# Alternate Renewable Energy Sources in New Zealand

## Solar, Bioenergy, and Marine

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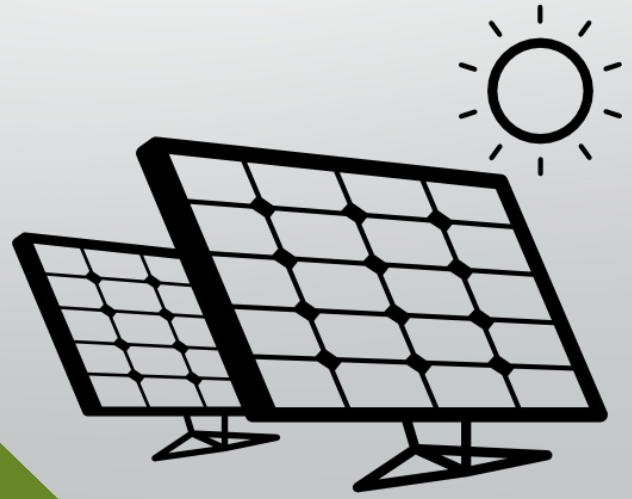
EGEE 497



# Overview: Electricity Production in NZ (2021)

## Renewable Sources

**35,528.4 GWh (82.1%)**

- Hydroelectric: 55.5%
- Geothermal: 18.4%
- Wind: 6.0%

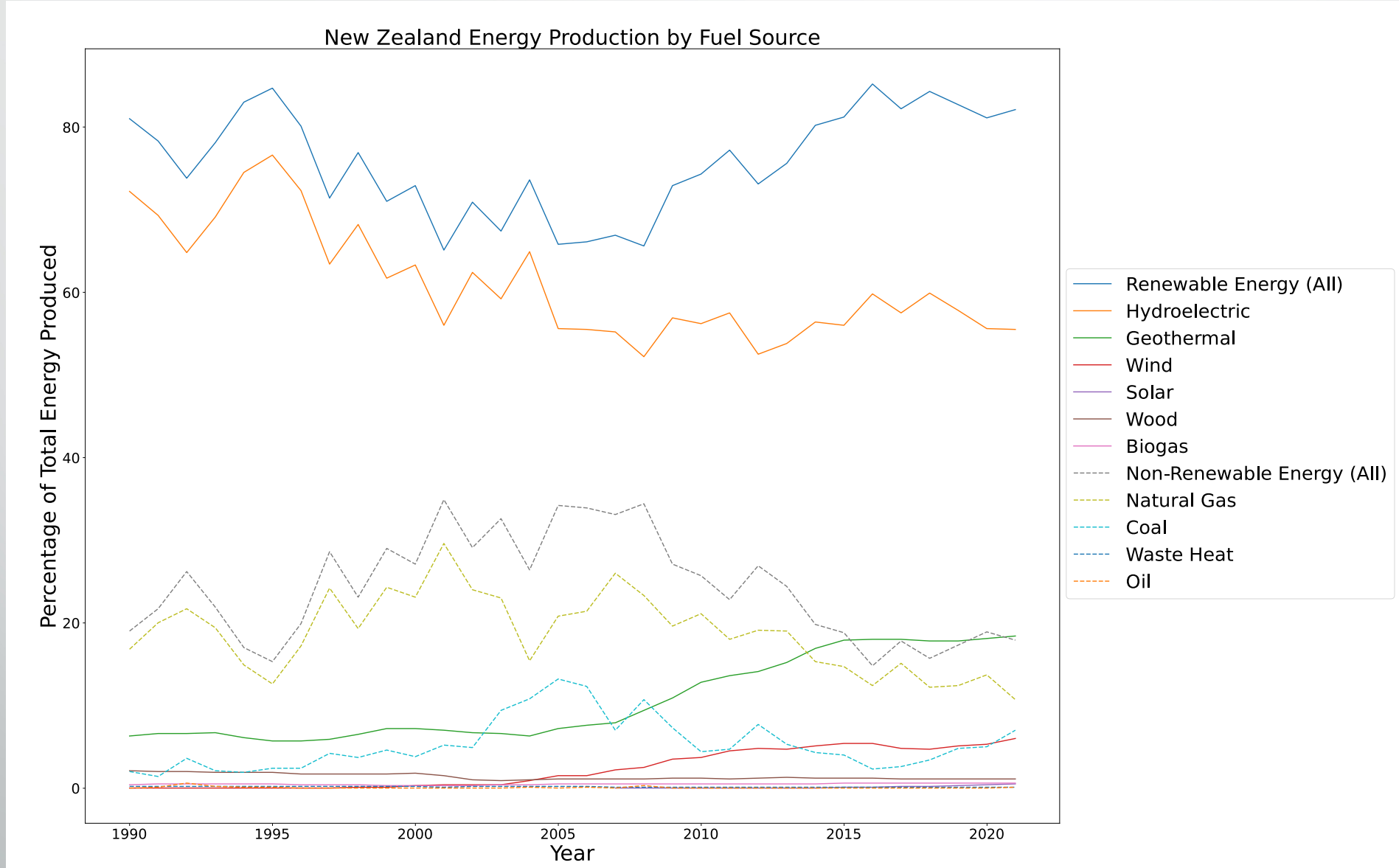
## Non-renewable Sources

**7,738.6 GWh (17.9%)**

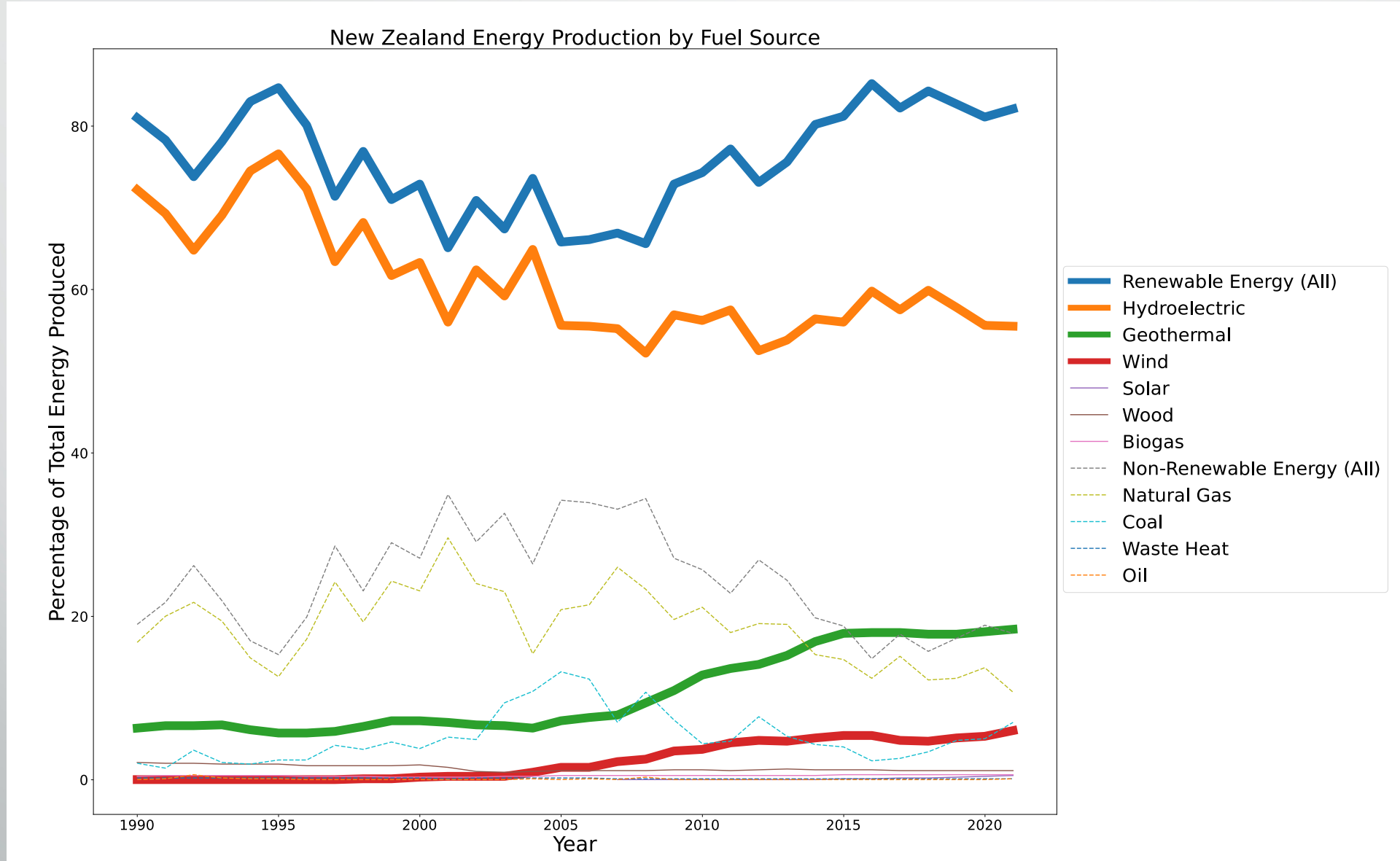
