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Geothermal Direct Air Capture at the Salton Sea

We submit a letter on behalf of Lawrence Livermore National Laboratory, UC Berkeley, Conservation Strategy Group, and Project 2030 researchers and analysts regarding how development of geothermal direct air capture (DAC) at the Salton Sea could support and complement the state's Lithium Valley ambition.

Additional submitted attachment is included below.

Blue-Ribbon Commission on Lithium Extraction in California
715 P Street
Sacramento, CA 95814

January 18, 2022

Subject: Highlighting the potential for utilizing geothermal resources in the Salton Sea area to support direct air capture (DAC) in addition to lithium extraction

To the Blue-Ribbon Commission on Lithium Extraction in California (Commission),

The undersigned thank you for the opportunity to submit comments to the Commission. With this letter, we highlight a climate and economic development opportunity that could be pursued in conjunction with and in support of lithium extraction: geothermal direct air capture (DAC).

DAC refers to purpose-built machines that directly remove CO_2 out of the atmosphere. DAC is a relatively new technology, although it is proven and viewed by many as important to bring to scale in order to avert the worst impacts of climate change. To function, DAC requires 24/7 power and, primarily, heat. Geothermal energy meets both of these needs. **DAC can make use of waste heat available as part of geothermal power and/or lithium extraction processes to meet the bulk of its energy needs.** This is expected to benefit developers, who in many cases incur a cost to cool geothermal brines for lithium extraction as well as re-injection. The incentives available for DAC under the state's Low Carbon Fuel Standard, federal 45Q tax credit, and billions of dollars of grant funds available in the recent Bipartisan Infrastructure Package can drive additional revenues to support lithium recovery projects. In short, geothermal DAC can be a complement to the state's lithium extraction goals.

Geothermal DAC can help California achieve net-zero emissions by 2045

DAC is an example of a 'negative emissions' or 'carbon dioxide removal' (CDR) technology, which multiple studies show are needed for California to achieve net-zero emissions by 2045.

In a report titled *Getting to Neutral*, Lawrence Livermore National Laboratory (LLNL) and partners estimate that about 125 Mt of CDR will be required for California to achieve net-zero emissions by 2045. The report highlights geothermal DAC at the Salton Sea as a key option in the state's CDR portfolio needed to achieve this goal. In another recent study developed for the California Air Resources Board (CARB), E3 identified a potential need for 80 Mt of CDR. In each of these studies, CDR is deployed to compensate for certain emissions sources that may be impossible to fully eliminate from the economy by 2045, such as animal agriculture, planes, ships, some industrial processes, and wildfire emissions. However, to achieve a *net-negative* economy, meaning that California is removing more carbon than it is emitting into the atmosphere, thereby contributing to a reduction in global warming, additional CDR

would be required. Some researchers argue that developed countries that are most responsible for climate change ought to take the lead in commercializing CDR technologies for global benefit.

Technology status and Climeworks 'Orca' facility

DAC is a proven technology, but it is not yet commercial. Further R&D investment is necessary to push DAC down the cost-curve, so it can become a real option to support the state's ambitious climate goals.

In September 2021, Swiss-based company Climeworks launched its largest-scale DAC demonstration plant, called Orca (Fig. 1). Orca is based in Iceland, and is a geothermal DAC project. It is possible that projects like this could also be developed at the Salton Sea in California, though more research is needed to assess and refine the DAC technology for the different geography, assess potential public health and environmental benefits or costs, as well as outreach to understand community views and interest. Heirloom, which is another promising DAC start-up based in San Francisco that has received early-stage investments from Breakthrough Energy Ventures and others, is currently exploring partnerships with geothermal developers to support its DAC via carbon mineralization process.

Figure 1 – Climeworks 'Orca' facility

A promising attribute of the Salton Sea area is the scale of geothermal reserves, which could feasibly support large DAC volumes. California could pioneer large-scale "renewable DAC" for global benefit.

