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Comments on the Gas R&D Workshop

Additional submitted attachment is included below.

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January 31, 2022

Jonah Steinbuck, Deputy Director
Research and Development Division
California Energy Commission
Docket Unit, MS-4
Docket No. 16-PIER-01
715 P Street
Sacramento, CA 95814-5512

Subject: Comments on the Gas R&D Workshop

Dear Deputy Director Steinbuck:

Southern California Gas Company (SoCalGas) appreciates the opportunity to provide comments on the January 19, 2022 California Energy Commission (CEC) Staff Workshop to Discuss Proposed Natural Gas Research Initiatives for Fiscal Year 2022-2023. California needs long-term strategies that utilize both clean molecules and clean electrons to help reach the State's carbon neutrality goals by 2045. We appreciate the thoughtful approach that has led to the scope for the 2022-2023 Natural Gas Research Initiatives and offer the following comments grouped into seven categories:

(1) **Potential challenges to large-scale targeted gas decommissioning;**
(2) **Decarbonization of gas end uses;**
(3) **Industrial clusters for clean hydrogen utilization;**
(4) **Mitigating criteria air pollutants in hydrogen-based power generation;**
(5) **Advanced hydrogen refueling infrastructure solutions for heavy transport;**
(6) **Entrepreneurial development; and,**
(7) **Further consideration of weighting metrics and score descriptions for the Guidehouse long-term study.**

(1) Potential challenges to large-scale targeted gas decommissioning

In this section, we answer: **What are potential challenges to large-scale pilots?**

SoCalGas is fully committed to advancing California's decarbonization goals and finding the feasible levers for achieving net-zero carbon emissions. Some of the key challenges to large-scale pilots include:

(1) Electrification/decommissioning pilots have not been tested or validated at any scale;
(2) Emissions reductions are projected to result from *electrification,* not decommissioning; and
(3) Going from concept to practice could result in significant costs to ratepayers with little to no commensurate benefits.

Because the concept of targeted electrification coupled with decommissioning has been advanced as a prospective building decarbonization lever, we are participating in a feasibility investigation, including implementing the project's zonal electrification/decommissioning pilot project within our distribution system. However, one takeaway from the workshop is that future policymaking will benefit from taking a clear objective approach to these early-stage efforts, which can inform, for the first time, the practical feasibility and cost-effectiveness of a prospective zonal electrification/decommissioning strategy. Workshop participants pointed out that certain early-stage data points for getting to scale are informative. Specifically, workshop presenter Amber Mahone of E3 stated that to date, such an approach is hypothetical as it has not been demonstrated in practice at any scale. She articulated that,

> "[…] out of our prior work, as well as the work of others, has emerged a hypothesis, which is the idea that targeted electrification in geographically specific regions could be combined with strategic decommissioning of gas infrastructure in order to reduce total gas system costs and thereby help to mitigate future rate impacts for remaining customers. Now that hypothesis hasn't been tested or validated at any scale, and so this research is sort of a first step towards further investigation of that (emphasis added)."[1]

It appears prudent and in the public interest for the State to assess the results of this pilot study and the most recent grant funding opportunity before dedicating additional funds from the 2022-23 fiscal year budget. This approach allows for the CEC to focus its budget informed by fact-based outcomes of its pilot programs to address those opportunities that have exhibited appropriate levels of benefits and cost-effectiveness.

[1] *See* Transcriptions of workshop statements in this comment letter should be considered unofficial and are based on the publicly web-provided workshop video. Zoom recording available at: https://energy.zoom.us/rec/play/q45LKz4kATIr_cqamhc8ECvZVoPpidfaUjZV8zXgtiCemB5qabh_YHeIyaAW2XaWgi5XxmUmdJKrEBgs.GJ8oyGESRe6AKsSO?startTime=1637172027000&_x_zm_rtaid=T0ieoV9KTkeWqBn3WE7_2w.1638317202212.5e44cb1ccb87f955f7be16a88b308165&_x_zm_rhtaid=149.

Additionally, we would emphasize that *emissions reductions are projected to result from electrification, not from decommissioning*. During the workshop Q&A,[2] a workshop presenter revealed that decommissioning does not necessarily bear a causal relationship to reducing emissions. Ari Gold of E3 stated that "emissions are not likely to be a driving factor for [decommissioning pilot] site selection" and that "the carbon avoided might be very similar in untargeted electrification versus targeted electrification."[3] He went on to explain that "[b]ut only in that latter case, would you have the opportunity to start exploring some of these options for strategic decommissioning of gas system infrastructure." Put another way, the zonal electrification/decommissioning hypothesis is premised on electrification as the implement for reducing emissions. On the other hand, decommissioning arises only as a prospective mitigant for the rate impacts resulting from electrification rather a direct driver for underlying emissions reductions themselves. It is thus important to recognize as part of these considerations that decommissioning does not necessarily equate to emission reduction.

