

I sell here, Sir,
 what all the world desires to have...
POWER

Matthew Boulton on the Steam Engine, 1776.

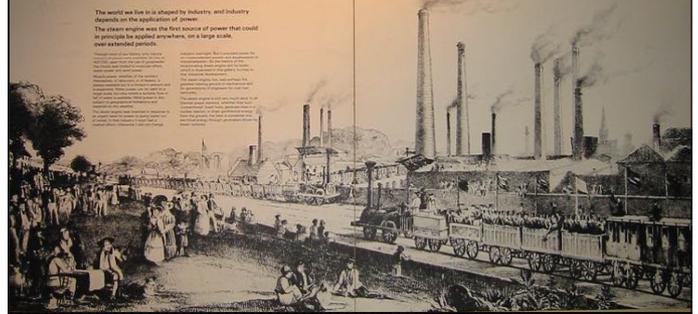
Powering our future

Bryan Leyland

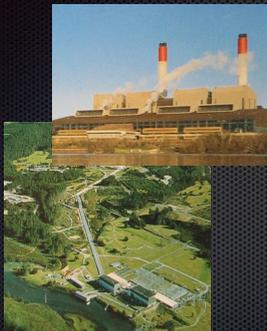
MSc, DistFEngNZ, FIMechE, FIEE(rtd), MRSNZ

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Vital Statistics..
 7,000 MW peak
 43,000 GWh pa



The DC Link

By 1950 NI Hydro was running out

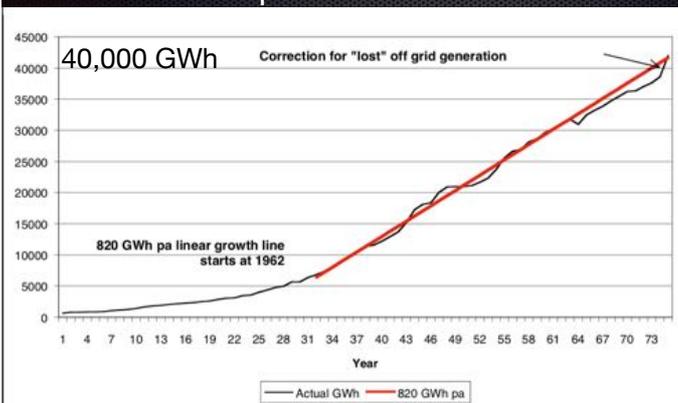
NI coal was the MWD option...

- Bill Latta's bold concept
 - Develop SI Hydropower & Transmit to NI
 - How to get it across the Cook Strait? HVDC??
 - 1952 Gotland 20 MW, 100kV
 - 1962 Cook Strait 600 (1200) MW +/-250 kV
 - Upgraded to 1400 MW

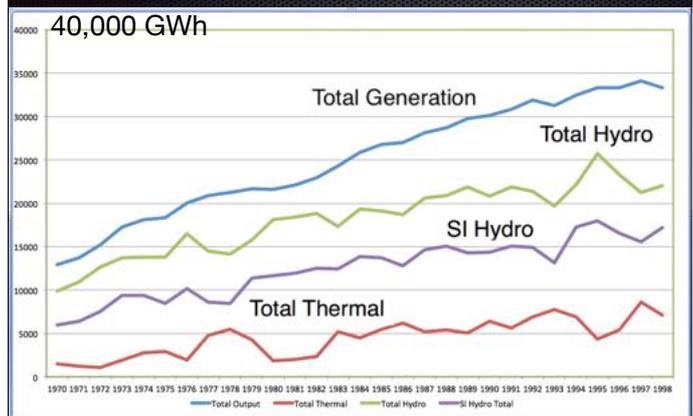


Could we make such a bold decision now?