- Natural Gas: 10.7%
- Coal: 7.0%

**<u>Total Electricity Produced</u>:**
**43,267 GWh**

Data from: NZ Energy Dashboard



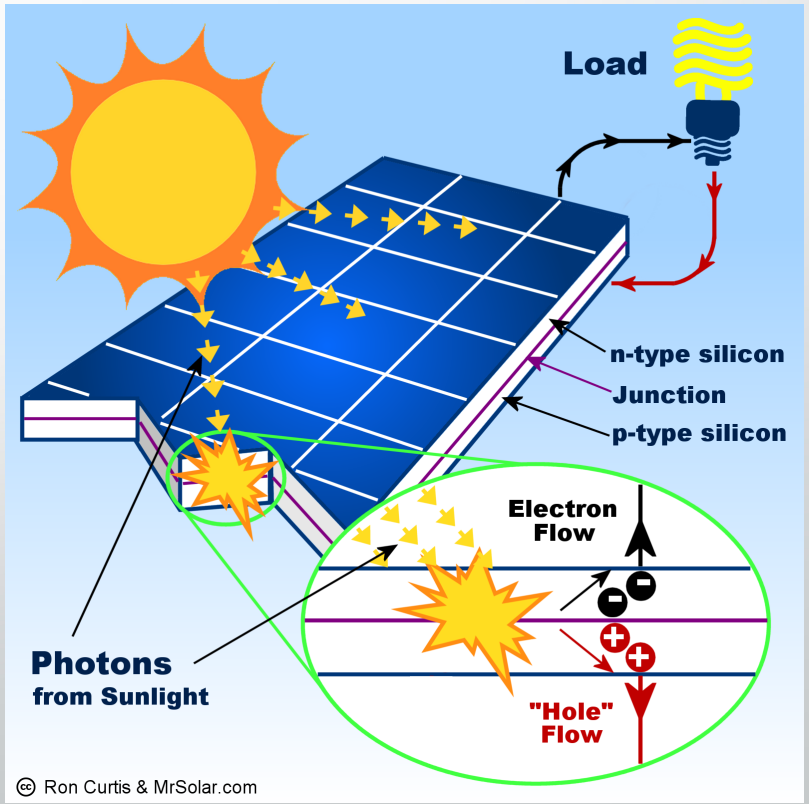

Data from: NZ Energy Dashboard




Data from: NZ Energy Dashboard

# Introduction to Solar Power

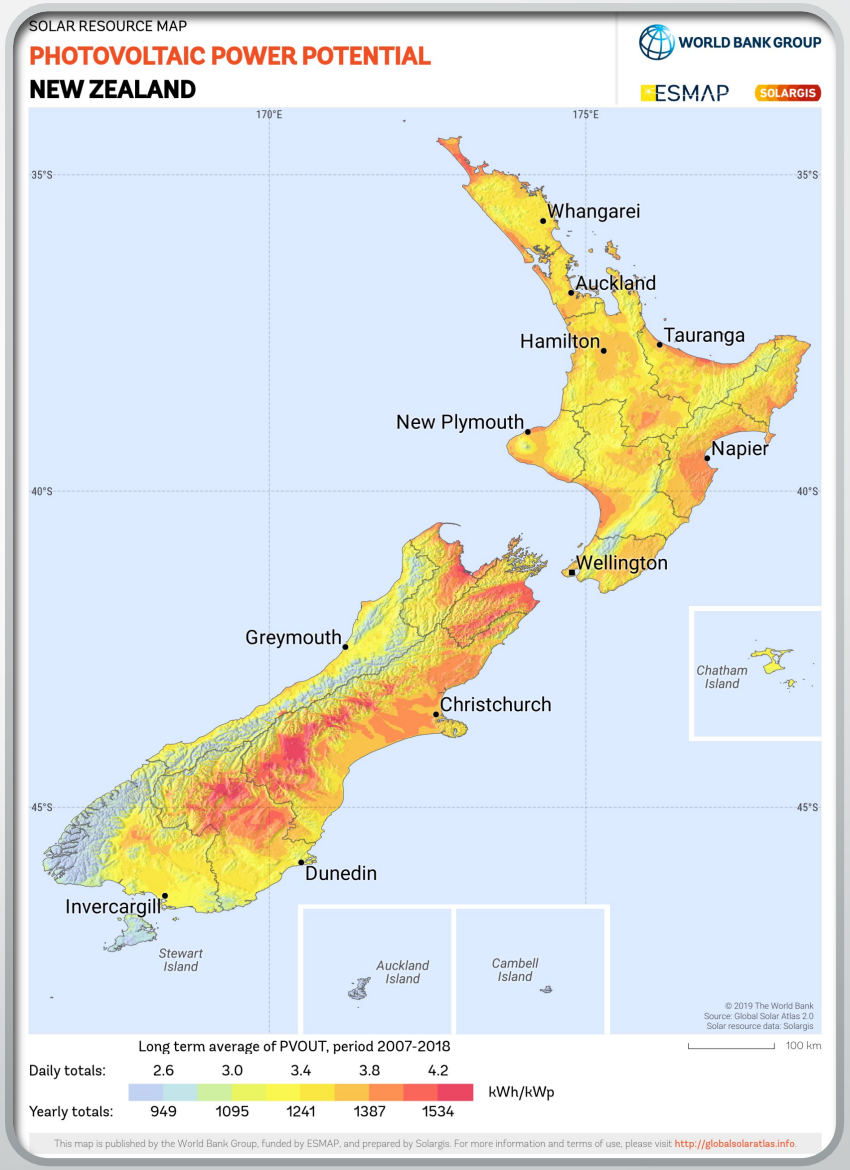
- Photovoltaics (PV)
  - Converts sunlight (photons) into electricity
- Several types of PV cells