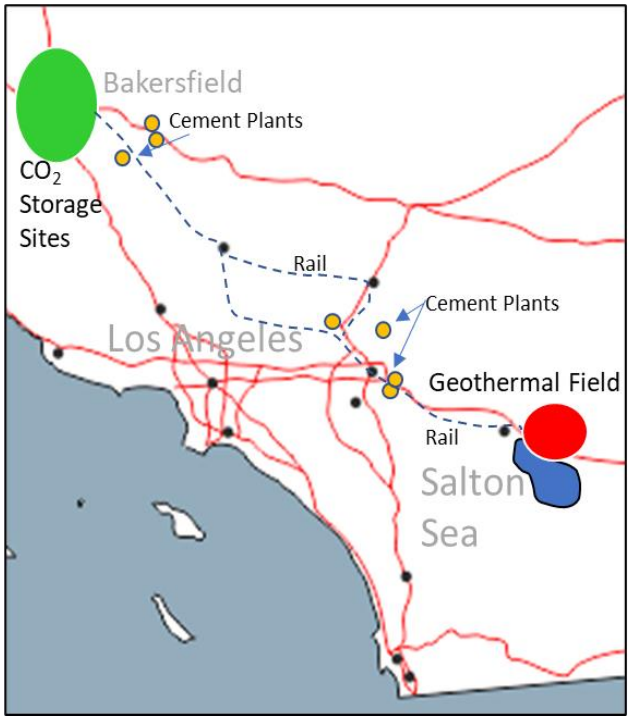
Need for CO_2 transport and storage

An important point to note is that there are no deep saline reservoirs available to support the permanent, underground storage of CO_2 in the Salton Sea region. As a result, captured CO_2 would need to be transported to a suitable location. In the *Getting to Neutral* report, LLNL identifies the Bakersfield region as having this suitable geology. While initial DAC pilots would be small, if geothermal DAC is

demonstrated as a viable option with a potential for (and community support to) scale, the State will need to consider transportation options to move the CO_2.

One interesting option is the idea of building a CO_2 pipeline from Bakersfield, along an existing Union Pacific rail corridor, via clusters of cement plants, and down to the Salton Sea (Fig. 2). This CO_2 pipeline could be initiated between the cement plants and Bakersfield, where we estimate that the CO_2 volumes currently being emitted would be sufficient to finance CO_2 pipeline development. The State needs to consider incentives and other regulatory clarifications to support CO_2 transport and storage projects. In addition, we note that any proposed industrial CO_2 capture projects should not undermine the ability to reduce criteria pollutants emitted from those same facilities, if applicable. This and similar environmental justice concerns must be addressed in tandem to inform any project development.

Figure 2 – CO_2 transportation option



Source: LLNL (2021)

Conclusion and next steps

We enthusiastically support the Commission's ongoing efforts to incubate "Lithium Valley", and appreciate your consideration of additional project opportunities. The undersigned continue to collaborate in efforts to explore the potential and viability of geothermal DAC at the Salton Sea, and welcome further discussion with members that may have an interest in this.

In terms of research work currently being performed, with a Department of Energy grant LLNL is currently evaluating cost-optimal CO_2 transport and storage pathways for DAC projects located in the Salton Sea, with a view to geologically store captured CO_2 in the Bakersfield region. PSE Healthy Energy

recently initiated a study to evaluate the potential public health and air quality impacts of a geothermal DAC project, with CO_2 transport and storage also anticipated to occur near Bakersfield. Both LLNL and PSE Healthy Energy welcome further discussion with interested members on their respective research.

Conservation Strategy Group (CSG) is supported by climate philanthropy to perform outreach, coordination, and explore policies to support the development of a geothermal DAC projects at the Salton Sea. CSG collaborates with researchers from a variety of institutions on the topic of technological CDR in California. Project 2030 is also supported by climate philanthropy to perform a similar role, including consideration of options to support cement decarbonization.

For further information, please contact Sam Uden (sam@csgcalifornia.com), who can also facilitate connections with the signatories below.

Respectfully submitted,

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