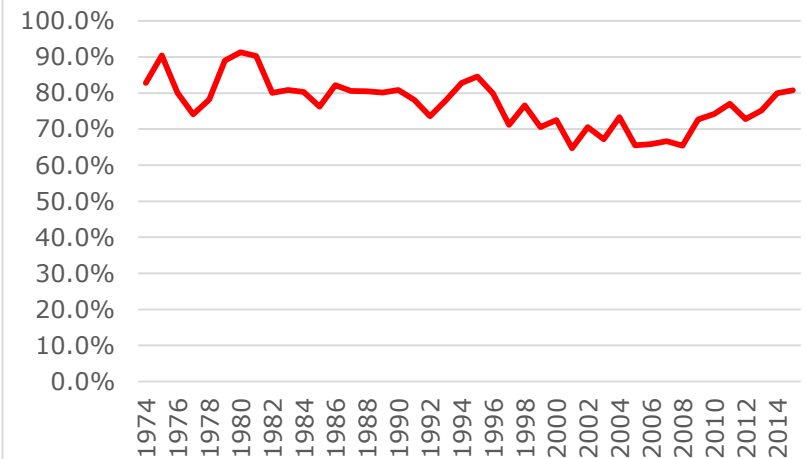
# NZ Electricity

Electricity Generation (PJ) s



## Renewable share

Renewable Share (%)



# Electricity prices US\$/kWh

Electricity for industry (kWh)	Electricity for households (kWh)	
..	..	Australia
..	0.2576	Austria
0.1245	0.2317	Belgium
0.0699	0.0945	Canada
0.0776	0.0932	Chinese Taipei
0.1439	0.1855	Czech Republic
0.1144	0.3563	Denmark
0.0948	0.1754	Finland
0.1056	0.1568	France
..	0.3248	Germany
0.1139	0.1584	Greece
..	..	Hungary
..	..	India
0.1372	0.2326	Ireland
0.2581	0.2632	Italy
0.1544	0.2322	Japan
..	0.0834	Korea
0.1219	0.2155	Luxembourg
0.1042	0.0888	Mexico
0.1230	0.2212	Netherlands
..	0.1815	New Zealand
0.0737	0.1758	Norway
0.1204	0.1791	Poland
0.1203	0.2152	Portugal
0.1691	0.2130	Slovak Republic
..	..	Spain
0.0964	0.2180	Sweden
0.1023	0.1800	Switzerland
0.1509	0.1841	Turkey
0.1211	0.1990	United Kingdom
0.0679	0.1158	United States

Highest ←

← Lowest

←

# Price elasticity: electricity

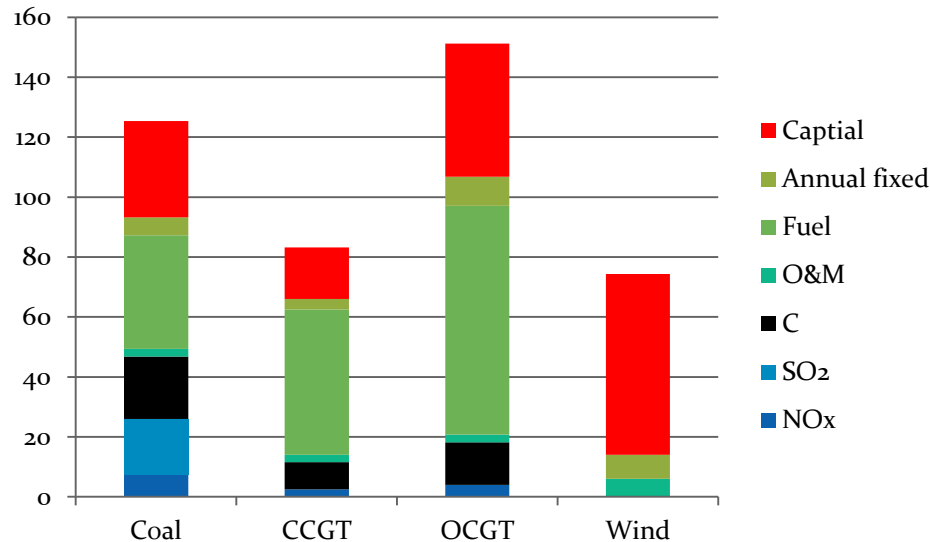
$$\frac{\% \Delta Q}{\% \Delta P}$$

	Proportion	Short-run	Long-run
Industrial	45%	-0.06	-0.28
Commercial	22%	-0.06	-0.28
Residential	33%	-0.08	-0.21
Weighted Av.		-0.07	-0.26

