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NFCRC Comments on Joint Agency Workshop April 8, 2019

NFCRC Comments attached for Docket Number 19-IEPR-06 â€“ Energy Efficiency and Building Decarbonization from Joint Agency Workshop April 8, 2019.

Additional submitted attachment is included below.

NATIONAL FUEL CELL RESEARCH CENTER

University of California, Irvine
Irvine, California 92697-3550
(949) 824-1999
(949) 824-7423 Fax
http://www.nfcrc.uci.edu

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California Energy Commission
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Re: Docket No. 19-IEPR-06
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: Joint Agency Workshop on Building Decarbonization:
Docket Number 19-IEPR-06 – Energy Efficiency and Building Decarbonization

The National Fuel Cell Research Center ("NFCRC") submits these comments on the April 8, 2019 California Energy Commission ("CEC") and California Public Utilities Commission ("CPUC") Joint Agency Workshop on Building Decarbonization.

I. Introduction

The NFCRC facilitates and accelerates the development and deployment of fuel cell technology and fuel cell 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 various stakeholders in the fuel cell community. A primary mission of the NFCRC is to enable the improvement of air quality and reduction of greenhouse gas emissions through increased use of distributed generation and clean energy sources.

The NFCRC was established at the University of California, Irvine by the U.S. Department of Energy ("DOE") and the CEC with the goal of both developing and transitioning to a form of power generation that is both energy efficient and environmentally sensitive. The DOE has recognized the significance of the NFCRC efforts in bringing government agencies, business and academia together to develop effective public-private alliances -- in the case of the NFCRC, in order to develop advanced sources of power generation, transportation and fuels.

II. Comments

A. Background of Fuel Cell Systems in Building Decarbonization

Fuel cells for power and heat generation are unique, non-combustion solutions that reduce greenhouse gas emissions ("GHG") in commercial, industrial, multi-unit residential buildings and other facilities. Combined heat and power and all-electric fuel cell systems offer substantial benefits that include:

1) reducing and eliminating greenhouse gas emissions and short-lived climate pollutants
2) virtually zero emission of criteria air pollutants in local communities
3) creating resilient power that can operate independent of the grid
4) the ability to operate on renewable gas, hydrogen and natural gas
5) increased energy efficiency
6) providing 24/7, load-following power behind-the-meter and at utility-scale

Due to their high efficiency, fuel cell systems are already reducing emissions associated with cooling and heating equipment in various building types today. In addition to electricity generation, the ability of stationary fuel cells to capture and utilize heat to provide cooling, heating, hot water, or steam results in overall fuel cell system efficiencies (electrical power generation and use of the captured thermal energy) ranging from 55% to 80% and, with a superior design and well-matched loads, exceeding 90%. All-electric and combined heat and power fuel cell systems reduce greenhouse gas emissions and have negligible criteria air pollutant emissions.

Additionally, fuel cells can provide load-following and ramping services, and enhance both onsite generation and assist utilities in managing a high penetration of intermittent renewable generation. As a result, fuel cell systems are preferred for increased reliability, resiliency and emission reduction. [1] California, with a substantial deployment of intermittent and diurnal varying renewable power generation systems is experiencing some challenging grid stability issues and gaps in power generation. The use of short-duration energy storage

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[1] Advanced Power and Energy Program at the University of California Irvine, "*Managing the Dynamics of a 100 Percent Renewable Electric Grid*" March 2018 available at: http://www.apep.uci.edu/Research/whitePapers/pdf/APEP_Grid_Management_3-Page_031518.pdf

technologies (mostly lithium ion battery systems) is helping with some of these grid management issues and gaps, but their use to-date has resulted in increased emissions on the California grid.[2] Reversible fuel cells or electrolyzers can also serve as controllable loads that correspondingly help the grid manage instances of overproduction from renewable resources to produce a renewable hydrogen fuel for storage and later electricity production or for use as a fuel in fuel cell electric vehicles. While battery energy storage is necessary, the inclusion of clean, 24/7 load-following power generation is also required for a successful conversion to 100% clean energy. Fuel cells are perfectly suited to serve in these long-duration storage and dispatchable zero-emissions power generation roles.

B. Decarbonization is Not Synonymous with Electrification

Limiting building decarbonization to focus only on certain technologies arbitrarily constrains program effectiveness in reducing GHG emissions. A technology neutral approach is critical because California needs multiple approaches to most efficiently and effectively achieve the goal of decarbonizing buildings. For example, current research at the University of California, Irvine regarding the effectiveness of electric residential heating and cooling from heat pumps has resulted in initial findings that electric heat pumps may increase GHG emissions to the extent that heating demand is out of sync with renewable electricity production on both a diurnal and seasonal basis. This is generally the case because the primary demand for heating is at night and during the winter. The result is that heating is mostly used at night – when renewable solar is not available – and the increased nightly heating demand creates increased GHG from reliance on dirtier, less efficient and higher GHG emitting generators. Similarly, there are seasonal challenges with only relying on one technology to provide electricity and heat; the preponderance of California's heating is required in winter when significantly less solar is available. Finally, local transmission and distribution constraints, resiliency reductions associated with reliance upon one system for delivering energy, and higher costs associated with decarbonization in some cases if flexibility is not retained in the program.

