April 4, 2022

California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Energy + Environmental Economics (E3)
44 Montgomery Street, Suite 1500
San Francisco, California 94104

COMMUNITIES FOR A BETTER ENVIRONMENT
established 1978

Submitted through CARB Portal

Re: CARB Draft Scoping Plan: AB32 Source Emissions Initial Modeling Results

To CARB and E3 Representatives:

Communities for a Better Environment ("CBE") submits the following comments on the CARB Draft Scoping Plan: AB32 Source Emissions Initial Modeling Results ("Initial Modeling Results") presented by E3 at the California Air Resources Board ("CARB") Public Workshop on the 2022 Scoping Plan Update – Initial Modeling Results Workshop on March 15, 2022. The comments focus on the Petroleum Refining and associated Hydrogen Production sector.[1] (Note that we are separately commenting about the electricity sector.) We request the publication of the detailed input assumptions used in the modeling soon as possible, even if only available in draft form.

CBE is a statewide environmental justice ("EJ") organization with a strong focus on addressing the fossil fuel energy sources that heavily pollute the California communities of Wilmington, Southeast Los Angeles, East Oakland, Richmond, and surrounding areas where we organize, live, and work. Climate change, smog, and toxic emissions severely and disproportionately impact our communities, including oil refineries, oil wells and drilling, power plants, transportation and other sources.

Despite our appreciation for the modeling work and presentation from E3, we are disturbed by the glaring omission of detailed written information explaining critical underlying input assumptions of the PATHWAYS modeling results. During the Q&A portion of the March 15 workshop, CARB indicated it does not intend to correct this serious flaw in the public process and plans to release that information alongside the draft Scoping Plan. At best, failing to disclose such critical assumptions creates fertile ground for extremely unrealistic concepts that skews public discourse and creates a bias for poor decision-making. Without this information, the public is left to speculate. Furthermore, it is essential that CARB disclose and ultimately revise its assumptions for the refinery sector. A recent OEHHA analysis indicated that communities living around refineries and hydrogen plants have seen an increase in GHG and PM2.5 toxic emissions during the period of the Cap and Trade program.[2] Four of the top five entities

---

[1] SP22-MODEL-RESULTS-E3-PPT.PDF, available at: https://ww2.arb.ca.gov/resources/documents/2022-scoping-plan-update-initial-modeling-results-workshop.

[2] Office of Environmental Health Hazard Assessment (OEHHA), Impacts of Greenhouse Gas Limits Within Disadvantaged Communities: Progress Toward Reducing Inequities, Feb. 2022, Table 2. Direction of Emission Changes at Facilities Near High-Scoring CES Communities Varies by Pollutant and Sector (2018 Compared to 2012 Emissions), p. 38

that use the most offsets own petroleum refineries.[3] The 2022 Scoping Plan must use the best available evidence to provide a clear path forward for the refining sector and refinery communities.

In the case of the Petroleum Refinery sector, the lack of real-world technical evidence to support the assumptions risks premature, or worse, predetermined policy decision-making. The comments below ask questions regarding the reasoning and inputs behind several key results and figures. **These include:**

- the assumed carbon capture rates on individual pieces of equipment and across a whole refinery,
- the lack of evidence of operational and comparable carbon capture and sequestration ("CCS") systems at existing refineries,
- hypothetical CCS-driven emission reduction timelines which inexplicably start immediately,
- non-CCS versus CCS starting points,
- assessment of major physical constraints for siting CCS equipment at California refineries,
- and accompanying safety implications, for starters.

I. Present capture rate assumptions and emissions reductions results for petroleum refining GHGs indicate alarming need for disclosure of additional assumptions and rigorous review of corresponding evidence base.

A. REQUEST FOR RESPONSE: Please clarify the "90% CCS capture" percentage assumption in the context of a whole refinery's emissions.

1. Please detail the total percentage of the overall refinery that is assumed to be covered by CCS,

2. Please detail which parts of the refinery are assumed covered by CCS, including oil refinery hydrogen plants.

3. Please also refer to Table 2-1 of the South Coast 1109.1 report, later excerpted, which lists hundreds of different major refinery combustion equipment (heaters, boilers, incinerators, turbines, FCCUs, calciners, flares, etc.). Did the modeling consider the feasibility of applying CCS to such a complex set of equipment at California refineries, when determining the percentage of emissions covered by CCS? Please detail which specific types of the listed equipment are assumed covered.