  - Silicon
  - Thin-Film
  - III-V
  - Next-Generation
- Additional heat energy can be harnessed




Source from: NREL

# Solar Power Potential in NZ

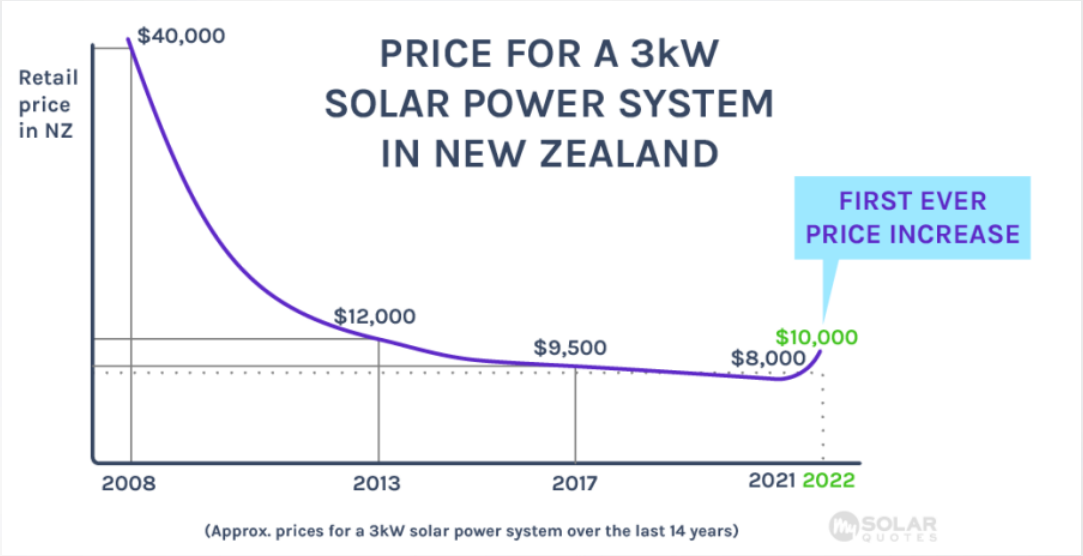
- North Island receives ~3.4-3.8 kWh/kWp a day
  - Between 1200-1400 kWh/kWp per year
- South Island more variable:
  - ~4.2 kWh/kWp per day (~1500 per day) in island center
  - ~2.6 kWh/kWp per day (>1000/day) along high-elevations

