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Re: Comments on the 2017 Climate Change Scoping Plan Update regarding Carbon Capture and Sequestration

We, the undersigned, span a wide spectrum of capped and uncapped companies, academic institutions and non-profit organizations located in California, as well as elsewhere in the nation. We thank the Air Resources Board (ARB) for the opportunity to submit comments on the 2017 Climate Change Scoping Plan Update (hereafter "Proposed Plan"). Although some of our organizations are submitting further comments on the Proposed Plan, the present joint comments are limited to one particular technology that is of common interest to us: Carbon Capture and Sequestration (CCS).

We support ARB's assertion in the Proposed Plan that "Carbon capture and sequestration also offers a potential new, long-term path for reducing GHGs for large stationary sources".[1] However, we feel that the Proposed Plan underestimates the effectiveness and readiness of the technology, and that it does not sufficiently support the potential role that CCS could play in reducing California's carbon dioxide (CO_2) emissions. Additionally, it does not present the steps that need to be taken by the state in the near future to enable the technology to meaningfully contribute to emissions reductions by the 2030 and 2050 timeframes. While new projects keep coming online in other jurisdictions, California can play a leadership role by addressing key policy and regulatory questions to ensure that CCS is part of its overall plan.

CCS is technologically viable today

CCS is a three-stage process. It entails capturing (i.e. isolating or stripping) the CO_2 from its source, compressing and transporting it, and finally injecting it into a suitable geological formation. All three stages have been demonstrated and safely operated in large-scale installations. There are currently sixteen integrated projects in North America alone that capture, transport and sequester CO_2 from a variety of sources, including fuel processing, power, fertilizer, and chemical plants (see Appendix A for a full list of North American integrated CCS projects).[2] These facilities can each capture from approx. 0.1-8.4 million metric tons of CO_2 annually, and the CO_2 is then injected into deep saline formations or oil fields. The oldest commenced operations in 1972, and the most recent ones this year.

Looking ahead, four more large-scale integrated projects are currently under construction,[3] while several more are in the planning stage. There are yet more projects that perform one or two of the three stages of CCS as capture-only, or injection-only projects.

In terms of transport infrastructure, over fifty individual CO_2 pipelines with a combined length of over 4,500 miles transport CO_2 across North America for the purpose of underground injection.[4]

In addition to dedicated CCS projects, the practice of CO_2 injection has been taking place since the early 1970s for the purpose of enhancing recovery of oil from fields with declining production. Today, an estimated 68,000,000 tons of CO_2 are injected underground annually, in U.S. oil fields.[5]

CCS has an important role to play in reducing global CO2 emissions

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[1] Proposed Plan at 93.
[2] See also "Global Carbon Capture & Storage Institute, Projects Database". Retrieved here: https://www.globalccsinstitute.com/projects/large-scale-ccs-projects#map
[3] Ibid.
[44] National Energy Technology Laboratory, "A Review of the CO2 Pipeline Infrastructure in the U.S.", April 21, 2015, DOE/NETL-2014/1681.
[5] Kuuskraa, V. and Wallace, M. "CO2-EOR set for growth as new CO2 supplies emerge", Oil and Gas Journal, April 7, 2014.

The Intergovernmental Panel on Climate Change reports that fewer than half of its climate models were able to reconcile an atmospheric stabilization at 450ppm CO_2eq without CCS, and that without it, modelled mitigation costs rose by 138 percent on average.[6]

In its 2°C scenario, the International Energy Agency (IEA) estimates that CCS can deliver 94 gigatons (Gt) of CO_2 emissions reductions through 2050, or 12% of the cumulative emissions reductions in the energy sector. The technology is used with electricity generation, industrial processes and fuel transformation. Absent CCS, IEA estimates that the transformation of the power sector will cost at least USD 3.5 trillion more, and that in the industrial sector "much of the 29 $GtCO_2$ reductions achieved by CCS would need to be offset by efforts in other sectors".[7]

In the industrial sector in particular, the IEA has concluded that there are no practical alternatives to the use of CCS technology to achieve deep decarbonization because many of the emissions from steel, cement, natural gas processing, and fertilizer production plants are process emissions.[8]

California's leadership on CCS can help the state itself, while also having a global impact. CCS technology provides a viable way to dramatically reduce CO_2 emissions from fossil-fueled power generation and industrial facilities. Near-zero fossil power generation would also enable faster and deeper scale-up of renewable generation.

Other Benefits of CCS Deployment

Aside from the potential to reduce CO_2 emissions, CCS can also offer opportunities to reduce emissions of toxics and criteria pollutants, as well as other benefits.

Using conventional technologies, scrubbing CO_2 from power plants sometimes necessitates almost complete removal of sulfur oxides. The investment in CO2 capture equipment is also often accompanied by an overhauling of the plant to make it leaner and more efficient, with concurrent installation of technologies that control nitrogen oxide emissions.

