IN THE WAITANGI TRIBUNAL

WAI 3325
WAI 3262

IN THE MATTER AND	of the Treaty of Waitangi Act 1975
IN THE MATTER AND	of the Climate Change Priority Inquiry (Wai 3325)
IN THE MATTER	of a claim by Emily Tuhi-Ao Bailey on behalf of herself and Climate Justice Taranaki

STATEMENT OF EVIDENCE OF STEPHEN GOLDTHORPE

Dated: 28 April 2025

RECEIVED
Waitangi Tribunal
28 Apr 25
Ministry of Justice
WELLINGTON

BENNION LAW

Barristers and Solicitors
L1, 1 Ghuznee Street
PO Box 25433
Panama Street
Wellington 6011
Counsel: Tom Bennion / Emma Whiley / Kudrat
tom@bennion.co.nz / emma@bennion.co.nz / kudrat@bennion.co.nz

INTRODUCTION

1. My full name is Stephen Henry Goldthorpe.

2. I am a retired energy systems analyst. My expertise is based on computer modelling of physical and chemical processes. I developed my expertise in computer modelling of energy conversion systems while working for British Coal from 1979 to 1995.

3. After emigrating to New Zealand in 1995, I worked as a consultant with URS New Zealand, formerly Woodward Clyde, where I expanded my expertise to include air dispersion modelling. In 2002 I left URS and worked as an independent consultant, trading as Steve Goldthorpe Energy Analyst Ltd. In 2019, I closed that consultancy business and retired. I have continued to use my expertise as requested.

4. I have been requested by Climate Justice Taranaki to assess the impact on the adjacent marine environment of the emission of carbon dioxide (CO_2) from industrial activities in the Taranaki region.

Qualifications and Experience

5. I hold the academic qualification of Bachelor of Science in Chemical Engineering from Leeds University in the UK.

6. I have experience in computer simulation of chemical processes and energy conversion processes. Initially I developed computer modelling systems for British Coal for studying processes for converting coal into oil. I subsequently applied those modelling capabilities to studies of other novel energy conversion systems, in particular many studies including the integration of carbon dioxide capture into the operation of fossil fuel power stations.

7. In 1994, I was commissioned by the Electricity Corporation of New Zealand as an overseas expert witness to evaluate capture and storage of carbon dioxide (CCS) for the call-in of the consent application for the then proposed Taranaki Combined Cycle (TCC) gas fired power station. I provide further detail on this separately attached to my statement as **Appendix A**.

Compliance with Code of Conduct

8. I confirm that I have read the Code of Conduct for expert witnesses contained in the Schedule 4 of the High Court Rules 2016. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Summary

9. The spatial CO_2 emissions in the Taranaki region of New Zealand are substantially greater than the average spatial CO_2 emissions in New Zealand and the global average. Therefore, the concentration of CO_2 in the Taranaki regional air space will be greater than the global average CO_2 concentration in the atmosphere. As the global atmospheric concentration of CO_2 increases the concentration of dissolved CO_2 in seawater increases, making the oceans more acidic. I estimate that a consequence of the enhanced CO_2 emissions in the Taranaki region is that the on-going acidification of coastal seawater in the South Taranaki Bight due to global Climate Change, occurs about one year earlier than would otherwise be the case without local enhanced CO_2 emissions.

Scope of evidence

10. My evidence will address the following:

  a. A 2018 inventory of CO_2 emissions from all sources in Taranaki.
  b. Comparison of spatial distribution of CO_2 emissions in Taranaki region with the national and global averages.
  c. Modelling of air flows in the Taranaki regional air space and the consequent dispersion of CO_2.
  d. Comparison of the local and global rates of increase in atmospheric CO_2 emissions and consequential rates of acidification of seawater.

11. My evidence will not address the enhanced emission of the greenhouse gas Methane in the Taranaki region, which arises from natural gas production activities in addition to dairy farming emissions. Methane emissions contribute to global warming, but do not directly impact ocean acidification. So, that adverse environmental effect is outside of the scope of my brief.

Taranaki CO_2 emissions inventory

12. Indigenous natural gas production in New Zealand is currently all sourced from the Taranaki region. About half of that natural gas is reticulated to other regions of New Zealand, the rest is used in the Taranaki region for Power generation, and the manufacture of methanol and urea.