Load growth 1930 - 2004
 820 GWh pa

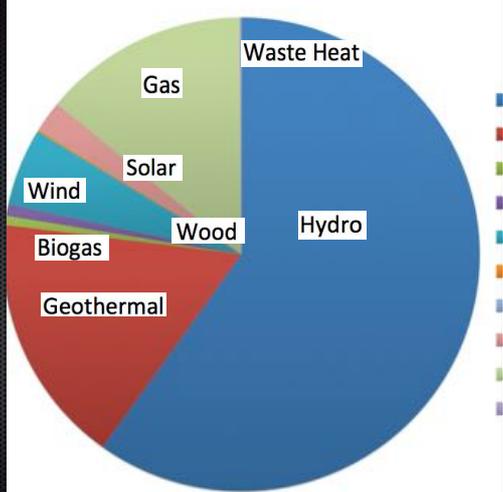


NZ generation 1970-1998

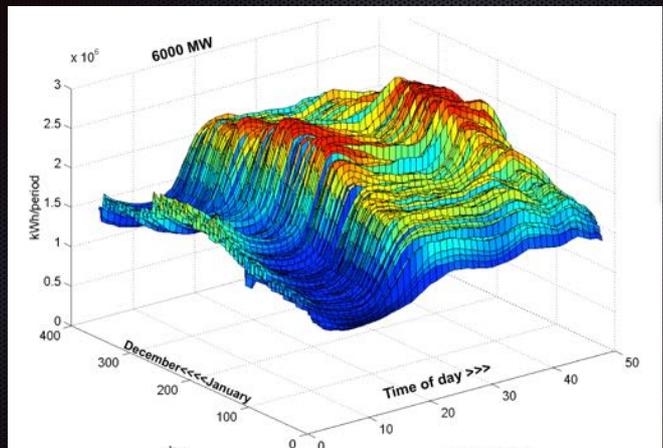


Where our power comes from

978 MW of geothermal generates a lot more than 690 MW of gas!



What our load looks like



Fuel

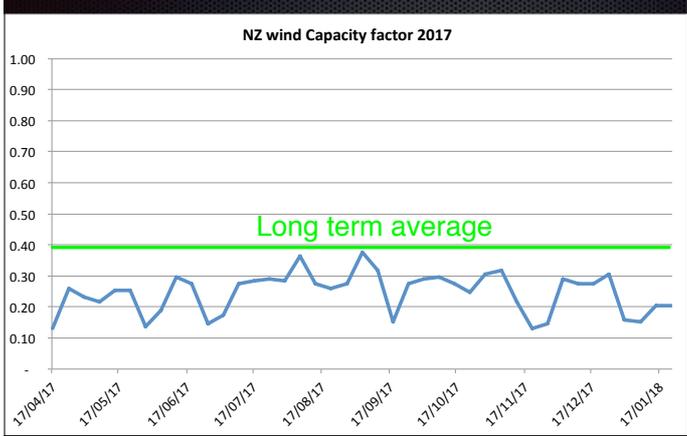
- **Coal***
 - Waikato: 714 M tonnes
 - N Taranaki: 174 M tonnes
 - West Coast: 343 M tonnes
 - Otago: 1,154 M tonnes
 - Southland: 6,256 M tonnes
- **Hydro**
 - Upper and Lower Clyde ~1000 MW
 - Aqua 550 MW
 - West Coast >1000 MW
- **SI Offshore Gas**
 - Canterbury Bight
 - Oamaru
 - Great Southern basin

More than Maui?
- * A 1000 MW station uses about 3 M tonnes pa

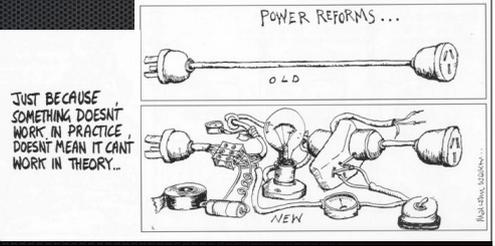
Dry years

- NZED power planning
 - must survive a dry year without a shortage
- In a 1:20 dry hydro generation dropped by 3600 MW
- The old Meremere coal-fired station and the Huntly coal-fired station were built to provide extra generation in a dry year.
- With wind and solar added to the system, the dry year problem is even worse
- Transpower has pointed out that we are at risk of shortages in dry years in a few years
- No alternative to a coal stockpile!