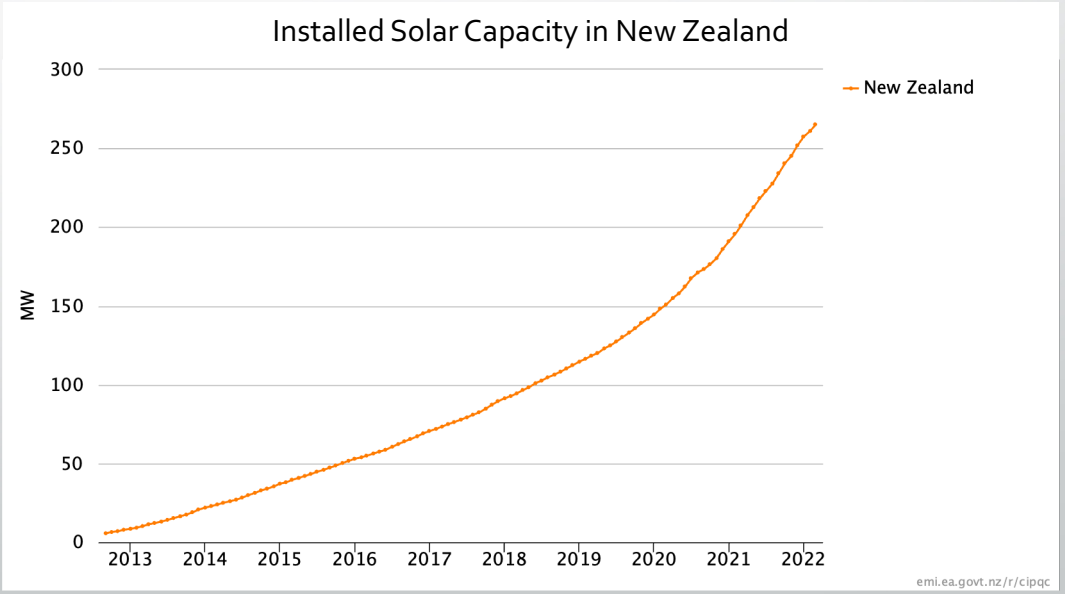



Map from: SolarGIS

# Development of Solar in NZ

- Price of 3 kW system
  - $40,000 NZD in 2008
  - $8,500 NZD in 2019
- Installed capacity
  - 8.57 MW 2013
  - 114.618 MW 2019
- Electricity generation
  - 3 GWh 2007
  - 127 GWh 2021



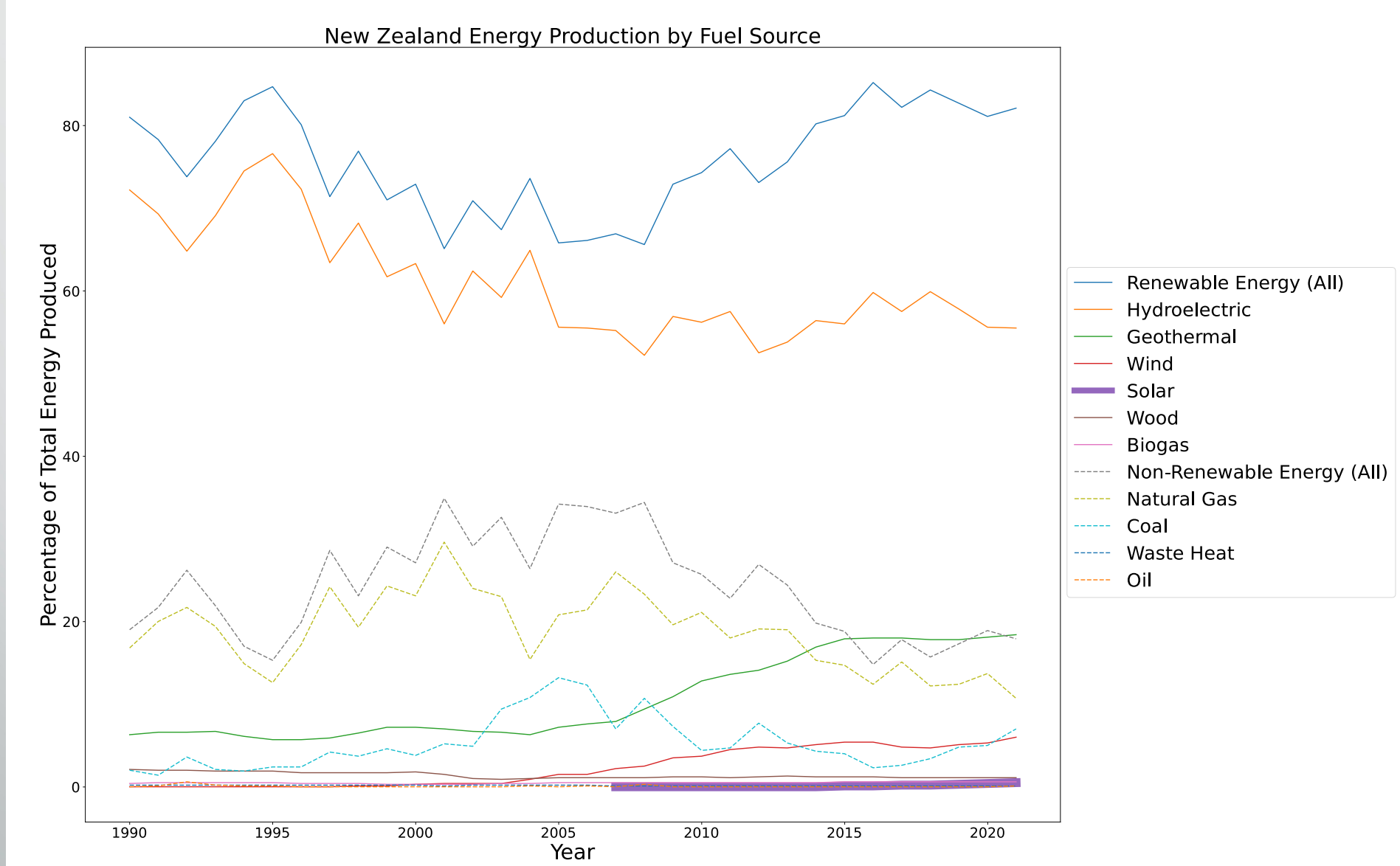

Sources: EMI, MBIE, and My Solar Quotes

# Current Solar Power in NZ

- 0.5% electricity generation (2022)
  - 0.2% energy consumption
- 265.23 MW Capacity (Feb 2023)
- 205 GWh Generation (2021)

South Auckland Forging Engineering Ltd. (S.A.F.E. Ltd.)
Solar Plant opened in Drury, 2012
360 PV Cells, 68kW (~476 kWh)