Next generation technologies offer yet further advantages. For example, NET Power's Allam Cycle technology now being tested at the 50 megawatt scale, offers the opportunity to generate power from natural gas with near zero CO_2 and nitrogen oxide emissions, while at the same time eliminating water use for cooling. The Lake Charles methanol project, which recently received a conditional approval for a Federal loan guarantee from the U.S. Department of Energy, would convert waste petroleum coke from refining into chemical products, eliminating harmful emissions. FuelCell Energy's carbon capture technology captures carbon emissions from existing power plants, while simultaneously producing power. The fuel cells also destroy approximately 70% of the plant's nitrogen oxide emissions.

While it is hard to generalize on these synergies, they merit further consideration.

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[6]Intergovernmental Panel on Climate Change, "Climate Change 2014 – Synthesis Report", p. 86.
[7] International Energy Agency, "20 Years of Carbon Capture And Storage – Accelerating Future Deployment", 2016.
[8] IEA, Carbon Capture and Storage: The Solution for Deep Emissions Reductions (2015), available at http://www.iea.org/publications/freepublications/publication/carbon-capture-and-storagethe-solution-for-deep-emissions-reductions.html

The Quantification Methodology is only the first step

Technology aside, the pace at which CCS may be deployed in California will be determined largely by legal, regulatory and policy considerations. A major step forward is the development of the Quantification Methodology by ARB that is currently under way. But there are a number of other practical considerations that will need to be resolved as well.

CCS integrates a long chain of industrial activity, often involving multiple companies, and spread over multiple sites including (i) the capture of CO2, (ii) transportation to an injection site, (iii) the injection of CO_2 into subsurface and (iv) potential production of oil (in the case of enhanced oil recovery with sequestration). Not only is the chain of activities long, but eventually there may be multiple capture sources linked by pipelines to serve multiple injection sites, as evidenced by the development of the CO2 transport and injection industrial complexes elsewhere in the United States. As ARB considers in the Scoping Plan the potential for CCS to contribute to cost-effective emission reductions, the regulatory regime should be conceived to also allow for the development of the technology at a scale that is meaningful to the State's ambitious carbon reduction goals.

Complexity will vary by project, but possible steps that developers may need to go through include project design and engineering, permitting, CEQA review, acquisition of rights to inject in the subsurface[9], and construction. In addition, pipelines will almost certainly be necessary to transport CO2 to suitable injection sites: finding the correct geologic characteristics for such a site – although well understood and perfectly feasible in a state with several highly suitable geologic sinks like California – is paramount for project effectiveness and safety. Injecting on site at the capture facility may not always be the best option. Collectively, this may amount to a period of several years to over a decade from the concept phase to project commissioning, depending on project specifics.

CCS could potentially deliver large levels of reductions in the 2030-2050 period, but for that to happen policy action would need to begin now.

Recommendations

Based on the above, we offer the following recommendations:

- The Scoping Plan should make it clear that no technology barriers stand in the way of safe and effective, near-term CCS deployment.
- The Scoping Plan should identify CCS on the menu of CO_2 reduction strategies not only for industrial sources, but also in the power sector.
- The Scoping Plan should identify a range of emission reductions that could come from CCS deployment in those sectors.

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[9] In California, if injection is not tied to the ongoing production of minerals, pore space ownership is vested with the land surface owner.

- The Scoping Plan should identify the potential for synergies between CO_2 and the reduction of other emissions (toxics and criteria pollutants) through the use of CCS at large point sources, and recommend further work to analyze these.
- The Scoping Plan should identify the policy and other steps that would need to be undertaken in order to make sure CCS could be implemented by 2025 if necessary. As a starting point, ARB should consider the recommendations by the state-appointed CCS Review Panel that concluded its work in 2010, expanding as necessary to reflect today's conditions.[10]
- In addition to developing "a regulatory monitoring, reporting, verification, and implementation methodology for the implementation of carbon capture and sequestration projects"[11], the Scoping Plan should identify any barriers in current regulatory programs that impede CCS deployment.
- ARB should formally clarify (in the short term) and subsequently revise the requirement that "[c]arbon capture must take place onsite at the crude oil production facilities" in the Innovative Crude section.[12] This requirement may prevent captured CO_2 from being transported to, and injected at, a site with the most suitable geological characteristics for safe and effective sequestration. Further, ARB should allow appropriate credit under this section even if the CO2 emissions are captured outside the crude oil production facilities, provided this leads to a lower-carbon energy input into the fuel supply chain of the crude oil.[13] ARB should seek further stakeholder input on this topic.