Less wind in a dry year?



And then came the Electricity Reforms.



Before and after

Before

- The Electricity Department and MOW had a monopoly on building lines and power stations (Bad)
- Both were over manned and under political control (Bad)
- Planned long term (Good)
- Two CEO's paid at Public service rates (Good)
- Mostly managed by engineers (Good)

Before and after...

After

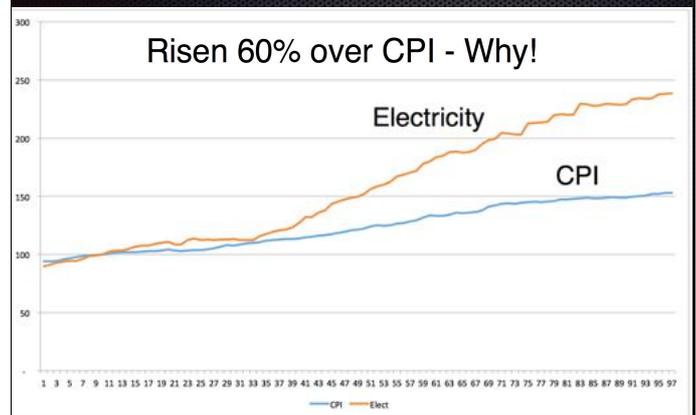
- Monopoly replaced by oligopoly (Bad)
- No long term planning (Bad)
- 6 highly paid CEO's and management (Bad)
- 10%+ of staff are "traders" (Bad)
- Regulated by the EA which is under the Minister's thumb (Bad)
- High and unpredictable prices (Bad)
- Asset values racked up regularly (Bad)

The reforms were based on..

These (dodgy) assumptions:

- electricity is a commodity like any other
- supply and demand will balance at a price that is politically acceptable
- five generators acting in their selfish interests = "the public good"
- They ignored the need for reliable peak capacity and a supply of reserve energy for dry years

Power prices 1993 - 2017



We once had some of the cheapest power in the world..

New Zealand



Wind and solar industries

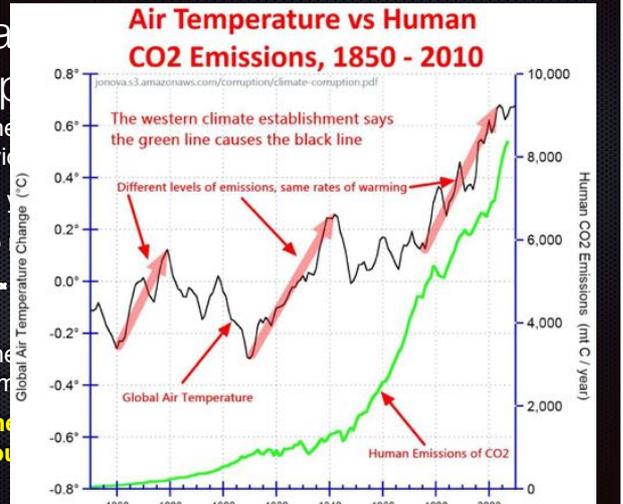
- Exist only because of large direct and indirect subsidies
 - Subsidies exist because governments believe that they are a cheap and effective way of reducing man-made CO2
 - they aren't
 - When the subsidies are abandoned, development stops
- Can be useful when conventional options are expensive
 - e.g. supplying small loads in isolated situations