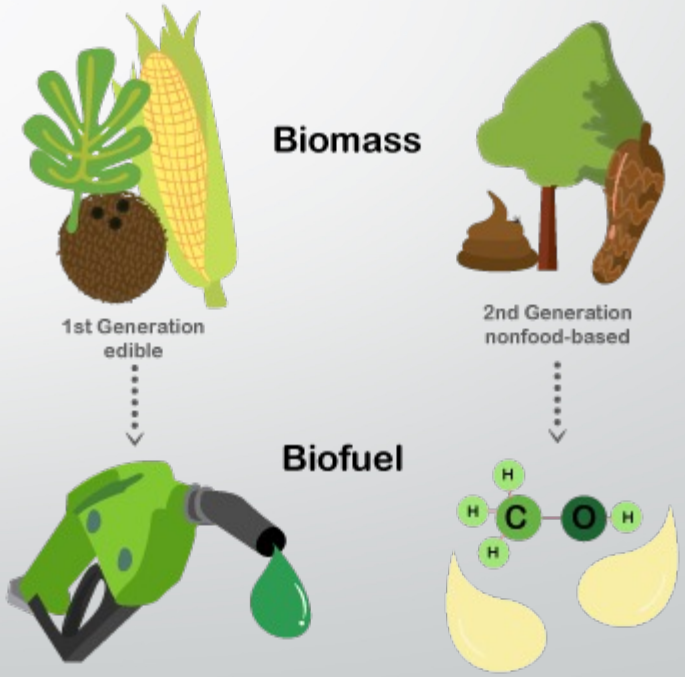
Sources: MBIE, EMI, DEMM Engineering & Manufacturing




Data from: NZ Energy Dashboard

# Introduction to Bioenergy

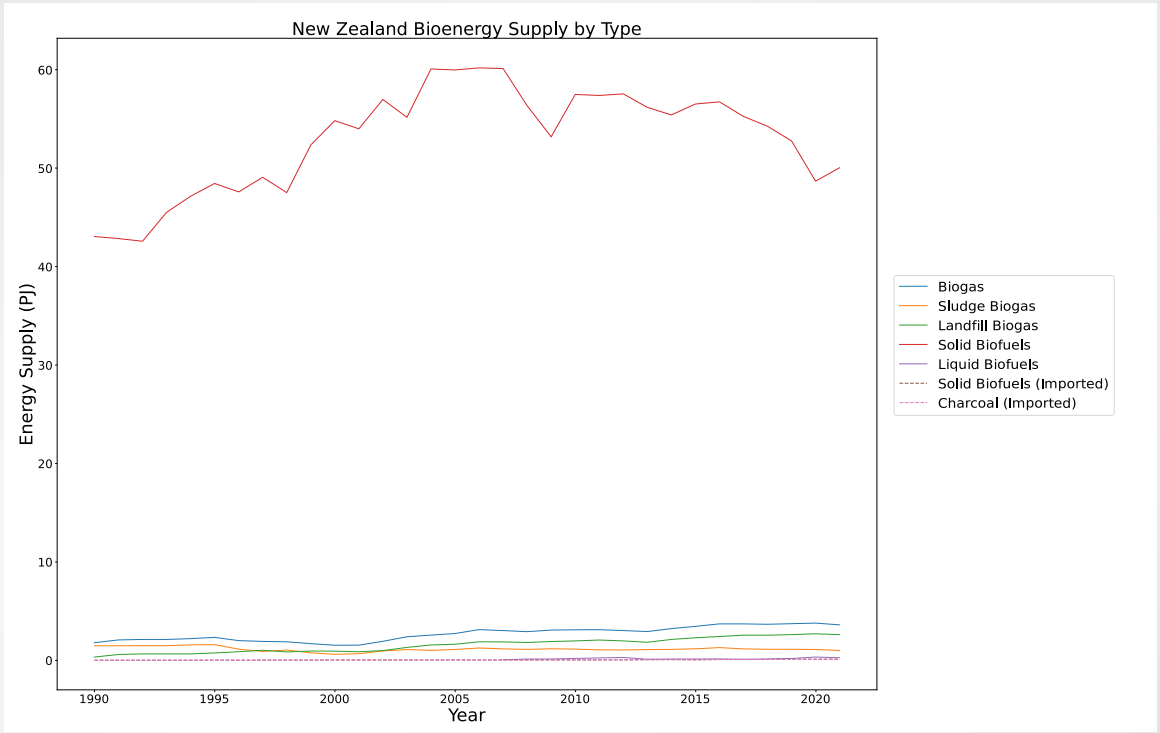
- Biomass, Biofuel (Solid/Liquid), Biogas
- Organic materials act as biomass/biofuel
  - Crops, trees, agricultural residue, organic waste, etc.
- Some GHG emissions, less than fossil fuels
- Requires dedicated land, plants