4. Please explain whether or how much capture may occur over combustion sources, and whether the percentage is only for carbon dioxide or additionally methane fugitive emissions and other pollutants. Please provide the detailed accompanying spreadsheets used for the relevant portions of the GHG inventory.

[3] Id. at 8

5. Please provide citations on the basis of the assumption that 90% of emissions are captured, where CCS is applied within a refinery, and also identify all existing and operational refinery CCS systems in place in the U.S. and in California that can help assess the validity of the modeling assumptions.

During an Environmental Justice Advisory Committee (EJAC) Fossil Fuel Transportation Working Group, CARB staff indicated the Quest carbon capture and storage project in Alberta provided CARB with a basis for understanding CCS on refineries. We highly discourage CARB from relying on the existence of this project to validate the idea of investing in CCS on refineries generally. The project cost $1.35B (of which $865 Million came from the Canadian government[4]) and only captured a third of the upgrader's emissions. And despite initially claiming that its project Polaris would capture more than 90% of emissions,[5] Shell now states that it is only expected to capture up to 40% from the refinery as a whole and up to 30% from the chemicals plant.[6] We request an explanation for the capture assumption that addresses which part of the Quest project data CARB has considered, if at all.

B. REQUEST FOR RESPONSE: Please explain the reasoning behind the starting time and levels of emission reductions results in scenarios with CCS.

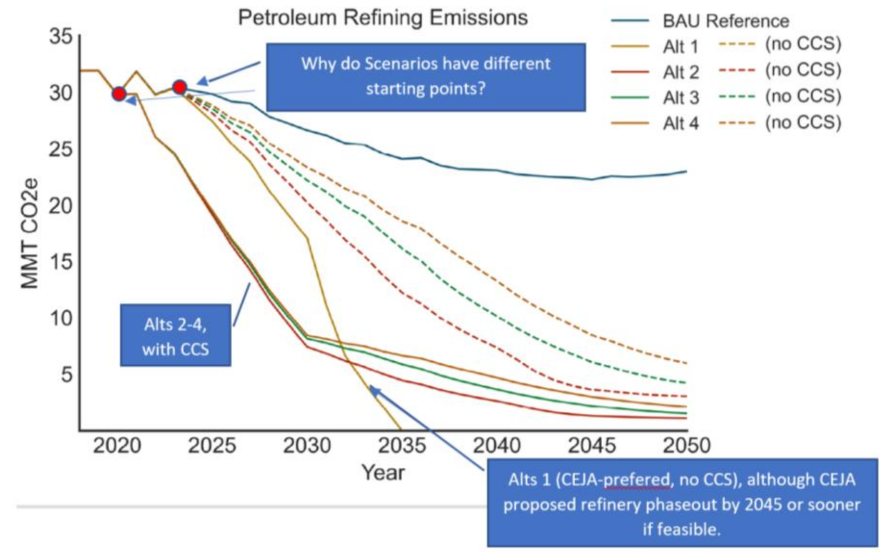
To assist comments on the oil refining sector, below is an annotated version of the graph on refining emissions as presented on Slide 10 at the workshop on March 15, 2022. This graph includes projected emissions in the four Alternatives ("Alt") scenarios 1-4, plus BAU ("Business As Usual").

We interpret this graph to mean, as recommended by the Environmental Justice Advisory Committee ("EJAC"), Alt 1 for refineries does not include CCS. As a result, there is only one Alt 1 line shown, whereas Alts 2-4 are shown both with and without CCS. The three closely grouped solid lines which fall quickly prior to 2030 are Alts 2-4 *with* CCS. The dotted lines are Alts 2-4 *without* CCS.

[4] https://sequestration.mit.edu/tools/projects/quest.html

[5] See: https://www.cnbc.com/2022/01/24/shell-ccs-facility-in-canada-emits-more-than-it-captures-study-says.html "The hydrogen projects we're planning – like Polaris – will use a new technology that captures more than 90% of emissions."

[6] See: https://www.shell.ca/en_ca/media/news-and-media-releases/news-releases-2021/shell-proposes-large-scale-ccs-facility-in-alberta.html



Given that **no CCS units currently exist at California oil refineries**, and for reasons further detailed below, this sharp decline indicates magical thinking around the current state of California refineries and refinery carbon capture technology.

6. Please provide any underlying evidence base for the assumption that results in all three scenarios with CCS (Alternatives 2-4, shown as three tightly-grouped solid lines above) rapidly declining through 2030, *starting immediately*.

