Energy System Integration: *New Zealand Case Study, 2030 & 2050 Futures.*

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Background & Overview

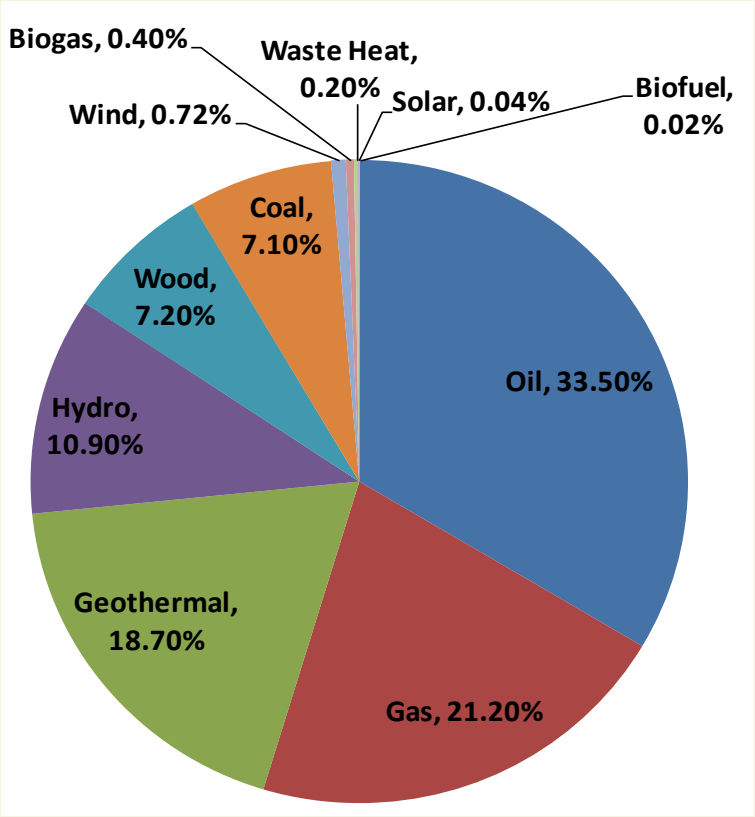
- NZ has LOTS of domestic energy resources!
  - Natural gas
  - Coal
  - *Lots of renewables – hydro, geothermal, wind, solar*
- National energy risks
  - Islanded system → no benefits from “neighbors”
  - Reliance on hydro→ energy - limited → vulnerable systems during drought
  - Earthquakes are common
- Population & energy outlook
  - Population – 2013:~4.5M, 2030: ~5.5M; 2050: ~6.5M
  - Per capita energy use 2011
    - Electricity: 2011 - 9,300 kWh-capita/yr → will likely decrease due to increased EE measures
    - 42.245 GWh annual electric energy
- Strong renewable policies (90% electric sector by 2020)

Energy Map of New Zealand

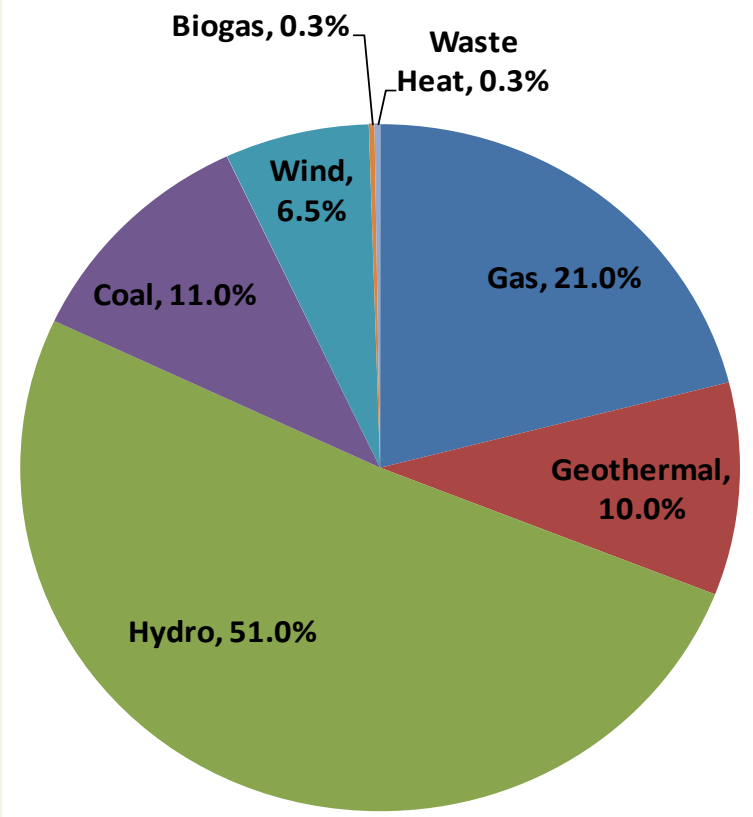
- High Temp Geothermal sources are located primarily in central part in northern island, while medium/low temperature sources are spread all through the N and S islands.
- Offshore and inland sites all through the country conducive to harnessing of wind power.
- High quality coal deposits in the southern island make the country self reliant in coal.
- Hydro energy sources are well spread.
- Country experiences moderate sunlight ideal for PV and solar thermal applications.

