Submission: Proposed regulatory regime for Carbon Capture, Utilisation, and Storage (CCUS)

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Disclosures:

1. The authors of this submission are University of Canterbury academics and scientists whose research interests include climate change impacts, renewable energy, decarbonisation and carbon dioxide removal.
2. We receive funding from the Ministry of Business, Innovation and Employment to undertake public-good research in some of these areas.
3. In our research, we develop relationships with parties who are affected by the ETS and other energy sector regulations. These relationships can provide us with access to proprietary data that enable our research and they are channels through which we disseminate research findings to relevant stakeholders. However, we do not purport to speak on behalf of, nor is this submission influenced by, those parties.

Context relevant to this submission:

4. The Ministry for the Environment estimates[1] that, for New Zealand to meet NDC1, it will "almost certainly require domestic and offshore mitigation [carbon removals]". The cost to purchase these removals could range between $3.3 billion and $23.7 billion.
5. The International Renewable Energy Agency (IRENA) estimates[2] that, to stay within 1.5°C of warming, the world will need capacity for 3.5 billion tonnes of carbon removals annually by 2050.
6. The IPCC, through Article 6.4 of the Paris Agreement[3], are exploring mechanisms that enable emissions reductions by parties in one country to be sold to parties in other, that is, an international carbon market.
7. Voluntary carbon markets have already emerged[4-5], which enable companies to purchase removals or emission offsets.

Response to Consultation Question 1 "*Do you agree that the government should establish an enabling regime for CCUS?*"

8. Yes.
9. Decarbonization of the economy will be achieved most effectively through a range of measures, including the adoption of new low-carbon technologies, reducing emissions

[1] https://www.treasury.govt.nz/sites/default/files/2023-04/cefa23.pdf: § 7, p 80.
[2] https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023: § 1.2, p 40.
[3] https://unfccc.int/process-and-meetings/the-paris-agreement/article-64-mechanism
[4] CORSIA, an aviation-focused offset and reduction scheme. https://www.transport.govt.nz/area-of-interest/environment-and-climate-change/corsia/
[5] Frontier Climate, an advanced market commitment mechanism. https://frontierclimate.com/

from existing processes and industries, and policy interventions. The IPCC has made clear that CCUS is a low-carbon technology, featuring it in all AR6 transition pathways[6].

10. This regulatory proposal largely frames CCUS as an emissions mitigation practice for the natural gas sector and its downstream industries. However, if successfully deployed, there should be significant spillover benefits for other parts of the economy.
    a. Domestic production of steel and cement is strategically important for a country to retain in the face of uncertain geopolitical trends. However, these industries are emissions-intensive and hard-to-abate. CCUS provides one avenue to lower their emissions profiles.
    b. Some capacity for CO2 transport and storage would enable the growth of a domestic carbon dioxide removal industry. Collectively, these technologies for removing carbon dioxide directly from the atmosphere are a substantial feature of future IPCC pathways.

Response to Consultation Question 2 "*Do you agree with our objectives for the enabling regime for CCUS? Please provide any further information to support your answer.*"

11. No. Disagree with Objective 3 which refers to energy security.
12. "Energy security" could refer to several issues relevant to New Zealand, including near-term supply constraints in the domestic gas market, reliance on imported oil, or exposure to dry-year risk in the electricity system. However, the framing of this document and timing alongside other energy sector initiatives (repeal of the offshore exploration ban) suggests the term primarily refers to the domestic gas market.
13. CCS projects are large, expensive and technically complex. They take many years to plan and deliver, particularly if constrained to an offshore environment. It seems overly hopeful to suggest that CCS projects could be implemented rapidly enough to bring new gas onstream and avert supply constraints in the short-term.
14. The rapid pace of implementation of CCS at Top Energy's Ngawha plant is commendable but is not representative of CCS time scales generally.

Response to Consultation Questions 3 & 4 "(3) *Should the ETS be modified to account for the emissions reductions achieved using CCS? If so, how do you think it should be modified? (4) Do you agree that all CCS activities should be eligible to receive recognition for the emissions captured and stored? If not, why not?*"

15. Yes to (3). The ETS is the most logical policy tool to use for rewarding emissions reductions achieved through CCS.
16. Mostly yes to (4). The majority of CCS activities should be eligible to receive recognition. However, to incentivize quality, the degree of recognition should be tied to the quality of the CCS activity.
17. We recognize that doing so risks introducing additional complexity into the ETS. We feel that the government should be bold in introducing a future-proofed framework with carefully crafted incentives and that doing so justifies the additional complexity.
18. CCS activities should recognize carbon dioxide removal (CDR) activities generally, as opposed to particularly technologies or processes specifically (e.g., forestry,

[6] https://www.ipcc.ch/report/ar6/wg3/chapter/chapter-3/, § 3.42 & 3.47

geothermal emissions capture). The ETS should be modified to be broadly enabling to both CCS and CDR activities, with an understanding that the latter will come to dominate over time.