13. Natural gas resources are processed in gas production stations where light condensate liquids and liquefied petroleum gas (LPG) are separated as co-products and hydrogen sulphide is removed.

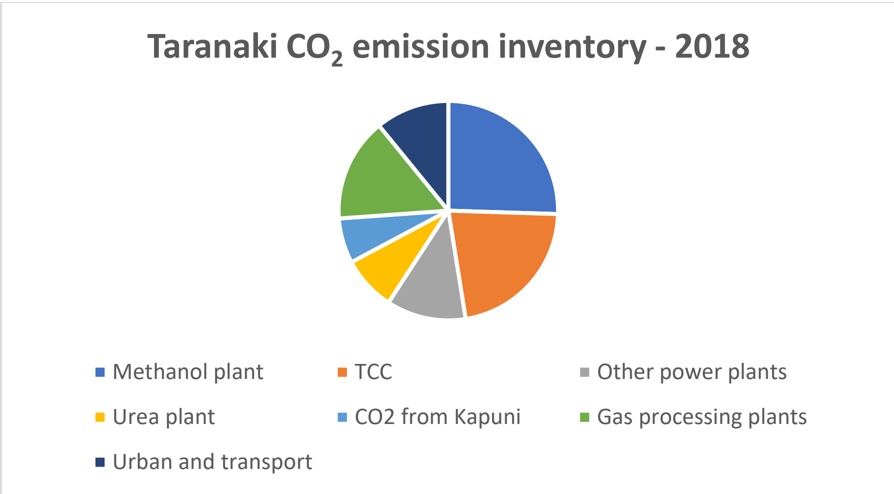
14. The Kapuni gas field in South Taranaki has an unusually high CO_2 content of 43% by volume. The specification of reticulated natural gas has a maximum CO_2 content of 4%. Therefore, the Kapuni gas production station also includes a Benfield CO_2 removal process to produce sales quality gas from the Kapuni resource. The CO_2 removed by that process is discharged to atmosphere.

15. The production of methanol from natural gas requires a natural gas resource with an elevated CO_2 content of about 20%. Methanol production is located in North Taranaki and is suited to local gas resources with enhanced CO_2 content.

16. Efficient gas fired power generation in 2018 was mostly from the Taranaki Combined Cycle (TCC) power plant. A load factor of 65% is assumed for the inventory. That power station is now (2025) approaching the end of its life and is being used less. The smaller less efficient peaking gas turbines were assumed to operate with a load factor of 20%.

17. Domestic and commercial use of fossil fuels, and the use of petrol and diesel in transport, also contribute to the CO_2 inventory. I have estimated that contribution on a per capita basis.

18. Figure1 shows a CO_2 inventory for the Taranaki Region based on data for 2018. The total estimated emissions in the Taranaki Region in 2018 was 4 million tonnes of CO_2.



19. The total New Zealand CO_2 emission in 2018 was 35 million tonnes. So, 11% was emitted in Taranaki Region, which is 2.7% of the land area of New Zealand. So, the spatial distribution (tonnes per square kilometer) of CO_2 emissions in Taranaki is 4 times greater than the CO_2 spatial distribution in the whole of NZ.

20. Likewise, the global CO_2 emission in 2018 was 36 billion tonnes and the global land area is 20,000 times the area of Taranaki. So, the spatial distribution of CO_2 emissions in Taranaki is 2.2 times greater than the global average.

