POWER GENERATION IN NEW ZEALAND

Disclaimer:
I am in no way an expert of the NZ power system. I am merely sharing my personal experiences of publicly available information.

New Zealand Electricity System

Until 1987, New Zealand had a centrally run system of providers of generation, transmission, distribution, and retailing. Reform has since led to the separation of the monopoly elements from the contestable elements to create competitive markets in energy retailing and generation. Regulation has also been imposed on the natural monopolies of transmission and distribution. Currently the market is split into the following areas:
Regulation, administration, generation, market clearing, transmission, distribution, metering and retail.

The owner of the national transmission grid is Transpower, a state-owned enterprise. Transpower is also the System Operator, responsible for ensuring real time electricity supply security and quality. Transpower is the market scheduler, predicting demand to help generators make offers, as well as the dispatcher, in charge of matching demand and supply in real time.

Distribution of electricity from the grid exit points to the end consumers' premises is the responsibility of about 30 distributors, also known as lines companies, who have monopoly control of the lines services on their networks. Ownership of distributors is through trust-owned companies, such as Auckland Energy Consumer Trust, and public companies.

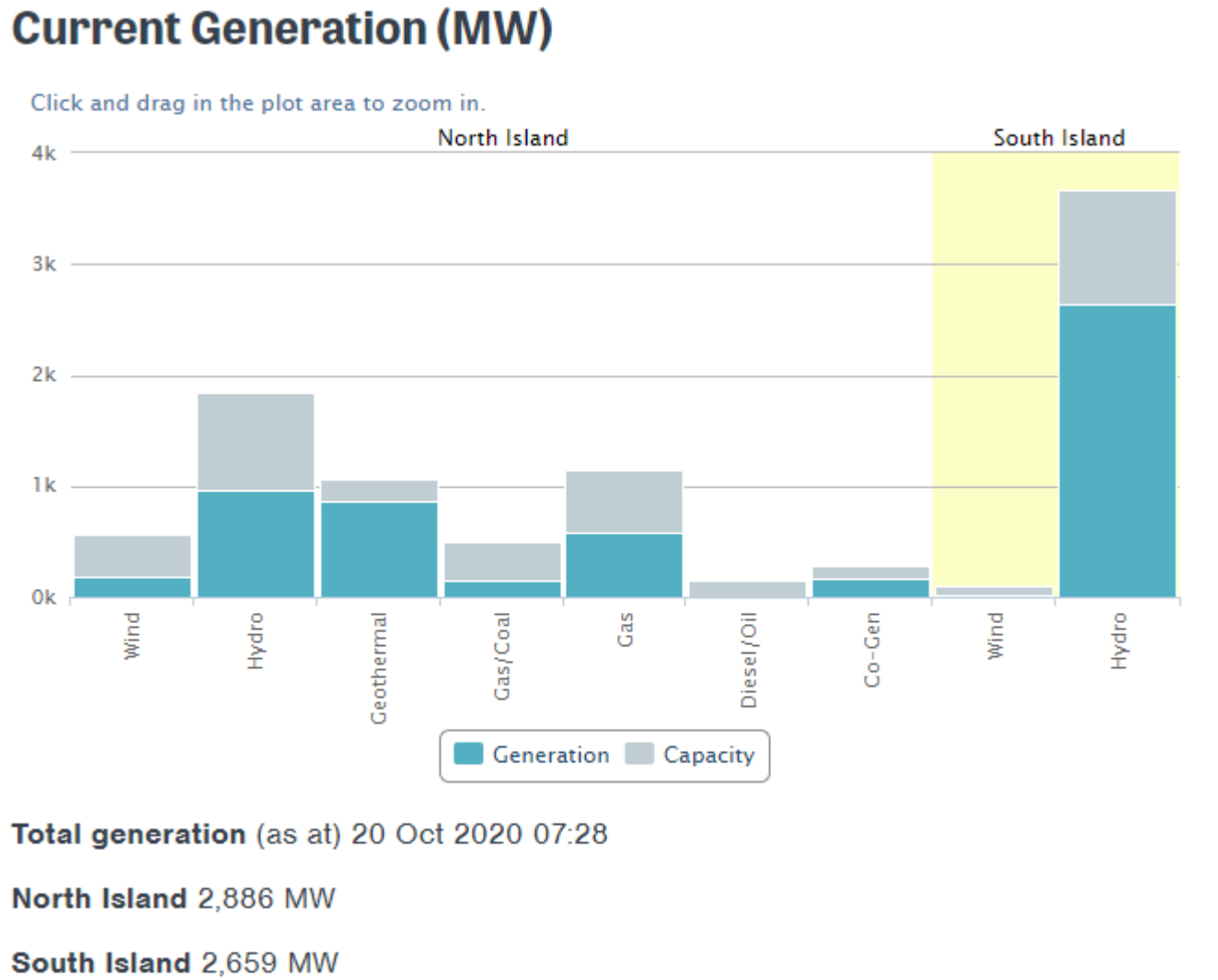
Energy Market Reinvention Timeline