19. The following points elaborate on possible modifications of the ETS to improve the incentives around CCS and CDR, with a view towards to long-term enablement of CDR (removals).

20. The ETS should **define, clearly and in non-exclusive terms, what CCS and CDR activities qualify for recognition**.

    a. Clarity is important for reducing uncertainty for those investing in research or deployment of emerging CCS and CDR technologies.

    b. A non-exclusive definition should be adopted to avoid precluding new technologies that may emerge in the future.

    c. *A possible definition for a CDR activity is*: "A removal is any activity or process that (i) removes CO_2 directly from the atmosphere; and (ii) is purposefully designed, that is, would not occur except through the intentional activities of a compensable party[7]"

21. ETS as a framework should continue to **incentivize emissions removals** even after most emissions-generating activities have been displaced, i.e., beyond net-zero.

    a. Our reasoning is that removals in some form will almost certainly be required for the government to meet NDC1[8] and probably for future NDCs. Further, the IPCC views CDR removals as essential in the second half of this century.

    b. This could be achieved within the ETS by providing *a government purchase mechanism for a broad range of carbon dioxide removal activities beyond afforestation*.

22. ETS should **set a minimum volume or term of duration** (durability) for a removal to be eligible.

    a. This is intended to exclude incidental or non-commercial removals[9] for which the accounting costs are likely to exceed any abatement benefits.

    b. An illustrative[10] example: *minimum eligible removal volume of 100 tCO_2/year with a minimum durability of 10 years*.

23. ETS should **recognize and incentivize privileged classes of removals** based on specified, desirable characteristics.

    a. The intent is to recognize that some removals are more effective than others at achieving climate goals.

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[7] This therefore includes landowners engaging in soil carbon sequestration, ecosystem restoration, forestry, or direct air capture, but would exclude passive removals in global commons, e.g., passive ocean removal.

[8] https://www.treasury.govt.nz/sites/default/files/2023-04/cefa23.pdf: § 7, p 80.

[9] For example, tree plantings on private residences.

[10] "Illustrative" examples, here and elsewhere, are not evidence-based nor are they specific recommendations by us. They are simple scenarios created to explain the broader idea we are advocating.

b. This could be achieved within the ETS by introducing *categories of removals with different prices*, or issuing partial NZUs for removals of lower quality.

c. This would provide a price mechanism to change the incentives of certain removal technologies that dominate a particular category.

24. ETS should **recognize durability as a desirable characteristic**.

    a. Durability is here used to refer to the time elapsed from when the removal is created to when it is likely to have returned to the atmosphere.

    b. Removals with higher durability should be privileged over those of a more temporary nature.

    c. Privileging durability will incentivize removal technologies that accrue larger climate benefits over the long term.

    d. Durability could be recognized within the ETS by specifying *removal categories based on durability.*

    e. An illustrative example with three durability categories:

        i. Temporary removal, lasting between 10 and 50 years.

        ii. Durable removal, lasting between 50 and 200 years.

        iii. Effectively permanent removal, exceeding 200 years.

25. ETS should **incentivize activities that increase the durability of a removal**.

    a. This is intended to recognize and incentivize specific biomass-based technologies that do not create a new removal but do substantially increase the durability of an existing removal.

    b. An illustrative example: planting an exotic forest creates a temporary removal. Harvesting the forest and creating biochar does not create a new removal. However, biochar has a much longer removal period than the maturation time of an exotic forest.

    c. This could be achieved within the ETS by providing *a removal credit that recognizes the price difference between tiers of different durability*.

    d. Alternatively, this could be recognized via a CCS framing, where harvesting of a forest is an emissions-generating activity whereas the creation of biochar is a CCS activity.

    e. This provision would also recognise and incentivise bioenergy with carbon capture and sequestration (BECCS) technologies.

26. ETS should **recognize uncertainty as an undesirable characteristic of removals**.

    a. Removals with greater certainty of amount AND durability of removed carbon volume should be privileged over those that are uncertain.

    b. This is intended to build confidence in removal integrity that will ultimately support stronger social licence for removal activities and enabling policy.

c. This could be achieved within the ETS by *paying for removals at the conservative P10 level of estimated durability and volume*[11].

d. This quantification scheme has long been used by the energy industry for prospecting resources supporting operational and investment decision-making[12].

e. Crediting only high-confidence removals has the further benefit of incentivizing research activities that reduce the uncertainties associated with a removal process[13].

