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California Air Resources Board

Re: Comments on the 2022 Scoping Plan Update – Initial Modeling Results Workshop

Calpine Corporation (Calpine) appreciates this opportunity to provide comments in response to the California Air Resources Board (CARB) 2022 Scoping Plan Update: Initial Modeling Results Workshop held on March 15, 2022.

Calpine has been at the forefront of the energy transition since its inception in 1984 when it invested in geothermal power, creating the foundation for Calpine's role today as the largest single supplier of renewable energy in California and the largest geothermal power producer in the United States. Since 1984, Calpine has continued to invest in clean power by developing, constructing, owning, and operating a portfolio of 76 efficient and reliable power plants which produce well over 100,000,000 megawatt-hours (MWh) of electricity each year. Calpine accomplished this in large part by fostering strong partnerships with the communities it operates in and serves. In 2021, Calpine added its first battery energy storage system to its operating portfolio and now has over 1,000 MW of additional battery energy storage systems in development. Consistent with this longstanding focus on sustainability, Calpine has also made it a priority to study the technical and commercial feasibility of wide-scale deployment of carbon capture and storage (CCS) technology across its fleet. This technology has received extensive support from the federal government, including Department of Energy grants for CCS engineering studies at two of Calpine's facilities, including one in Contra Costa County.[1] Additionally, Calpine is working with two technology companies, Blue Planet and ION Clean Energy, on pilot demonstration projects at Los Medanos Energy Center to facilitate further development and cost effective implementation of carbon capture and storage.[2]

Calpine strongly believes the 2022 Scoping Plan to be an essential component of achieving California's carbon neutrality goals in the most equitable manner possible. The numerous workshops, coupled with CARB's presentations at Board and Environmental Justice

[1] Department of Energy. "DOE Invests $45 Million to Decarbonize the Natural Gas Power and Industrial Sectors Using Carbon Capture and Storage." Accessed April 4, 2022. https://www.energy.gov/articles/doe-invests-45-million-decarbonize-natural-gas-power-and-industrial-sectors-using-carbon.

[2] SF Bay Aggregates. "Carbon Negative Aggregate." Accessed April 4, 2022. https://www.sfbayaggregates.com. ION Clean Energy. "ION Clean Energy Successfully Completes Six-Month CO2 Capture Campaign Demonstrating >98% Capture Rate at Industry-Leading Energy Requirements on Post-Combustion Natural Gas," November 8, 2021. https://ioncleanenergy.com/ion-clean-energy-successfully-completes-six-month-co2-capture-campaign-demonstrating-98-capture-rate-at-industry-leading-energy-requirements-on-post-combustion-natural-gas/.

Advisory Committee (EJAC) meetings, have allowed for all stakeholders (including members of the public) to take part in observing and contributing to this process. However, the Initial Modeling Results Workshop, specifically the presentation on PATHWAYS outputs, has raised concerns about the transparency of the modeling process and the need to consider the totality of currently available literature in translating results into the Final Scoping Plan.

While Calpine appreciates the Scoping Plan's recognition of the need for CCS across multiple sectors, the lack of CCS deployment in the electricity sector in initial modeling results runs counter to the goal of ensuring a reliable, decarbonized power source for a future California reliant on greater electrification.[3] Calpine would appreciate greater clarity on how the model reached this result, and if it is tied to the input cost used in the model potentially excluding available federal subsidies and technological cost declines.[4] Currently, there is no way for Calpine to assess this assumption.[5] Calpine requests that CARB make more data available on the assumptions embedded in PATHWAYS in order to better guide future feedback on how to decarbonize the electricity sector.[6]

Beyond decarbonizing the electricity grid, adding CCS to power plants has a myriad of co-benefits, with network hub potential, job creation, and land use management among the most significant.

CARB clearly understands the deployment of CCS as imperative to fighting the climate crisis. However, by underestimating the potential for CCS in the electricity sector, CARB underestimates the feasibility of CCS deployment across the board. Industrial hub and cluster networks work by allowing multiple emitting facilities to share the costs and risks of carbon transport and storage, enabling not only lower costs, but safer operations that can better protect communities.[7] Researchers have already identified areas across California that are uniquely suited to hub networks, allowing for the development of shared pipeline infrastructure across existing rights-of-way -- this avoids duplicative infrastructure and minimizes the land impact of the energy transition.[8] Furthermore, greater levels of uncertainty exist surrounding the costs of

