New Zealand Geothermal Association

Updates from NZGA Emissions Working Group

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NZGA Emissions Working Group

- The NZGA Emissions Working Group was established in 2021.
- Core members of the group are the owners/operators of NZ geothermal power stations:
  - Mercury New Zealand Ltd
  - Contact Energy Ltd
  - Ngawha Generation
  - Eastland Generation
  - Tauhara North No. 2 Trust
  - Ngati Tuwharetoa Geothermal Assets (owned GDL at the time)
- This group represents 96% of the country's geothermal energy supply.
- The reduction of carbon emissions is a common cause across the industry, and the world.
- There are shared technical challenges and regulatory issues.

Emissions Calculations

- One of the things the working group does is pool together emissions data.
- Emissions are reported by calendar year, because of NZ regulations, the data presented today is for CY2022.
- In NZ we report CO_2 **and** methane (CH_4).
- The effect of CH_4 is included by converting its effect on the atmosphere into CO_2, then adding that to the actual CO_2.
- As a greenhouse gas CH_4 is x25 stronger than CO_2.

$$CO_2e = CO_2 + (25 \times CH_4)$$

- The combined effect of CO_2 and CH_4 is called CO_2-equivalent, or "CO_2e". All the NZ data is CO_2**e**.

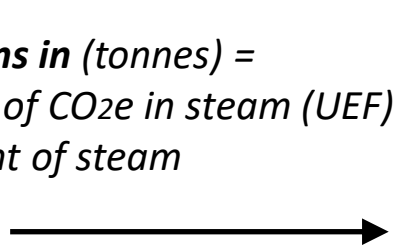
Emissions Calculations

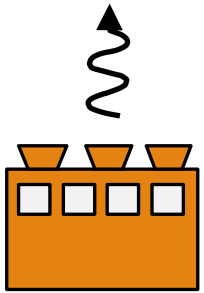
- Emissions from an individual power station are calculated as follows:

Emissions to atmosphere = emissions in – emissions out

Emissions to atmosphere

Emissions in *(tonnes) = fraction of CO_2e in steam (UEF) x amount of steam*





Emissions out *(tonnes) = fraction of CO_2e in reinjection fluid x amount of reinjection fluid*

Emissions Calculations

- **Emissions intensity** (operational) is then calculated by dividing the total emissions by the amount of power generated by that power station over the year:

Emissions intensity (operational)	=	***emissions to atmosphere*** / ***net generation***
(tCO_2e/GWh or gCO_2e/kWh)		*(tCO_2e)* *(GWh)*

- The additional embedded emissions associated with materials/construction are accounted for by adding a value of +10 gCO_2e/kWh, to give full lifecycle emissions intensity:

Emissions intensity (lifecycle) = emissions intensity (operational) + 10

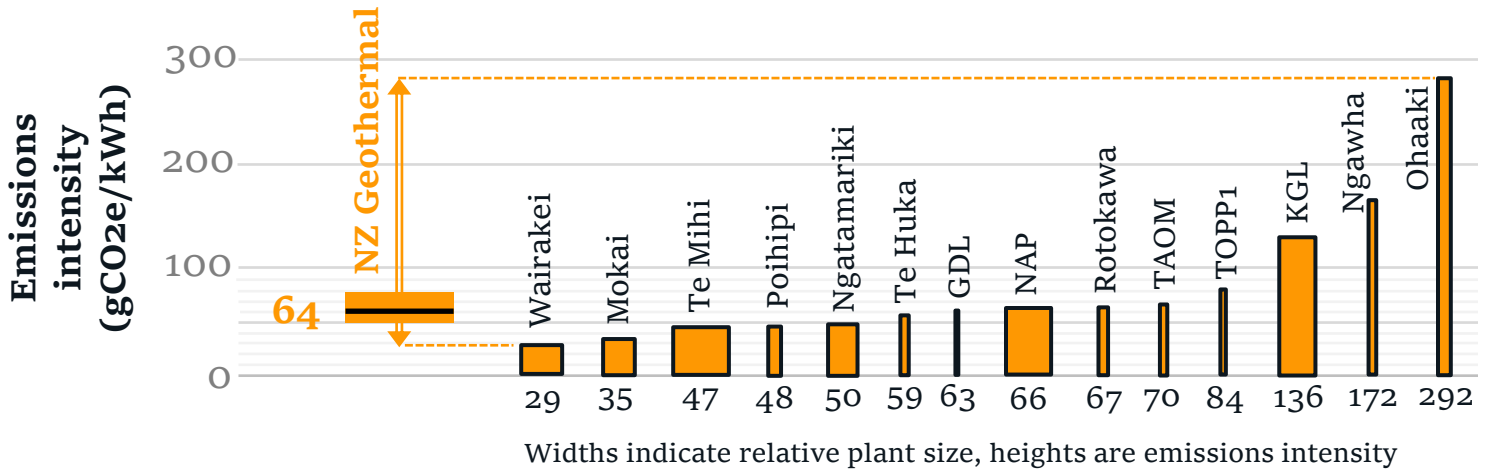
- The lifecycle emissions intensity allows comparison between different sources of energy such as other renewables, or fossil fuels.

