Greenhouse Gas Emissions From Geothermal Power Stations:

Context and Opportunities

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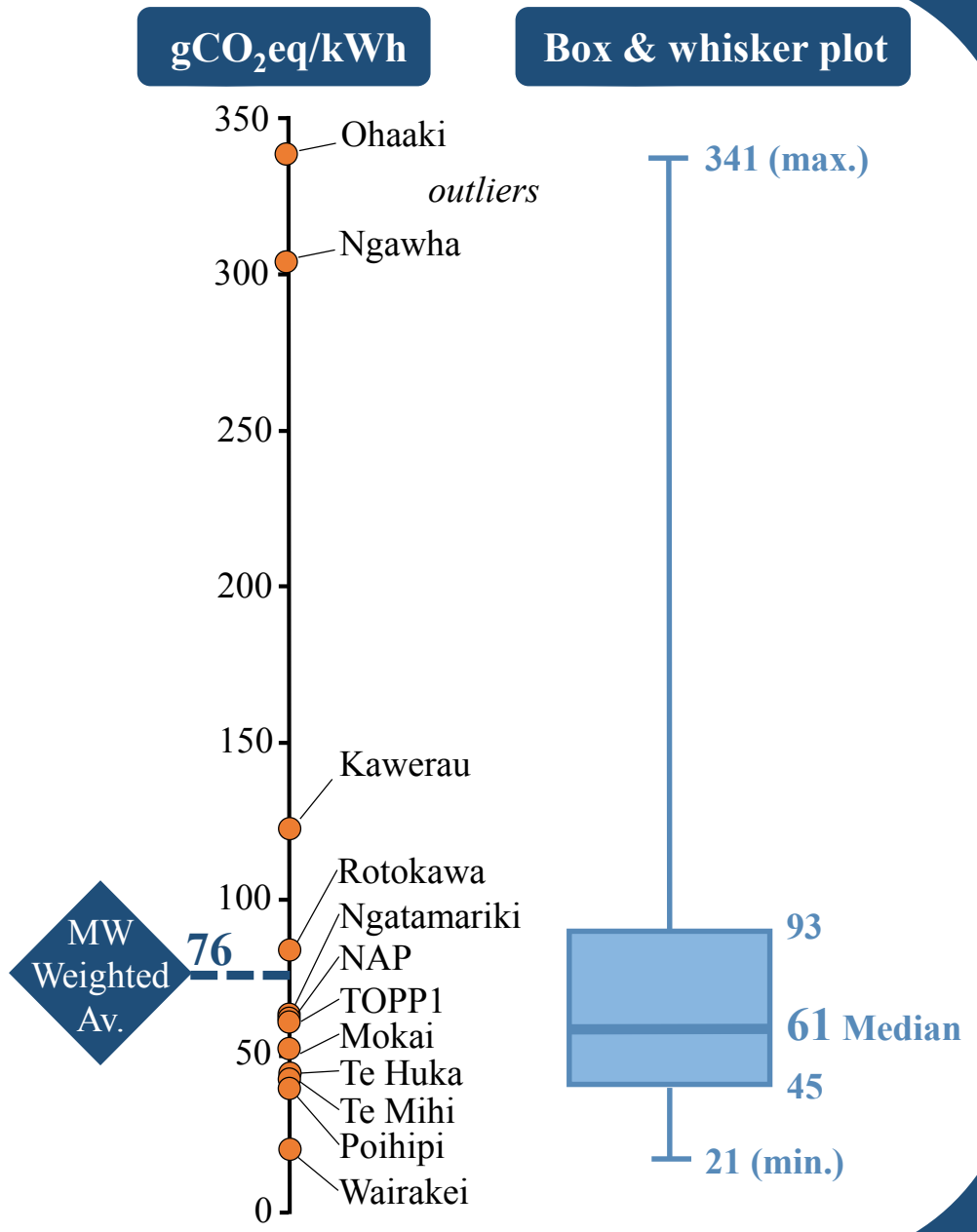
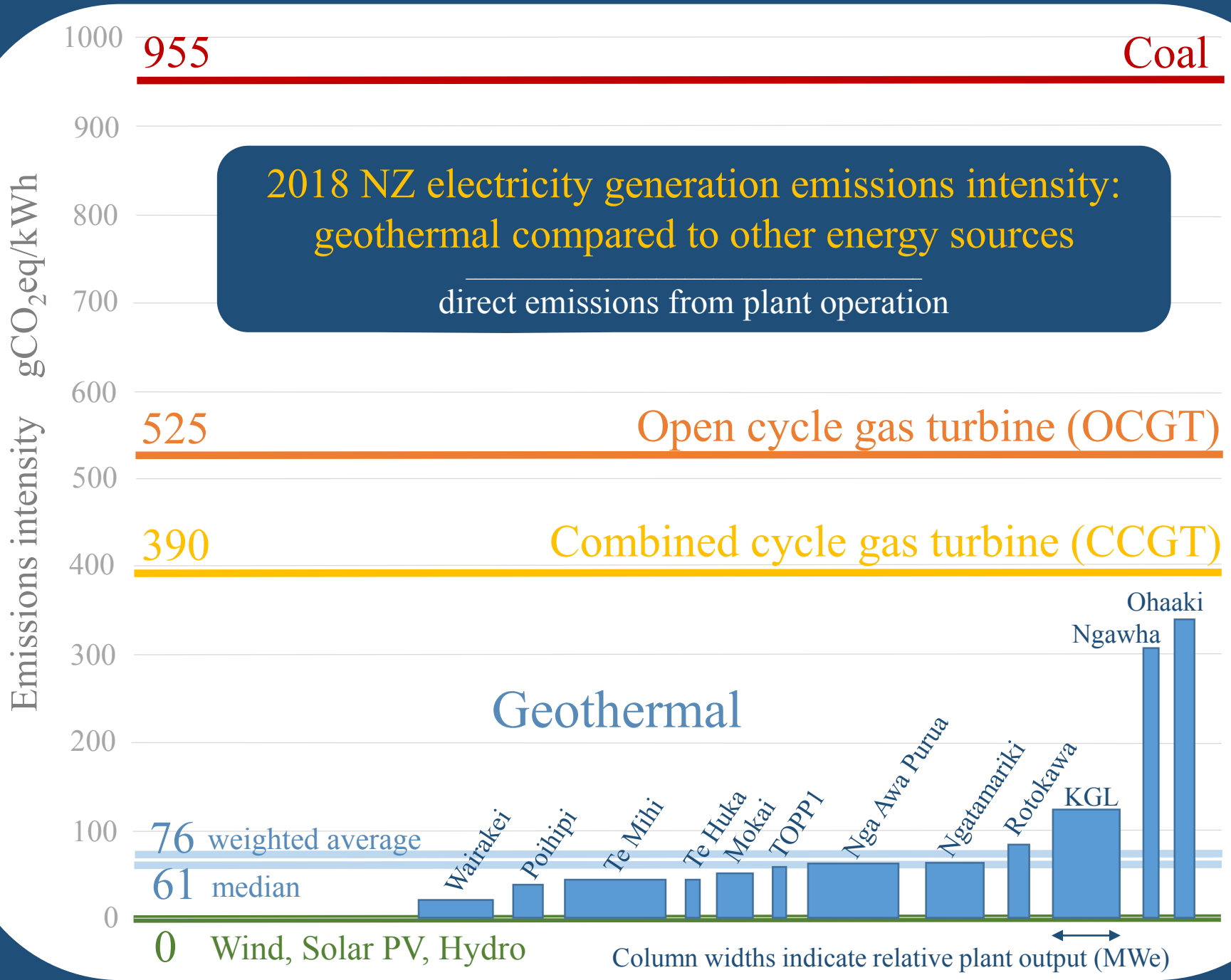
2018 New Zealand geothermal emissions intensity