[3] This finding that electric sector CCS is vital is backed by the Intergovernmental Panel on Climate Change, the International Energy Agency, the Energy Futures Initiative, and the Lawrence Livermore National Laboratory, among others.
[4] Available subsidies include the 45Q tax credit, while the decline in CCS costs in the power sector has been documented.
[5] Although CARB has hosted workshops on Input Assumptions for the 2022 Scoping Plan Update, none of those workshops detailed the specific costs or other constraints associated with the technologies offered in each alternative, including the zero carbon resource identified as natural gas generation with CCS.
[6] Making these assumptions more widely available would also help interested parties address the unusual buildout described in alternative 1, where natural gas power plants are retired only to be rebuilt (a process that causes emissions) and operated with 0% capacity factors.
[7] "Special Report: Understanding Industrial CCS Hubs and Clusters." Melbourne: Global CCS Institute, June 2016. https://www.globalccsinstitute.com/wp-content/uploads/2019/08/Understanding-Industrial-CCS-hubs-and-clusters.pdf.
[8] Energy Futures Initiative and Stanford University. "An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions," October 2020. https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5f91b40c83851c7382efd1f0/160338

industrial CCS relative to that of the power sector[9] -- by including electricity generation facilities in hubs, a level of certainty is added to the storage and transport costs, providing greater assurances to industrial facilities such as cement and steel that their projects will be viable.[10] By ignoring the potential for electricity generation to generation to facilitate technology development and anchor hubs, CARB raises the barrier to participation in deploying this necessary technology.

Beyond jeopardizing CCS deployment across all sectors, underestimating the potential for CCS in electricity generation potentially understates the opportunity for a just transition.[11] As has been made clear, California's blue-collar union labor force is not interested in being forced to retrain, and instead supports CCS deployment across all sectors (including the electricity sector) so as to use their extensive training to aid in the energy transition.[12] This belief is well backed by Calpine's own assessments: a single CCS facility retrofit would provide nearly 2.4 million construction hours for a period of three years, directly supporting trades and utilizing existing industry skill sets.[13] After construction, each capture unit is estimated to provide 22 to 26 full time salaries at or above the prevailing wage for operations staff, with individuals filling those jobs often being drawn from surrounding, historically economically disadvantaged communities.[14] Because these CCS retrofits occur at already established industrial sites, local businesses in the community already provide the services needed, creating a positive feedback loop.[15]

A final benefit worthy of consideration is that retrofitting existing natural gas plants with CCS technology avoids the rising risk (and inevitability) of land-use conflicts between agriculture, natural lands, and renewable infrastructure siting by optimizing the already existing pipeline right-of-ways, transmission infrastructure, and developed sites.[16] New transmission extensions are expensive, difficult to site due to a blend of social and environmental concerns, and time intensive, all of which can result in inefficient and less-than-optimal land cover change

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[9] Leeson, D., N. Mac Dowell, N. Shah, C. Petit, and P.S. Fennell. "A Techno-Economic Analysis and Systematic Review of Carbon Capture and Storage (CCS) Applied to the Iron and Steel, Cement, Oil Refining and Pulp and Paper Industries, as Well as Other High Purity Sources." *International Journal of Greenhouse Gas Control* 61 (June 2017): 71–84. https://doi.org/10.1016/j.ijggc.2017.03.020.

[10] Sun, Xiaolong, Juan Alcalde, Mahdi Bakhtbidar, Javier Elío, Víctor Vilarrasa, Jacobo Canal, Julio Ballesteros, et al. "Hubs and Clusters Approach to Unlock the Development of Carbon Capture and Storage – Case Study in Spain." *Applied Energy* 300 (October 2021): 117418. https://doi.org/10.1016/j.apenergy.2021.117418.

[11] Moniz, Ernie. "A Regional Approach to Low Carbon Energy Transition in the U.S." Presented at the Fireside Chat with Ernie Moniz, President & CEO, Energy Futures Initiative, Scott Institute for Energy Innovation, October 14, 2021. https://ceepr.mit.edu/roosevelt-project/publications/.

[12] Meredith, Andrew. "State Building and Construction Trades Council of California Recommendations for Senate Climate Working Group," February 11, 2022.

[13] Calpine Corporation's Response to DE-FOA-0002660, February 1, 2022.

[14] *Id.*

[15] *Id.*

[16] Example: Wu, Grace C, Emily Leslie, Oluwafemi Sawyerr, D Richard Cameron, Erica Brand, Brian Cohen, Douglas Allen, Marcela Ochoa, and Arne Olson. "Low-Impact Land Use Pathways to Deep Decarbonization of Electricity." *Environmental Research Letters* 15, no. 7 (July 1, 2020): 074044. https://doi.org/10.1088/1748-9326/ab87d1.

at the expense of agricultural communities and natural land conservation.[17] New electricity generation sites, especially renewable energy production, increase energy sprawl and the land footprint of the electricity sector while still facing many of the same issues as new transmission.[18] This land use consideration has impacts on other components of the Scoping Plan; With respect to land use, Calpine commends CARB for its Natural and Working Lands modeling. However, in the same vein, the fact that this analysis is in many ways novel means CARB's analysis should consider natural and working lands sink values conservatively, so as to not overstretch the abilities of California's carbon sinks. Thus, CARB must ensure the Scoping Plan does not result in unaddressed residual emissions or misrepresented land use availability. By lending more explicit support to CCS across all sectors, CARB's Scoping Plan can better protect against land cover change that may negatively impact the state's carbon sink capabilities.