Moving forward with the CEC-sponsored pilot project is also critical to investigating the costs of a prospective zonal electrification/decommissioning strategy. The limited experience and initial data to date suggest that going from concept to practice will be costly for the State and ratepayers. A recent analysis by the City of San Francisco estimates the costs of electric appliance retrofitting for San Francisco residences to range from $14,363 per housing unit at the low end, up to $19,574 for multi-family units and $34,790 for single-family homes. It estimates the citywide cost to retrofit all residential units using natural gas-fueled appliances with electric ones from $3.5 to $5.9 billion.[4] Workshop presenter David Sawaya confirmed the high costs of electrification when discussing Pacific Gas and Energy Company's (PG&E) experiences. He stated,

> "[W]e cannot fund electrification projects at scale using gas rates and expect to have a benefit in terms of reduction of rates on the gas side on the gas bill, because the electrification of the individual premises is very expensive in our experience. Generally speaking, we're talking about anywhere from $25[,000] to $50,000 per resident if we're talking about residential in order to electrify them. So, when you start talking about projects at the scale of 50 or 100 homes those numbers start getting very big very quickly and quickly outstrips the potential savings that you would have."

PG&E's experience, while limited, reinforces the need to thoroughly assess the feasibility and financial challenges to homeowners and building owners. A 2021 research paper by the Energy Institute at Haas proposes to address potential inequitable customer cost impacts resulting from electrification "through the general tax base rather than from utility customers."[5] This approach, coupled with the high homeowner cost of building electrification, raises the possibility of subsidies

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[2] *See* Workshop recording at 01:56. A questioner asked, "how is carbon displacement calculated in this effort?"
[3] *Ibid*
[4] *See* Budget and Legislative Analyst Policy Analysis Report, April 2021, available at: https://sfbos.org/sites/default/files/BLA.ResidentialDecarbonization.042221.pdf.
[5] *See* L. Davis and C. Hausmann, "Who Will Pay for Legacy Utility Costs?" Energy Institute at Haas, July 2021, available at: https://haas.berkeley.edu/wp-content/uploads/WP317.pdf.

being required in order to offset costs to households and building owners to electrify, and then adding on additional tax revenue-funding in order to address the fixed cost impacts of electrification on remaining gas customers. However, additional data is needed on the cost implications resulting from electrification, particularly insofar as they may impose disproportionate community and household impacts particularly in light of more vulnerable customer groups.

It is imperative that the necessary decarbonization policies, especially those adopted for widespread implementation and with equally widespread effect, such as the zonal electrification/decommissioning hypothesis, are also developed with a thorough and fact-based understanding of prospective consequences and results. SoCalGas remains fully engaged in this investigation and all such relevant efforts to explore implementation of decarbonization levers in the future.

(2) Decarbonization of gas end uses

In this section, we answer: **What are the promising use cases and suitable geological storage opportunities in California?**

A large-scale hydrogen transportation and storage network does not currently exist in California. Utilizing the existing natural gas grid to transport hydrogen through blending in addition to building out a dedicated hydrogen pipeline network could encourage long-term, inter-seasonal storage of hydrogen, support renewable generation optimization, and increase energy grid resiliency. There is a distinct value proposition for policymakers to support hydrogen infrastructure development by implementing hydrogen policies to scale the adoption of hydrogen energy storage, which would then drive down costs. SoCalGas' Clean Fuels Report describes the detailed buildout of a potential clean fuels network in Southern California.[6] As depicted in Figure 1 (below), a clean fuels transmission backbone system has the potential to serve thermal generators, trucking routes, and match industrial hydrogen demand with hydrogen supply. When handling substantial hydrogen volumes, "[m]ultiple natural gas transmission pipelines would need to either blend hydrogen alongside natural gas or be retrofitted for hydrogen transport."[7]

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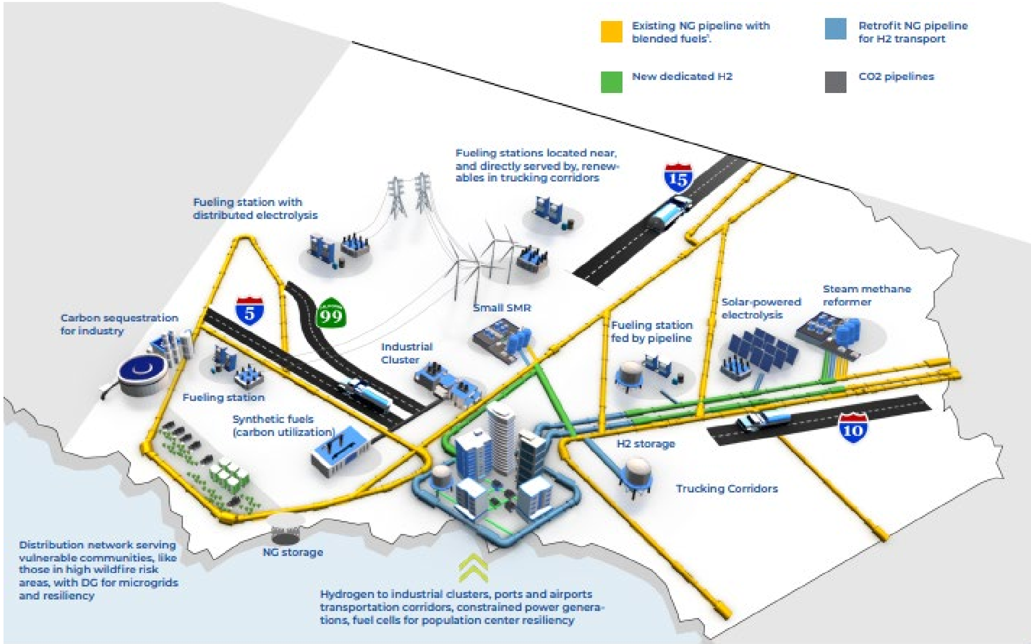
[6] *See* SoCalGas Clean Fuels Report, available at: https://www.socalgas.com/sites/default/files/2021-10/Roles_Clean_Fuels_Full_Report.pdf.
[7] *See* SoCalGas Clean Fuels Report, p. 43.