Geothermal Emissions in NZ - CY2022

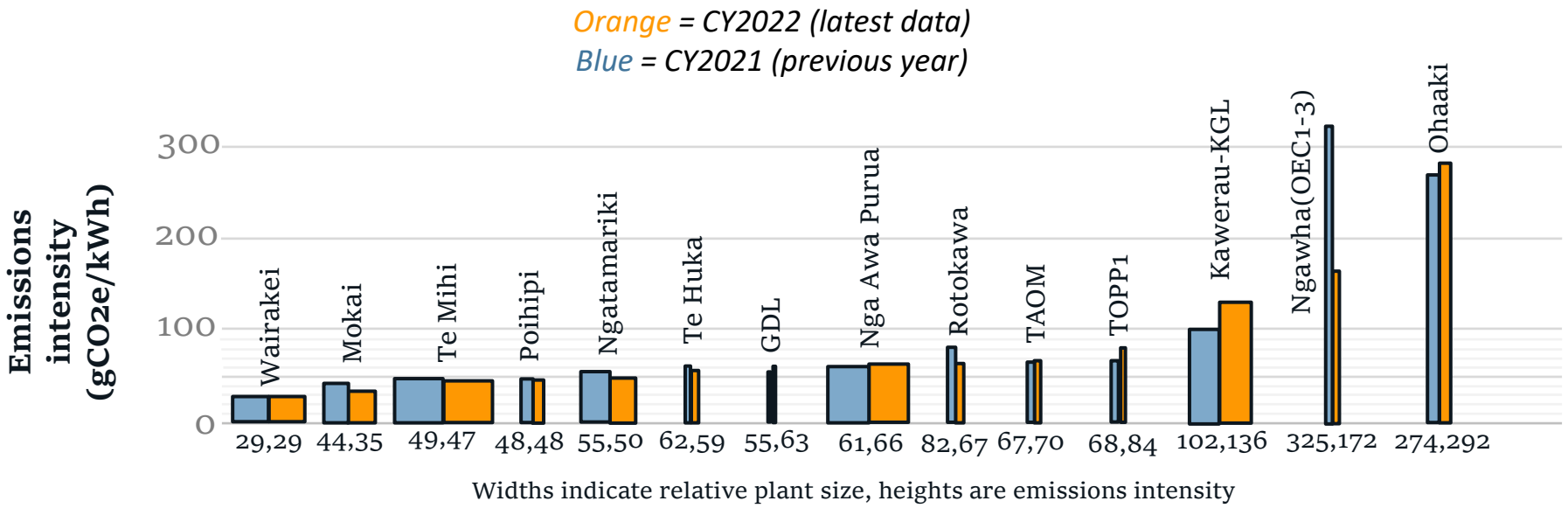
Plant	Lifecycle Emissions Intensity CY2022 (gCO_2e/kWh)
Wairakei	29
Mokai	35
Te Mihi	47
Poihipi	48
Ngatamariki	50
Te Huka	59
GDL	63
Nga Awa Purua	66
Rotokawa	67
TAOM	70
TOPP1	84
Kawerau - KGL	136
Ngawha (OEC1-3)	172
Ohaaki	292