Beyond the co-benefits, research supports the need for a diverse electricity resource mix that does not limit the deployment of CCS. The Environmental Defense Fund and Clean Air Task Force, supported by research groups from Princeton University, Stanford University, and Energy and Environmental Economics (E3), published a report concluding that relying on solar, batteries, and wind alone would be neither realistic nor sufficient to reach net-zero emissions in California's electricity sector by 2045.[19] Relying upon solar, wind and storage alone "would require building the system up to nearly 500 gigawatts of power-generating capacity," which "is roughly half the capacity of the entire United States electricity generating system today," just to serve California.[20] Not only "may [it] simply not be possible to build renewable facilities at this scale" – "most of which [would] seldom [be] used" – but "[t]his excess capacity would be expensive," causing wholesale electricity rates in California to increase "by about 65% over today if renewable energy and currently available storage technologies alone were to be used to meet demand in 2045."[21]

Instead, a "better solution" for California would be to develop "clean firm power," which could include retrofitting power plants with carbon capture technologies.[22] Calpine appreciates CARB's fleet of zero-carbon options in the PATHWAYS inputs, as well as the explicit inclusion of natural gas with carbon capture as an input option,[23] but continues to express alarm that the modeling results of this single exercise could possibly override the wealth of literature expressing the need to create space for CCS in the power sector.

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[17] Example: Hernandez, Rebecca R., Madison K. Hoffacker, Michelle L. Murphy-Mariscal, Grace C. Wu, and Michael F. Allen. "Solar Energy Development Impacts on Land Cover Change and Protected Areas." *Proceedings of the National Academy of Sciences* 112, no. 44 (November 3, 2015): 13579–84. https://doi.org/10.1073/pnas.1517656112.

[18] McDonald, Robert I., Joseph Fargione, Joe Kiesecker, William M. Miller, and Jimmie Powell. "Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America." Edited by Juan A. Añel. *PLoS ONE* 4, no. 8 (August 26, 2009): e6802. https://doi.org/10.1371/journal.pone.0006802.

[19] Long, Jane, Ejeong Baik, Jesse Jenkins, Clea Kolster, Kiran Chawla, Arne Olson, Armond Cohen, et al. "Clean Firm Power Is the Key to California's Carbon-Free Energy Future." *Issues in Science and Technology*, March 24, 2021. https://issues.org/california-decarbonizing-power-wind-solar-nuclear-gas/.

[20] *Id.*

[21] *Id.*

[22] *Id.*

[23] Verification of this was received during the Workshop Q&A, with a question posed by Emily Turkel and an answer provided by Jessie Knapstein

As touched on earlier, the modeling itself lacks the necessary transparency to fully understand how the electricity resource mix was selected. PATHWAYS notably does not account for many realities of the electricity sector, ranging from transmission availability to local resource adequacy safeguards. Calpine would appreciate feedback on if RESOLVE was used to determine the makeup of the electricity sector inputs in PATHWAYS, and, if so, would highlight that even that method includes unrealistic assumptions. Additionally, the modeling results as presented assume CDR technologies such as direct air capture will "make up" for the residual emissions economy-wide in order to achieve carbon neutrality.[24] Calpine supports the deployment of direct air capture and other forms of engineered carbon removal, but that support does not change the fact that direct air capture requires at least a gigajoule (over 277 kWh) of electricity per ton of carbon removed.[25] None of the necessary energy to power DAC was included in the modeling, and instead was counted as "off grid."[26] Calpine is unclear on exactly what this means, and believes CARB should clarify in the Scoping Plan to what degree negative emissions technology deployment relies on out-of-state resources.

Calpine appreciates the opportunity to provide input on the Initial Scoping Plan Modeling Results and looks forward to ongoing engagement with CARB and all stakeholders throughout the 2022 Scoping Plan Update process, particularly with respect to the consideration of CCS in the electricity sector.

Sincerely,

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[24] Although natural and working lands carbon sinks do contribute to addressing the residual emissions, under no modeling alternative does land-based carbon removal make up for the entirety of residual emissions.
[25] Realmonte, Giulia, Laurent Drouet, Ajay Gambhir, James Glynn, Adam Hawkes, Alexandre C. Köberle, and Massimo Tavoni. "An Inter-Model Assessment of the Role of Direct Air Capture in Deep Mitigation Pathways." *Nature Communications* 10, no. 1 (December 2019): 3277. https://doi.org/10.1038/s41467-019-10842-5.
[26] This call for "off grid" power also applies to CARB's plans for hydrogen to play a role in the Scoping Plan.