Man-made global warming is not supported by the evidence

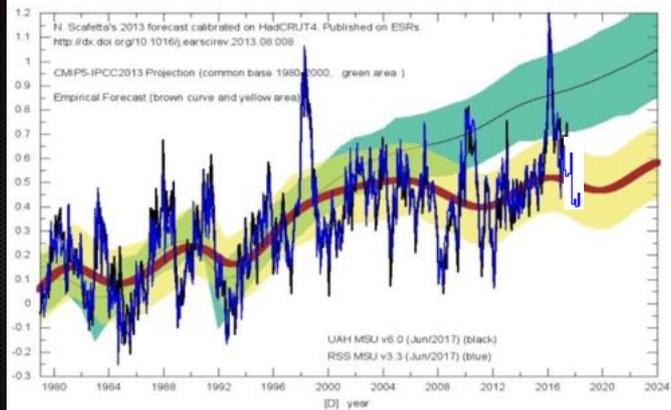
- The Royal Society of New Zealand has failed to produce evidence supporting this hypothesis
 - yet it continues to promote "climate change"
- To my knowledge, the evidence does not exist
 - **It could be the biggest hoax in the history of the world**
- There is nothing abnormal or unusual about the temperature record since 1900.
- **There is convincing evidence that global cooling could soon start.**

Man-made global warming is not supported by the evidence

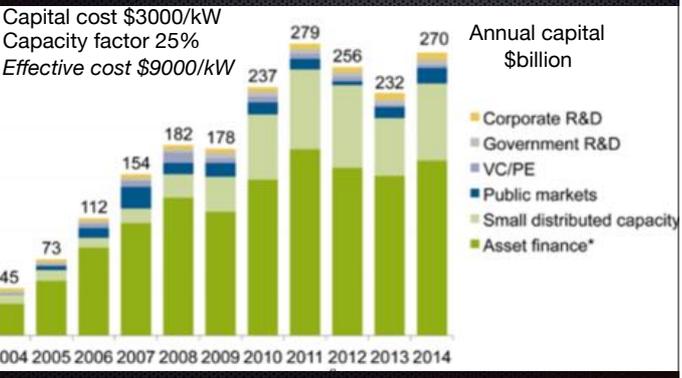
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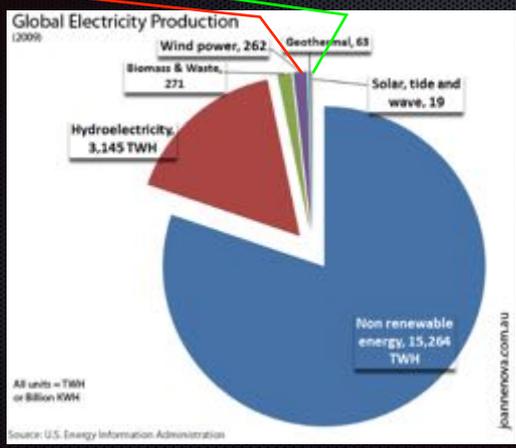
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New renewables cost - \$2,500 billion!
 Capital \$2,000 bn, Subsidies ~\$500 bn (\$88 bn/yr)



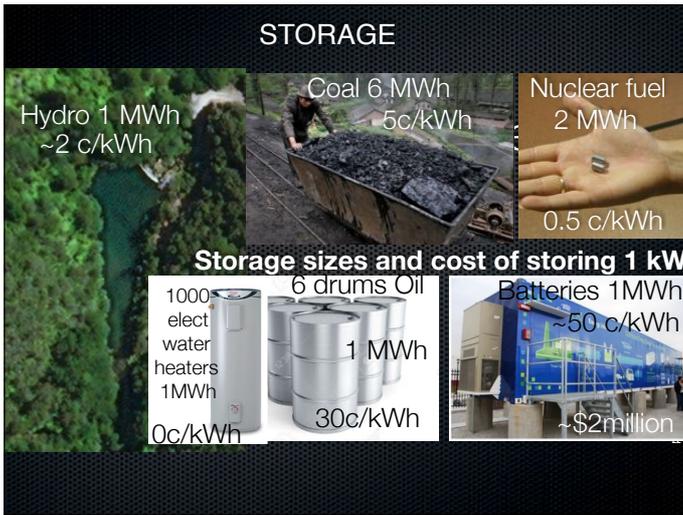
Wind and solar make a trivial contribution



2009 data
 Doubled since then

Storage the "Achilles Heel" of RE

- Large scale wind, wave and marine power cannot exist without
 - **long term, low cost, efficient, energy storage**
 - energy generated when the wind is blowing and the sun is shining must be stored so that it can be used when it is needed
- No economic technology exists
 - and it is not even on the horizon
 - all we have is expensive long term pumped storage and very expensive batteries
- So we use inefficient open cycle gas turbines and diesels
 - Producing lots of CO2