Existing Energy Resources (2008-10 figures)

Primary Energy, 2010

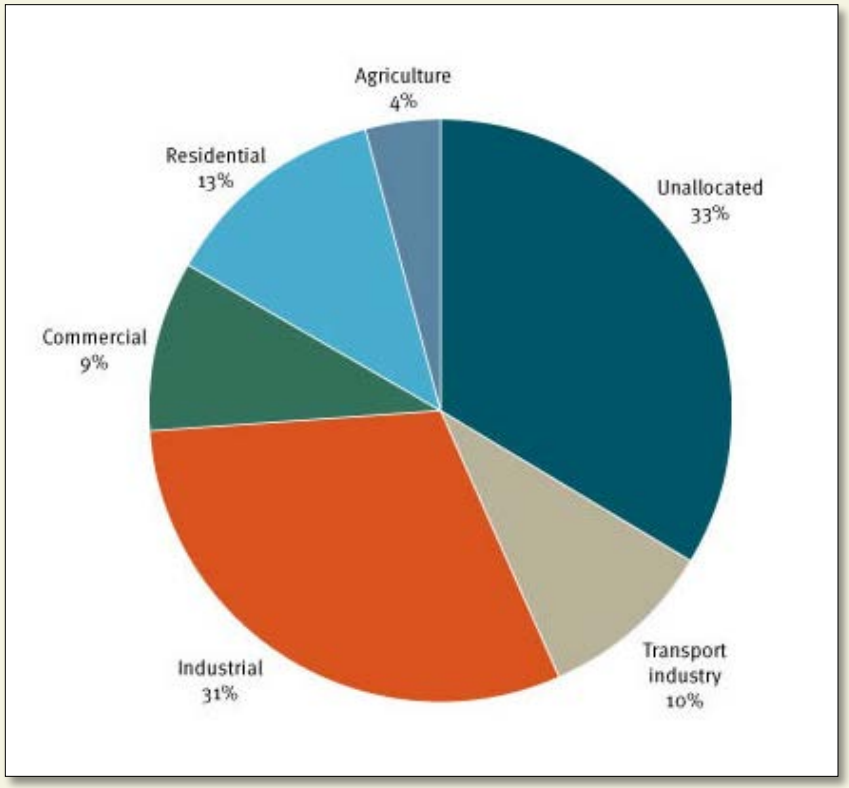


Electric Energy, 2010
Winter Peak ~ 9,900MW