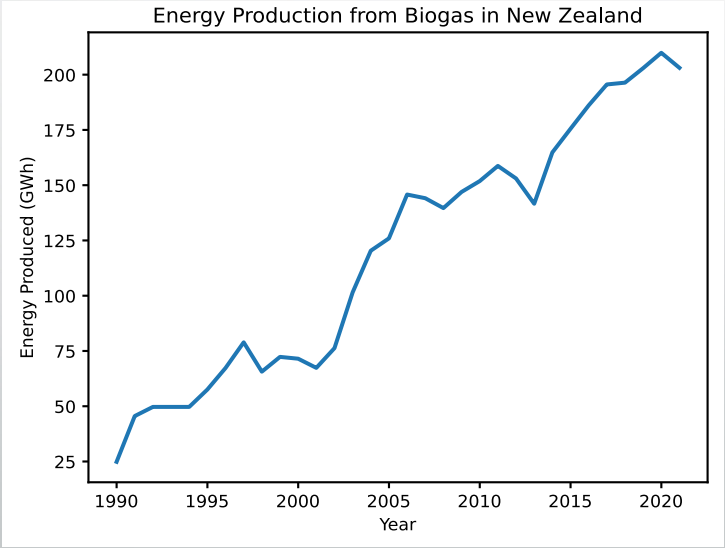


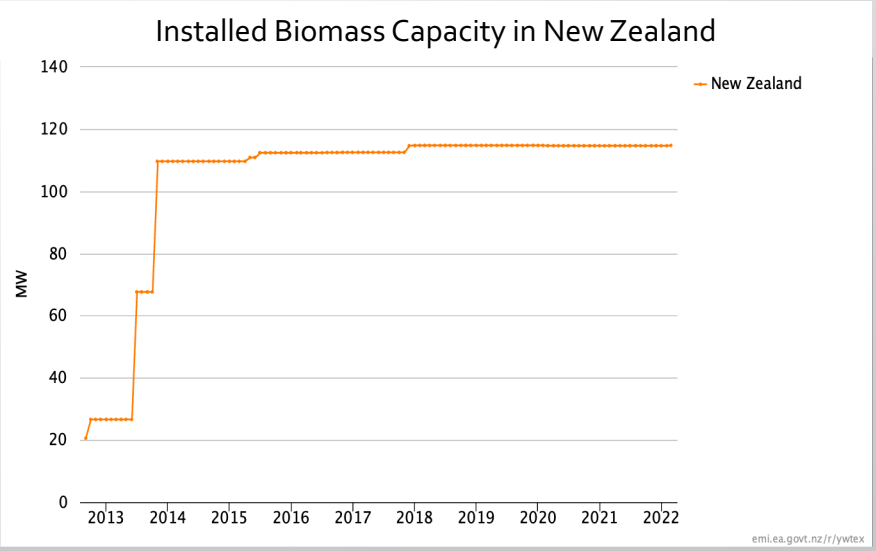

Sources: UN, Bioenergy Association

# Development of Bioenergy in NZ

- Biomass Capacity:
  - 26.62 MW 2013
  - 114.64 MW 2021
- Biogas Generation:
  - 25 GWh 1990
  - 203 GWh 2021
- Solid Biofuel Supply:
  - 43.04 PJ 1990
  - 50.03 PJ 2021



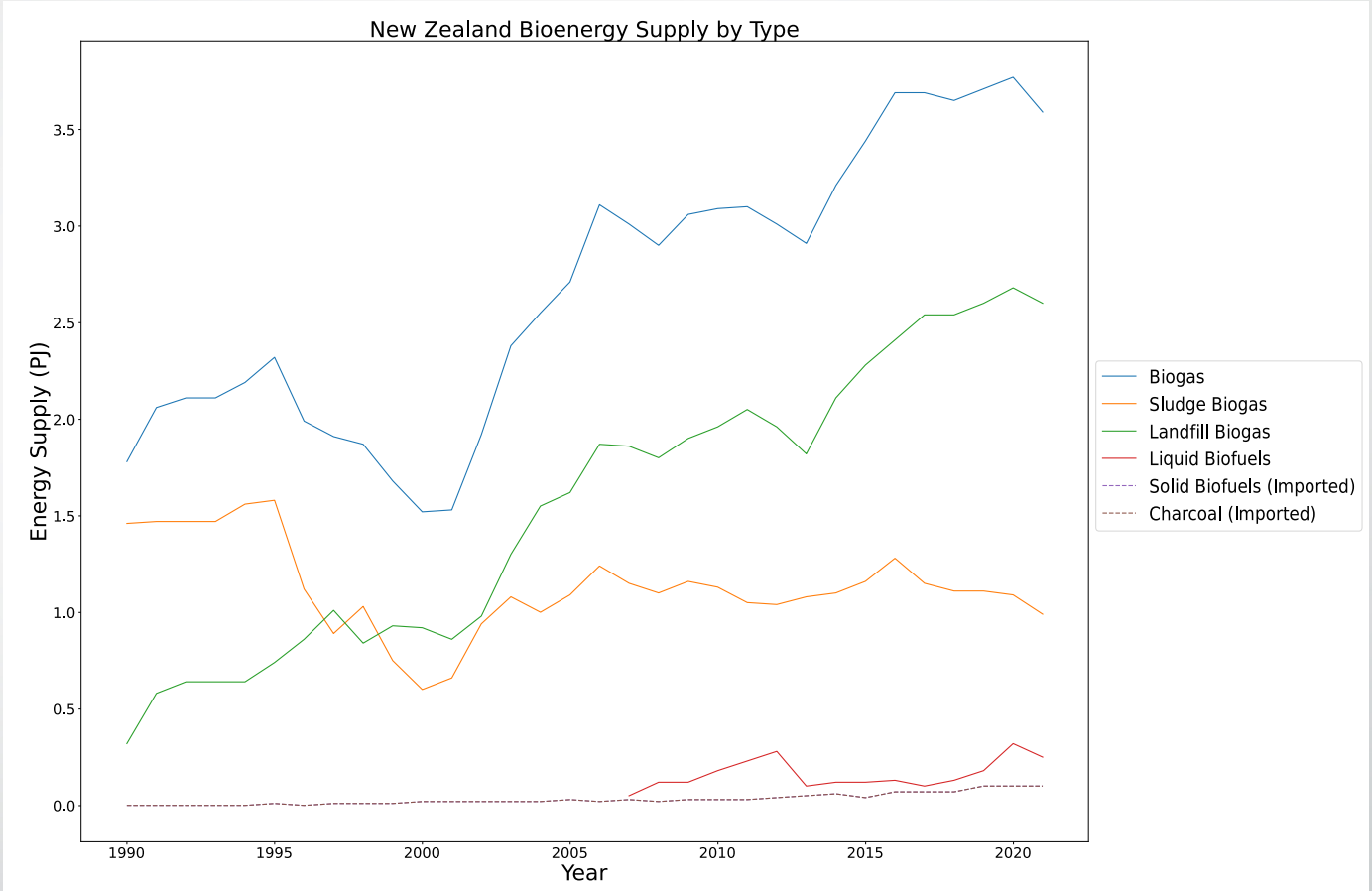




Data from: EMI, MBIE

# Development: Biogas/Biofuel Supply Breakdown

- Biogas Supply:
  - 1.78 PJ 1990
  - 3.59 PJ 2021
- Sludge Biogas Supply:
  - 1.46 PJ 1990
  - 0.99 PJ 2021
- Landfill Biogas Supply:
  - 0.32 PJ 1990
  - 2.6 PJ 2021
- Liquid Biofuels Supply:
  - 0.05 PJ 2007
  - 0.25 PJ 2021