7. Please explain why non-CCS scenarios and CCS scenarios use different starting points of emissions. Why do CCS scenarios begin earlier at a lower level of refinery emissions (which might reflect low refinery production and emissions during the pandemic), yet all the non-CCS scenarios start at the higher level, apparently after refinery production and emissions increased again. Or is there another reason for the spike in emissions after 2021?

II. Carbon capture of high percentages of refinery carbon emissions is unlikely at refineries due to their complexity, and the infeasibility of adding controls to hundreds of massive combustion units and thousands of fugitive sources.

Setting any assumptions for a new technology for refineries must be, at least in part, informed by the immensely complex and large physical scale of oil refinery emissions sources and controls. Just last fall 2021, the South Coast Air Quality Management District (SCAQMD) adopted Regulation 1109.1 to address high emissions of Nitrogen Oxides (NOx) at oil refineries after years of rule development, and also after decades of failure of the NOx pollution trading program in the South Coast called RECLAIM.

This is relevant to the Scoping Plan analysis and modeling, because NOx is another combustion pollutant emitted with CO_2 when hydrocarbon fuels are burned or otherwise used at oil refineries.[7] As a result, the data collected on these combustion sources, and the engineering difficulties in siting emissions controls, is also at issue in the Scoping Plan process related to evaluations of Carbon Capture equipment.

The South Coast District performed an updated assessment of the numbers and types of individual combustion units at South Coast refineries. As the largest oil refining region in California, it serves as a ready example of statewide issues and source of critical insights. The next largest region is the Bay Area, with additional substantial refining activities in Bakersfield and Santa Maria.

The South Coast 1109.1 regulation staff report included the following graphics, charts, and tables identifying the large number of major refinery and refinery hydrogen plant sources at play in the South Coast alone. Figure 5 for instance identifies 9 petroleum refineries, 3 small refineries, and 4 related Hydrogen Plants and Sulfuric Acid Plants that are substantial emissions sources (p. 2-1):

Figure 5. PR 1109.1 Affected Facilities

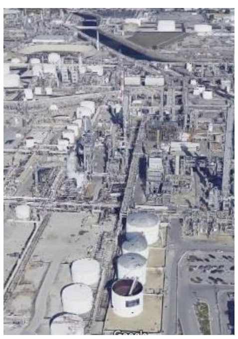
The SCAQMD report identified hundreds of major combustion sources within these facilities. Each one is massive - one refinery heater can combust as much fuel in an hour as four homes using natural gas burn in a year.[8] For a visual, the google map below shows two massive coker heaters at the Marathon (Tesoro) Wilmington refinery, out of the hundreds of combustion units at South Coast refineries and related operations. They dwarf the warehouses and container units seen across the channel and hide multiple burners inside. The NOx, CO_2, and other pollutants emitted through the tall stacks are invisible.

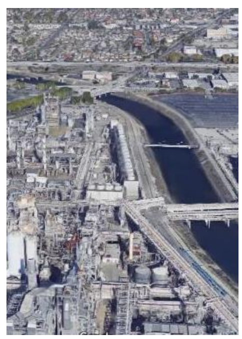
[7] For example, SCAQMD Rule 1109.1 staff report, p. A-1 describes combustion reactions resulting on both NOx and CO_2 emissions, such as Fuel NOx Formation ($R\text{-}N + O_2 \rightarrow NO, NO_2,$ $\mathbf{CO_2}$, H_2O, trace species), or Prompt NOx Formation ($R + O_2 + N_2 \rightarrow NO, NO_2,$ $\mathbf{CO_2}$, H_2O, trace species).

[8] A million BTUs (British Thermal Units) of heat content is present in approximately 1000 cubic feet of natural gas (which varies a little in energy content). *"**In 2012, the average U.S. home consumed** 61,200 cubic feet of natural gas (or **62.7 million Btu**)."* (American Gas Association Playbook, 2015, p. 78) So a refinery heater rated at 250 million BTUs per hour can burn the same amount of fuel hourly as about 4 homes burn in an entire year. (250/62.7 =~4)

[Google map of Marathon LA Refinery](#)

For an idea of the complexity of refineries in the Wilmington / Carson / W. Long Beach area, here are a few refinery views from google maps:






Panning further out shows the extreme density of the area, with 5 oil refineries (two Marathon, two Phillips 66, and one Valero), numerous warehouses and other industrial facilities, thousands of homes, and numerous schools and sensitive receptors:

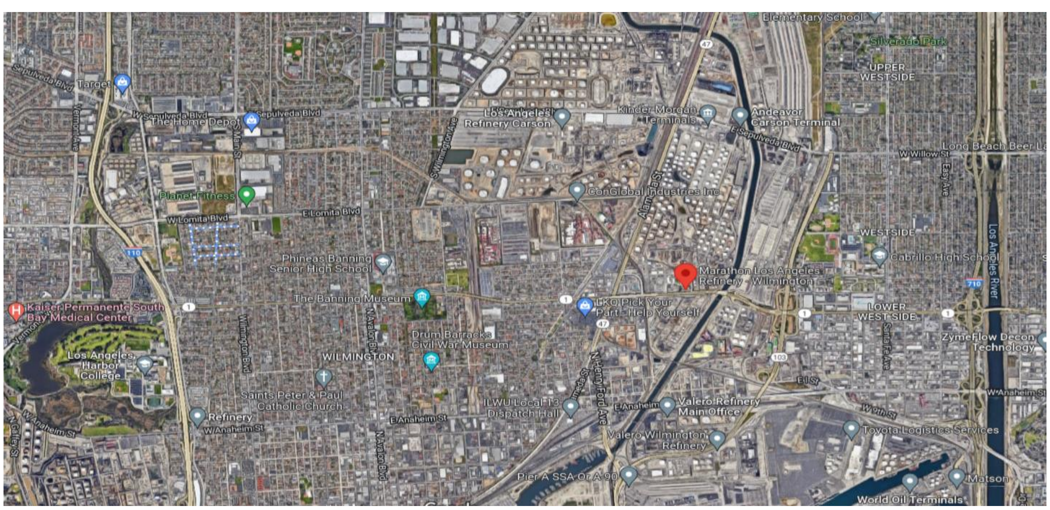


Table 2.1 from the South Coast staff report below identifies 228 Process and SMR[9] heaters and boilers in the South Coast, plus 56 other combustion units. (p. 2-3)

Table 2-1. PR 1109.1 Affected Equipment by Facility

	Process Heater/ SMR Heater/ Boiler	SRU/TG Incinerator	Vapor Incinerator	Gas Turbine	Start-Up Heater/ Boiler	FCCU	Coke Calciner	Flare
Tesoro-Carson	30	2	0	4	1	1	0	0
Tesoro-Wilmington	33	0	0	2	0	0	0	0
Tesoro-Sulfur Recovery Plant	0	2	0	0	0	0	0	0
Tesoro-Coke Calciner	0	0	0	0	0	0	1	0
Torrance	28	2	2	0	1	1	0	0
Chevron	37	4	5	4	1	1	0	0
P66-Carson	10	2	0	0	0	0	0	0
P66-Wilmington	34	2	0	1	2	1	0	0
Ultramar	19	1	0	1	1	1	0	0
AltAir	25	1	4	0	0	0	0	0
Lunday Thagard	5	0	2	0	0	0	0	0
Air Products-Carson	1	0	0	0	0	0	0	0
Air Products-Wilmington	1	0	0	0	0	0	0	0
Air Liquide	1	0	0	0	0	0	0	0
Eco-Services	0	0	0	0	2	0	0	1
Valero Asphalt Plant	4	0	0	0	0	0	0	0
Total	**228**	**16**	**13**	**12**	**8**	**5**	**1**	**1**

When faced with regulating the many combustion sources, oil refiners complained of the need for long timelines. The final rule includes implementation through 2035, fourteen years after adoption, in addition to a 3-year rulemaking process.

These issues illustrate the complexity of the detailed rulemaking process, engineering and design, and construction of complex oil refinery emissions controls. **These realities underline the absurdity of setting modeling assumptions (even if space could be found), that assume non-existent CCS technologies can be quickly constructed and implemented across broad parts of California oil refineries.** This is to say nothing of the high costs.

III. Carbon capture at scale is unrealistic at California refineries due to major limitations in physical space at oil refineries.

During many regulatory proceedings, oil refineries have successfully argued against adding pollution controls, based on physical space limitations. For example, SCAQMD relaxed the originally

[9] Steam Methane Reforming

proposed NOx standard under Regulation 1109.1 from the demonstrated achievable level of 2 ppm, up to 5ppm and higher. Refiners claimed it would require additional stages of Selective Catalytic Reduction (SCR) equipment to meet the 2ppm standard, without sufficient physical space available. The same combustion sources at refineries which emit NOx are also major emitters of GHGs – including hundreds of Boilers & Heaters identified in South Coast rulemaking.