<1987	In the 1980s the **New Zealand Electricity Department (NZED)**, a government department, controlled and operated almost all New Zealand electricity generation and operated the electricity transmission grid.
1987	**Electricity Corporation of New Zealand Ltd** (**ECNZ**) is a New Zealand state-owned enterprise (SOE) formed on 1 April 1987, as a transition entity in the process of deregulating the New Zealand electricity market
1994	**Transpower** was separated from ECNZ and created as an SOE to own and operate the national grid
1996	ECNZ was split into two SOEs, **ECNZ** and **Contact Energy**
1999	ECNZ was split into three electricity generation SOEs: Genesis Energy, Meridian Energy, and Mighty River Power (now Mercury Energy).

Present Electricity System

- There are five major generators: Contact Energy, Genesis Energy, Mercury Energy, Meridian Energy and TrustPower.
- These five together produce about 95% of New Zealand's electricity.
- Meridian Energy, Genesis Energy and Mercury Energy are 51% majority owned by the New Zealand government
- Contact and Trustpower are 100% publicly traded companies.
- An important feature of the New Zealand market is that all the major generators also own retailing arms. The companies are thus commonly known as "gentailers" (generator–retailers.)
- Retailers purchase electricity from the wholesale market, and on-sell it to consumers. Competition for retail customers varies across the country but since 1999, when full retail competition was introduced, customers have switched at a rate between 9% and 14% between different retailers per annum.
- Gentailers are modern and dynamic which is a probably a direct outflow from the direct competition in the retail market.