Figure 1: Illustrative Vision of a Potential Clean Fuels Network in Southern California[8]



Further, a recent Bloomberg NEF report, "Hydrogen: The Economics of Storage," evaluated eight major hydrogen storage technologies that can be utilized today. The report found that rock caverns are "[t]he next best large-scale storage solution in locations without salt caverns, as they have the potential to store hydrogen for $0.71/kg, which [researchers] postulate could fall to $0.23/kg if abandoned tunnels or mines can be used."[9] The report also found that depleted oil and gas fields "could be especially good at storing large volumes for long periods."[10] Table 1 (below) shows the different storage options of which five are in current use and three are being further explored.[11]

[8] *See* SoCalGas Clean Fuels Report, p. 44.
[9] *See* Hydrogen: The Economics of Storage, Full Report, Bloomberg NEF, July 2019.
[10] *Ibid.*
[11] Five technologies that are used today include: pressurized vessels, liquid hydrogen, salt caverns, ammonia, and metal hydrides. A further three that are being explored for potential use include: depleted gas fields, rock caverns, and liquid organic hydrogen carriers.

Table 1: Hydrogen Storage Options Summarized, Based on Identified Criteria by Bloomberg NEF[12]

	Gaseous state				Liquid state			Solid state
	Salt caverns	Depleted gas fields	Rock caverns	Pressurized containers	Liquid hydrogen	Ammonia	LOHCs	Metal hydrides
Main usage (volume and cycling)	Large volumes, months-weeks	Large volumes, seasonal	Medium volumes, months-weeks	Small volumes, daily	Small - medium volumes, days-weeks	Large volumes, months-weeks	Large volumes, months-weeks	Small volumes, days-weeks
Working capacity (t-H_2)	300-10,000t per cavern	300-100,000t per field	300-2,500t per cavern	5-1,100kg per container	0.2-200t per tank	1-10,000t per tank	0.18-4,500t per tank	0.1-20kg
Pressure (bar)	45-275	70-280	20-200	Up to 1,000	Ambient	Ambient	Ambient	~10
Benchmark LCOS ($/kg)[1]	$0.23	$1.90	$0.71	$0.19	$4.57	$2.83	$4.50	Not evaluated
Possible future LCOS[1]	$0.11	$1.07	$0.23	$0.17	$0.95	$0.87	$1.86	Not evaluated
Flexibility	Medium	Low	Medium	High	Medium	Medium	Medium	Medium
Losses (% H_2 lost / year)	Near-zero	2%	Near-zero for lined caverns	Near-zero	50%	Near-zero (if re-liquefied)	Near-zero	Near-zero
Parasitic load (% H_2 HHV)[2]	1 - 2.5%	1 - 2.5%	1 - 2%	0.5 - 11%	25 - 33%	25 - 28%	29-33%	11 - 28%
Density (kg/m^3)[2]	4 - 20	4 - 20	4 - 20	3.5 - 50	70.8	107 - 121	47 - 57	40 - 140
H_2 purity after release	High	Low	High for lined caverns	High	High	May need purification	High	High
Geographical availability	Limited	Limited	Limited	Not limited	Not limited	Not limited	Not limited	Not limited
Technological readiness[3]	TRL 9	TRL 2 - 3	TRL 2 - 3	TRL 9	TRL 7 - 9	TRL 9	TRL 7 - 9	TRL 7 - 9
Commercial readiness[3]	CRI 4	CRI 2	CRI 2	CRI 5 - 6	CRI 1 - 4	CRI 1 - 5	CRI 2	CRI 4
Social acceptability[4]	High	High	Medium	High	High	Low	Medium	High
Safety concerns[4]	Low	Low	Low	Medium	Medium	High	Medium	Medium

(3) Industrial clusters for clean hydrogen utilization

In this section, we answer: **What are key criteria when determining what industries to cluster and where? What California industries would benefit most from the clustering of hydrogen infrastructure? Are there relevant examples of similar clustering efforts nationally or internationally? What approaches should be considered when deploying hydrogen infrastructure? And what are some resources that can help inform this research initiative?**

(3a) Key criteria when determining what industries to cluster and where

SoCalGas believes industry composition, geographical location, existing infrastructure, energy costs and policy, and technology landscape are key criteria to consider when determining which industries to cluster and when deciding on a location. Characteristics specific to each industry (e.g., raw materials, process inputs, energy consumption and fuel type, waste by-products, readiness to adopt renewable fuels) within a cluster will influence the feasibility and economics of various

[12] *See* Hydrogen: The Economics of Storage, Full Report, Bloomberg NEF

decarbonization solutions. An integrated, low carbon energy system, therefore, needs to account for all the industries within the region that contribute to emissions, including transportation (on-road, marine, and aviation), oil and gas, power/utilities, and heavy industry and manufacturing, including steel, cement, chemicals, etc., given high-temperature, heavy-duty processes, and the associated difficulty of electrification.