The space issue was not a small or rare complaint. The Staff Report for SCAQMD Rule 1109.1 (Heaters and Boilers and Other Refinery Combustion Sources) identified widespread industry and Air District concerns about space constraints in extremely old facilities.[10] As reported in the Staff Report, the Fossil Energy Research Corporation Assessment (FERCo) conducted site visits to the five major refineries, Chevron, Marathon (Tesoro Refinery), Phillips 66, Torrance, and Valero, to evaluate and discuss facility constraints and challenges of implementing SCR on specific refinery systems. The main concern refinery stakeholders frequently raised to staff was the issue of space and the ability to install post-combustion control.[11] Based on the site visits, FERCo concluded that ***all the facilities exhibited space limitations to varying degrees.*** Not all open space that surrounds a unit is available for an SCR system, as ***open space may be necessary for maintenance work and thus, safety***.[12] As a result, advanced technology, engineering, and design for additional pollution controls are required specifically to address space constraints.[13] The cost for two facilities operating around 8 ppmv NOx to upgrade and meet 8 ppmv NOx was approximately $1 million to $3 million, but to completely replace the SCR or add new technology to meet 2 ppmv ***while addressing space constraints*** ranged from $75 million to $220 million.[14]

Another important example includes the South Coast Rule 1410 rulemaking process, which would have banned the use of deadly Hydrogen Fluoride or Modified Hydrogen Fluoride at two South Coast refineries. This regulation was killed by industry complaints, despite the County of LA's Health Dept. stating that the use of this chemical caused the risk of severe injury or death to a million people in the region. Despite the dire need for regulation, one reason given by the industry opposing the regulation was space constraints at the Valero Wilmington refinery: "Of particular note, available plot space adjacent to the existing HF alkylation unit was identified as a key criteria for success; ***as the District is well aware, such plot space does not exist at the Wilmington Refinery***."[15]

---

[10] "The affected refineries were built 50 to over 100 years ago and while equipment has changed over the years, most of the equipment affected by the rule is old and **the spacing configuration of the sites are dense**. Thus, to install pollution control requires creative engineering and design to accommodate the space necessary and perform properly. Some projects currently taking place involve building vertically requiring deep earth pylons to support the structure housing the control technology or constructing complex ducting to house the SCR catalyst beds that stretch long distances horizontally away from the basic equipment", p. 2-19; "Replacing conventional burners with LNB or ULNB often requires special attention because of the flame dimensions and limited space within a refinery process heater," p. A-6; Refinery stakeholders immediately raised the concern that staff did not consider space availability and constraints for this type of design. Refineries cannot accommodate a second SCR reactor which makes the alternative pathway not technically feasible, p. B-20.
[11] p. 2-47.
[12] "Despite the space limitations, some facilities have devised several workarounds such as vertical SCR orientation, running ductwork over existing roadways, and replacement of air heaters with SCR reactors. In addition, FERCo also identified that the locations or sites for SCR installations may hold many unknowns such as electrical capacity for the SCR and uncertainties that can complicate foundation work such as underground pipes," p. 2-47.
[13] p. 2-36.
[14] p. 2-36.
[15] Valero letter to AQMD, Sept. 18, 2017 to Susan Nakamura, South Coast Air Quality Management District, In response to August 23 PR1410 Working Group Meeting, p. 2, available at: https://www.aqmd.gov/docs/default-

Especially after the adoption and planning of broad application of SCR (Selective Catalytic Reduction) controls for NOx, oil refinery real estate will be even more constrained. The record in these proceedings illustrates the foolishness of assuming that additional end of pipe emissions controls are a feasible choice even with regard to a well-established technology, unlike CCS, which does not exist at California refineries.

IV. Oil and chemical plant risk assessment literature states that increasing oil refinery density also increases dangers during fires and explosions.