STORAGE

Storage medium	Energy capacity per kg of medium [MJ/kg]
Lead-acid battery	0.5
Lithium-ion type batteries	0.5 or less
Super-capacitor (not yet available)	1.2
Sodium polysulfide (NaS) battery	2.8
Gasoline	48.0

Wind power: Technology and costs

Technology is stable

- no significant technological improvements in the last 20 years
- variable speed operation becoming more common
- as time goes on, unit size increases with a small decrease in costs/kW
- O&M costs are high due to problems with blades, bearings, gearboxes and generators

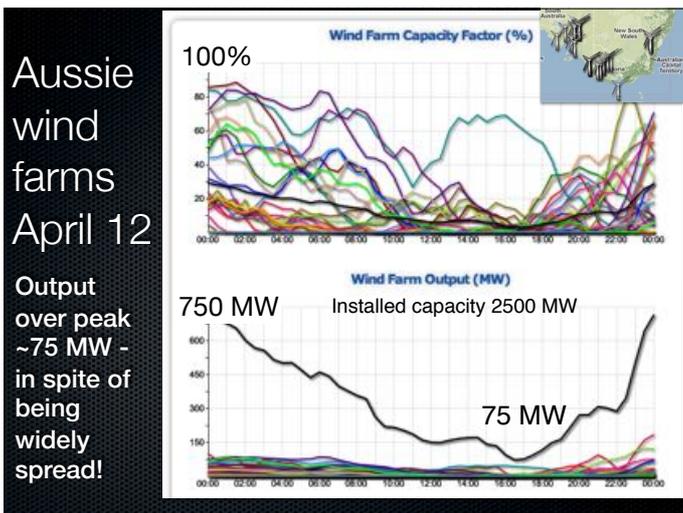
Costs are dropping only slowly

- currently ~\$NZ 2100/kW - equivalent to Geothermal at \$6500/kW

Cost of wind power

International Renewable Energy Agency

- Capital Cost \$NZ2100/kW
- Energy Cost 8.2 cents at 35% capacity factor
- Operation and Maintenance ~2 c/kWh – increases as time goes on
- Exclude subsidies and include reserve plant etc**
- Energy cost**
 - Onshore 15.1 c/kWh
 - Offshore 19.2 c/kWh
- Combined cycle GT ~ \$NZ 1400/kW and ~7cents/kWh**



Status

- Expensive and intermittent
- Relies on a belief that it is an effective and cheap method of reducing man-made CO2
- it isn't
- Costs not decreasing
- Serious O&M problems
- Not a good investment

Solar power

Cost is ~\$2000/kW - at 10-20% capacity factor

- ~ \$3000/kW for rooftop installations

Maximum power in the middle of summer

- none during most NZ system peaks

Rapid drop in output when a cloud crosses the sun

Solar companies are going broke

- Solyndra defaulted on a \$500 m loan
- Suntech - bankrupt owing \$1.6 billion
- SunEdison, the "world's largest green energy company," broke - owes \$11 billion

Olmedilla Solar Voltaic Farm

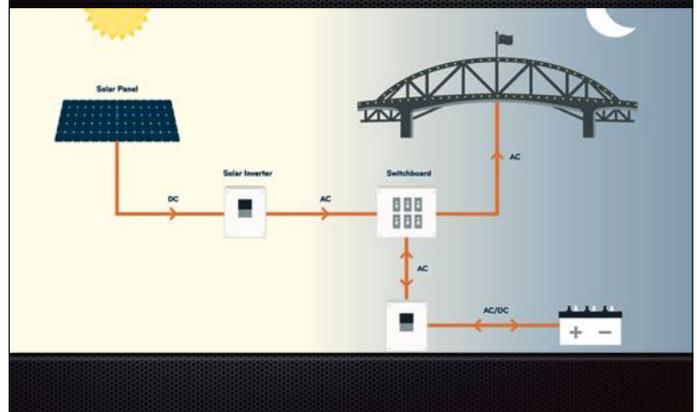
- 60 MW for \$US530 million
- \$US8800/kW
- ~87.5 GWh pa
- ~60c/kWh
- Loses 60% output on a cloudy day and 100% every night
- Subsidy: ~6 times market price for 25 years!
- A lot of glass to clean!