New Zealand Installed Capacity



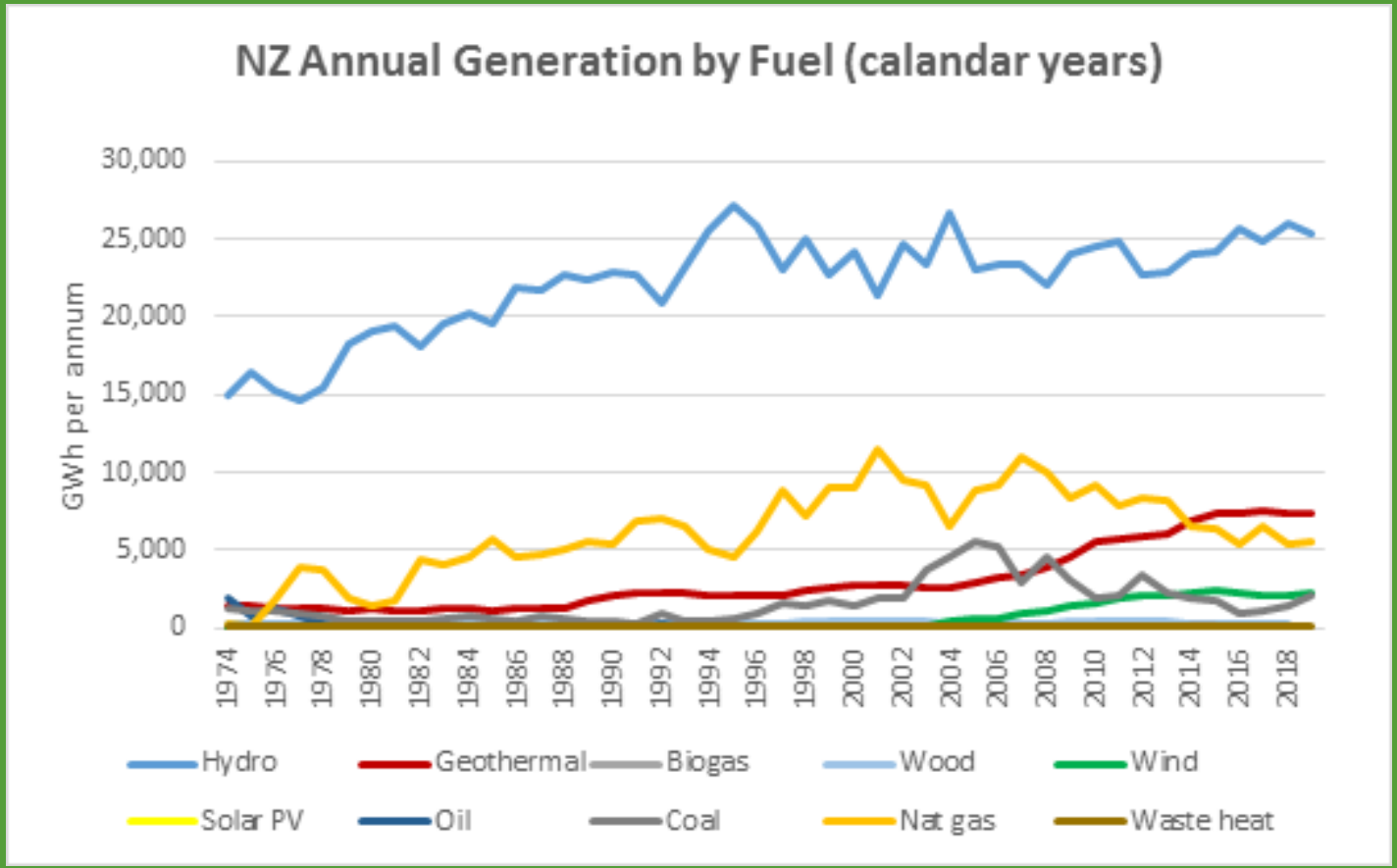
Source: Transpower

- NZ population of 5M
- Total Generation Installed: 9 313 MW

- Wind: 659 MW
- Hydro (N+S): 5 508 MW
- Geothermal: 1 064 MW
- Coal: 500MW
- Gas: 1 1150 MW
- Diesel/Oil: 155 MW
- Co Gen: 277 MW

- Aim is to be completely Renewable by 2035.