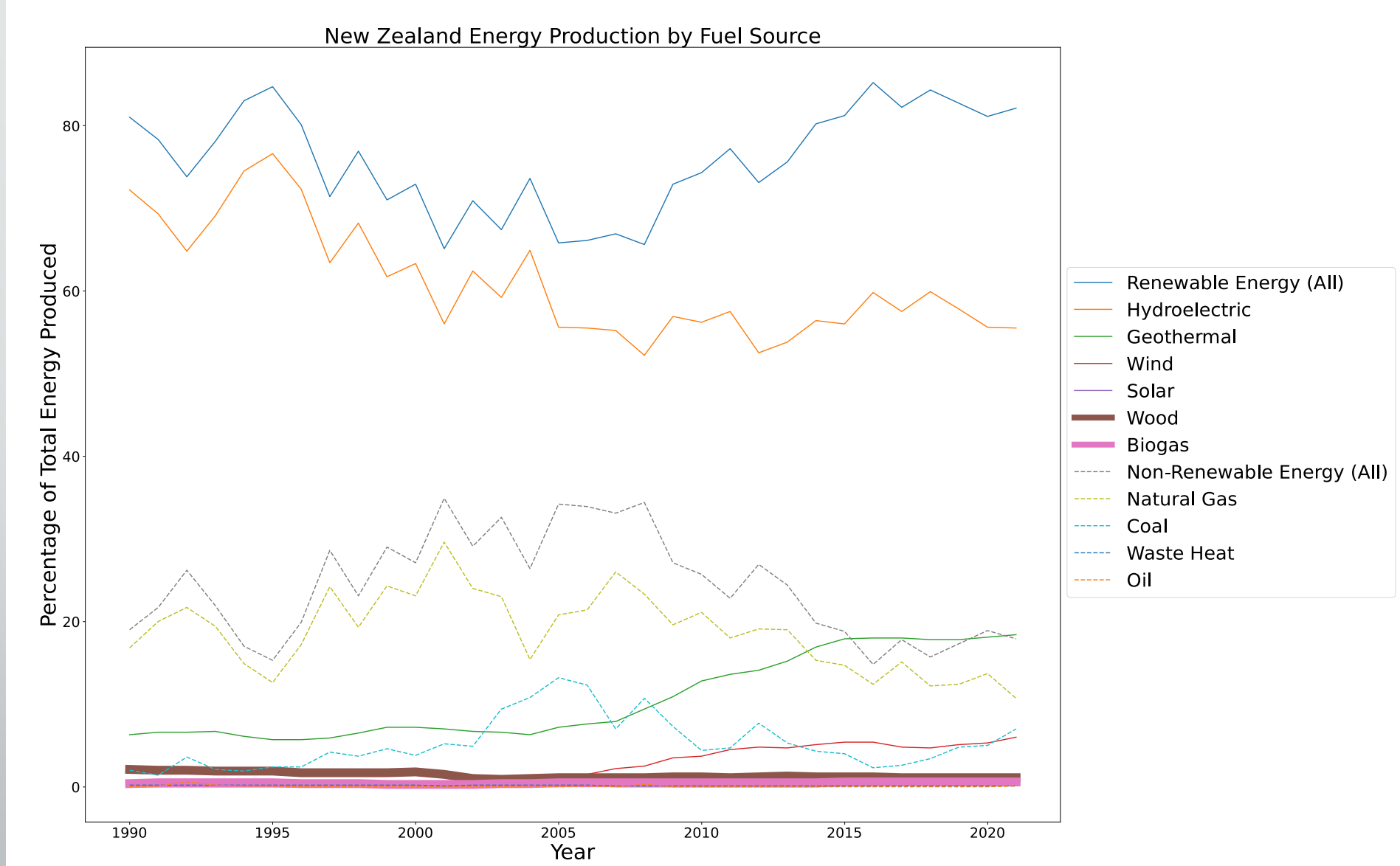



Data from: MBIE

# Modern (and Future) Bioenergy Use

- Solid Biofuels most prominent
  - Mostly wood
- 9-10% total energy production
- Up to 27% energy needs by 2050
  - 15% GHG emission reductions from 2017
- 114.74 MW Biomass Capacity 2023
  - Only 0.10 MW increase from 2021