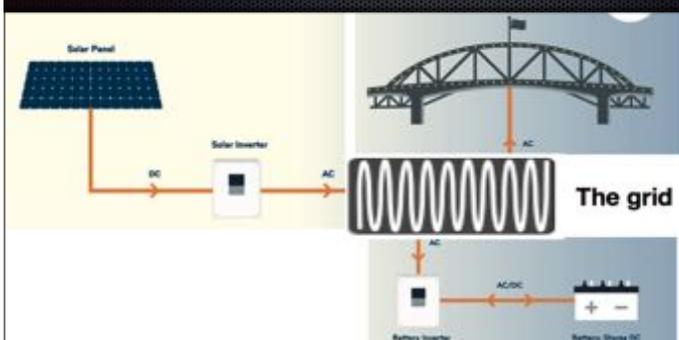
Wind, solar and wave power

- These technologies exist only because governments have chosen to subsidise them
 - at the expense of consumers and taxpayers
- Because they are intermittent, unpredictable and have a low capacity factor they load considerable additional costs on to the power system
 - paid for by consumers
- With present technologies, they have no prospect of competing with conventional generation on an equal basis.

The Harbour Bridge lighting - the promise



The reality



Transpower has concluded that grid connected batteries are not economic

Status

Expensive and intermittent

Costs not decreasing

Share prices have collapsed

Not a good investment

Workers needed to produce the same amount of electricity:

coal - 1; natural gas - 2; wind - 12; solar -79

Wave power

750 kW Pelamis: Average output 100 kW
Weight 1300t - 700t of machinery +600t of sand
Company went bust in 2014

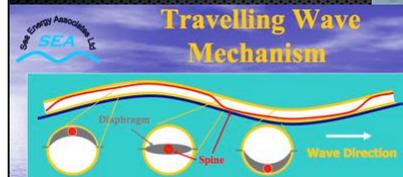


At \$5000/t, cost is ~\$9000/kW

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Sea Wave

A new concept
Under development
Great potential



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Status

Expensive

Technically difficult

Costs are high

Sea Wave could be a breakthrough

- watch this space..

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Why wind and solar power?

If the objective is

- reducing CO2
 - nuclear is far better and cheaper
 - or converting from coal to gas
- low cost power
 - CCGT and coal wins every time

But if the objective is transferring wealth from the poor to the rich

- **Subsidised wind and solar will do it!**

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Nuclear power

- The safest and most environmentally friendly form of power generation
- Uranium resources
 - proven: ~80 years supply
 - expected: ~250 years supply
 - 1000+ years with breeder reactors!
- Energy from thorium
 - 3 times as abundant as uranium ~750 years supply

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Nuclear power

- The safest and most environmentally friendly form of power generation

- Uranium resources

Nuclear power could supply all the energy the world needs for more than 500 years

- 3 times as abundant as uranium ~750 years supply

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Scenarios for the future

- Rational scenario
 - Continue to build hydro and geothermal
 - Stop building uneconomic wind and solar power
 - Keep nuclear power under review
 - Set up a market for dry year reserve energy
 - Set up a market for those who:
 - provide reliable power over peak demand periods
 - manage demand over peak demand periods
- Outcome: a reliable and economic supply

Scenarios for the future..

- Likely scenario
 - Continue with geothermal development
 - Encourage/subsidise the construction of wind and solar power
 - Avoid hydropower
 - Shut down Huntly
 - Run down gas supplies
- Outcome:
 - High prices and frequent shortages
 - Loss of energy intensive industries such as wood processing
 - Extreme difficulty in matching the fluctuations of wind and solar power
 - no gas for open cycle gas turbines
 - frequent under frequency load shedding

Questions