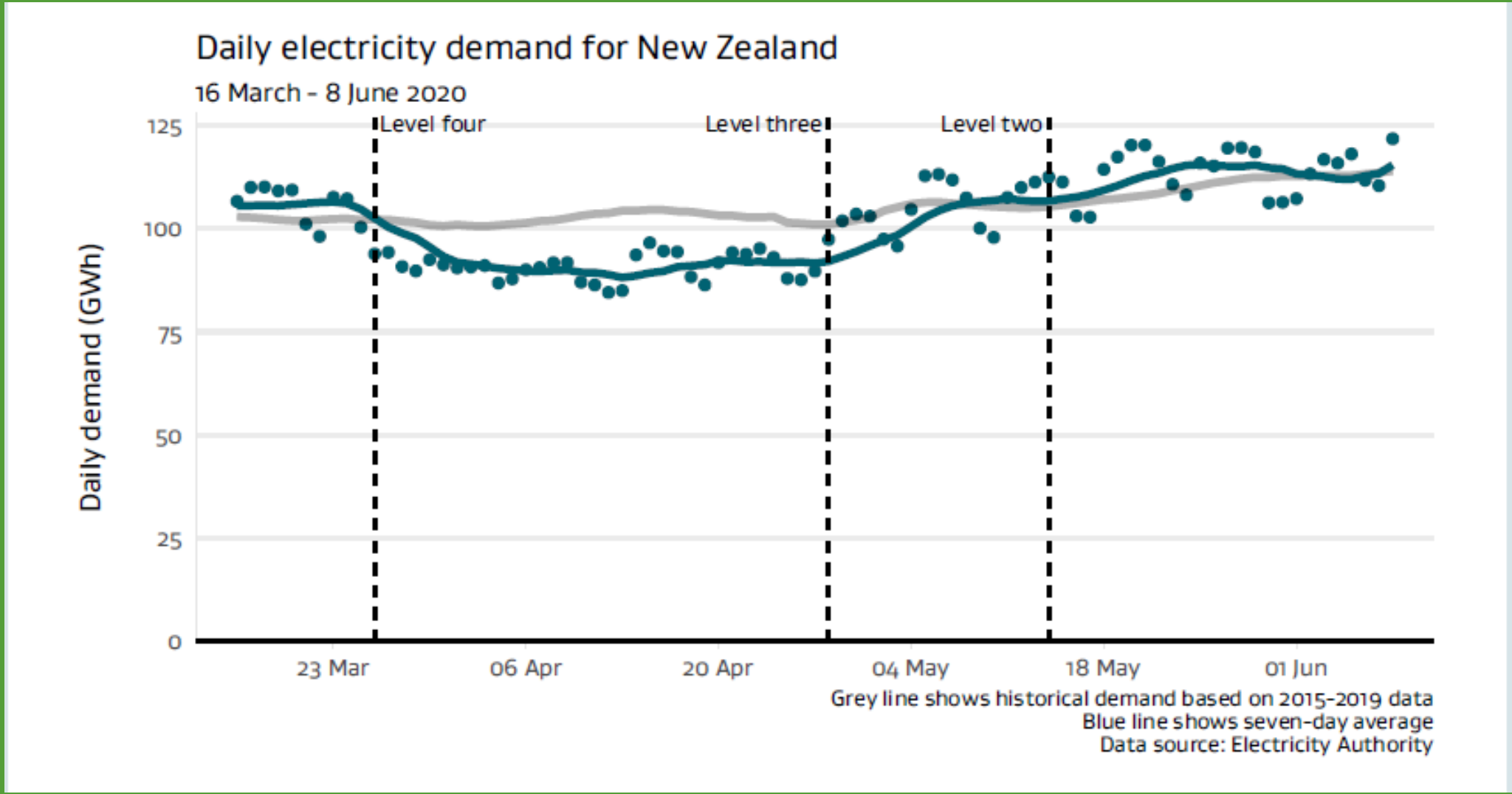
New Zealand Annual Net generation 2019



- Renewable generation make up 83% of New Zealand's total power generation
- Hydro generation the major contributor to renewable generation but is affected by seasonal hydro conditions – 2019 was a very dry year impacting directly on hydro.
- Geothermal generation represent 17% of total NZ power generation 2019 (7 439 GWh)
- Wind Generation presently the major expansion in the renewable energy sector
- Only one major thermal power plant in New Zealand – Huntley Power Station in the Waikato region.