Sources: Bioenergy Association, EMI, MBIE




Data from: NZ Energy Dashboard

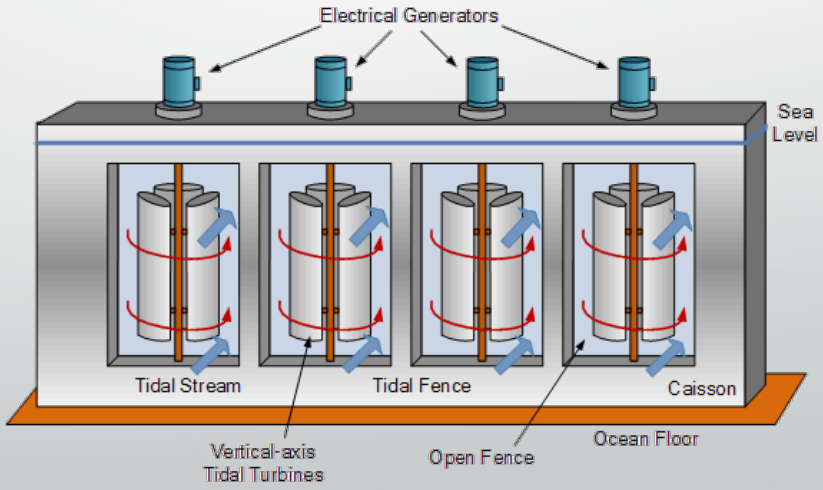
# Introduction to Marine Power

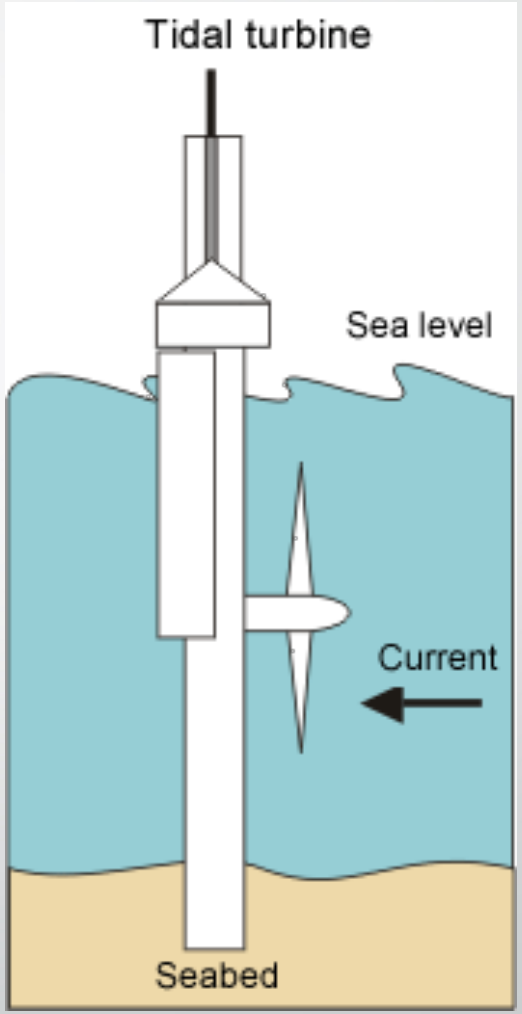
- Energy from seawater
  - Waves, tides, currents, etc.
- Uses kinetic and thermal energy
  - Electricity and heating
- Still in early development stage
- Needs large tidal range
  - At least 10 feet (3 meters)


Sources: UN, National Geographic

# Types of Tidal Energy

- Tidal Barrages
  - Tidal basin, control water levels and flow rates
  - Fill on high tide, empty on low
- Tidal Turbines
  - Heavier, sturdier wind turbines
  - More expensive, produces more energy
- Tidal Fences
  - Vertical axis turbines on fence/row
  - Water pushes through turbines




Sources: EIA

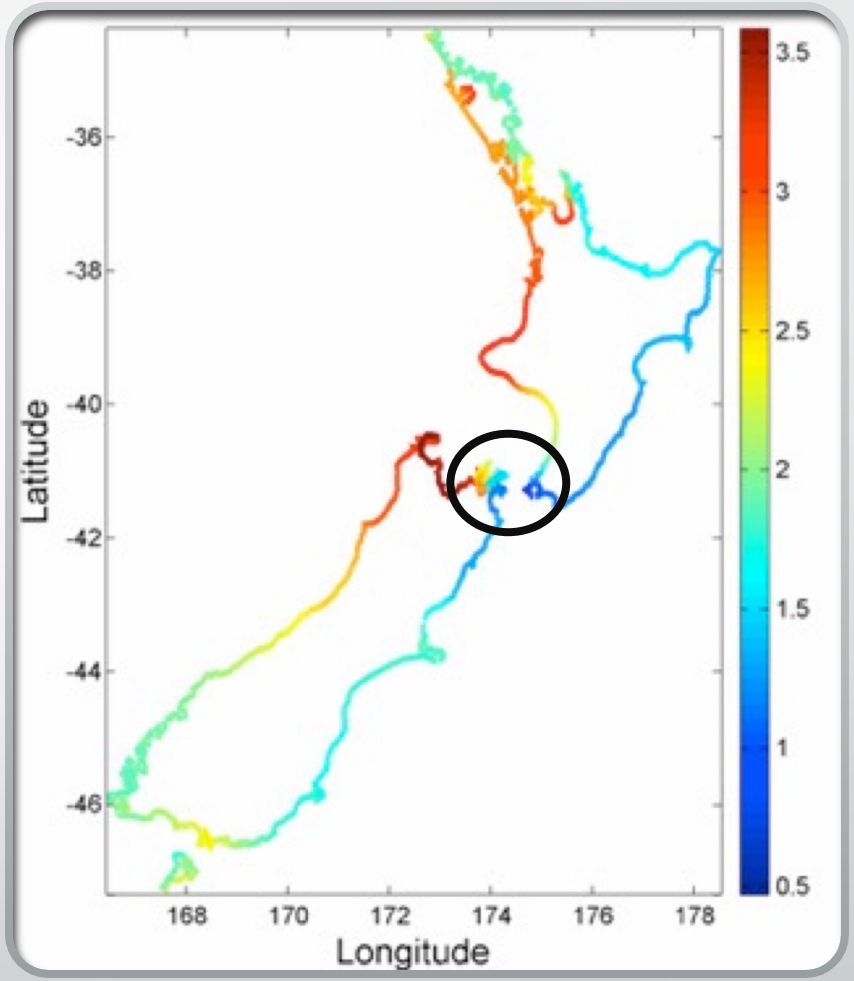
# Future Marine Energy Projects in NZ?

- Aotearoa Wave and tidal Energy Association
  - Formed in 2006
- Local Projects:
  - AzuraWave – Wave energy device
  - Aotea Buoy – Smart wave energy device (University of Auckland)
  - Smart polymer for energy harvesting (Auckland Bioengineering Institute, PowerOn)

Sources: AWATEA

# Tidal Power Potential: The Cook Strait

- Huge potential for tidal power
- Modeled array: 95 tidal turbines
  - Possible to deliver 90 MW output
- Estimated 15,000 MW potential energy regularly
  - Unique tidal patterns, large size
- Only some locations viable
  - Cape Terawhiti (Southern tip of North Island)
  - Tidal flows above 2 m/s
- Costs need to fall 25% to make viable




Sources: MFE, Renew Economy

# Conclusions

- Great potential for all renewables
  - Production potential and falling costs of solar
  - Supply and reduced GHG of bioenergy sources
  - High potential for tidal, with some issues
- Overall, could be effective to move away from fossil fuels

# Sources


- MBIE Energy Dashboard
- MBIE Renewable Statistics (NZ)
- MBIE Electricity Statistics (NZ)
- MBIE – Energy in New Zealand 2022 Report
- NREL – Solar Photovoltaic Technology Basics
- EMI – Solar Total Capacity
- SolarGIS Solar Potential NZ Map
- My Solar Quotes – Solar in NZ 2013-2019
- My Solar Quotes – Price of a Solar Power System
- NZ Bioenergy Association
- United Nations Renewable Energy
- EMI – Bio-mass Total Capacity
- National Geographic – Tidal Energy
- EIA – Tidal Power
- AWATEA – About Us
- AWATEA – Projects
- Renew Economy – Cook Strait Article
- MFE – Tides Around New Zealand