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National Fuel Cell Research Center Comments - FY 2022-23 Gas R&D Initiatives

Additional submitted attachment is included below.

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Subject: FY 2022-23 Gas R&D Initiatives

The National Fuel Cell Research Center (NFCRC) submits these comments in response to the request for feedback on the Fiscal Year 2022 and Fiscal 2023 Gas Research and Development Program initiatives proposed.

I. Introduction

The NFCRC facilitates and accelerates the development and deployment of fuel cell technology and systems; promotes strategic alliances to address the market challenges associated with the installation and integration of fuel cell systems; and educates and develops resources for the power and energy storage sectors. The NFCRC was established in 1998 at the University of California, Irvine by the U.S. Department of Energy and the California Energy Commission (Commission) in order to develop advanced sources of power generation, transportation and fuels and has overseen and reviewed thousands of commercial fuel cell applications.

II. Comments on the Fiscal Year 2022-23 Gas Research & Development Initiatives

A. Scaled-up Gas Decommissioning Pilots and Integrated Planning Tools

1. **What emerging zero-carbon fuels should be considered by the planning tool?**

The NFCRC recommends that the planning process for gas decommissioning should be more optimally construed. Conversion, suspending operations and complete decommissioning should only happen after the CEC determines that the system or certain parts of the system will be neither used nor useful in the future. The CEC decisions and premature presentation of gas decommissioning can have the unintended consequence of stifling the investment and necessary research and demonstration for zero carbon solutions using the gas grid.

The overall study for the optimal decarbonization of all sectors of the economy should be accomplished before gas system decommissioning should commence. This is particularly important given the very recent policy decisions all around the world (e.g., China, Japan, Australia, all of Europe, and most recently in the U.S.) to focus investment and support of hydrogen production, storage, distribution and conversion to support zero emissions policy goals. If announced targets, such as the $1 for 1 kilogram within 1 decade of the U.S. Department of Energy are achieved, the cost-optimal decarbonization of all sectors of the economy are likely to significantly include gas system transformation to use renewable hydrogen (rather than decommissioning).

The NFCRC recommends that the CEC analyze scenarios to identify the optimal means to reliably transform the entire energy system to one that is zero carbon. The economics of alternatives for 100% decarbonized gas system should consider:

a. Magnitude and dynamics of all stationary and transportation gas demand,
b. Magnitude of storage resources required to reliably meet such demand throughout the year with very high use (near 100%) of renewable power,
c. Cost and resiliency of transforming all demand to electricity and using only electric infrastructure and electricity storage technologies to achieve near 100% renewable energy in the state,
d. Cost and resiliency of transforming many loads to electricity and using both the gas and electric infrastructures for storing, transmitting and distributing near 100% renewable energy in the state, and

e. Cost of engendering resiliency in the context of increased wildfires and public safety power shutoff (PSPS) events.

2. What are potential challenges to large-scale pilots?

NFCRC suggests that an alternative to decommissioning be considered in all of these pilots taking into account the potential for production and delivery of low-cost renewable hydrogen use for decarbonization.

3. What are the best practices in customer engagement on gas-to -electricity transition?

The CEC should consider the following impacts to customers when analyzing gas-to-electricity scenarios:

- How does gas decommissioning affect reliability of the electric grid?
- What is the required increase in electricity to meet the new demand transferred from the gas system?
- How does California plan for such an increase in electric demand and what timeline is necessary for such a transition?
- What is the new infrastructure cost? System cost? Customer cost?

4. What are the recommendations on minimizing cost impacts and supporting equity?

Disadvantaged communities will likely need significant investment in electrical infrastructure and significant financial support (e.g., incentives for electric appliances) for their purchase of electric alternatives to their current use of gas. Assessment of the magnitude of financial support needed throughout the state of California should be included as soon as possible. Assessment of the alternative decarbonization through the use of renewable hydrogen in these same disadvantaged communities is merited.