Source: NZ Ministry of Business, Innovation and Employment

COVID IMPACT ON POWER GENERATION



Mercury Power Generation

Generation in Mercury

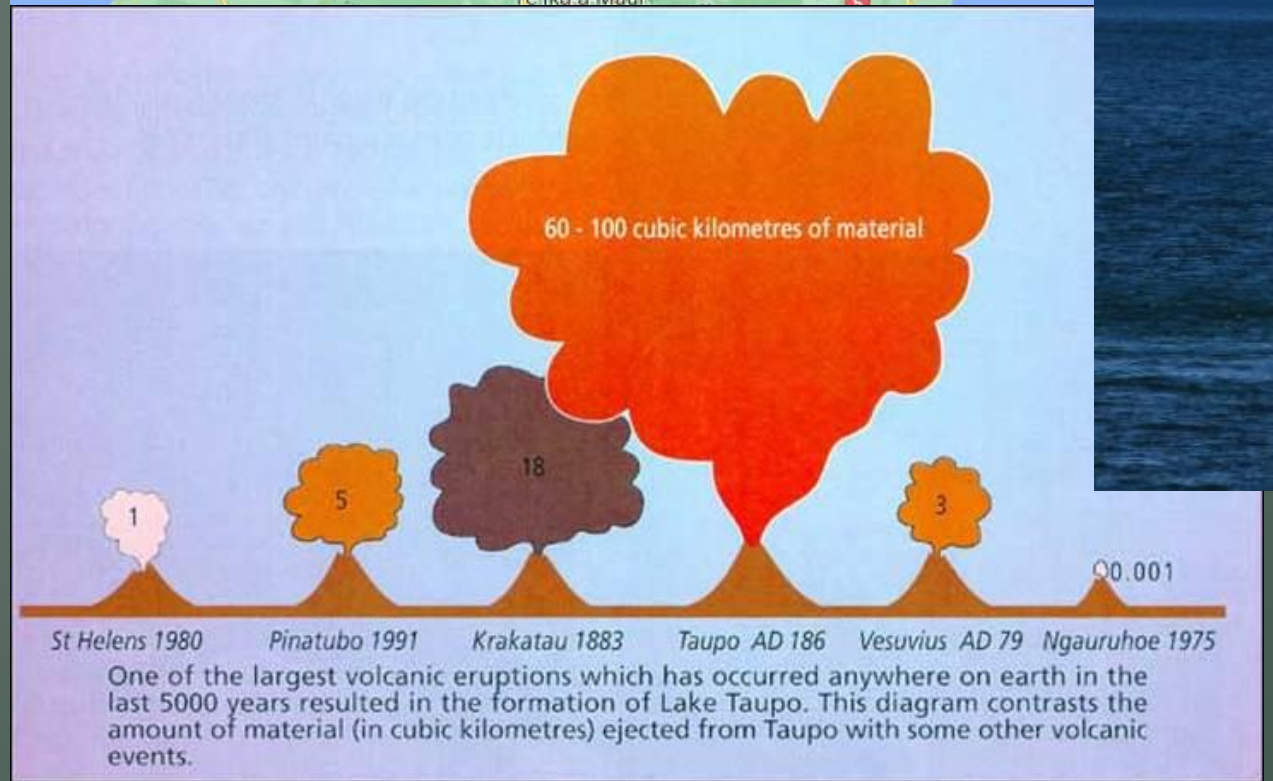
- Geothermal
- Hydro
- Wind
- Solar

BIRTH OF MERCURY

- **On 1 April 1999 – a reform of the New Zealand electricity sector took effect: the Electricity Corporation of New Zealand was broken up into three state-owned generating companies – Mighty River Power (now Mercury), Genesis Energy and Meridian Energy. MRP (now Mercury) took ownership of the eight hydroelectric power stations in the Waikato river.**
- In 2000 MRP purchased into its first geothermal power stations as joint ventures with local trusts.
- National Government introduced a mixed ownership plan in 2011, to sell off 49% of its shareholding in generating assets to private investors, which took affect on 5 May 2014.
- MRP changed its name to Mercury NZ Limited on 29 July 2016 after merging its retail and generation businesses.
- Generates 17% of NZ's energy from Hydro and Geothermal Generation – 100% Renewable
- One of 5 generation companies servicing NZ – Genesis, Meridian, Contact Energy, Trustpower

HYDRO

- Lake Taupo – Largest lake in NZ
- 46km long x 33km wide, 186 m deep at maximum point
- Same size as Singapore
- The lake formed from one of the largest volcanic eruptions to occur anywhere on earth
- Legislated control level of only 1.4 meter
- Mercury Hydro



One of the largest volcanic eruptions which has occurred anywhere on earth in the last 5000 years resulted in the formation of Lake Taupo. This diagram contrasts the amount of material (in cubic kilometres) ejected from Taupo with some other volcanic events.

All of Mercury's Hydro Generation is situated in the Waikato river.

The Waikato river outflow from Lake Taupo (Huka Falls) for 425km before flowing into the Tasmin Sea South of Auckland