direct emissions from plant operation

Power Station	Average MWe (net)	Emissions Intensity $gC0_2eq/kWh$
Wairakei A&B and binary	116	21
Te Mihi	157	43
Poihipi	46	38
Ohaaki	31	341
Te Huka	22	45
Rotokawa	33	84
Nga Awa Purua (NAP)	141	63
Mokai	56	52
Ngatamariki	90	64
Kawerau (KGL)	104	123
TOPP1	21	60
Ngawha	23	304
MW-weighted average		76
Median		61
25th percentile		45
75th percentile		93



McLean and Richardson, 2019, in press



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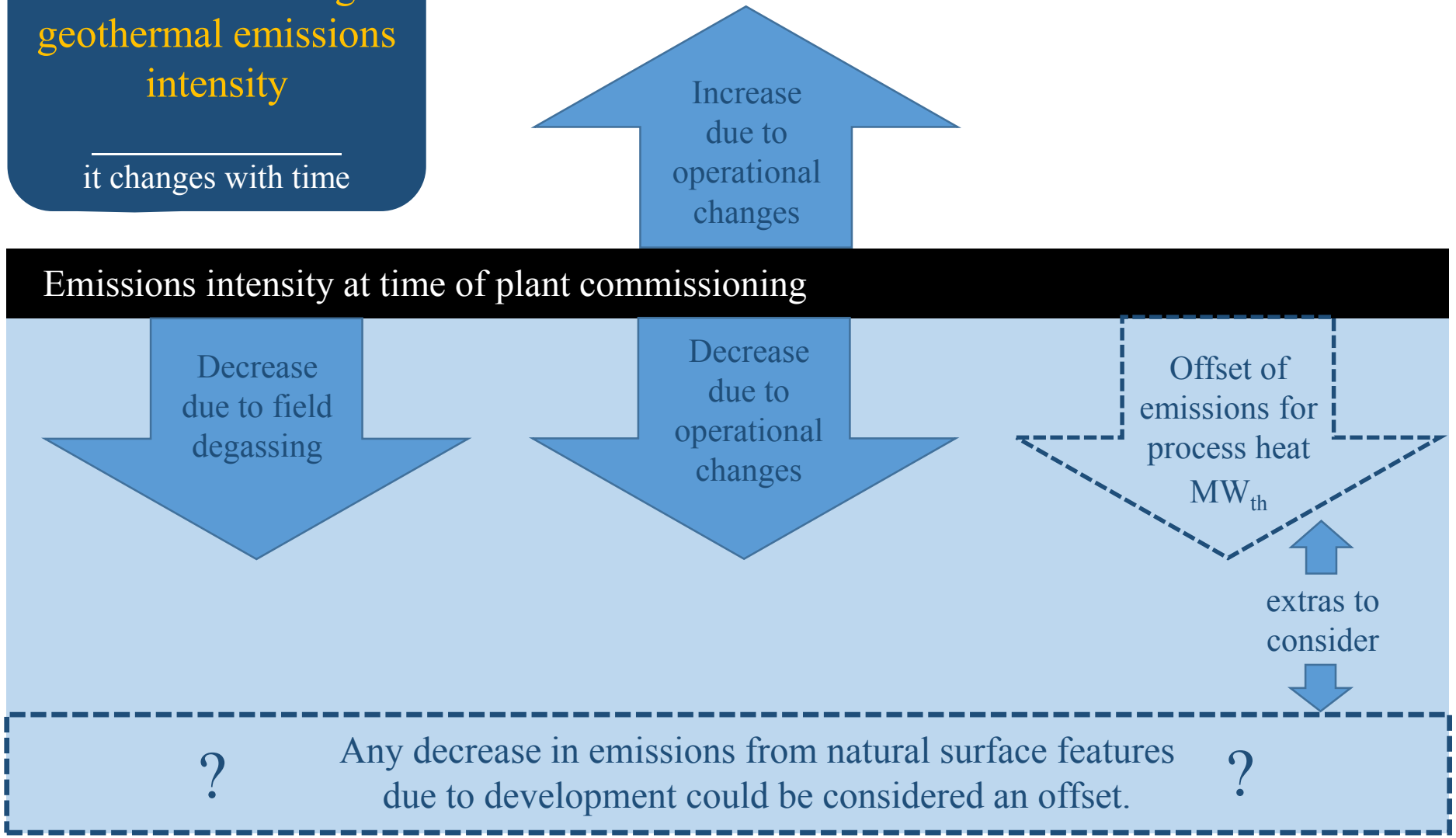
Factors affecting geothermal emissions intensity