Locations with co-located industrial facilities in proximity are ideal for taking advantage of synergies between facilities and companies, with the sharing of resources and infrastructure to minimize costs and drive efficiencies. The surrounding area of a cluster can also play a role in determining cluster location, where clusters can take advantage of their surroundings to pursue specific solutions. For example, a cluster located close to carbon dioxide (CO_2) geological storage sites can more easily pursue carbon capture and sequestration (CCS) solutions. Similarly, a cluster located near large waste sites such as farms, urban centers, etc. can pursue renewable natural gas (RNG) production. In addition, locations with high solar or wind availability can be prime candidates for clusters looking to pursue hydrogen initiatives involving electrolytic production. Lastly, a cluster located near ports can unlock numerous maritime applications, off-road vehicle fueling opportunities, and potential hydrogen export possibilities.

The presence and quality of existing infrastructure and assets can enable solution viability for clusters. Locations with infrastructure that can be leveraged or repurposed, such as gas pipelines that can be used for hydrogen blending or storage, can be favorable candidates for clusters. In addition, locations with assets nearing the end of life and needing replacement can be ideal cluster candidates to ensure new investments are undertaken effectively (e.g., repowering fossil fuel generators).

The cost profile and policies related to fossil energy and electricity can significantly influence decision-making. Key cost and policy enablers for a successful cluster include the negative value of CO_2, energy market reform, and a path to sustainable commercial models. For instance, carbon pricing, carbon border adjustments and other regulatory support measures such as subsidies and tax incentives are effective tools for improving the economics of emissions reduction initiatives. To value and support the development, production, and use of alternatives to unabated fossil fuels energy market reform may be necessary. Clear roadmaps with achievable milestones and commercial frameworks are conducive to the adoption of low-carbon technologies and sustainable business models.

Given that technology solutions serving as a cornerstone to industrial clusters have not yet scaled up, locations with a strong technology landscape for R&D can be a key criterion for cluster buildout. Cross-sector funding of RD&D projects, as well as partnerships with technology startups and academia, can unlock new technical and digital capabilities needed to accelerate progress towards cluster goals.

An industrial cluster provides the means for utility companies, shipping companies, fleet operators, transit agencies, and automotive companies to jointly plan and develop low-carbon infrastructure that is resilient and meets the needs of the population. Connecting hydrogen producers with off-takers in a market with coordinated buildout of fueling stations and fleet onboarding through the cluster can enable decarbonization of the hard-to-abate heavy-duty transport sector. Taking a broad systems analysis approach to hydrogen fueling infrastructure enables the transition to be made most efficiently, with aggregated data regarding traffic, fleet routes, hydrogen supply, etc., being used for system optimization as well as sharing of technical expertise and innovation. Furthermore, a cluster framework provides a structured and consistent process to onboard fleet operators and station operators to ensure a standardized, scalable, and replicable build-out.

(3b) California industries that would benefit most from clustering of hydrogen infrastructure

Port decarbonization is a key priority for California and is an industry that can greatly benefit from a cluster approach for hydrogen infrastructure. According to the California Air Resources Board (CARB), major seaports in California are experiencing a substantial increase in cargo imports, resulting in significant congestion at terminals and surrounding areas and emissions increases from freight-related sources, which can negatively impact air quality in communities near ports. As of March 2021, the increased cargo movement and congestion has resulted in overall emissions increases of "14.5 tons per day (tpd) of oxides of nitrogen (NOx) and 0.27 tpd of particulate matter (PM) in the South Coast Air basin relative to the average pre-pandemic baseline levels."[13] Across port complexes, there are a variety of end uses that benefit from a clustered and connected hydrogen system. For example, offshore wind renewable power can be used in electrolysis for production of green hydrogen, which can be consequently used for fueling stations for ground equipment, shipping via production of green ammonia, and heavy-duty processes across industrial users. A cluster allows the facilitation of partners across the value chain to ensure supply from these end uses balances with potential production at the ports, as well as supply brought in from elsewhere. With a cluster, hydrogen infrastructure at the ports can be coordinated with fueling stations and pipelines across the broader region covered by the cluster to ensure efficient buildout at the lowest cost, while also creating a seamless experience for manufacturing and shipping companies connected to the ports through clean transport corridors. This integrated energy system ultimately allows for end-to-end green shipping channels, speeding up the timeline of decarbonization and providing a business opportunity for companies routing through the port via premium low-carbon products.

Industrial processes for heavy industry, such as steel, cement, and chemicals, among others, require high temperatures and are therefore difficult to electrify. Industrial clusters provide a unique platform to aggregate energy demand and create a scalable internal market for hydrogen that can be used in these industrial processes. Benefits of a cluster for this sector include the reduction of emissions to avoid potential carbon taxes and associated financial consequences, as well as a business opportunity through the development of premium low-carbon products.

[13] *See* Emissions Impact of Recent Congestion at California Ports, CARB, available at: https://ww2.arb.ca.gov/sites/default/files/2021-09/port_congestion_anchorage_locomotives_truck_emissions_final_%28002%29.pdf.

Furthermore, an increased visibility on industrial demand for different sources of energy can aid capital expenditure planning and strategic outlook for energy companies.