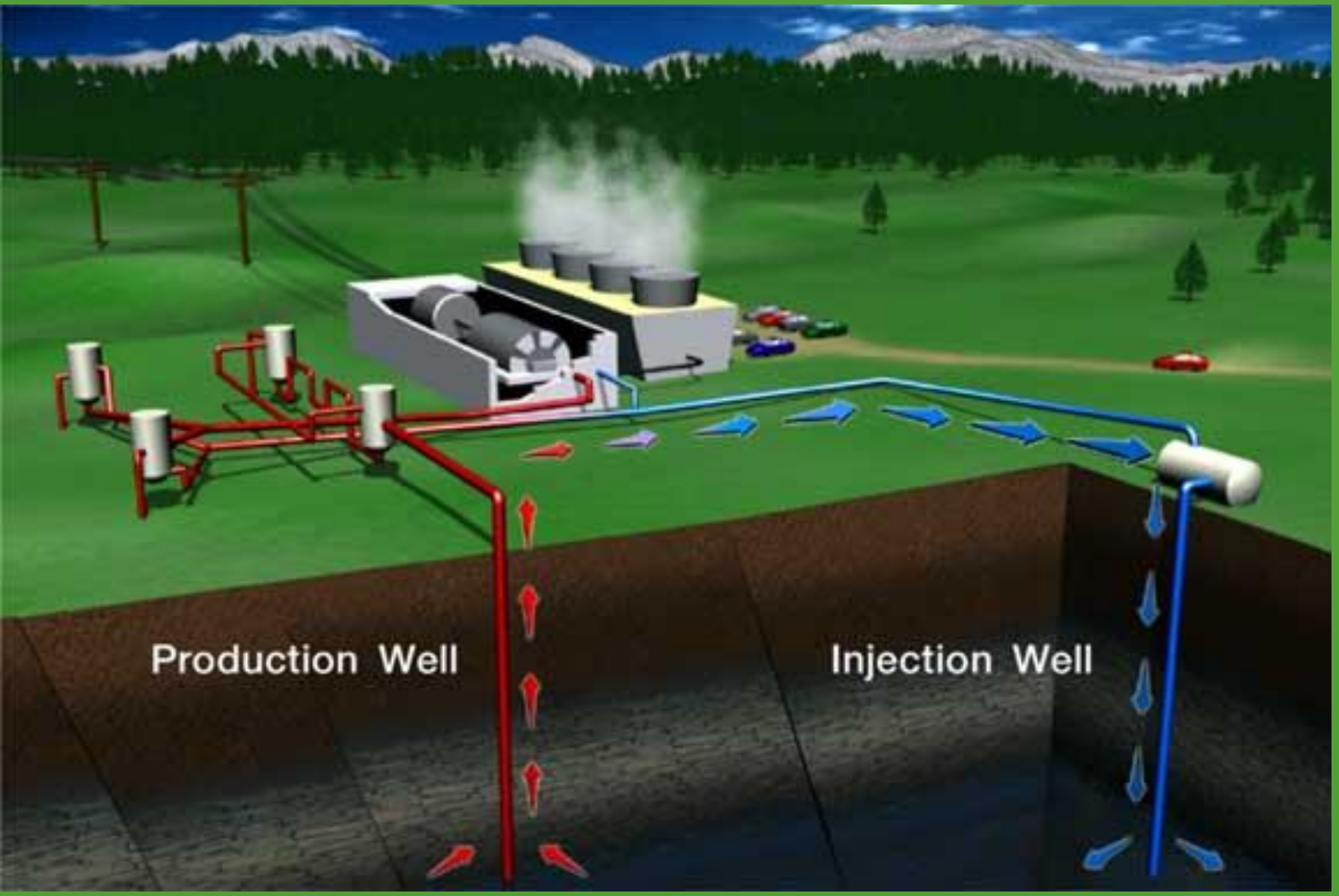
Power Generation from 9 power plants situated along the river

Mercury control complete river flow and dam levels

- Aratiatia – 78MW – 1964 – Refurb 2018 to 2020
- Ohakuri – 106MW – 1961
- Atiamuri – 74MW – 1958
- Whakamaru – 1956 – 124MW – Refurb 2017 to 2020
- Maraetai 1 – 1952 – 180MW
- Maraetai 2 – 1970 – 180MW
- Waipapa – 1961 – 54MW
- Arapuni – 1929 – 192MW
- Karapiro – 1947 – 96MW

Huka Falls

Geothermal



- Steam wells extend in excess of 3km into earth
- Steam temperatures of 375°C can be achieved
- Base load generation
- Two technologies in use to extract energy from geo-thermal steam:
  - Direct steam fed into turbines
  - Steam heat energy is used to heat up Pentane which drives turbines – clean and flash point is very low

Largest Geothermal plant is Nga Awa Purua (NAP) – 135MW steam turbine – largest single shaft turbine in the world