B. Decarbonization of Gas End Uses

The NFCRC supports all the initiatives proposed for decarbonization of gas end uses; that is, (a) Large-volume Hydrogen Storage for Targeted Use Cases, (b) Industrial Clusters for Clean Hydrogen Utilization, (c) Mitigate Criteria Air Pollutants in Hydrogen-Based Power Generation, and (d) Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport. NFCRC suggests that these initiatives comprise an incomplete set of the R&D investments that are needed for gas system decarbonization, but understands that the limited amount of funding available requires focus upon only some of the key issues.

1. **What are the promising use cases and suitable geological storage opportunities in California?**

   Salt caverns are already widely used and proven and as a storage facility for hydrogen. Results of both daily and seasonal simulation conducted by UC Irvine suggest that with the same size wind farm and salt cavern, a compressed hydrogen energy storage system could better complement the wind intermittency and could also achieve load shifting on a daily and seasonal time scale.[1] Air Liquide and Praxair have been operating salt cavern hydrogen storage in Texas since 2016. These massive energy storage facilities have a very low leakage rate, and represent safe and low cost storage. Europe has had similar success in using salt cavern storage.

   Magnum Development is bringing together a Western Energy Hub ("WEH") site located adjacent to the Intermountain Power Project ("IPP") in Millard County, Utah, that:

   > …can serve as a foundation of the Sustainable City Plan for Los Angeles, Southern California, and the Western region. This regional platform, with ready access to Southern California energy and transportation markets, offers a unique combination of geography, geology, energy and transportation infrastructure, and renewable energy resources that can serve to rapidly deploy new clean energy technologies and practices at commercial scale—meeting regional needs and speeding clean energy adoption and use worldwide... The unique combination of resources and

[1] Maton, J-P., Zhao, L., Brouwer, J., *Dynamic modeling of compressed gas energy storage to complement renewable wind power intermittency,* International Journal of Hydrogen Energy 38 (2013) 7867 e 7880

infrastructure makes the WEH site an exceptional platform for the development of a regional clean energy hub serving both power and transportation markets. The potential exists to use the massive and unique salt cavern resource to store wind and solar energy in the forms of hydrogen and compressed air and to access greater Los Angeles energy and transportation markets via a 2,400 MW, 500 kV direct-current transmission line, as well as major rail and highway routes for moving hydrogen to regional transportation markets.[2]

Recent studies in Europe[3,4] have begun to produce results for the investments required to transform their current depleted oil and gas fields into renewable hydrogen energy storage facilities. Some research and development to explore similar research and development for California depleted oil and gas storage facilities is merited.

2. What types of requirements should inform geological storage decision-making?

Depleted oil and gas fields in California could also potentially be used for hydrogen storage, if some critical research and development in the following areas is completed:

- Hydrogen leakage
- Hydrogen reaction with petroleum remnants
- Hydrogen biological interactions
- Hydrogen storage capacity
- Hydrogen safety

This research should be followed by pilot testing of hydrogen injection into depleted oil and gas fields with a detailed and robust measurement and verification testing plan.

3. Recommendations on research approach(es)?

a. Invest in R&D to determine whether and how current CA facilities can be transformed to store large amounts of hydrogen.

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[2] Reed, J., Brouwer, J., Webster, R. *Integrating Clean Energy Technologies with Existing Infrastructure, Western Energy Hub Site Benefits for Rapid Clean Regional Grid Transition*. January 30,2020. Available at: [Microsoft Word - White Paper_v11_5.docx (uci.edu)]

[3] Colbertaldo, P., Cerniauskas, S., Grube, T., Robinius, M., Stolten, D., & Campanari, S. (2020). Clean mobility infrastructure and sector integration in long-term energy scenarios: The case of Italy. *Renewable and Sustainable Energy Reviews*, *133*, 110086.