(3c) Relevant examples of national and/or international clustering efforts

First, consistent with the federal Infrastructure Investment and Jobs Act (IIJA), which seeks to establish a clean hydrogen strategy and roadmap for the United States, California should support the direction and scope of opportunities that include clean hydrogen. The IIJA establishes the federal statutory definition of clean hydrogen as "hydrogen produced with a carbon intensity equal to or less than 2 kilograms of carbon dioxide-equivalent produced at the site of production per kilogram of hydrogen produced," which is subject to the development of an initial standard for the carbon intensity of clean hydrogen production to be developed by the Secretary of Energy in consultation with the U.S. Environmental Protection Agency (EPA) and stakeholders within 180 days of enactment.[14] Considering this federal definition of clean hydrogen, the CEC should support inclusive clean hydrogen efforts and seek to promote ways California can facilitate federal efforts to accelerate research, development, demonstration, and deployment of hydrogen from clean energy sources. For instance, California could continue its leadership in climate change pursuits by becoming a more attractive location for federal funding opportunities.[15,16] This would strengthen California's "toolbox" to decarbonize the energy ecosystem by looking to uses for clean hydrogen in the transportation, utility, industrial, commercial, and residential sectors. In addition to clean hydrogen funding over $9 billion,[17] an incremental and separate provision of the IIJA specifically allocates over $12 billion[18] to CCUS opportunities, as discussed further below. This funding may result in accelerated advancement of other promising technologies that, once scaled, could favorably impact hydrogen development and decarbonization efforts.

It is important to recognize that a myriad of clean solutions and technologies may play an important role in carbon-neutral hydrogen production beyond just electrolytic hydrogen. By aligning with the national strategy that focuses on various hydrogen pathways including the development of hydrogen hubs and sector focused research and development directives, California better positions itself to achieve its ambitious climate goals and to be a leader in solutions that may be replicated across the nation. In other words, an integrated energy solution, which includes various forms of

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[14] 42 USC 16166 Sections (a) and (b).

[15] During the CEC Business Meeting held on January 13, 2022, Commissioner Monahan stated she would lead an effort to try to direct federal funding from the U.S. Department of Energy (DoE) infrastructure bill towards California's Clean Transportation Program. Considering a more inclusive definition of "clean hydrogen", based on carbon intensity instead of color, could make it easier for California to align with federal requirements.

[16] *See* "Meeting of the California Energy Commission," CEC, January 13, 2022, available at: https://www.energy.ca.gov/event/meeting/2022-01/meeting-california-energy-commission.

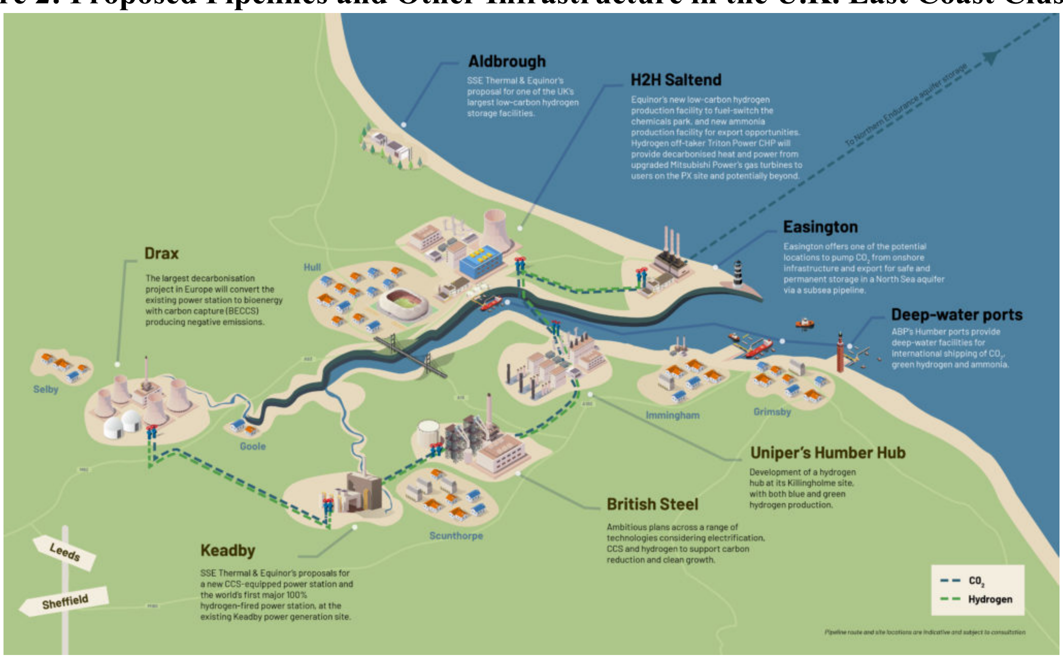
[17] *See* "Infrastructure Investment and Jobs Act: Accelerating the Deployment of Hydrogen," National Law Review, November 18, 2021, available at: https://www.natlawreview.com/article/infrastructure-investment-and-jobs-act-accelerating-deployment-hydrogen.

[18] *See* "Carbon Utilization Research Council (CURC) Welcomes House Passage of Infrastructure Investment and Jobs Act," CURC, available at: http:/www.curc.net/curc-welcomes-house-passage-of-infrastructure-investment-and-jobs-act.

clean energy and technologies, will provide more options, configurations, and potential synergies for all stakeholders (regulated utilities, private and public companies, local, state, and federal organizations, and policymakers) to learn from, refine assumptions, and make more informed decisions.