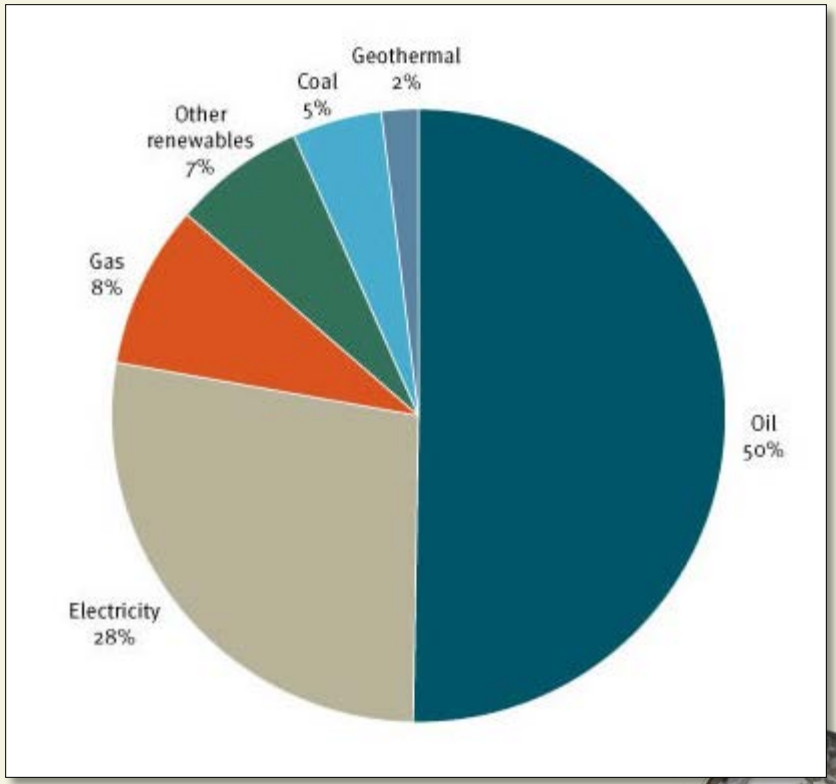


Detailed energy use statistics. (2007 figures)

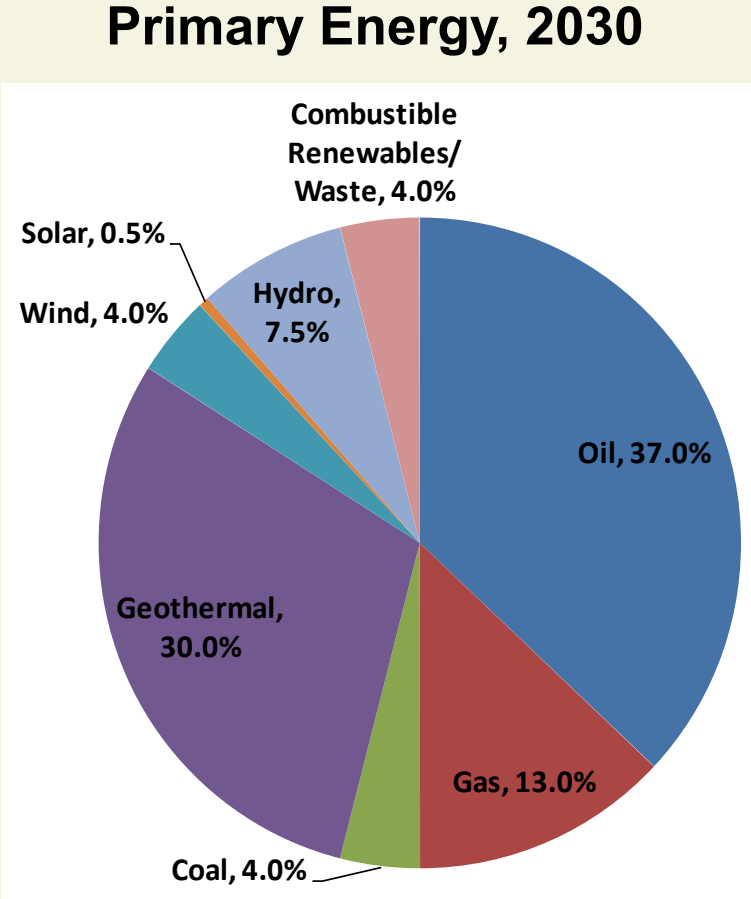
Consumer energy demand in New Zealand by sector.