[4] Snam, *2030 Vision and 2021 – 2025 Strategic Plan*, available on-line at: https://www.snam.it/en/Investor_Relations/Strategy/2021-2025_strategic_plan/

b. Even small percentages of hydrogen injection into the natural gas system (e.g., 5-10% by volume) could provide a massive resource for supporting very high renewable use in the electric grid.

c. Investigate challenges to hydrogen injection and conversion throughout the infrastructure by holding hydrogen to and hydrogen natural gas mixtures to standards of gas infrastructure.

d. Investigate hydrogen leakage phenomena. A recent study shows that hydrogen may leak at the same rate as natural gas in typical low-pressure gas infrastructure, but much more needs to be done.

e. Encourage regulation and policies at CARB and sister agencies to expedite the formulation and adoption of pipeline hydrogen injection standards

f. Investigate the subsequent piecewise transformation of gas infrastructure to 100% renewable hydrogen.

C. Industrial Clusters for Clean Hydrogen Utilization

1. **What are key criteria when determining what industries to cluster and where?**
2. **What California industries would benefit most from clustering of hydrogen infrastructure?**
3. **Are there relevant examples of similar clustering efforts nationally or internationally?**
4. **What are some resources that can help inform this research initiative?**
5. **What approaches should be considered when deploying hydrogen infrastructure?**

Policymakers and regulators around the world have objectively analyzed the features that are needed to meet zero emissions policy goals and, as a result, are developing hydrogen strategies, investing in hydrogen demonstration projects and research and development, and laying the groundwork to ready infrastructure for green hydrogen production, storage, transport, and conversion. Japan, Germany, United Kingdom, and Canada have developed formal hydrogen roadmaps and are implementing a range of industrial policies to enable green hydrogen.

The European Union (EU) has awarded “Hydrogen Valley” funding to several regions with the objective of large-scale clusters with production, distribution, and multi-sector end uses of hydrogen. The cited Hydrogen Valley report provides insights into the most advanced Hydrogen Valleys globally. The findings are based on data gathered during the development of the Mission Innovation Hydrogen Valley Platform (www.h2v.eu) by the FCH JU, a global information sharing platform set up under the Innovation Challenge 8 'Renewable and Clean Hydrogen' of Mission Innovation and funded by the European Commission. The data on the platform and in this report comes out of a comprehensive survey conducted among 30+ Hydrogen Valleys globally providing cumulatively more than 2,500 datapoints on their projects.[5] The EU defines a Hydrogen Valley as large in scale; with high value chain coverage; hydrogen supply to more than one sector; and a geographically defined scope. Following on the initiation of these valleys, the EU released a *Hydrogen Strategy for a Climate Neutral Europe*[6] to guide over €1 billion of investments and measures, with an at least equivalent amount from the private sector of cost share.

Additionally, in December 2021, the European Commission announced support for a German plan to support €900 million of investments in the production of renewable hydrogen resources outside of the European Union (EU) for import and sale to the EU. [7]

In November 2021 the federal government in the U.S. has included $9.5 billion in the Infrastructure Investment and Jobs Act[8] with $8 billion of the funding targeted at regional hydrogen hubs to demonstrate the production, processing, delivery, storage, and end-use of clean hydrogen. This groundbreaking initiative includes requirements for feedstock diversity with at least one hub required to demonstrate production of hydrogen from fossil fuels, at least one hub for hydrogen from renewable energy, and at least one hub for hydrogen from nuclear energy. The initiative includes end-use diversity with at least one hub to demonstrate hydrogen use in power generation, at least one hub for hydrogen use

[5] Hydrogen Valleys. Insights into the emerging hydrogen economies around the world (europa.eu)

[6] European Commission, A Hydrogen Strategy for a Climate Neutral Europe, August 7, 2020. Available at: hydrogen_strategy.pdf (europa.eu)

[7] European Commission Approves €900 Million German Scheme to Support Investments in Production of Renewable Hydrogen - Hydrogen Central (hydrogen-central.com)

[8] Available at congress.gov: H.R.3684 - 117th Congress (2021-2022): Infrastructure Investment and Jobs Act | Congress.gov | Library of Congress

in the industrial sector, at least one hub for hydrogen in heating, and at least one hub for hydrogen in transportation. Lastly, the initiative also includes geographic diversity requirements with at least two hubs designated to be in regions of the United States with the greatest natural gas resources.[9]