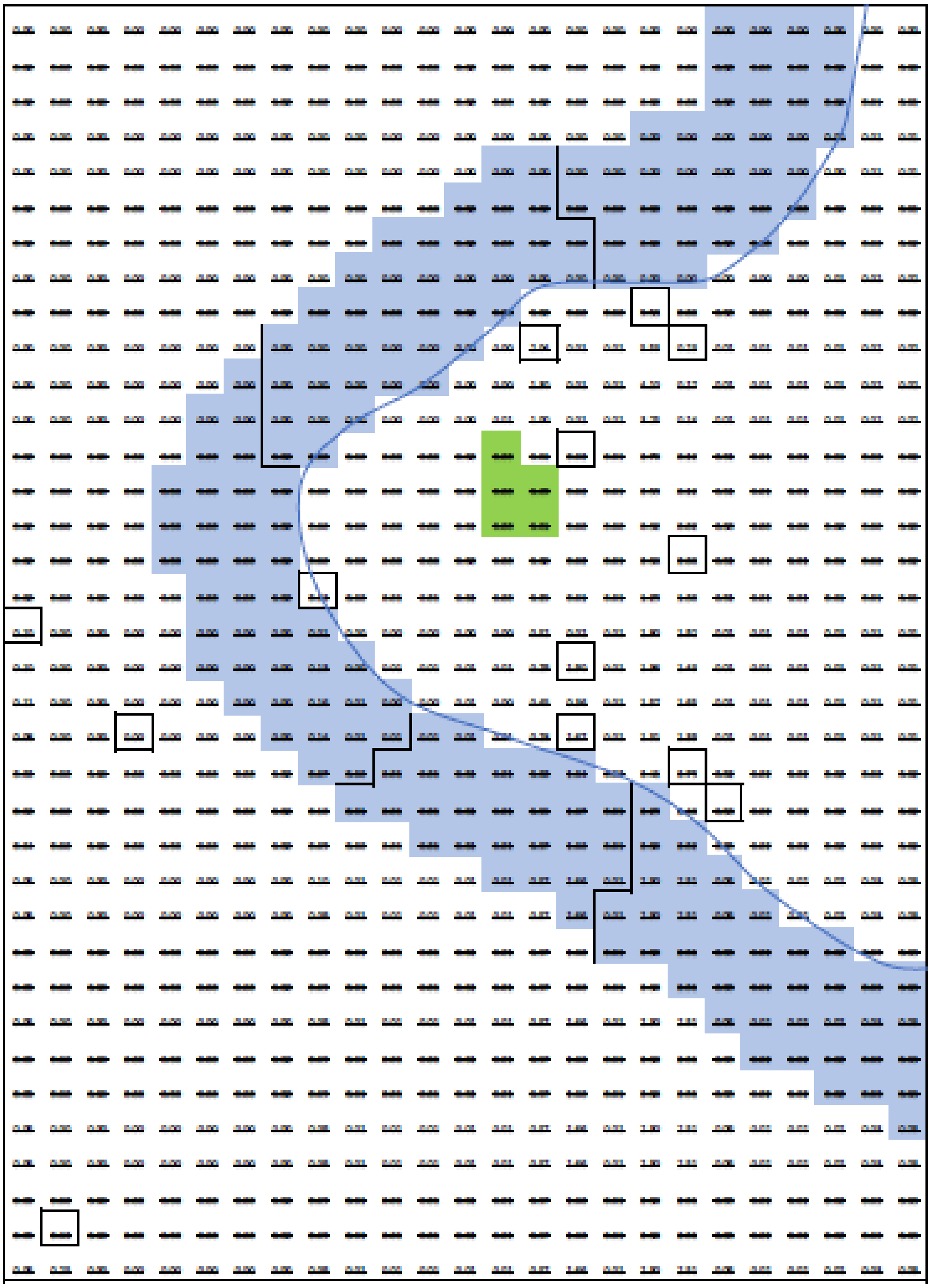
Modelling of CO_2 dispersion

21. I modelled the air space above Taranaki as a 5km by 5km grid 1 km deep. Using 4 wind rose datasets, I determined the fraction of each cubic kilometer block of air that moves horizontally into the 4 adjacent blocks (to the North, East, South and West) in one hour. On that basis, I calculated the CO_2 additions and removals for each square kilometer of land on an hourly basis to determine the elevated CO_2 concentration at that location above the ambient air CO_2 concentration. That

elevated CO_2 concentration results from the hourly CO_2 emissions and their redistribution due to wind.

22. Figure 2 shows a copy of the spreadsheet model that I used to carry out these calculations. I modelled a 125 km by 180 km area to include all the Taranaki region and the adjacent sea area out to the 12-mile territorial limit. For each cell, the spreadsheet calculates the increase in parts per million of CO_2 concentration above the ambient air CO_2 concentration.