it changes with time



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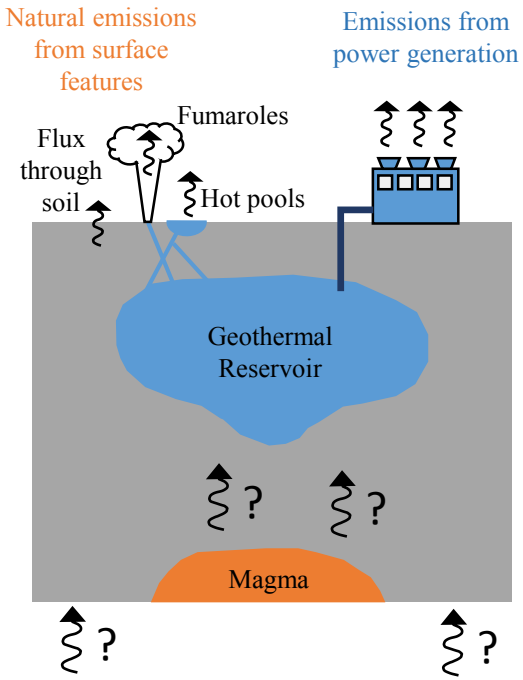
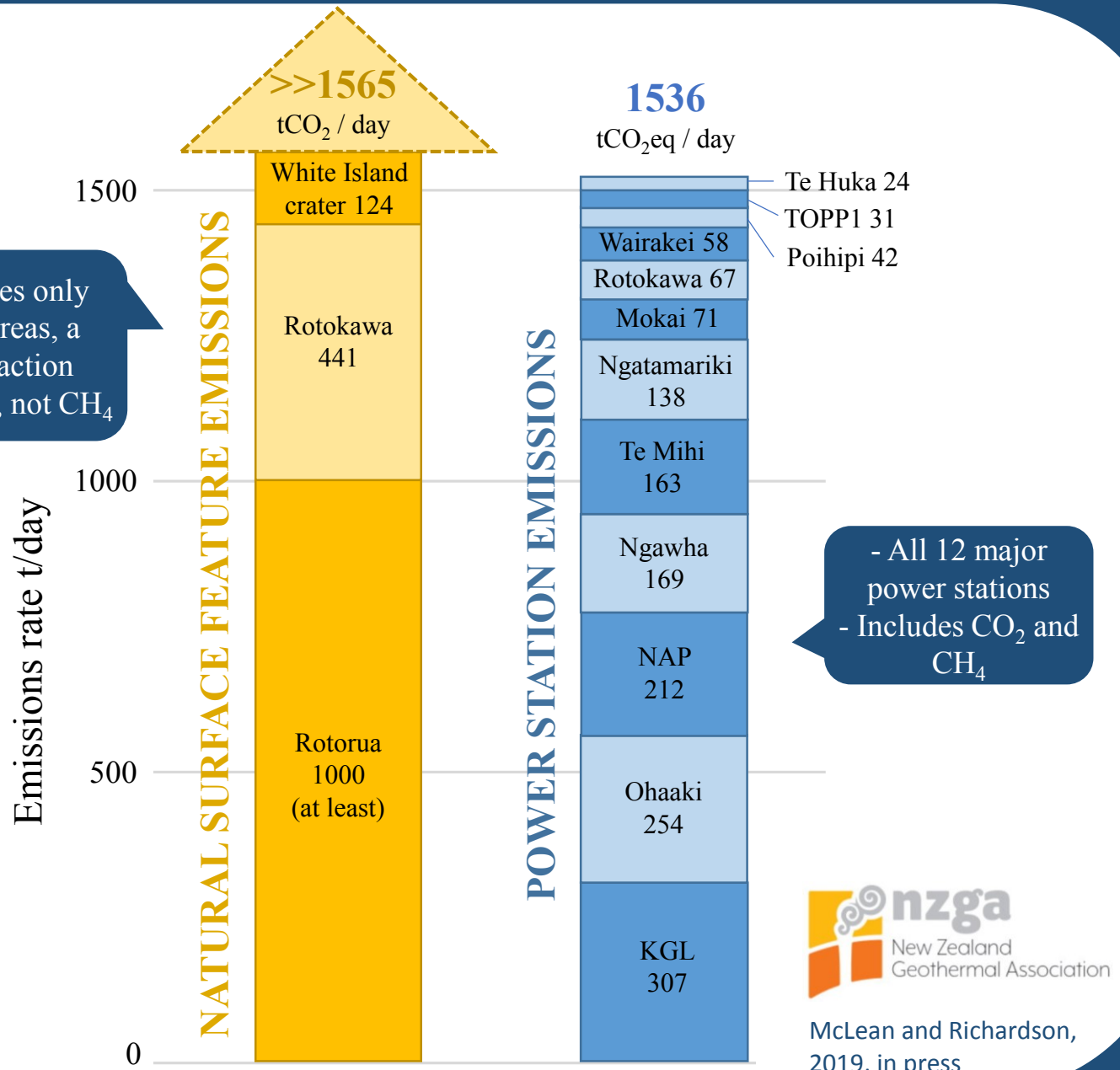
Natural surface feature emissions greatly exceed power station emissions