Median	64
Interquartile range	49-80
MW-weighted average	73

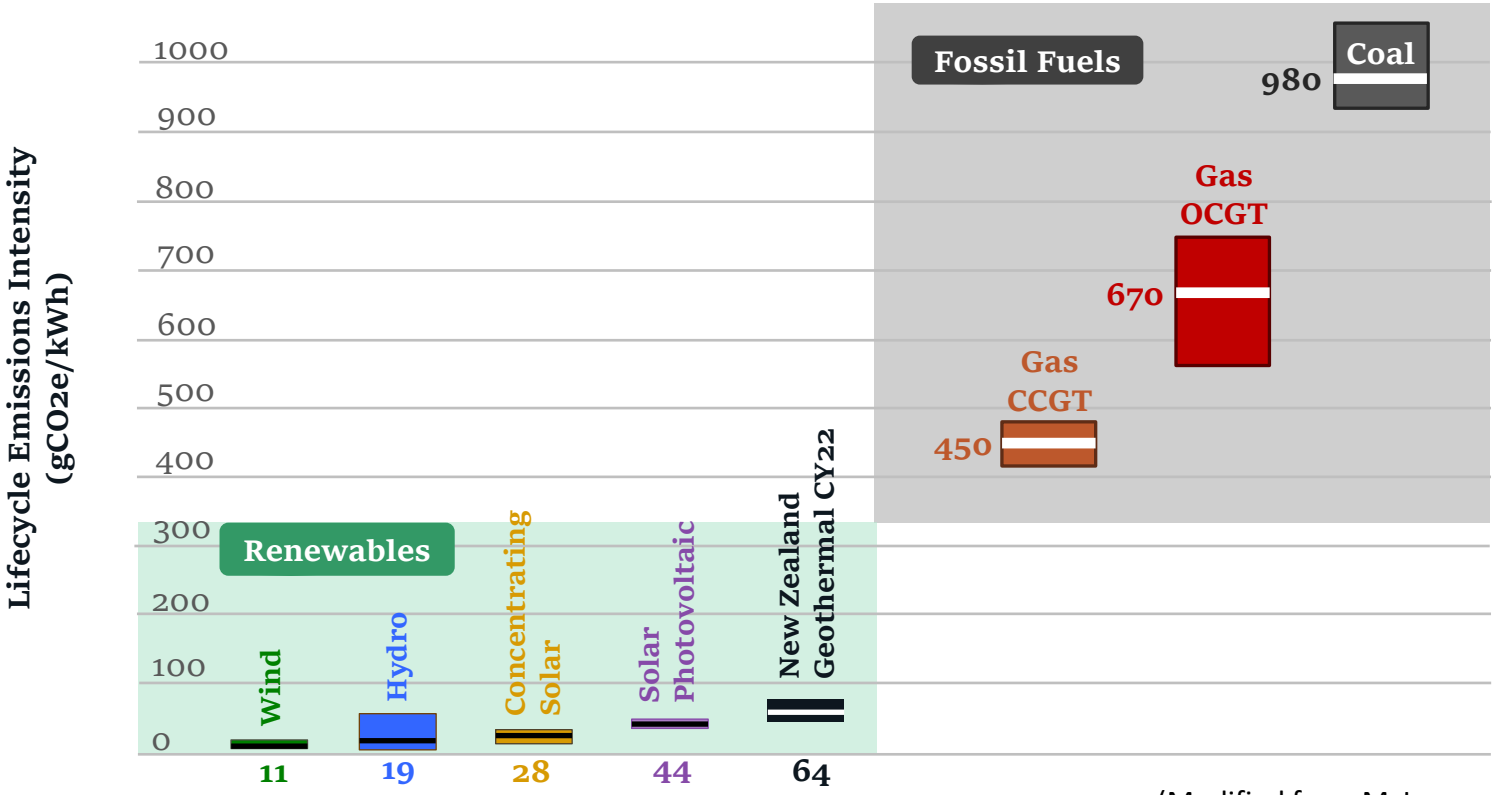
Geothermal Emissions in NZ - CY2022



Geothermal Emissions in NZ
CY2022 Compared to Previous Year



Comparison to Other Energy Sources

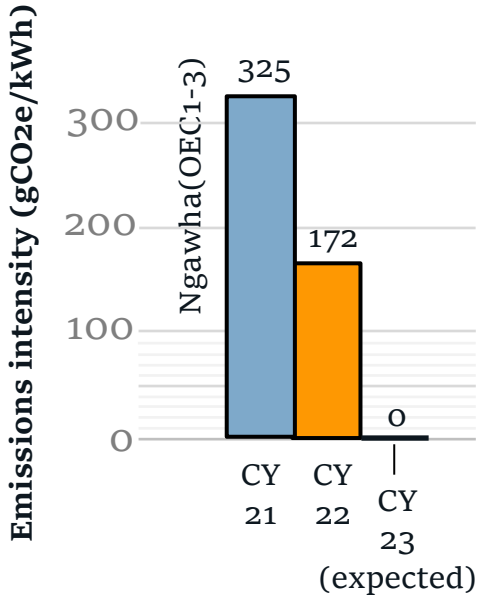


(Modified from McLean and Richardson, 2020)

Updates from the working group

Ngawha Generation

- **Stations 1 and 2 (OEC1-3)**
  - Station 1 was the first carbon-zero geothermal power station in NZ!
  - OEC1 had 100% reinjection in May, and OEC2 in August 2022.
  - Station 2 followed, with OEC3 at 100% reinjection in January 2023.
  - Combined UEF for CY2022 roughly halved, offsetting 31k tonnes CO_2e.
  - So far, the UEF for CY2023 is zero (yet to be audited).
- **Station 3 (OEC4) – new station**
  - Station 3 (OEC4) is still stabilising, but at 70% reinjection since April.
