6 August 2024

Ministry of Business, Innovation and Employment
PO Box 1473
Wellington 6140

Attention: CCUS consultation 2024

1 Fairway Drive, Avalon
Lower Hutt 5010
PO Box 30368
Lower Hutt 5040
New Zealand
T +64-4-570 1444
F +64-4-570 4600
www.gns.cri.nz

RE: INSTITUTE OF GEOLOGICAL AND NUCLEAR SCIENCES TE PŪ AO SUBMISSION ON CALL FOR FEEDBACK: PROPOSED REGULATORY FRAMEWORK FOR CARBON CAPTURE UTILISATION AND STORAGE

1.0 SUBMITTER DETAILS

Name of Organisation:	Institute of Geological and Nuclear Sciences Te Pū Ao
Email	[redacted]
Capacity of response:	Public sector
Confidentiality and Disclosure:	Not commercially sensitive
Publication of response:	Consent provided to publish the content of this submission

2.0 INTRODUCTION

The Institute of Geological and Nuclear Sciences Te Pū Ao ("GNS Science") welcomes the opportunity to comment on the Government’s proposed framework for Carbon Capture Utilisation and Storage (“CCUS”).

Background

As a Crown Research Institute, GNS Science is mission led and we strive to contribute to Aotearoa New Zealand's well-being by conducting world-class scientific research that generates economic, environmental, and social benefits.

GNS Science provides expert scientific input to inform policy, regulation, standards, and guidance. This submission has been formulated within the framework of GNS Science’s four strategic science themes, namely: Land and Marine Geoscience, Natural Hazards and Risk, Environment and Climate, and Energy Futures.

Our work in Environment and Climate and Energy Futures is particularly relevant to this submission. GNS Science has conducted extensive research on the climate system, examining the drivers, scale, and rates of change in coupled ocean-atmosphere-hydrosphere interactions. We have also dedicated significant efforts to researching geothermal energy exploration and development, monitoring carbon dioxide (“CO_2”) emissions and attributing them to specific human activities, geothermal CO_2 reinjection effects, managing groundwater resources and studying natural and anthropogenic carbon capture and storage. We have significant in-house expertise on evaluating and responding to multi-hazard risks that are particularly relevant to the New Zealand context.

3.0 SPECIFIC GNS SCIENCE COMMENTS

GNS Science agrees with the Government that a clear regulatory framework for CCUS is needed and that it could allow industries to access CCUS technologies on a level playing field with other emissions reduction and removal mechanisms. A robust and effective regulatory framework may incentivise the reduction of carbon emissions from large point sources. It may also improve the economics of natural gas production and improve the supply and carbon balance of natural gas as a transition fuel. If implemented well, this framework will better enable a least cost transition towards net zero emissions.

Our detailed comments are provided below.

Objectives of proposed regulatory framework

GNS Science supports the Government’s high level objectives for the enabling regulatory framework: efficient emissions abatement, environmental integrity, and energy security. We recommend that the term ‘carbon storage’ be used rather than ‘CO_2 storage’, to include a wider range of carbon sequestration technologies.

We recommend a stronger focus on multiple-hazard risk identification, risk mitigation, and risk management in the proposed regulatory framework. New Zealand’s geological context and position on active plate boundaries requires careful consideration of associated risks. While the Government identifies environmental integrity as an objective of the framework, we recommend a stronger focus on identifying and mitigating particular environmental risks in different locations. We provide additional details in this submission in the section on a consenting regime.

With respect to addressing societal risk, Māori and local community engagement are critically important to the viability of long-term carbon storage. GNS Science recommends a deliberate focus on ensuring social buy-in throughout the regulatory framework following our own research on public perceptions of carbon capture and storage (“CCS”) in New Zealand (Coyle 2016, Doody et al 2012). Transparent public access to data is important to ensure durable public support and is a strong recommendation internationally (Blanchard et al 2024). This is particularly relevant for long-duration activities like monitoring for CO_2 leakage and evaluating impact of storage on natural springs and water wells (von Rothkirch et al 2021, Shah et al 2022).