- Estimates only from 3 areas, a small fraction
- CO_2 only, not CH_4



- All 12 major power stations
- Includes CO_2 and CH_4

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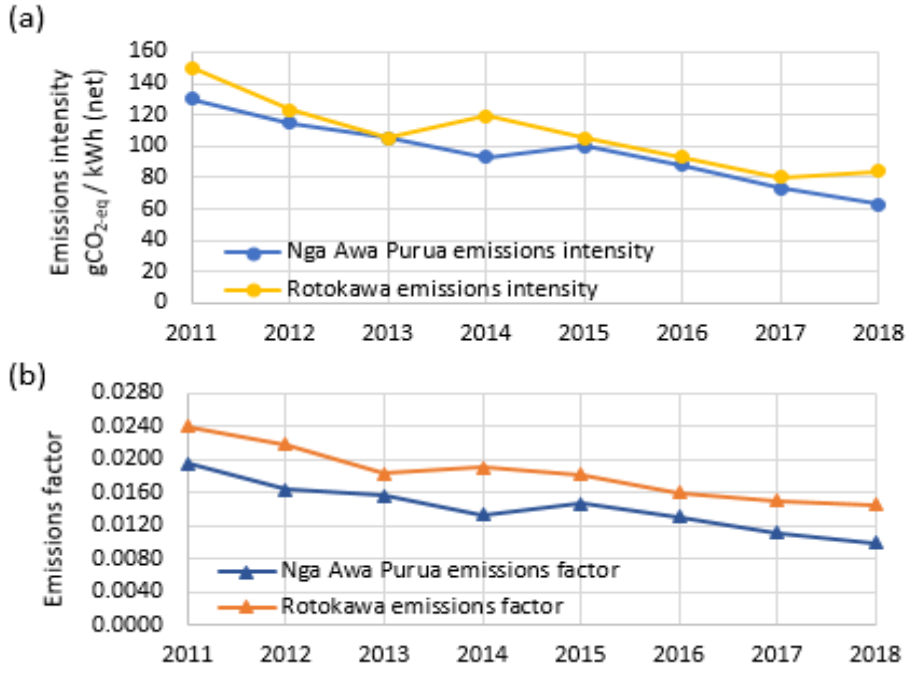
Emissions over time period 2010-2018