Oil and chemical industry risk management literature also identifies the need to maintain adequate space for safety at oil refineries (which already regularly have major explosions and fires). For example, an analysis called *Oil and Chemical Plant Layout and Spacing* found:

> **Loss experience clearly shows that fires or explosions in congested areas of oil and chemical plants can result in extensive losses.** Wherever explosion or fire hazards exist, proper plant layout and adequate spacing between hazards are essential to loss prevention and control. Layout relates to the relative position of equipment or units within a given site. Spacing pertains to minimum distances between units or equipment. [16]

While this analysis identified many specific hazards, it recommended performing detailed site by site risk analysis, and identified general comments about access between process units. We have excerpted some recommendations to illustrate the complexity of the safety issues, but also request that CARB and modelers consider the entire document and its implications for realistic assessment of added CCS at oil refineries. Importantly, the final recommendation on this list, which was highlighted in bold by the authors, stated: "**Do not consider the clear area between units as a future area for process expansion.**"

> Provide access roadways between blocks to allow each section of the plant to be accessible from at least two directions.
>
> > • Avoid dead end roads. • Size road widths and clearances to handle large moving equipment and emergency vehicles or to a minimum of 28 ft (8.5 m), whichever is greater.
> >
> > • Maintain sufficient overhead and lateral clearances for trucks and cranes to avoid hitting piping racks, pipe ways, tanks or hydrants.
> >
> > • Do not expose roads to fire from drainage ditches and pipeways.

---

source/rule-book/Proposed-Rules/1410/1410-comment-letters/valero-2017-09-18-working-group-meeting-5.pdf?sfvrsn=6

[16] Property Risk Consulting Guidelines, A Publication of AXA XL Risk Consulting, PRC.2.5.2, Copyright 2020, AXA XL Risk Consulting, available at: https://axaxl.com/prc-guidelines/-/media/axaxl/files/pdfs/prc-guidelines/prc-2/prc252oilandchemicalplantlayoutandspacingv1.pdf?sc_lang=en&hash=996EA28071174510C4DA5D35102A9222

• Slightly elevate roads in areas subject to local flooding. • Locate hydrants and monitors along roads to allow easy hook-up of firefighting trucks.

• Provide at least two entrances to the plant for emergency vehicles to prevent the possibility of vehicles being blocked during an incident, e.g., open bridge, railway.

• Plan and implement a "Roadway Closure" permit system authorized and controlled by site Emergency Response personnel as part of the site impairment handling system.

Provide spacing between units based upon the greater of either Table 1 or a hazard assessment. The space between battery limits of adjoining units should be kept clear and open.

Do not consider the clear area between units as a future area for process expansion.

Thus, increases in hazards at oil refineries through broad application of CCS at the hundreds of combustion units at oil refineries represents a *new* safety hazard, increasing the risk for workers and neighbors.

V. CARB Should Request New Modeling to Reflect a 2045 Phasedown Target Without CCS to Support a Commitment to a Statewide Plan to Manage Refinery Phasedown.

Ultimately, we urge CARB to begin crafting new modeling assumptions for the refining sector. We support the EJAC recommendation to model a 2045 phaseout date *without* the use of CCS. Currently, the initial modeling results are rife with cognitive dissonance between phasing out fossil fuel transportation while allowing oil refineries to continue operating in disproportionately pollution burdened communities of color.

California must lead by choosing modeling inputs that reflect the values of environmental justice *and* which will succeed in truly addressing impending climate disaster. Fossil fuel corporations repeatedly and regularly state to investors their intentions to *expand export*s of transportation fuels produced at California oil refineries (including gasoline, diesel, etc.), to add emissions during a climate crisis. Exporting outside of California over the Pacific Rim, prolonging the life of otherwise stranded assets which carry multi-billion dollar clean up liabilities, leaves California environmental justice communities holding the bag of continued harmful toxic emissions and eventual remediation liabilities or workers' pension losses at the point of bankruptcy. For a just and equitable transition, CARB must sound the alarm on the need for a fossil fuel worker and community safety net and commit to develop a plan by 2024 to manage the decline and coordinate the phasedown of California oil refineries by 2045. As the EJAC recommendations discussed and the comments above reflect, the oil refineries are enormously complex and require thoughtful and rigorous planning now.

We appreciate the hard work involved in this modeling, including the many valid assumptions and results that do appear. However, the public, both community-based organizations and corporations alike, need transparent access to the assumptions used and to understand which parts are unchangeable technical matters and which are a matter of policy choice.

We look forward to the background documentation so we can more fully comment in the future.

Sincerely;

Julia May, Senior Scientist, CBE Connie Cho, Associate Attorney, CBE

Kiran Chawla, JD/PhD Candidate, ’24,
Stanford Environmental Law Pro Bono Project