To provide some informative international examples, the Humber industrial cluster in Yorkshire is the United Kingdom's (U.K.'s) largest cluster by industrial emissions, emitting 10 million tons of CO_2 per year, more than two percent of the U.K.'s total greenhouse gas (GHG) emissions.[19] Primary industries include steel, chemicals, cement, and oil refineries. Zero Carbon Humber[20] aims to establish the world's first net-zero industrial cluster by 2040 via the creation of CCS infrastructure and the production of blue and green hydrogen. There will be three major areas of project work: (1) develop a carbon-capture usage and storage network; (2) produce low-carbon hydrogen and create shared hydrogen infrastructure; and (3) in the longer term, produce green hydrogen using offshore wind electrolysis. Hydrogen to Humber (H2H) Saltend will be the first mover in utilizing the shared CO_2 and hydrogen transport and storage infrastructure. This will eventually enable multiple carbon abatement projects in the region to scale quickly to achieve net-zero targets for the cluster, and U.K. industrial users will be able to reduce emissions by capturing carbon and transporting it via shared pipelines for offshore storage, as depicted in Figure 2 (below). Access to shared hydrogen infrastructure will spur demand for use as feedstock in industrial processes and enable the potential for further use outside the cluster.

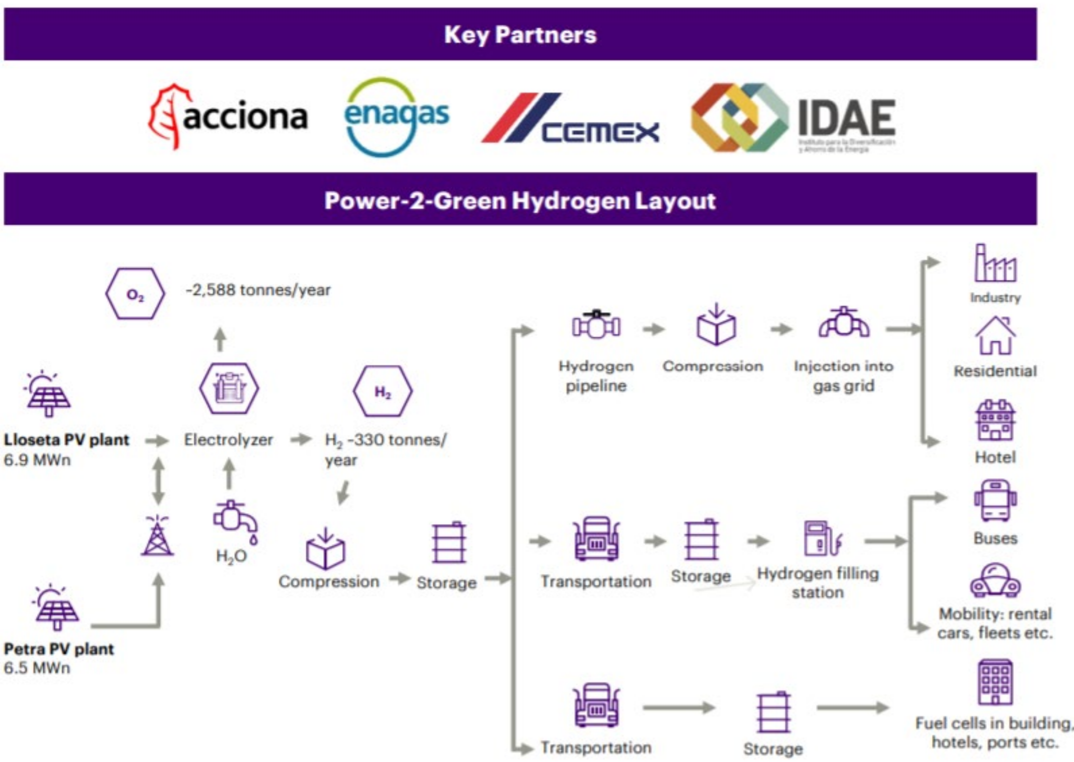
Figure 2: Proposed Pipelines and Other Infrastructure in the U.K. East Coast Cluster[21]



[19] *See* Industrial Clusters, Working together to achieve net zero, Accenture, p. 27, available at: https://www.accenture.com/_acnmedia/PDF-147/Accenture-WEF-Industrial-Clusters-Report.pdf.
[20] *See* Zero Carbon Humber: Delivering Our Net Zero Future, ZCH, available at: https://www.zerocarbonhumber.co.uk/the-vision/.
[21] *See* "What a Zero Carbon Humber would look like," available at: https://www.zerocarbonhumber.co.uk/.

As another example, Majorca Green Hydrogen, Power-2-Green Hydrogen,[22] project aims to pioneer a solution for island GHG emissions reduction and industrial reconversion on the island of Majorca, Spain. The Power-2-Green Hydrogen is planned as a revitalization project for the Balearic town of Lloseta, which has been significantly impacted by the end of cement production, a major employer in the area. The project consists of two solar PV plants making up more than 13 MW of combined generation capacity and a 2.5MW polymer electrolyte membrane (PEM) electrolyzer. The output from the electrolyzer will support multiple end-use applications: Powering part of the island's public transportation fleet; green hydrogen injected into the gas grid to supply industrial parks and as backup energy for buildings (public buildings, ports, hotels, etc.). Figure 3 (below) shows the key partners for the project as well as an initial layout.

Figure 3: Green Hydrogen Schematic for the Majorca Cluster[23]



(3d) Approaches that should be considered when deploying hydrogen infrastructure

Approaches that should be considered when deploying hydrogen infrastructure include system value impact with a focus on environmental justice and equity; integrated energy system design; building a coalition of key stakeholders; demand aggregation; and ensuring commercial viability through innovative public-private mechanisms.

[22] *See* Power to Green Hydrogen Mallorca, available at: https://www.acciona.com/projects/power-to-green-hydrogen-mallorca/.