  - Civil works starting as we speak, and pipe spooling ongoing.
  - 100% reinjection expected by September/ October.
- **With all plants at 100% reinjection, annual offset will be ~128k tonnes CO_2e.**



Updates from the working group

Ngawha Generation

- On site forestry produces ~1,500 credits per annum, used to offset all other carbon emissions.
- Currently being audited by Toitū Envirocare across the business to progress towards net zero certification.
- Making it a reality that all electricity consumed on the Top Energy network will be zero emissions, with a positive flow on effects for Far North businesses.
- With less than $4.3m spent, this results in around $33/tonne CO_2e abatement capital costs.

Watch out for Fabian Hanik at the Energy Excellence Awards in August!

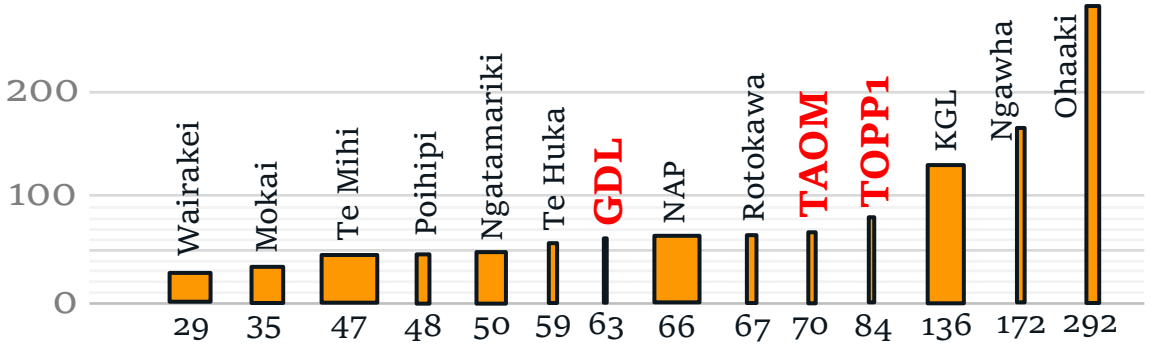
He has been named a finalist in the Young Energy Professional of Year category.