27. ETS should **avoid prejudicing removal activities based on the environmental impact** of those activities.

    a. Environmental impacts and externalities should be managed through separate frameworks[14].

    b. This is intended to avoid scope and mission creep of the ETS that might dilute its effectiveness or introduce conflict with other policy areas.

    c. However, we do affirm that any removal activities should minimise their negative environmental impacts because this will be important for maintaining social licence.

28. Government should carefully consider **actions that limit the ability of removals to be sold outside the ETS**.

    a. Removals sold in international markets should not be sold under the ETS or credited towards New Zealand's NDC.

    b. However, limiting access to voluntary markets could reduce removal revenues and make some removal activities financially infeasible. This would reduce global removals. This may also disincentivise international investment in removal projects.

    c. Limiting access to other removal markets could create conflicts with international agreements, e.g., the Paris Agreement Article 6.4 mechanism, which seeks to enable trading of emissions reductions between countries.

29. ETS should **clearly define ongoing, post-removal activities that maintain the integrity of a removal.**

    a. These are activities that reduce the impacts of a leakage/reversal event.

    b. At a minimum, they should include:

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[11] For example, if the P[10, 50, 90] confidence distribution for removals for a particular wetland restoration are estimated to be [2, 10, 100] tCO_2/yr/ha, then removals should only be credited at the lower limit of 2 tCO_2/yr/ha.

[12] https://en.wikipedia.org/wiki/Oil_and_gas_reserves_and_resource_quantification

[13] Uncertainty reductions are likely to lift P10 estimates of volume and durability. This has the potential to increase the volume of eligible removals, and potentially access a higher category of durability, if tiered pricing is used.

[14] For example, problems with forestry slash should be managed via the Resource Management Act or Workplace Heath and Safety Act because slash is not directly an emissions issue.

i. Monitoring of the removal to verify its durability and determine if leakage/reversal is occurring or may do so in the future.

ii. Mitigation for leakage/reversal events, including financial compensation for affected parties.

c. The costs of ongoing, post-removal activities should be estimated prior to the purchase of a removal.

30. ETS should specify **a fixed end time for ongoing post-removal activities**.

    a. The intention is to avoid an uncapped liability pool as removals are created and accrued.

    b. As an illustrative example, 100 years after a removal is created, any obligation to monitor for or compensate against leakage/reversal expires.

31. ETS should **vest responsibility for post-removal activities with the owner of the removal.**

    a. This presumes that the government will become the ultimate owner of all removals.

    b. The intention is to shift long-term costs and responsibility away from commercial entities that may cease to exist or be unable to make good on their obligations.

    c. Costs associated with ongoing, post-removal activities could be recovered through ETS revenues.

    d. The government purchaser should estimate these future costs before entering a purchase agreement for a removal or issuing NZUs recognizing a removal.

    e. Passing on estimated future costs of ongoing activities to the removal provider (via the purchase price) should incentivize removals with low leakage/reversal risk and low monitoring costs. It should also incentivize research and development activities that reduce leakage/reversal risk.

Response to Consultation Question 7 "*Is there any other information that CCS project operators should be required to verify and report? Please reference the relevant overseas standards where applicable*"

32. A pressure management plan for the reservoir and associated protocols for managing induced seismicity, e.g., a traffic light system, well bleed-off. A monitoring program that requires pressure to be measured within the storage system and the first overlying aquifer[15].

33. A catalog of wells that penetrate the proposed (CO2) closure and investigations determining their status and security. A monitoring program that regularly surveys these wells and associated protocols for mitigating any leakage that is discovered.

34. If there is a regional aquifer in pressure communication with the CO2 storage site, and it is proposed to operate the site at overpressure, then a second "area of review" catalog

[15] World Resources Institute (WRI). CCS Guidelines: Guidelines for Carbon Dioxide Capture, Transport, and Storage. Washington, DC. pp 12-17 http://pdf.wri.org/ccs_guidelines.pdf

of wells should be identified. For these wells, the risk of brine lift into shallower aquifers[16] should be assessed and mitigated.

