HAWAII STATE ENERGY OFFICE
STATE OF HAWAII

JOSH GREEN, M.D.
GOVERNOR

SYLVIA LUKE
LT. GOVERNOR

MARK B. GLICK
CHIEF ENERGY OFFICER

235 South Beretania Street, 5th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804
Telephone: (808) 451-6648
Web: energy.hawaii.gov

Testimony of
MARK B. GLICK, Chief Energy Officer

before the
SENATE COMMITTEES ON ENERGY, ECONOMIC DEVELOPMENT, AND TOURISM AND AGRICULTURE AND ENVIRONMENT

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Providing Comments on
SB 2451

RELATING TO AN ATMOSPHERIC CARBON CAPTURE PLANT.

Chairs DeCoite and Gabbard, Vice Chairs Wakai and Richards, and Members of the Committees, the Hawaiʻi State Energy Office (HSEO) provides comments on SB 2451, which directs HSEO, in conjunction with the Hawaiʻi Natural Energy Institute (HNEI), to develop and submit a strategy interim report and final report no later than forty days before the convening of the regular sessions of 2025 and 2026, respectively, for the construction of at least one atmospheric carbon capture plant in the State by 2029.

HSEO's comments are guided by its mission to promote energy efficiency, renewable energy, and clean transportation to help achieve a resilient, clean energy, decarbonized economy.

HSEO appreciates the opportunity to investigate and pursue the use of atmospheric carbon capture and sequestration technologies activities further and supports the intent of SB 2451. However, HSEO notes before the construction of any atmospheric carbon capture plant, the facility and technology chosen must undergo not only a thorough environmental review but should also undergo robust lifecycle emissions analysis to determine the efficacy of the plant itself due to the substantial energy requirements of atmospheric carbon capture, also known as direct air capture (DAC) technology. Further, if geological sequestration is paired with the atmospheric carbon capture plant, the selected site's geological substrate must be adequately studied and researched.

HSEO notes a few technical definitions that should be used when referring to both direct air capture and carbon sequestration technologies.

(a) Carbon Capture and Storage (CCS) is the process by which carbon dioxide is captured from a smokestack or flue from a power plant or factory and then sequestered underground. This industrial process captures emissions from a point source GHG emitter and not the atmosphere. It is a mitigative action aimed at reducing emissions from point source facilities such as factories, refineries, or energy production facilities.

(b) Carbon Capture and Utilization (CCU) is the process by which carbon dioxide (CO_2) is captured and converted into useful products including sustainable aviation fuel, carbon-negative concrete, or carbon dioxide for industrial and commercial use, such as use in beverages.

(c) Carbon Dioxide Removal (CDR) is the process by which CO_2 gas is removed from the atmosphere and sequestered. Sequestration is the process of capturing and removing CO_2 from the atmosphere for long-term storage in the following ways:

   a. The Biological type stores CO_2 in vegetation, soils, and oceans.
   b. The Geological type stores CO_2 in geological formations (underground rocks).
   c. The technological type refers to the storage in engineered molecules.

(d) Direct Air Capture (DAC) is the process by which carbon dioxide is removed from the ambient air into a form in which it can be stored or utilized.

(e) Direct Air Capture with Carbon Storage (DACCS) is a CO_2 removal method in which carbon dioxide is captured from the ambient air via a contractor and is compressed into a pure stream to be injected into a geological reservoir for long-term storage.

(f) Geological Sequestration is a technology in which captured carbon is mixed with water and injected into an appropriate substrate, such as basalt, where it creates a carbonate rock and is stored for millennia.

(g) Negative Emissions Technology (NET) is a technology that removes more carbon out of the air than it emits during its full life cycle, also known as greenhouse gas removal technology. NETs include DACCS and CCS.

Notably, a DAC facility alone does not include a permanent storage mechanism for the captured atmospheric carbon. Geological sequestration provides the promise of long-term storage; however, some critical challenges and concerns must be addressed before its safe implementation in Hawaiʻi. As with any industrial facility before the adoption of the technology adequate community engagement and environmental analysis must occur. Further, understanding the geological substrate for permanent storage should be prioritized before substantially investing in DAC technology.

Per Act 238, Session Laws of Hawaiʻi 2022, HSEO worked with the University of Hawaiʻi (UH) Climate Resilience Collaborative (CRC) on evaluating carbon sequestration and carbon utilization opportunities for the state of Hawaiʻi. As a part of this work, HSEO and UH CRC collaborated on a white paper, which HSEO submitted as an appendix to the Act 238 legislative report.[1] As a part of the white paper, HSEO evaluated the space, energy, regulatory, and other requirements of a facility similar to the Orca facility in Iceland. The facility in Iceland was chosen for comparison due to Hawaiʻi's similar basalt geology required for the sequestration of CO_2 after DAC.