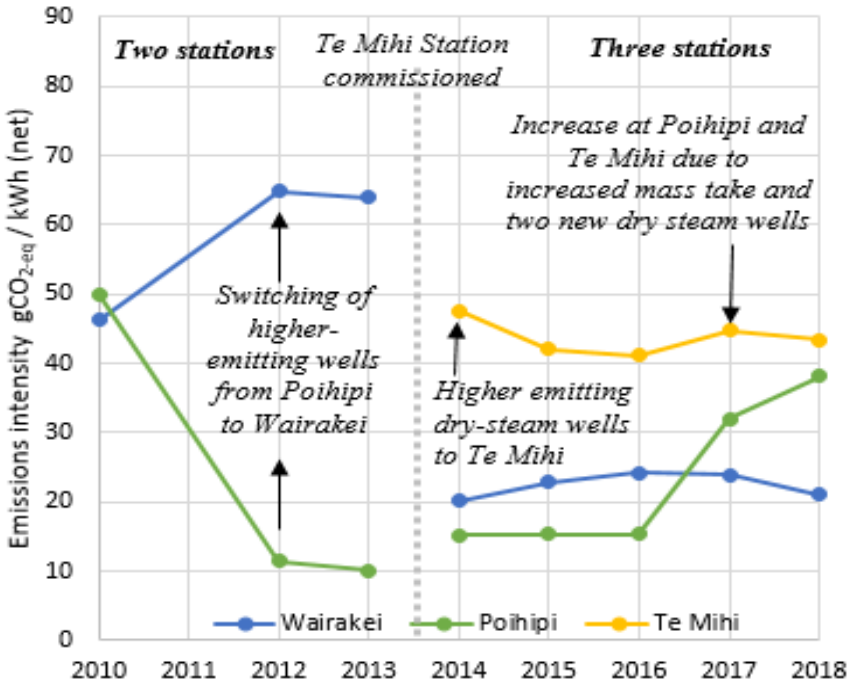
Decline due to degassing

NAP and Rotokawa



Operational change

Wairakei, Te Mihi and Poihipi



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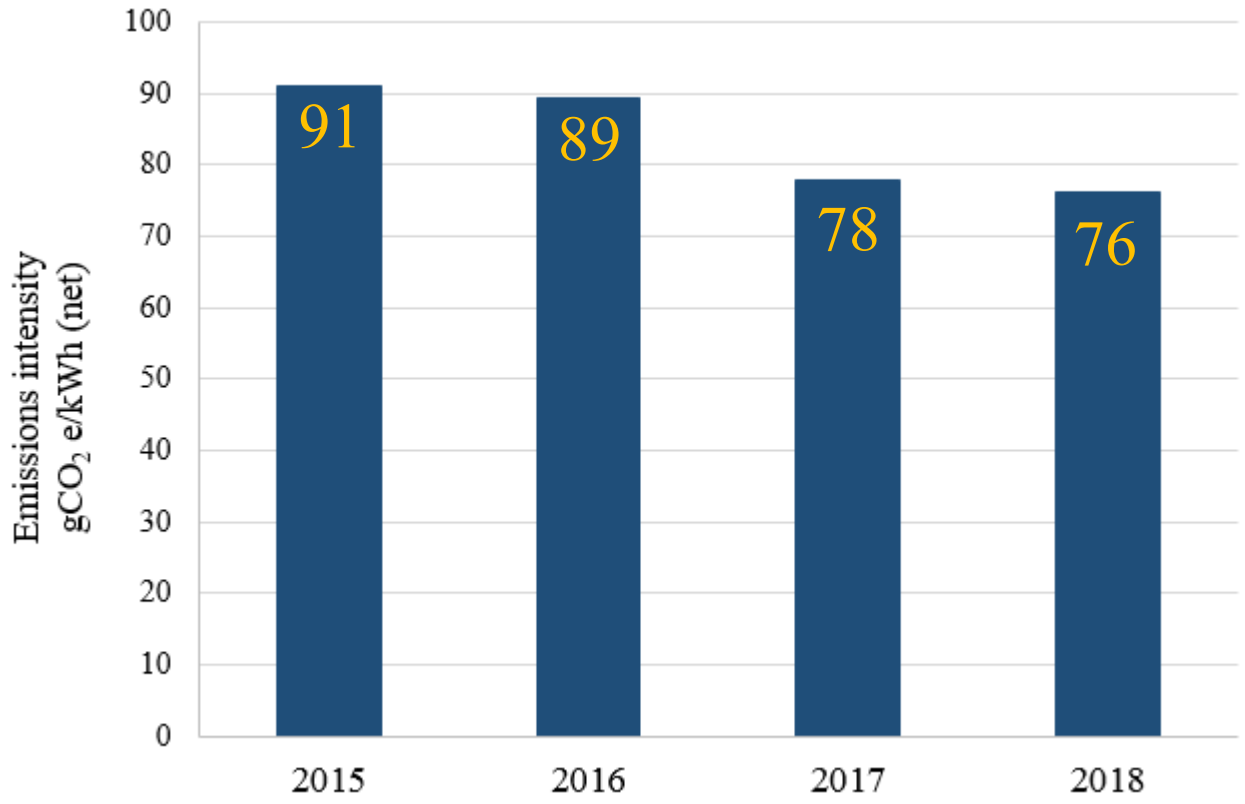
Weighted average emissions intensity 2015 - 2018