Green hydrogen has been identified by New York Governor Hochul as a nascent energy sector that is critical to the State's energy transition.[10] There is also growing recognition in New York that the green hydrogen economy presents a unique economic development *and* climate change strategy. For example, regulators and analysts are calling attention to the State's need for a significant buildout of firm, zero-carbon electricity as it expands its reliance on intermittent wind and solar resources to meet the Climate Leadership and Community Protection Act's emission targets – as much as 30,000 MW of new installed capacity may be needed by 2040.[11] The Climate Action Council's Draft Scoping Plan underscores the potential role of hydrogen across various end-uses and recognizes the need for the State to evaluate incorporating hydrogen as part of the gas system's transition.[12]

Governor Hochul announced several large-scale hydrogen initiatives in her 2022 State-of-the-State book.[13] The Governor calls for an integrated, decarbonized energy system to animate the market for green hydrogen and ensure green job creation.

In addition to stating an objective of making New York a green hydrogen hub, the State-of-the-State book describes additional proposals for:

- Development of a Regulatory Framework to measure emission reduction and codes and standards
- Program for locally-owned green hydrogen microgrids

[9] Hydrogen hub summary courtesy of the Fuel Cell and Hydrogen Energy Association.
[10] *2022 State of the State*, Governor Kathy Hochul. Available at: 2022StateoftheStateBook.pdf (ny.gov)
[11] *Climate Change Impact and Resilience Study – Phase II: An Assessment of Climate Change Impacts on Power System Reliability in New York State*, Final Report, Analysis Group for NYISO, September 2020. https://www.nyiso.com/documents/20142/16884550/NYISO-Climate-Impact-Study-Phase-2-Report.pdf
[12] *New York State Climate Action Council Draft Scoping Plan*, New York Climate Action Council, December 2021. https://climate.ny.gov/-/media/Project/Climate/Files/2021-12-17-Draft-Scoping-Plan-for-Council-Consideration.ashx
[13] *2022 State of the State*, Governor Kathy Hochul. Available at: 2022StateoftheStateBook.pdf (ny.gov)

- NYSERDA Hydrogen Innovation Funding $27M – product development, pilots, and demonstrations Q222 w/federal FOAs.
- District Heating and Cooling – NYSERDA green hydrogen demonstration
- Industry Collaboration – NYSERDA invest in convening utilities, renewable energy cos, auto OEMs and hydrogen end users
- Green Hydrogen Prize program for firms seeking NY expansion
- New York Truck Voucher Incentive Program include green h2 school bus electrification

D. Mitigate Criteria Air Pollutants in Hydrogen-Based Power Generation

1. **What are the most promising energy innovations that could drive down cost of mitigation technologies?**

   It is premature for the CEC to assume that hydrogen categorically increases emission. When used in non-combustion fuel cell systems, hydrogen produces no emissions. In addition to fuel cell technology there is burner design, all these things we do with gasifiers. Research should be conducted on combustion design and aftertreatment.

2. **What are suggested target metrics for the mitigation technologies?**
3. **What types of demonstrations are needed to expand deployment of these technologies in the future?**
4. **Are there technology development opportunities to accommodate both higher blends of hydrogen and emission reductions simultaneously?**

E. Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport

1. **Are there additional barriers or innovations that should be targeted or prioritized?**
2. **What recommendations do you have on research approaches or performance metrics to target?**
3. **How beneficial is the funding augmentation approach for potential applicants?**

There is no reason that the CEC should limit the discussion of hydrogen refueling infrastructure to heavy-duty transport. Hydrogen is more efficient for long trips, long time to store electricity. Hydrogen infrastructure can serve many customers with a very small footprint. Infrastructure investment and total cost of ownership is cheaper for hydrogen vehicles.

III. Closing Comments

The NFRC appreciates the opportunity to comment on the Draft 2021 Integrated Energy Policy Report (IEPR), Volume III: Decarbonizing the State's Gas System.

Respectfully submitted,

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