[23] *Ibid.*

Industrial clusters need to select the solutions that maximize system value outcomes beyond only GHG emissions, pursuing collaborative actions that improve outcomes across the economy, the environment, and local communities. Key systems value dimensions include air quality, health impacts, jobs and economic impact, energy affordability, equitable access, resiliency, reliability, flexibility, and cost and investment competitiveness. When developing an industrial cluster and determining the hydrogen infrastructure to employ, it is important to quantify these outcomes to determine which solutions and infrastructure pathways are equitable and maximize benefits for local communities.

The approach taken to deploy hydrogen infrastructure must consider how the infrastructure connects with existing assets, a broad variety of end uses, and other decarbonization technologies to build an integrated energy system in the region. From an asset perspective, policymakers must consider how to maximize existing assets and reduce stranded assets by repurposing them in the context of hydrogen infrastructure (e.g., using current pipelines for blending or storage, shifting carbon capture, utilization, and storage (CCUS) over time from carbon sequestration to manufacturing end use cases requiring CO_2). The infrastructure must also be built with the expectation that it will be scaled as additional off-takers are onboarded onto the integrated system, and with the ability to meet these end-use case requirements. Finally, policymakers should consider the interconnection with other decarbonization technologies and initiatives, including wind and solar buildout, CCUS, alternate renewable fuels such as RNG, battery storage, etc. Hydrogen alone will not enable California to reach net-zero goals; policymakers should take a technology-inclusive approach to explore all decarbonization pathways. Coordinating projects such as electrolysis from wind and solar energy and blue hydrogen from CCUS with the hydrogen infrastructure in terms of location, costs, supply and demand balancing, and policy and regulatory standards is essential to work in harmony towards net zero.

Prior to undertaking hydrogen infrastructure development, it is important to align key stakeholders on the initiative. Sharing the vision of the project, the populations it will impact from an equity perspective, and the impact it will make on supply, demand, and prices will help to create a broad base of support when looking to gain approvals, shape policy, and integrate hydrogen into the broader energy system. Government involvement and support can enable and advance the time-to-market for an industrial cluster and create the policy landscape necessary for technology investment and commercial feasibility. Additional key stakeholders to engage prior to project development include regulators, labor, local environmental justice groups, government, other industry players and collaborators, and research and academia.

To build out the cluster, there needs to be a clear approach to synchronizing demand ramp-up, production build-out, and infrastructure availability. In other cluster examples across the world, this has taken a variety of different pathways. In Mallorca, the cluster followed a demand approach, with multiple smaller hydrogen off-takers aggregated as a first step to ensure end-use. A differing approach was used in the U.K.'s Humber cluster, with an initial core group of a few large off-takers, suppliers, and infrastructure operators coming together to define a joint roadmap.

Determining the approach used in choosing cluster membership and the implications it has on supply and demand will be a key consideration for deployment of infrastructure as it relates to an industrial cluster.

Project financing also is a core element critical to the development of an industrial cluster, requiring collaboration and alignment between infrastructure operators, suppliers, and off-takers. Policy alignment and innovations are a key element to enabling this financing landscape, and new commercial mechanisms will be required to ensure hydrogen infrastructure is economically viable. In global examples, this has taken a variety of approaches, including hydrogen purchase agreements (e.g., Contract for Difference mechanisms) to guarantee a market, new fee structures incorporating connection fees, capacity fees, and volumetric fees to ensure commercial viability for infrastructure operators, and direct grants, loans, and tax credits.

(3e) Additional resources that can help inform this research initiative

Lastly, additional resources to inform the CEC's research initiative include, but are not limited to:

- Frontier Economics Business Models for Lowe Carbon Hydrogen Production[24]
- World Economic Forum & Accenture Industrial Clusters Report[25]
- World Economic Forum System Value Report[26]
- The Future of Clean Hydrogen in the United States: Views from Industry, Market Innovators, and Investor[27]
- Evaluating Net-Zero Industrial Hubs in the United States[28]
- Humber Energy Intensive Industries Report[29]

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[24] *See* Business Models for Low Carbon Hydrogen Production, BEIS Research paper number 2020/026, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/910382/Business_models_for_low_carbon_hydrogen_production.pdf.

[25] *See* Industrial clusters, working together to achieve net zero, Accenture & World Economic Forum (WEF), available at: https://www.accenture.com/_acnmedia/PDF-147/Accenture-WEF-Industrial-Clusters-Report.pdf#zoom=40.

[26] *See* System Value, World Economic Forum (WEF), available at: https://www.weforum.org/projects/system-value.

[27] *See* The Future of Clean Hydrogen in the United States: Views from Industry, Market Innovators, and Investors, Energy Future Initiative (EFI), available at: https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/614a8729e756155644c6250c/1632274226712/EFI+Future+of+Clean+Hydrogen+in+the+U.S.+Report.pdf.

[28] *See* Evaluating Net-Zero Industrial Hubs in the United States: A Case Study of Houston, available at: https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/Houston,%20final%20design,%206.29.21.pdf.

[29] *See* Study of the Humber Energy Intensive Industries Cluster, Version 3.6, March 2018, available at: https://www.humberlep.org/wp-content/uploads/2019/08/Humber-EII-Cluster-Study-Final-Report.pdf.