All the new geothermal power stations are operational by 2015

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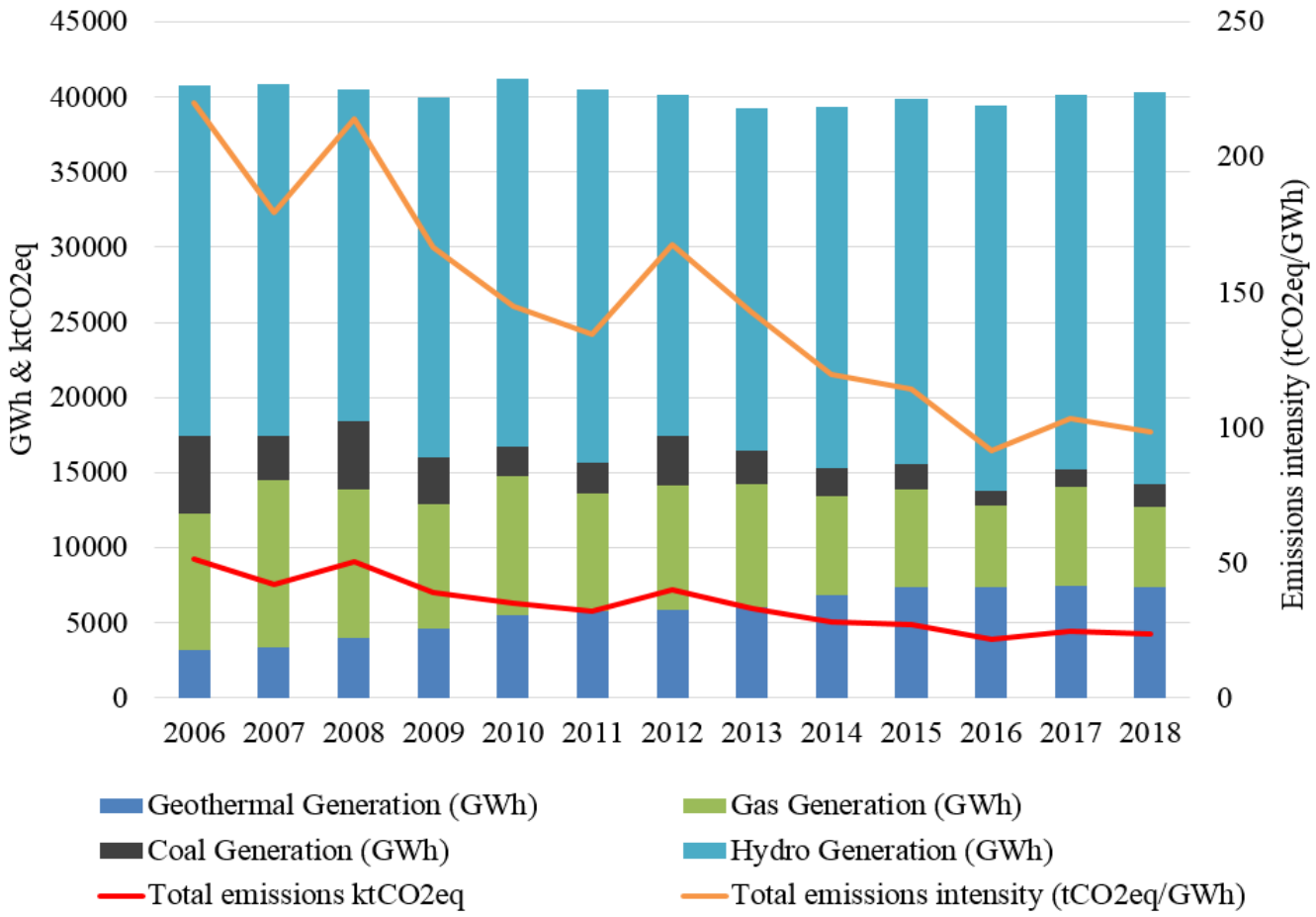
Contribution of geothermal to overall NZ electricity generation and emissions trends



Coal and gas generation decrease

Geothermal generation increases

Overall emissions and emission intensity decrease

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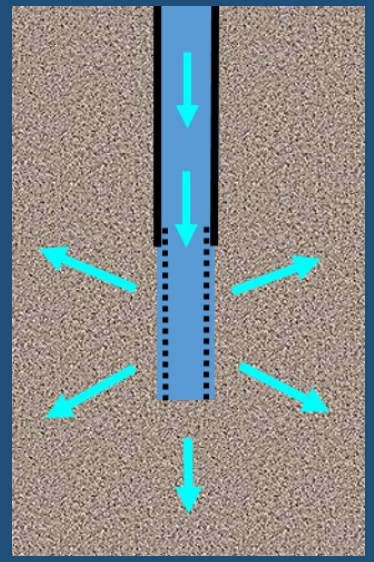
What can be done?

Capture and reinject

CO_2 and methane (and hydrogen sulphide) are dissolved in reinjection water and return to the reservoir.

Large volumes involved.



Capture and utilise

CO_2 captured and used for industrial purposes.

CO_2 will have to be purified for use in greenhouses for example.

Smaller volumes involved but other benefits.

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Geothermal greenhouse gas reinjection: it is happening