Response to Consultation Question 17 "*Should the government indemnify the operator of a storage site once it has closed? If so, what should be the minimum time before the government chooses to indemnify the operator against liabilities for the CO2 storage sites?*"

35. Yes.
36. The minimum time should be set with reference to good practice internationally.
37. During the closure period, but before liability passes to the government, there is a risk the storage operator may cease commercial operations and may be unable to make good their obligations to monitor for or mitigate leakage. Government should therefore withhold some proportion of the financial reward for storage, or otherwise bond the storage operator, until such time as the liability can be properly transferred.

Response to Consultation Question 23 "*Should CCS project proponents be required to submit evidence that proposed reinjection sites are geologically suitable for permanent storage, in order for projects to be approved? If so, what evidence should be provided to establish their suitability?*"

38. Yes.
39. An operator should be able to demonstrate site suitability against the following criteria:
    a. Suitability of the top seal to contain buoyant phase CO2 under the proposed operating pressure.
    b. Existence of lateral closure extending at least the same vertical extent of the proposed buoyant phase storage volume. The geometry of the closure should be well constrained.
    c. The above two criteria need not be demonstrated if CO2 injection is to be as a dissolved component in water, e.g., as generally occurs into geothermal fields.
    d. CO2, when it dissolves into subsurface water, forms an acid that can mobilize some heavy metals[17]. Proposed sites should be able to demonstrate no risk of migrated dissolved CO2 that might pose a hazard to drinking water aquifers.

Response to Consultation Question 24 "*Should there be separate permitting regime for CCU activity if there is no intention to store the CO2?*"

40. No. It is simpler to handle it through the existing ETS. Producers of CO2, where it has a fossil origin, should have to surrender NZUs. They can choose to pass these costs along to those who would purchase CO2 for various utilization activities.
41. Sometimes, Utilization refers to a practice called Enhanced Oil Recovery, where CO2 injection is undertaken to increase the recovery of fossil fuels. The same might be conceivably done in a gas reservoir.

[16] https://www.sciencedirect.com/science/article/pii/S1750583612001077
[17] https://link.springer.com/article/10.1007/s11242-009-9509-8

42. Such enhanced recovery practices should not be credited for removals unless a project can demonstrate CO2 storage to the same standards of as other qualifying CCS activities.

Response to Consultation Question 26 "*What potential markets for CO2 derived products do you see as most critical in New Zealand?*"

43. Methanex uses CO2 as a feedstock in the production of methanol. As a large export industry, this would be the obvious near-term use.
44. Substituting hydrogen and CO2 feedstocks with low-carbon alternatives, e.g., blue or green hydrogen, green CO2 from biomass combustion, would enable the production of green methanol.
45. CO2 supply to horticultural industries is important for improved plant growth and crop quality, allowing greenhouses to extend growing seasons. Horticulture is an important domestic and export market for NZ.
46. Green CO2 is likely to be a key feedstock for the production of sustainable aviation fuel and possibly other synthetic biofuels.

Response to Consultation Question 27 "*Are there any specific barriers to transportation of CO2*"

47. CO2 pipelines have a different risk profile than natural gas pipelines. Unlike natural gas, which is buoyant relative to air but explosive, CO2 is heavier and could create a local asphyxiation hazard near a major leak.
48. Recent studies[18] indicate that both CO2 and natural gas pipelines have incidents/failures at similar rates (per length of pipeline). However, the nature of these incidents is likely dissimilar. CO2 pipelines may be more vulnerable to corrosion where water is able to enter the pipeline and become acidified.
49. This can be mitigated by ensuring gas injected into a CO2 pipeline has gone through proper cleaning processes. NZ should ensure it has clear and robust guidelines for the construction, testing, operation, maintenance and monitoring of CO2 pipelines.
50. In the US, pipeline regulation is managed by the Pipeline and Hazardous Materials Safety Administration (PHMSA)[19]
51. There are existing international standards for pipeline transport (ISO 13623:2017[20]) that have been amended for CO2 applications.
52. Standard AS/NZ 2885 describes requirements for pipeline transport of liquid hydrocarbons including fluids that are "predominantly CO2". Appendix T provides extensive guidance on CO2 pipelines.

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[18] Vitali, M., Zuliani, C., Corvaro, F., Marchetti, B., & Tallone, F. (2022) https://doi.org/10.1016/j.jlp.2022.104799; Duncan, I. J., & Wang, H. (2014) https://doi.org/10.1016/j.ijggc.2013.11.005

[19] https://www.phmsa.dot.gov/regulations see also here https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-D/part-195

[20] https://cdn.standards.iteh.ai/samples/61251/bf87fd707c844e1c932fc9c94b880406/ISO-13623-2017.pdf