The energy requirements for a DAC facility can generally be divided into two categories: 1) the energy required for mechanical components such as the fans to collect the CO_2 from the air and 2) the energy required to adequately heat the CO_2 collected and desorb it from the surface of the collection adsorbents (carbon filters). Regarding the latter, studies have indicated that the climatic benefits of DAC are highly dependent on the energy source used to power the associated capture

[1] Hawaiʻi State Energy Office (2023). Hawaiʻi Pathways to Decarbonization. Appendix D, pages 333-357.

facility.[2] For an autonomous system (not attached to the utility grid), that is entirely powered by photovoltaic electricity (including a high-temperature heat pump (HTHP) operated with electricity from the grid), energy requirements increase, as there is no direct heat source.[3]

Estimated energy requirements for CO_2 capture using the DAC technology used by the first net-negative facility Orca in Hellisheiði, are about 500 kilowatt-hours (kWh) per ton CO_2 for electricity, not including the electricity consumption for CO_2 compression, and 1,500 kWh per ton CO_2 for heat (for temperatures around 100 degrees Celsius).[2] This equates to approximately 2,000 megawatt-hours (MWh) per year of mechanical energy, excluding the energy used for compression, and approximately 6,000 MWh of energy annually for heating.

Various CO_2 removal technologies, such as the DAC, are a critical component to achieving Hawaiʻi's net negative goals; however, they should not be construed as the fix-all solution for various reasons. Firsthand, the DAC has lower energy efficiency when compared to CCS – another technology utilized for greenhouse gas abatement, but the incentives at the federal level are not as high. Inflation Reduction Act 45Q tax credits authorized by the Inflation Reduction Act (IRA) specify credit values of $85 and $180 for both point source capture and direct air capture, respectively. Conversely, at the low end of the cost spectrum DACCS systems have estimated costs of $134-342 per metric ton.[4] Yet some research still suggests that reasonable expectations place costs substantially higher in the range of $600-1,000 per net metric ton removed.[5] At this point, federal tax provisions and carbon markets are not adequate to fund this type of facility.

Considering DAC's substantial energy requirements that make its viability highly sensitive to the cost of the energy source, substantial subsidies would likely be necessary to support the viability of DAC in the current market. It is also

[2] Terlouw, T., Treyer, K., Bauer, C., & Mazzotti, M. (2021). Life cycle assessment of direct air carbon capture and storage with low-carbon energy sources. Environmental Science & Technology, 55(16), 11397-11411
[3] Hawaiʻi State Energy Office (2023). Hawaiʻi Pathways to Decarbonization. Appendix D, pages 333-357.
[4] Herzog, H. (2022). Direct Air Capture. Greenhouse Gas Removal Technologies, 31, 115. https://doi.org/10.1039/9781839165245-00115
[5] Herzog, H. (2022). Direct Air Capture. Greenhouse Gas Removal Technologies, 31, 115. https://doi.org/10.1039/9781839165245-00115

important to keep in mind that CO_2 removal is not currently a cost-effective alternative to reducing emissions through first-order solutions such as energy efficiency, renewable energy development, electric vehicle adoption, prioritizing infill and transit-oriented development, and alternative and active transportation mechanisms. Furthermore, carbon removal technology is not an alternative to maintaining and increasing natural sinks through measures such as reforestation and afforestation, and soil carbon sequestration or regenerative agriculture.

As additional background information, HSEO notes that annual emissions from Hawaiʻi's energy sector (excluding international bunker fuels) were the equivalent of approximately 19.4 million metric tons of CO_2 annually.[6] Comparatively, the annual amount of atmospheric carbon dioxide captured and sequestered in Iceland was 4,000 metric tons, less than one percent of Hawaiʻi's energy sector emissions.

HSEO recommends that, while general research and attention to carbon capture continue, the specific tasks envisioned in this bill be delayed to a future time when Hawaiʻi's grids have an excess of zero-carbon energy available and when there is the necessary understanding of the geological substrate needed for carbon capture. Currently, it is not clear whether the act of geologic sequestration would affect geologic resources including minerals and state land, doing appropriate geological investigations should be prioritized to determine if the physical geological substrate is appropriate for carbon storage. The University of Hawaiʻi Groundwater and Geothermal Resources Center is a better-suited entity to complete this type of research.

HSEO believes that mandating construction by a specific date is not appropriate at this time because the technology is still relatively nascent and this type of project requires substantial environmental review, energy resources, and complex lifecycle emissions analysis.

However, if the Committee does decide to proceed with this measure, HSEO requests the following revisions to clarify the intent of SB 2451:

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[6] State Department of Health (2023). Hawaiʻi Greenhouse Gas Emissions Report for 2005, 2018, and 2019

1) Section 1 should clarify whether the Hawaiʻi State Energy Office will be evaluating a DAC facility only, or if the strategy should also be inclusive of the DACCS - a facility that sequesters and/or geologically stores CO_2 after it is captured. Storage and/or utilization after direct air capture are technologies separate from atmospheric carbon capture and the pathways for CO_2 utilization or storage after collection differ and require varying levels of analysis, environmental review, and permitting dependent upon the chosen pathway.
2) Removing or extending construction date requirements to ensure adequate environmental analysis, community engagement, and economic analysis can commence.

Thank you for the opportunity to testify.