Technically feasible but depends on local conditions

Coso, California
Large scale for ~10 years
H_2S emissions regulations

Brawley, California

Puna, Hawaii
Large scale until eruption
Strict emissions regulations

CarbFix at Hellisheiði, Iceland
Large scale, funded by EU

Ogachi and Hijiori, Japan
Pilot scale, EGS research sites

Tongonan, Philippines
Pilot scale, funded by Global Environment Facility

Not in NZ so far – there has been nothing to drive it

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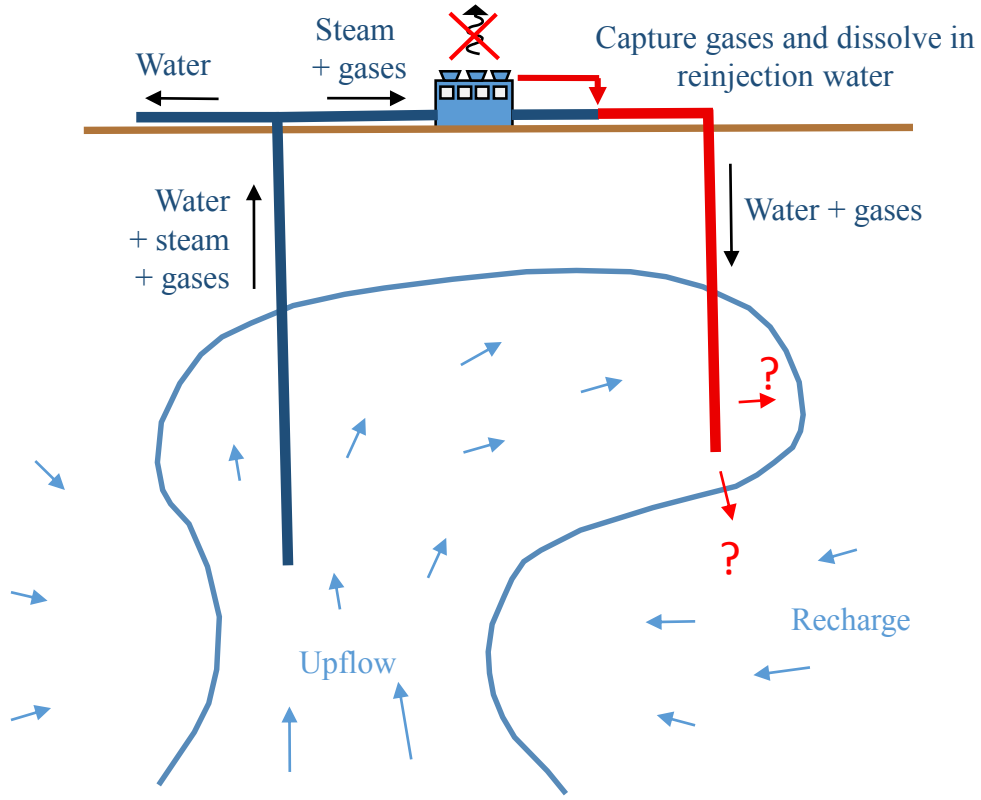
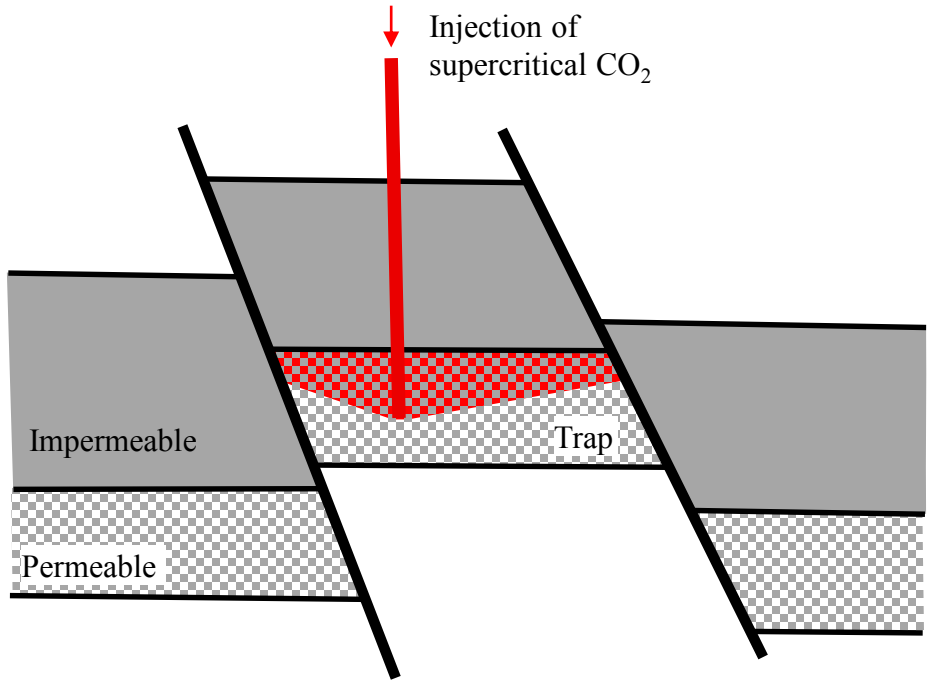
Geothermal Reinjection vs Typical CCS



The gases are returned to their original source

- Fluid moves underground due to convection (open reservoir).
- CO_2 is not buoyant, dissolved in water.
- May react and be permanently stored as minerals.



- CO_2 is buoyant but trapped underground (closed reservoir).
- May react and be permanently stored as minerals.

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Thank you

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