(4) Mitigating criteria air pollutants in hydrogen-based power generation

In this section we answer the following: **What are the most promising energy innovations that could drive down the cost of mitigation technologies? And what types of demonstrations are needed to expand deployment of these technologies in the future?**

The SoCalGas RD&D group has begun to explore these issues through the following projects:

- UCI Effect of Hydrogen Addition into Natural Gas on SCR of NOx Lab Testing[30]
- UCI Fuel Flexible Microturbine Generator Development[31]
- UCI Fuel Flexible Rotary Engine MicroCHP Development[32]

Data collection from these demonstrations will help us better understand the relationship between higher blends of hydrogen and emissions reductions.

(5) Advanced hydrogen refueling infrastructure solutions for heavy transport

In this section, we answer: **What recommendations do you have on research approaches or performance metrics to target?**

In November of 2021, the Energy Commission approved a plan for $1.4 billion to help speed up the state's zero-emission vehicle infrastructure build-out.[33] In addition, SoCalGas understands that the Governor is proposing to inject an additional $6.1 billion, building upon last year's investment of $3.9 billion in zero-emission vehicles, to accelerate the statewide transition to ZEVs, including hydrogen refueling infrastructure.[34] We support this activity; however, it is unclear how a subset of the already limited PIER NG $24 million annual budget for similar projects will fund what the multi-billion-dollar funding will not. To provide clarity and certainty for these foundational projects intended to accelerate ZEV adoption, we recommend the Energy Commission's Fuels and Transportation Division fund these types of activities, rather than through the PIER NG program at this time.

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[30] *See* Transitions: Research Development & Demonstration Program 2020 Annual Report, p. 183, available at: https://www.socalgas.com/sites/default/files/2021-09/RD%26D%20Annual%20Report%20Full%20Version.pdf.
[31] *Ibid*. p.184.
[32] *Ibid*.
[33] *See* CEC Approves $1.4 Billion Plan for Zero-Emission Transportation Infrastructure and Manufacturing, California Energy Commission (CEC), available at: https://www.energy.ca.gov/news/2021-11/cec-approves-14-billion-plan-zero-emission-transportation-infrastructure-and.
[34] *See* Governor Newsom Outlines Historic $10 Billion Zero-Emission Vehicle Package to lead the World's Transition to Clean Energy, Combat Climate Change, Office of Governor Gavin Newsom, available at: https://www.gov.ca.gov/2022/01/26/governor-newsom-outlines-historic-10-billion-zero-emission-vehicle-package-to-lead-the-worlds-transition-to-clean-energy-combat-climate-change/#:~:text=Building%20upon%20last%20year's%20historic,Californians%2C%20while%20building%20out%20the.

(6) Entrepreneurial development

In this section, we answer: **What technologies are being developed by start-ups that can support safe decarbonization of existing uses of fossil gas?**

We suggest that the CEC consider supporting funding competitions to increase innovation. For example, SoCalGas has been a long-time sponsor of Caltech's Rocket Fund, which helps academic and garage innovators turn their technologies into commercial realities through financial support and entrepreneurial mentoring and education.

Further, SoCalGas suggests that the California Sustainable Energy Entrepreneur Development Initiative (CalSEED) include Diversity, Equity, and Inclusion (DE&I) provisions so that entrepreneurial development resources reach traditionally underserved communities. We recommend connecting with community-based organizations (CBOs) in disadvantaged communities and reaching out to diverse colleges and universities, such as California State University, Los Angeles and California State University, Long Beach. CalSEED should develop metrics and reporting to demonstrate to the public stakeholders that funding and development resources are reaching communities that are diverse with respect to race, gender, geography, and socioeconomics.

(7) Further consideration of weighting metrics and score descriptions for Guidehouse long-term study

In this section, we answer: **Are the metrics and score descriptions clear enough? And is there anything missing from the metrics and score descriptions that should be considered?** SoCalGas understands that the Guidehouse Prioritization Metrics are in early development. However, we believe it will benefit the public interest to have a transparent, detailed, and comprehensive understanding of the scoring methodology, related to both score categories of Barriers and Strategic Value. We also seek clarification on the matrix/score descriptions, especially on the Technology Equity and Accessibility of the Strategic Value Score Category.

Investments in clean energy technologies should benefit all communities directly, especially those classified as disadvantaged by CalEnviroScreen, through providing incentives and cost savings, while also considering affordability and rate impacts. SoCalGas believes that affordability, especially for low-income areas and disadvantaged communities[35] as defined in the Energy Equity Indicators tool,[36] should potentially be given a greater weight percentage as Guidehouse moves forward with developing the Scoring Methodology.

Conclusion

In closing, we appreciate the opportunity to comment in support of the CEC's continued efforts to advance research and development on the transition to clean energy solutions statewide. Advancing decarbonization goals by deploying available technologies and identifying and characterizing optimal co-location of industries to share hydrogen infrastructure are critical to achieving California's climate and air quality goals. We look forward to working with CEC staff in the development of this plan.

Respectfully,

/s/ Kevin Barker

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[35]As defined in the Energy Equity Indicators tool, the Disadvantaged Communities Advisory Group (DACAG) will adopt as the definition and advocate for equitable programming to reach all the following communities (including community residents, workers, and businesses): CalEnviroScreen, as defined by Cal EPA; Tribal Lands; Census tracts with area median household income/state median income, less than 80%; and Households with median household income less than 80% of Area Median Income (AMI).

[36] *See* CEC Energy Equity Indicators, available at: https://www.arcgis.com/apps/webappviewer/index.html?id=6f1348cbb30546b2982174841a36173a&extent=-14375673.8066%2C3900734.3721%2C-12027528.2977%2C5058908.2246%2C102100