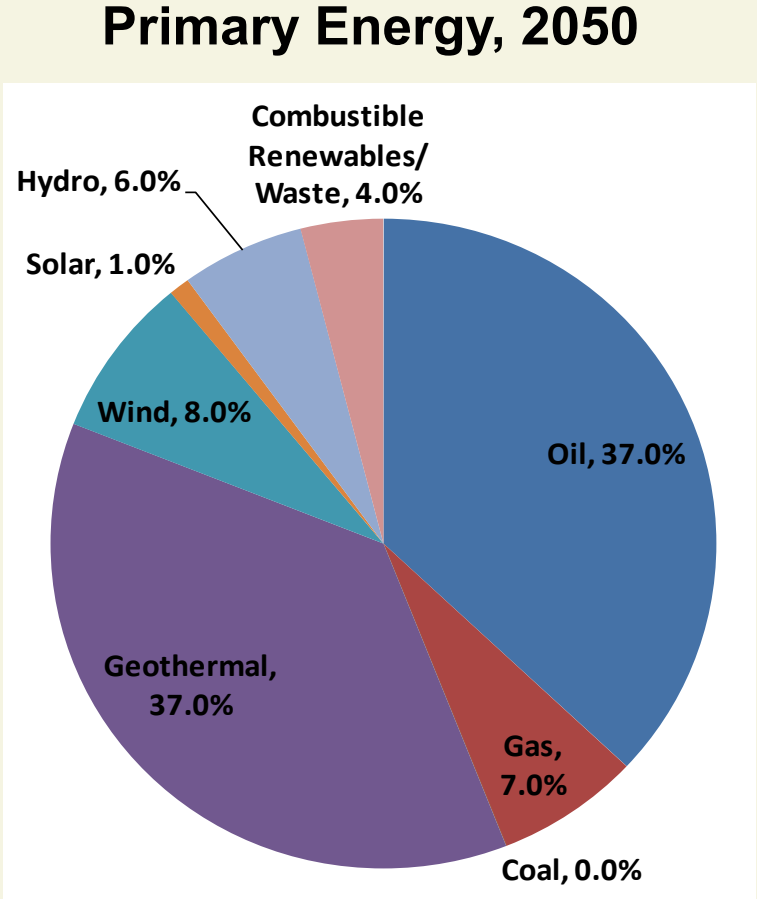


Consumer energy demand in New Zealand by fuel type.

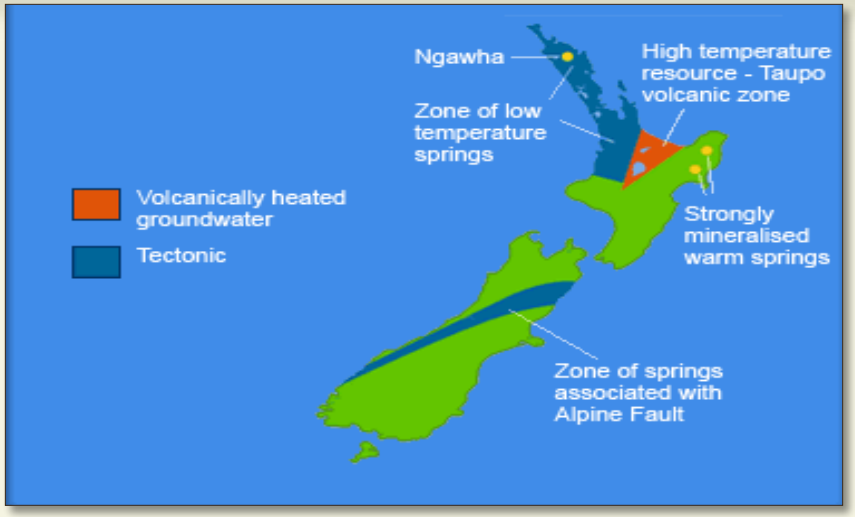


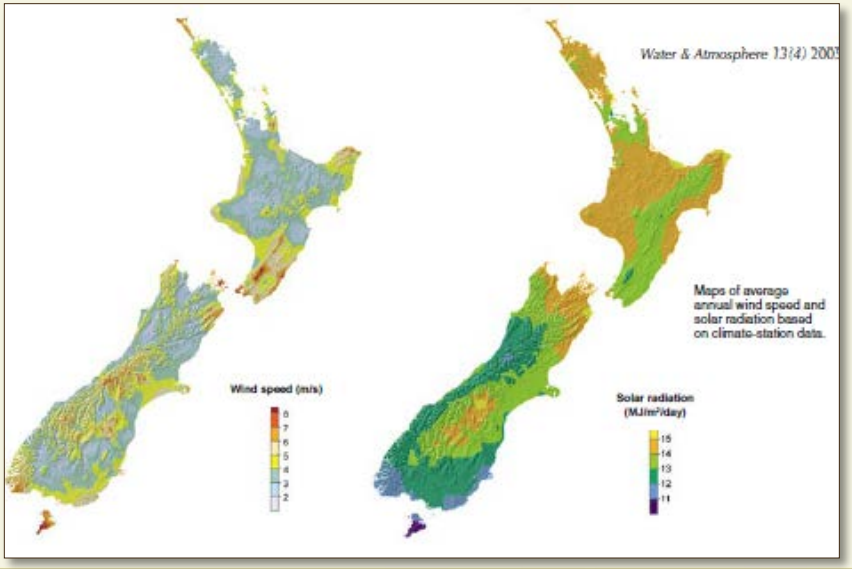
Estimated Future Energy Resources





Resource Projected Growth





- Geothermal
  - 100% total growth possible
  - High temp – Power/cogen
  - Low temp – GSHP, industry low pressure steam
- Wind
  - 623MW current
  - ~2,500 MW under development
  - Future growth anticipated
- Solar
  - Distributed PV
  - Solar thermal