Figure 2 Taranaki CO_2 dispersal model



23. This dispersion modelling showed that the greatest offshore CO_2 increase occurred in the South Taranaki Bight south of Hawera where the atmospheric concentration of CO_2 is estimated at 2.5 ppm greater than the ambient CO_2 concentration.

24. The CO_2 concentration in the global atmosphere has been increasing for decades. The monitoring at Mauna Loa Observatory on Hawaii indicates that the current rate of increase is 2.5 ppm per year.

25. I am not an expert in the process of acidification of ocean waters by atmospheric CO_2, but I proceed based on the well understood science that an increased concentration of CO_2 in the atmosphere over ocean surface water, relative to the pre-existing CO_2 level in that sea water, leads to absorption into the seawater. The CO_2 dissolves in the seawater, and reacts with the water to form carbonic acid, which then dissociates into bicarbonate and hydrogen ions. These hydrogen ions increase the acidity of the water, lowering the pH.

26. Therefore, the coastal seawater in the South Taranaki Bight is continuously exposed to an atmospheric CO_2 concentration that is one year ahead of what it would be in the absence of CO_2 emissions in the Taranaki region.

Conclusion

27. Since the acidification of ocean water is a direct consequence of increasing atmospheric CO_2, I conclude that a consequence of the enhanced CO_2 emissions in the Taranaki region is the acidification of coastal seawater in the South Taranaki Bight about one year earlier than would otherwise be the case without enhanced CO_2 emissions.

Steve Goldthorpe

____

Steve Goldthorpe

Appendix A: Further discussion of CCS

1. An outcome of that hearing was that the cost and energy penalty of CCS would be excessive, and that tree-planting would be carried out as a CO_2 emission offset instead. The TCC consent was granted. [As far as I am aware, during the 25 years of operation of TCC not a single tree has been planted to offset its CO_2 emissions under the conditions of that resource consent.]

2. Subsequently, I presented evidence on CCS technologies to the consent hearings for the Stratford gas-fired peaking power plants. I proposed that a condition of consent might be a commitment to investigate the potential for CO_2 storage in depleted natural gas fields in Taranaki. The proponent's engineer declared that the idea of CO_2 storage in depleted gas fields was *"off the planet"*. In his summary of the consent hearings the panel chair repeated that phrase *"off the planet"* in his final summing up.

3. In the later years of my career, I carried out various studies of CCS schemes for the Asian Development Bank in China and a major study of CCS in Indonesia for the World Bank. The CO_2 capture element of those schemes was straightforward chemical engineering. I assessed the substantial cost and energy penalties. The CO_2 storage element of CCS schemes, involving CO_2 injection into depleted oil and gas fields was less definitive and raised questions of the certainty of permanent CO_2 storage and the adequacy of CO_2 storage capacity in the long term.

4. On the international CCS scene, the International Energy Agency Greenhouse Gas R&D Programme (IEAGHG) and the Global Carbon Capture and Storage Institute (GCCSI) only consider geological storage (i.e. injection of CO_2 underground or beneath the sea floor). Most practical applications of CCS overseas involve injection of CO_2 into depleted oil wells to enhance oil recovery (EOR), thus making them economic. Such applications are included in the portfolio of Carbon Capture and Utilisation or Storage (CCUS) schemes. Since the amount of carbon injected into an oil field as CO_2 for EOR is similar to the amount of fossil carbon produced in additional oil, the net global environmental benefit of EOR in terms of global CO_2 emissions reduction is minimal.

5. I have developed a deep personal interest in an alternative CO_2 storage option, which has evolved into placement of CO_2 on the ocean floor at a depth in the range of 5-7 km, where the CO_2 should form a permanent dense solid CO_2-hydrate. I first investigated this concept for British Coal in the 1980's, I carried out a related study for IEAGHG in the late 1990s. I perceived this approach as a potential solution to the long-term CO_2 storage capacity issues in Indonesia, but it was outside of the scope of my work for the World Bank. Many researchers have expressed interest in the concept, but there has not yet been any uptake from Research Institutes willing to fund the research necessary to validate this approach to CO_2 storage. In particular, IEAGHG and GCCSI will only consider geological storage, which would be managed by the oil and gas industry.