Source: MED Demand is price inelastic:  
In short run, increase price to residential by 10%, demand falls by 0.8%



# External Cost of Electricity Generation

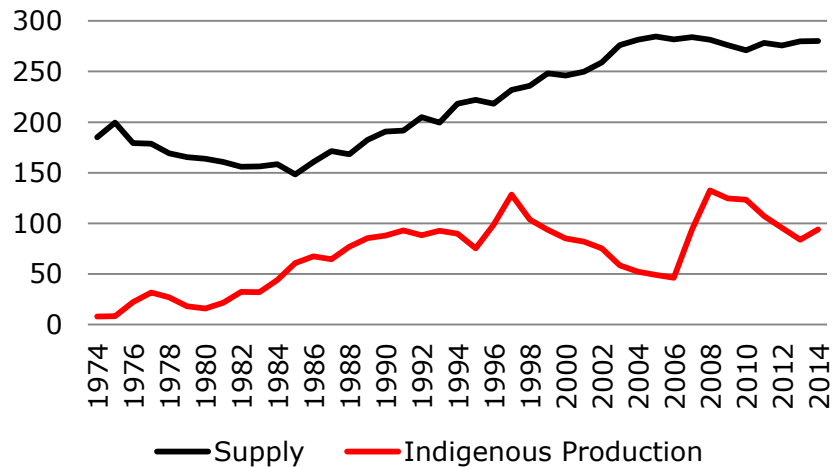


Source: COVEC (2006)

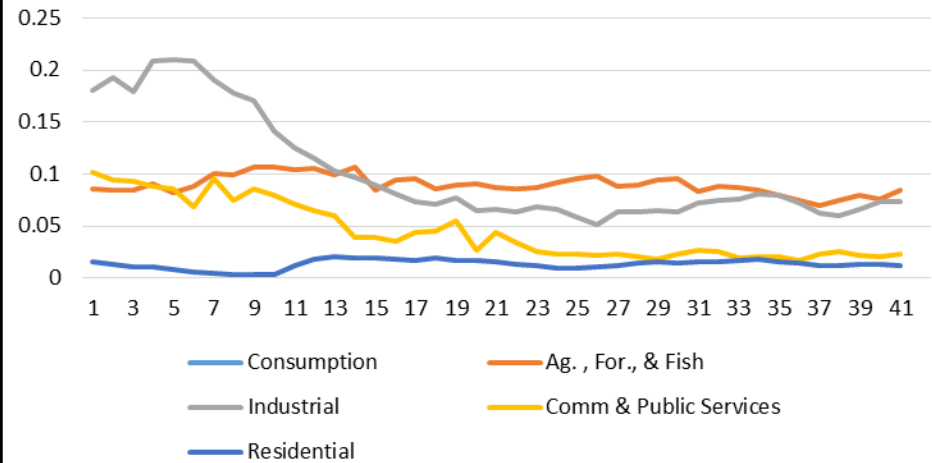
Assumption: new plant under high cost scenario

# Oil Supply & Demand

## Supply (PJ's)



## Oil Consumption (%)



Price elasticity of demand: in range of [-0.1 to -0.4]

# External cost of transport fuels

	Share of Emissions	Effects
CO	70%	Health, global warming
Hydrocarbons	38%	Health, acid rain
SO <sub>2</sub>	5%	Health & acid rain
NO <sub>x</sub>	41%	Smog, global warming
CO <sub>2</sub>	30%	Global warming, health
Air Toxins	23%	Health

# Development of renewables: Hydro resources

Existing ~5,300MW  
30% in DOC estate  
Av. Load factor ~ 56%

Storage:  
Measured in days (~60)

Potential:  
<\$3,500/kW ~ 1,845MW  
~90% s.t. RMA

\$3,500-\$7,000/kW ~ 4,729MW  
~ 75% s.t. RMA

Resource Management Act 1991  
First-come-first-served

Attenuated property rights  
Limited ability to trade  
Maximum duration 35 years

Outcomes  
Over allocation  
Existing uses likely to be inefficient  
Cross sector competition *viz.* hydro  
& agriculture