Sincerely,

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Al Collins, Sr. Director – Regulatory Affairs, Occidental Petroleum Corporation

Paul J. Deiro, Vice President, Government Affairs, California Resources Corporation

Walker Dimmig, Director of Government Relations, 8 Rivers (Inventor, Owner, and Developer of NET Power)

Grant Johanson, CEO, White Energy

[10] "Findings and Recommendations by the California Carbon Capture and Storage Review Panel", 2010. Retrieved here: http://www.climatechange.ca.gov/carbon_capture_review_panel/documents/2011-01-14_CSS_Panel_Recommendations.pdf
[11] Draft Scoping plan at 96.
[12] Low Carbon Fuel Standard regulation at §95489(d)(2).
[13] Some, but not all, of the undersigned believe that credit under this section should be allowed for any anthropogenic CO_2 that is captured outside the crude oil production facilities and injected in the oil field.
[14] The views of the researcher do not necessarily represent the views of Stanford University.

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Appendix A: Existing Integrated CCS Projects in North America

- **1972: Terrell gas processing plant in Texas** - A natural gas processing facility (along with several others) began supplying CO2 in West Texas through the first large-scale, long-distance CO_2 pipeline to an oilfield.
- **1982: Koch Nitrogen Company Enid Fertilizer plant in Oklahoma** – This fertilizer production plant supplies CO_2 to oil fields in southern Oklahoma.
- **1986: Exxon Shute Creek Gas Processing Facility in Wyoming** – This natural gas processing plant serves ExxonMobil, Chevron and Anadarko Petroleum CO_2 pipeline systems to oil fields in Wyoming and Colorado and is the largest commercial carbon capture facility in the world at 7 million tons of capacity annually.
- **2000: Dakota Gasification's Great Plains Synfuels Plant in North Dakota** – This coal gasification plant produces synthetic natural gas, fertilizer and other byproducts. It has supplied over 30 million tons of CO_2 to Cenovus and Apache-operated EOR fields in southern Saskatchewan as of 2015.
- **2003: Core Energy/South Chester Gas Processing Plant in Michigan** – CO2 is captured by Core Energy from natural gas processing for EOR in northern Michigan, with over 2 million MT captured to date.
- **2009: Chaparral/Conestoga Energy Partners' Arkalon Bioethanol plant in Kansas** – The first ethanol plant to deploy carbon capture, it supplies 170,000 tons of CO_2 per year to Chaparral Energy, which uses it for EOR in Texas oil fields.
- **2010: Occidental Petroleum's Century Plant in Texas** – The CO_2 stream from this natural gas processing facility is compressed and transported for use in the Permian Basin.
- **2012: Air Products Port Arthur Steam Methane Reformer Project in Texas** – Two hydrogen production units at this refinery produce a million tons of CO_2 annually for use in Texas oilfields.
- **2012: Conestoga Energy Partners/PetroSantander Bonanza Bioethanol plant in Kansas** – This ethanol plant captured and supplies roughly 100,000 tons of CO_2 per year to a Kansas EOR field.
- **2013: ConocoPhillips Lost Cabin plant in Wyoming** – The CO_2 stream from this natural gas processing facility is compressed and transported to the Bell Creek oil field in Montana via Denbury Resources' Greencore pipeline.
- **2013: Chaparral/CVR Energy Coffeyville Gasification Plant in Kansas** – The CO_2 stream (approximately 850,000 tons per year) from a nitrogen fertilizer production process based on gasification of petroleum coke is captured, compressed and transported to a Chaparral-operated oil field in northeastern Oklahoma.
- **2013: Antrim Gas Plant in Michigan** – CO_2 from a gas processing plant owned by DTE Energy is captured at a rate of approximately 1,000 tons per day and injected into a nearby oil field operated by Core Energy in the Northern Reef Trend of the Michigan Basin.
- **2014: SaskPower Boundary Dam project in Saskatchewan, Canada** – SaskPower commenced operation of the first commercial-scale retrofit of an existing coal-fired power plant with carbon capture technology, selling CO_2 locally for EOR in Saskatchewan.

- **2015: Shell Quest project in Alberta, Canada** – Shell began operations on a bitumen upgrader complex that captures approximately one millions tons of CO_2 annually from hydrogen production units and injects it into a deep saline formation.
- **2017: NRG Petra Nova project in Texas** – NRG commenced operations on the Petra Nova project in January, 2017. It is the first American retrofit of a coal-fired power plant with CCUS and the world's largest post-combustion capture project. It captures up to 90% of the CO_2 from a 240 MW slipstream of flue gas from the existing WA Parish plant. The CO_2 is transported to an oil field nearby.
- **2017: ADM Illinois Industrial Carbon Capture & Storage Project** – Archer Daniels Midland began capture from an ethanol production facility in April, 2017, sequestering it in a nearby deep saline formation. The project can capture up to 1.1 million tons of CO_2 per year.