GEOTHERMAL GENERATION – MERCURY PLANTS

> Rotokawa (Pentane) - 34MW built in 2000 (Joint Operation with Tauhara No. 2 Trust)

> Ngatamariki (Pentane) – 82MW built in 2013 – Pentane 4 generators with 2 OEC turbines per generator (JV)

> Mokai (Steam and Pentane) -112 MW built in 2000 (JV with Tuaropaki Trust)

> Kawerau (Steam) - 106MW built in 2008

> Nga Awa Purua (Steam) – 135MW built in 2010 (Joint Operation with Tauhara No. 2 Trust)

- Mercury presently produces 52.7% of NZs geothermal generated electricity (385MW)
- Geothermal generation are base load stations, onload at full load 24/7.

Generator Technologies on Geothermal Sites

Generators in use are 11kV air cooled machines

Steam Turbine Generators are 2 pole generators

Ormat Energy Converter (Pentane) generators are all 4 pole generators with the largest 30MW generators driven by two 15MW OEC's

Generators operate in high humidity as well as H2S environments. This is affecting the Outer Corona Protection tape between stator core and stress grading, resulting in significant erosion of the OCP. Once the OCP is eroded, significant increase in Ozone levels are causing havoc to all metallic components in the generator – corroding cables, diodes, terminals, glands, etc.

Wind generation

Turitea Wind Farm in construction

On completion it will be the largest wind farm in NZ with 60 off 3.45 MW Vestas V112 DFIG wind turbine generators with a total generating capacity of 222MW and estimated 840GWh annual generation

Mercury Wind

GENESIS

> Thermal Generation:

The Huntly Power Station is the largest electricity generation facility in New Zealand by capacity - 953 MW. It is made up of two modern gas fired and two gas/coal fired generating units.

> Renewable Generation:

- Genesis has three hydro schemes: Tongariro (361.8 MW), Waikaremoana (138.0 MW) and Tekapo(179.0 MW). These schemes comprise eight power stations. Six are located in the North Island and two in the South Island.
- Genesis also have a 7.3 MW wind farm at Hau Nui in the North Island. This geographical spread of generation helps reduce the impact of localised dry periods on Genesis' earnings.

MIREDIAN

> Wind: 202 wind turbines with installed capacity of 417 MW

> Hydro:

- Owns NZs largest hydro power station – Manapouri located in the South Island – 850MW
- Owns six power stations in the Waitaki hydro scheme situated in the North Island 1 538 MW

> Solar

CONTACT ENERGY

> Hydro: Two Power Station with combined installed capacity of 784 MW

> Geothermal: 5 Power Stations with combined installed capacity of 468 MW

> Gas: Two power stations with combined installed capacity of 629 MW

> Diesel (Open Cycle): 155MW

TRUSTPOWER

> Pre-1998 Energy Reform Trustpower was mainly a municipal entity with generation, transmission and distribution assets.

> Trustpower now operates as a Generator/Retailer.

> Hydro – 431.5 MW Installed capacity from 28 power plants

Future Energy Landscape

Rio Tinto Tiwai Point Aluminium Smelter closure was announced in 2020.

- Tiwai Point is a major consumer of electrical energy in New Zealand (13% of total national electricity consumption) with a dedicated hydro power plant located nearby (Manapouri – Meridian).

- Tiwai point is located in the most southern tip of the South Island. Closure of Tiwai Point will result in excess generating capacity in the South Island with limited means of transmitting surplus electricity to the North Island.

- South Island landscape complicates fast and cost effective construction of additional transmission lines.

- Re-introducing the access electricity into the Transmission Network will result in 13% surplus which is presently placing all future generation projects on hold. New Geothermal projects

HYDROGEN

> Various demonstration projects are taking place which includes production from renewable energy, transport options (cars and busses) and refuelling stations, export studies, hydrogen gas pipelines, etc.

> NZ has ordered its first hydrogen fuel cell bus which will have an estimated range of 500km on a single fill.

> A 1.5 MW Hydrogen Production plant is erected near the Mokai Geothermal power plant, which will use renewable energy from the Mokai power plant for the production of Hydrogen Gas.

> Gas produced from Geothermal power plants will be used for the domestic as well as export market.

QUESTIONS