# Recent Example of Development: Wairau scheme



# Geothermal: economic features

- Existing capacity  $\sim$  1000MW
- Potential:  $\sim$  additional 1,000MW
- 129 geothermal areas classified as High temperature  $> 220^{\circ}$  C
- Drilling costs: Non-linear  $\sim$  \$3,000/m, up front risk
- Costs:
  - Reasonably robust governance
  - Negotiating with land owners
  - \$2,500 – 4,000/kW, temperature dependent
  - Modular design
  - Economies of scale
  - Significant operating and maintenance costs
  - High load factor  $\sim$  90%

# Cascading use



# Unsustainable use

- Rotorua New Zealand
  - Open access 1970s-1980s
  - Home heating, relatively inexpensive
  - Pressure dropped, subsidence & damage to tourist attractions
  - Entry closed
- Ohaaki plant
  - Commissioned capacity of 114MW
  - Production reduced to 30MW, now ~ 45MW
  - Subsidence & flooding



# Policy & Management

- Mineral resources “owned” by Crown
  - Fiscal tools available: ad valorem royalty & tax on profits
- Geothermal Energy Act 1953
  - Right to tap vested in the Crown
  - Rights of Maori recognised
- Resource Management Act 1991
  - Legal foundations for allocation & management
  - Classified as a renewable resource
  - Provision for royalties but never exercised
  - Implemented by regional government

# Summary

- Considerable scope for geothermal energy to contribute to renewable energy target & reduction in GHG emissions (MRP: NZ\$1.4b, 3 plants since 2008)
- Up front costs of exploration & obtaining necessary resource consents
- Development opportunities for Maori & local communities
  - Scope also for cascading uses of heat
- No free lunch
  - Access to, and management of, reservoir
  - Spill overs

# Development of renewables: On-shore wind

Current: 17 wind farms

Capacity of ~ 600MW

Load factor ~ 30 – 50%

Cost:

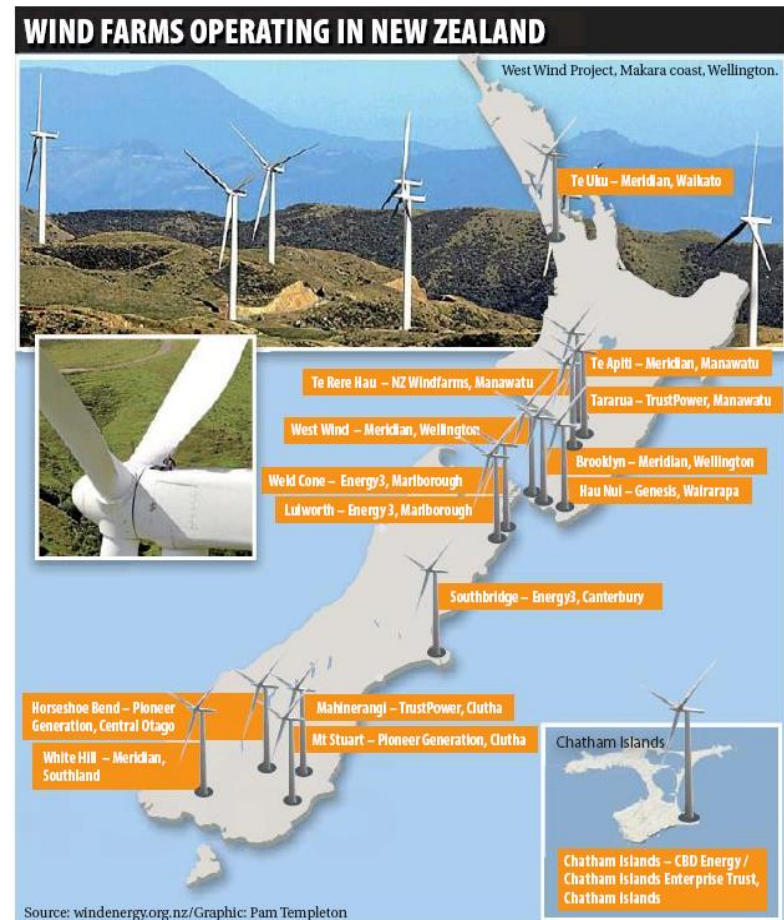
Typically around \$2,000 kW

Modular

Potential 2025:

3,995 MW

10,005 GWh/yr



# External impact of Wind Farms



Project Hayes:

630MW 176 turbines

Electricity for 278,000 homes

Estimated cost \$2b

Carbon savings

Environment Court & over  
turned in High Court

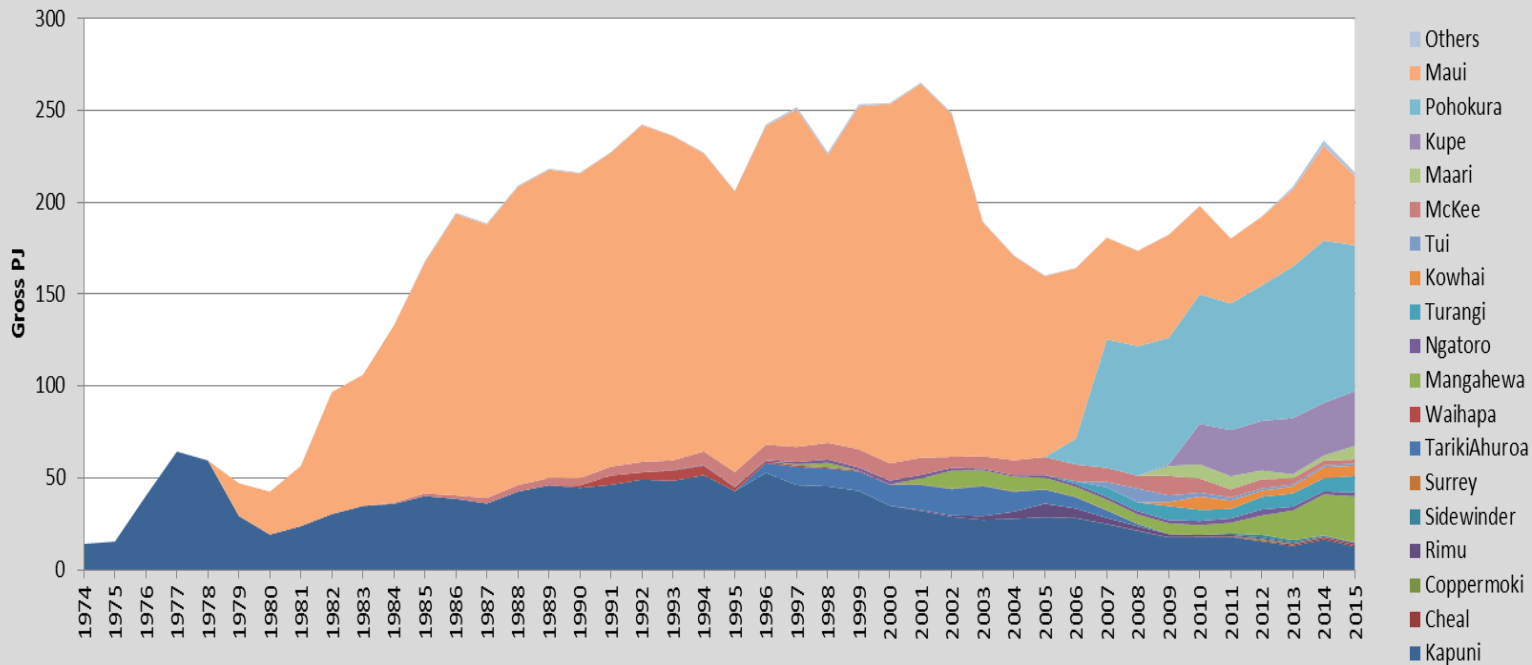
- Non-market impacts:  
aesthetics and noise
- No evidence (to date) in New  
Zealand

# Environmental Protection

- Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
  - September 2012
  - Extends coverage beyond RMA (12 nautical miles)
  - Interim voluntary measures in place until 2013
- Capital investment
- Does NZ have the capacity to handle a major oil spill
  - Deep Water Horizon US\$38 b
  - Cost of Christchurch rebuild NZ\$30 b

# Gas Production

Annual Gross Gas Production by Field



Source: Ministry of Business, Innovation and Employment

# Govt. Draft Policy Statement 2017-2022

Priority areas:

1. Renewable and efficient use of process heat Target: Decrease in industrial emissions intensity of one per cent per annum on average between 2017 and 2022.
2. Efficient and low emissions transport Target: Electric vehicles make up two per cent of the vehicle fleet by the end of 2021.
3. Innovative and efficient use of electricity We already have a target to increase the level of renewable electricity to 90 per cent by 2025.

# Concluding comments

- Economy
  - NZ relatively well placed in terms of fundamentals
  - GDP, unemployment, government debt
  - NZ exposure: oil products, machinery & dairy
- Energy
  - Renewable electricity target achievable, role of gas
  - Exposure – transport fuels
- Environment
  - Climate change
  - Air quality
  - Water quantity & quality