Proposed framework to more clearly distinguish between carbon capture, carbon utilisation and carbon storage

There are important differences between carbon capture, carbon utilisation, and carbon storage that need to be defined and considered within any regulatory and compliance mechanism. The first difference pertains to the duration that CO_2 is removed from the atmosphere or is captured prior to release. For example, industrial applications that capture and re-use CO_2 (e.g., greenhouse horticulture and the food and beverage industry), quickly release CO_2 back into the system and provide a near-zero gain as work towards our net-zero emissions target. Land carbon storage through planting trees can remove carbon on timeframes that vary from a few decades (for pine plantations) to a few centuries (with indigenous tree species plantations). Carbon that is sequestered geologically is removed for even longer time frames. Therefore, the regulatory framework for monitoring, and long-term liability will need to accommodate the different outcomes and risks associated with different capture and storage approaches. The regulatory framework for consenting will also require different threshold criteria for carbon storage activities (where the issue of leakage rates and viability of long-term sequestration is relevant), as compared to carbon capture and carbon utilisation activities..

The second difference pertains to the Emissions Trading Scheme (ETS) credits that would be available for emissions abatement for carbon capture, carbon utilisation and carbon storage activities. Evaluations of 'additionality' that are currently used for carbon offsets in forestry are likely to be required to apply for carbon utilisation activities, but is not relevant to CCS. It is relevant to note that 'additionality' evaluations face multiple methodological challenges including the need to better reflect the role of other soil carbon compared to above-ground biomass (see CarbonWatch NZ), which is relevant in seeking to extend it from forestry offsets to other carbon utilisation activities.

In the case of carbon storage, given the energy required for sequestration, an important assessment of CO_2 leakage rate is required to determine net benefit.. Even small leakage rates can result in a net cost to the project (Etheridge et al 2011, Turnbull et al 2017). We note that specific calculations would need to be done for the New Zealand context as we have renewable energy sources that may produce a more favourable cost-benefit analysis than international examples.

New consenting regime for carbon storage

Currently geothermal fluid reinjections are consented through 'discharge permits' under the Resource Management Act 1991 (RMA). These permits allow for a degree of post-injection environmental impact monitoring in line with resource consent conditions. However, these permits are not designed to address issues relating to carbon storage such as CO_2 leakage but allow the dilution of the power station emission in the reinjection fluids (Barton 2023). GNS Science recommends the creation of a tailored consenting regime for carbon storage, that include mineralisation, gas storage and geothermal reinjection that considers the geological conditions and natural hazard risks that are specific to New Zealand. This would align with global best practices adopted in countries such as Germany and the Netherlands.

New Zealand's oil and gas reservoirs and most of the country's saline aquifers are characterised by their relatively young geological age (generally less than 60 million years), as well as mineralogical composition that makes them susceptible to physical and chemical changes from reinjected CO_2 (Edbrooke et al 2009, Higgs et al 2006, Arnot et al 2009, Bland et al 2009). There are specific risks pertinent to the New Zealand context linked to active plate boundaries. Carbon storage sites in New Zealand are unlikely to be directly comparable to overseas reservoirs. GNS Science recommends that for CCS projects to be approved, project proponents should be required to submit evidence that proposed reinjection sites are geologically suitable for permanent storage.

This evidence, which considers local reservoir characteristics, would include the following:

Quantitative assessment of storage capacity:

- Reservoir mapping and assessment of porosity and permeability.
- Petrographic studies of reservoir rocks to identify mineralogical composition and diagenetic overprints.
- Geochemical studies to assess chemical reactivity from injected CO_2.
- Assessment of the mineralization potential for carbon conversion to minerals.
- Reservoir modelling to predict injectivity, well design and behaviour of the CO_2 plume in the reservoir (including geothermal reservoir).

Assessment of seal capacity, integrity and risk:

- Sedimentological characterisation of seal distribution, properties and spatial variability.
- Petrological analysis of seal mineralogy and permeability.
- Assessment of seal capacity (e.g. through Mercury injection capillary pressure measurements).
- Geomechanical modelling.
- Geochemical resistance studies.
- Hydrogeological studies.