New resources, new challenges

- Retired resources:
  - Coal by 2050.
  - Some gas-fired units will retire. A small percent will be maintained as peaking units as well as for spinning reserve.
- Wind power growth (seasonal/diurnal correlation w/ load?)
  - How to factor into capacity valuation?
  - Islanded system → emulated inertia needed, but is it fast enough?
- Solar Thermal/PV
  - Prospects for solar have never been thoroughly analyzed.
  - How much potential do they have? What contribution to the electricity demand?
- Energy efficiency measures and demand response necessary to sustain this highly renewable based system.
- Complete independence from coal, minimum dependence on gas, high penetration of wind will give rise to demand-supply mismatch.
- Very high dependence on hydro makes system very sensitive to shortage which will lead to severe energy shortage.

Energy System Integration

Emphasize Fuel Diversity & Synergies

- Transportation electrification
  - EVs and CNG based commercial transport to be encouraged.
  - Research work to be done for development of bio-fuels.
  - Increased solar PV network may help in dealing with increasing EV load.
- District heating/energy implemented in urban areas
  - Inputs: CHP (gas/biomass), geothermal, “excess” wind, waste industrial heat.
  - All this coupled with intelligent control for maximum efficiency.
- Integration of wind/solar → increased fuel diversity
  - Times of drought = high solar resource
  - Pumped storage for maintaining spinning reserve.
- Gas system
  - Use of biogas, synthetic methane for storage in depleted gas/petroleum reservoirs.
  - These storage units will serve as a back-up for the system in times of seasonal emergencies (ex. Drought conditions restricting operation and output of hydro power plants)
- Efficient water usage
  - Water treatment plants to be linked with biogas facility as well as CHP plants for a highly efficient, symbiotic operation.
- Thus, the New Zealand energy system will be well integrated in the coming years, along with 100% contribution of renewable energy sources for electricity generation.

ESI Example: *"Smart City" of Auckland*

- Auckland the largest city of New Zealand, has high population growth and is well situated with respect to all renewable energy resources.
  - Primary power for the city will be obtained from the grid. Presence of high-temp geothermal resource nearby is a plus.
  - District heating to be completely dealt with from low to medium temp geothermal source. These will also supply to the industry.
  - Extensive penetration of rooftop solar, and high output is possible as it has temperate climate. Possibility to be explored of tying the output of solar PV to a EV charging network (grid connected), and creating a "resilient communication network"
  - Water input and heat input to be metered with the help of smart meters. Data used for demand forecasting and thus efficient scheduling of both.
  - Demand response for heat and electricity to be synergized using smart water heaters and pumps.
  - Micro-grid like structure (by clubbing a number of households) can be considered a single unit for modular development of all these innovations.
  - Gas storage facilities to be tied in to the energy grid as reserve capacity.
  - Utility – Micro-grid – Private Company – Customer, communication network working on uniform standards to be developed.

New Zealand Energy Efficiency and Conservation Strategy 2011–2016

- Electricity System: An efficient, renewable electricity system supporting New Zealand's global competitiveness.
- Transport: A more energy efficient transport system, with a greater diversity of fuels and alternative energy technologies.
- Business: Enhanced growth and competitiveness business from energy renewable improvements.
- Homes: Warm, dry and energy efficient homes with improved air quality to avoid ill-health and lost productivity.
- Public Sector: Greater value for money from the public sector through increased energy efficiency.
- Products: Greater business and consumer uptake of energy efficient products.

New tools for achieving the objectives

- Software tools for demand forecasting and efficient dispatch for heat-water-electricity grid.
- Wide area, high speed communication network for quick co-ordination of consumers-utility-3rd party providers.
- Critical improvements/inventions necessary to solve power system stability constraints for a network with high penetration of renewables.
- Tools that can envisage creation of energy market structure at micro-grid level to achieve high flexibility.

References

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  - Ministry of Business, Innovation and Development.
- *Energy Policies of IEA countries, IEA Review. 2010.*
- *The New Zealand Energy Sector: New Zealand Trade and Enterprise.*
  - *East Harbor Energy Limited.*
- *New Zealand Energy Strategy potential: Developing our energy, and New Zealand Energy efficiency and conservation strategy.*
  - *Ministry of Economic Development.*

Thank you!

- ✓ Questions are welcome!