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Washington Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503

RE: Feedback on Carbon Capture, Removal, Utilization, and Storage in the Cap-and-Invest Program

Dear Department of Ecology Staff,

Energy Innovation is a nonpartisan energy and climate policy think tank. We appreciate the work Washington's Department of Ecology is doing through the Cap-and-Invest program to cut climate pollution while creating jobs and supporting innovation.

We are writing in response to the department's request for feedback to inform its priorities relating to engineered carbon management under the Cap-and-Invest program. Engineered carbon management has a role to play in decarbonizing the industrial sector but should be limited to niche uses, which we explore below.

The industrial sector is responsible for 22 percent of Washington state's total greenhouse gas (GHG) emissions,[1] most of which come from burning fossil fuels to create heat for processes like drying paper and cooking food. Moreover, industries like cement and chemicals release "process emissions" as byproducts of chemical reactions, and products made from fossil fuel feedstocks release emissions during their use or disposal.

A range of existing technologies can cut these emissions, spanning three broad categories. The first category consists of solutions that reduce fossil fuel demand in industry, such as energy efficiency, material efficiency, and strategies like reuse and repair that extend the useful lives of products. The second category consists of solutions that replace fossil fuels with cleaner energy sources – whether replacing burning fossil fuels with electrified alternatives or using low-carbon fuels or feedstocks made from hydrogen, biomass, or derivative fuels. The third category refers to capturing carbon dioxide from fossil fuels and permanently storing it underground or in products that do not release CO2 over time – carbon capture, utilization, and storage (CCUS).

Each technological solution will play an important role in the transition to clean industry, but some are more important than others. Efficiency and product longevity strategies should come first because they cut costs, are commercially available, and minimize industry's long-term demand for expensive energy and materials. However, energy efficiency approaches should be avoided if they prolong industrial fossil fuel use, like purchasing a more efficient fossil-fueled

[1] Washington Climate Partnership. *Washington State Comprehensive Climate Action Plan.* 2026. https://deptofcommerce.app.box.com/s/bo1ly7ol0lfq4kof220y9exp7886view

boiler over an electric resistance boiler. Even as firms invest in efficiency, they should be electrifying remaining fossil fuel combustion wherever possible.

Electrification has five primary advantages over CCUS, which:

- Fails to address upstream emissions from fossil fuel extraction
- Captures only around 90 percent of CO2 at the point of capture
- Leaves some conventional air pollution unaddressed and can worsen ammonia emissions
- Prolongs the life of fossil fuel infrastructure
- Requires capital-intensive infrastructure and energy use that generate additional costs.

Electrification also has advantages over low-carbon fuel combustion: It is vastly more efficient, requires less land, and emits no conventional air pollution when powered by clean energy.[2] Clean hydrogen, bioenergy, and CCUS should be reserved for applications that cannot readily be electrified today, such as carbon-intensive feedstocks and some high-temperature heat.

CCUS has six high priority use cases. Two of those use cases have a permanent role to play in clean industry:

- **Process emissions:** Industries like cement, glass, and chemicals release process emissions that will not be addressed by switching to cleaner fuels. Alternative chemistries and feedstocks can only address some of these emissions, making CCUS a crucial long-term solution.
- **Bioenergy combustion or gasification:** Capturing CO_2 from the combustion or gasification of sustainable bioenergy will make those processes cleaner while also offering a source of CO_2 that was recently removed from the atmosphere by plants, which is essential for making low-carbon chemicals like methanol and olefins.

The remaining four CCUS use cases are temporary solutions that should be phased out as the economy decarbonizes, including:

- **Making blue hydrogen from refinery byproducts:** In addition to salable products like gasoline and diesel, petroleum refining creates refinery fuel gas and petcoke byproducts, which today are burned by the refinery, releasing CO_2. Refineries may use pre-combustion CCUS to convert these byproducts into blue hydrogen, which can be used for hydrotreating and hydrocracking until low-carbon energy fully displaces refinery products.
- **High-temperature process heat:** Around one-fifth of Washington's industrial process heat is difficult to electrify with today's commercialized technologies.[3] CCUS, along with low-carbon fuels, could be used to decarbonize these processes until higher-temperature electric heating technologies – which are proven at the laboratory scale today – reach the market.
- **High-purity CO2 streams:** CCUS is least expensive on concentrated CO_2 streams, at $60-66 per metric ton of CO_2 in ethanol production and natural gas processing compared to $159-

[2] Baldwin, et al. *Overcoming all Barriers to Industrial Electrification.* Energy Innovation, 2025. https://energyinnovation.org/report/overcoming-all-barriers-to-industrial-electrification/
[3] Rissman, et al. *Industrial Transformation Technology and Investment Model.* Energy Innovation, 2026. https://energyinnovation.org/report/the-industrial-transformation-technology-and-investment-model/

163/mtCO_2 in steel production and refining.[4] However, most sources of high-purity CO_2 (e.g., natural gas processing, coal-to-chemicals conversion, and fossil-derived ammonia) will phase out as the economy transitions to clean energy.

- **Process heat at new, efficient facilities:** CCUS can keep emissions low at fossil fuel-reliant facilities that are unlikely to decarbonize in the near term, such as new and efficient facilities that will only consider fuel-switching decades down the line when equipment nears the end of its life, or in some pulp and paper facilities that rely heavily on byproducts for energy and combined heat and power systems, making electrification particularly expensive.

If you would like to learn more about our work, please feel free to reach out to us at industry@energyinnovation.org.

Sincerely,

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[4] U.S. Department of Energy. *Pathways to Commercial Liftoff: Carbon Management*. 2023. https://climateprogramportal.org/wpcontent/uploads/2025/02/20230424-Liftoff-Carbon-Management-vPUB_update4.pdf