Assessment of reservoir and seal structural integrity:

- Mapping of faults and fault seal appraisal.

Structured multi-hazard risk assessment:

- Assessment of background seismicity.
- Assessment of seismic hazard and risk. Research and modelling such as that contained within the National Seismic Hazard Model (NSHM) can inform this modelling.
- Assessment of risk from other natural hazards such as sea level rise, tsunami, and volcanic eruptions. Volcanic eruptions are a particularly important risk for Taranaki and Central North Island areas.
- Consideration of climate change impacts as reflected in sea level rise risk or changes in groundwater levels.
- Public health impacts associated with CO_2 transport or potential catastrophic CO_2 leakage.
- Environmental impacts associated with CCS activities.

Monitoring carbon capture and storage sites

The Government has requested inputs on potential methods to monitor CCS sites. Monitoring and verification techniques best suited to subsurface CO_2 storage sites in New Zealand will depend on a number of factors, including the type of storage (e.g., deep saline reservoir or depleted oil and/or gas reservoir), the depth of the storage reservoir, whether the storage site is onshore or offshore, and the location of the site relative to population centres, environmentally sensitive areas, other subsurface resources (e.g., oil, gas, coal, mineral, groundwater and geothermal), local active faults, and sites of cultural significance.

The following methods are suggested for monitoring:

Indirect geophysical subsurface monitoring e.g.:

- Time-lapse 3D seismic reflection surveys to monitor pore-space saturation of CO_2 in deep reservoirs (deeper than about 800 m).
- Gravity, electromagnetics (EM), ground surface deformation, and microseismic monitoring.
- Modelling of ground deformation resulting from CO_2 injection using remote sensing techniques.
- Due to New Zealand's active plate boundary setting, passive seismic instruments to monitor fracturing and fault slip, as well as to track plume migration, may also be an essential component.

Direct observations:

- Downhole fluid chemistry and pressure measurements together with gas (soil and atmospheric) chemistry to identify increased CO_2 concentrations.
- Surface CO_2 flux monitoring.

Other information to consider while monitoring CCS sites:

- Nature of the gas mixture captured and how the mixture is treated.
- Treatment of gases that cannot be stored or used.
- Presence and extent of contaminants produced in the capture process.
- Nature of the water source for this process.
- Evaluation of potential CO_2 leakage to aquifers.
- Evaluation of CO_2 migration to the surface along with subsurface fluids.

GNS Science does not recommend an exception of monitoring requirements for new or pilot-scale CCS projects. Novel CCS technologies need to demonstrate viability not just technologically but also societally and environmentally, by establishing that they do not have any negative social and environmental consequences. Monitoring costs are part of the economics of CCS projects. GNS Science recommends that if a pilot-scale CCS project is unable to afford monitoring, then it be treated as unviable during the consenting process.

ETS credit methodologies

GNS Science currently assists the geothermal industry in its estimation of how much emissions credit is obtainable for reinjected fluid. This assessment is specific to geothermal reinjections. It is likely that emissions credit evaluations using the straightforward-subtraction method will need to be tailored to each carbon storage technology and no standardised approach is feasible. It is also likely that this process will require third-party verification of claimed emissions abatement. Small businesses in other industries already find the annual application process for rebates under the ETS to be onerous and time consuming. Therefore, compliance costs are likely to be an issue with the proposed regulatory framework.

4.0 CONCLUDING REMARKS

In previous submissions to the Government, including to the Climate Change Commission, GNS Science has recommended that CCUS be considered as it offers a mechanism to remove hard-to-abate residual emissions in the medium term and helps achieve net negative emissions in the long-term. Residual emissions from fossil sources are a factor in New Zealand's energy security decision-making, particularly during periods of peak electricity demand. CCUS plays an important role in off-setting this dependence, and enabling New Zealand's transition to a zero emissions economy and society.

Thank you again for this opportunity to provide feedback regarding the proposed CCUS regulatory framework. If you have any questions or would like to discuss any aspect of this submission further, please contact me at r.levy@gns.cri.nz.

Yours sincerely,

[redacted]

Professor Richard Levy

Interim Chief Science Advisor

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