Ngāwhā Generation Limited is a finalist in the Low Carbon Future Award category.

Updates from the working group

Eastland Generation

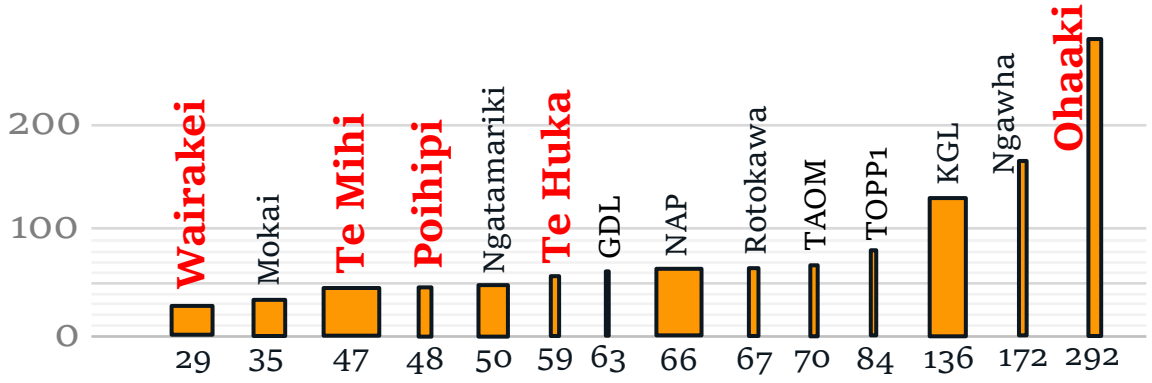
- Developing options for reinjection on Kawerau field.
- TAOM (26 MWe) and TOPP1 (24MWe) – will transition to CO_2 reinjection during the next 12-18 months.
- GDL plant (9 MWe) – will come next.
- The new station TOPP2 will be built with CO_2 capture.
- Taheke project is still several years away.



Updates from the working group

Contact Energy

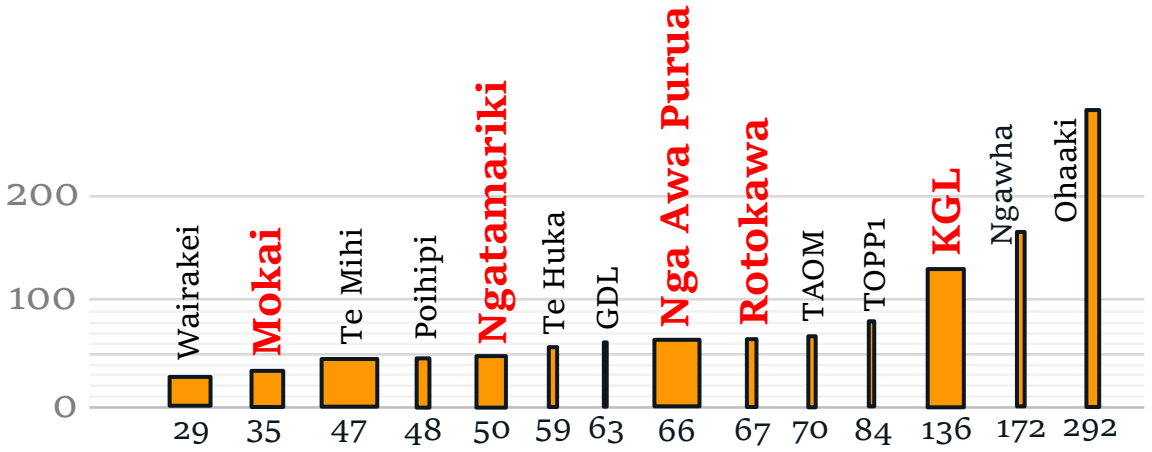
- 100% reinjection at Te Huka operational since November 2022.
- Too late to be seen in CY2022 emissions data.
- For updates and future plans, we are going to hear from Ian Richardson.



Updates from the working group

Mercury NZ Ltd

- 25% reinjection at Ngatamariki operational since October 2021.
- For updates and future plans, we are going to hear from Emily Collis.



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Thank you