The CEC should not consider mandating building electrification as the only option to achieve zero carbon buildings in the IEPR. (SCE, VEIC Energy Services presentation)

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[2] Itron, Energy + Environmental Economics (E3), 2017 SGIP Advanced Energy Storage Impact Evaluation, available on-line at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/Customer_Gen_and_Storage/2017_SGIP_AES_Impact_Evaluation.pdf

The emissions reduction potential associated with cooling equipment in various building types[3] is already being realized today by using fuel cell systems. The combined cooling, heating and power (CCHP) capability of stationary fuel cells to capture and utilize heat produced by the fuel cell for the provision of cooling, heating, hot water, or steam results in overall fuel cell system efficiencies (electrical power generation and use of the captured thermal energy) ranging from 55% to 80%[4] and, with a superior design and well-matched loads, exceeding 90%.[5] This attribute also displaces the fuel and emissions that would otherwise be associated with (1) boilers when using the thermal energy as heat, and (2) the electricity to drive chillers when using the thermal energy for cooling. The resultant effect is to dramatically reduce CO_2 emissions, criteria pollutant emissions, and the demand on fuel reserves. In contrast to combustion heat engines, fuel cells are unique in providing high fuel-to-electricity efficiency and high quality (i.e., high temperature) heat, as well as producing virtually zero emission of criteria pollutants.[6] This clean electricity can also power heat pumps for further reductions in GHG emissions associated with building heating and cooling.

SB 1477 broadly lists technology for building decarbonization and does not limit the BUILD and TECH programs to only electrification technologies. The first paragraph of the CPUC Order Instituting Rulemaking in the Building Decarbonization proceeding[7] states that "The initial scope of this proceeding is designed to be inclusive of *any alternatives* that could lead to the reduction of greenhouse gas (GHG) emissions associated with energy use in buildings [emphasis added]." Fuel cells decarbonize buildings and do so while providing always-on, reliable power.

Many of California's healthcare providers and other vital industries—e.g., data centers, advanced manufacturing—require this type of 24-7-365 energy delivery. Momentary losses of electricity to these commercial and industrial facilities are immensely damaging, potentially impacting health and well-being of citizens and costing thousands-of-dollars per each minute that

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[3] Draft 2018 IEPR Update Volume II, at 33.

[4] Darrow, K., et al., Catalog of CHP Technologies 2015: Available at: https://www.epa.gov/chp/catalog-chp-technologies (Accessed January 12, 2015).

[5] Ellis, M.W., M.R. Von Spakovsky, and D.J. Nelson, *Fuel cell systems: efficient, flexible energy conversion for the 21st century.* Proceedings of the IEEE, 2001. 89(12): at 1808-1818.

[6] *Supplemental Report: The Science of Fuel Cells; Assessment of Fuel Cell Technologies to Address Power Requirements at the Port of Long Beach.* MacKinnon, M and Samuelsen, S. Advanced Power and Energy Program, University of California Irvine, April 31, 2016.

[7] *Order Instituting Rulemaking Regarding Building Decarbonization,* (OIR 19-01-011), California Public Utilities Commission, February 8, 2019 at 2.

critical loads are dropped, jeopardizing both the innovation and productivity of these sectors. Access to critical electric infrastructure, especially in areas of utility grind network or power generation capacity constraints, is a prerequisite in attracting these industries and retaining them in the State, as well as meeting their growing electricity needs.

Fuel cells, which have fleet wide capacity factors exceeding 95%, are uniquely qualified to serve these 24-7-365 needs. Due to high operating efficiency and continuous operation, fuel cell systems generate electricity that is cleaner than the utility grid network - resulting in reduced GHG emissions and current building decarbonization, as demonstrated by substantial data and in CPUC reports from the Self-Generation Incentive Program. [8]

Finally, fuel cells generate this clean electricity with no combustion and thus virtually no smog-causing criteria air pollutants that harm human health. And when operating on renewable fuels, fuel cell systems produce completely decarbonized electricity, heating and cooling. **Overall, fuel cells are essential to decarbonizing buildings for key sectors of California's economy that also require always-on power.**

C. Resiliency Should Be A Core Facet of Building Decarbonization

As California grapples with more intense storms, heat waves, flooding, fires and drought, State programs must prioritize resiliency and reliability, while also prioritizing decarbonization. Indeed, the 2019 IEPR Update Scoping Order calls for continued state and stakeholder actions "to address major climate risks to the state's communities and energy system, recognizing differing vulnerabilities to the natural gas and electricity sectors" and "flexible and adaptive strategies to increase the state's resilience to multiple stressors from climate change on the energy system, with particular attention to vulnerable populations."[9]

The building decarbonization discussion is an excellent venue to identify cost-effective resiliency strategies, such as backup power options that displace polluting diesel generators. Additionally, it is important that the IEPR value and ensure the ability of technologies to reliably island while decreasing both GHG and criteria air pollutant emissions. Microgrids that use fuel cell systems as baseload power generators are able to immediately disconnect from the utility

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[8] *Final Report: SGIP 2014-2015 Impacts Evaluation Report.* Submitted by Itron to SoCalGas and the SGIP Working Group, September 29, 2016.

[9] *2019 Draft Scoping Order for the 2019 Integrated Energy Policy Report*, California Energy Commission, February 14, 2019 at 4.

grid network and island (operate autonomously from the larger grid) when circumstances demand (e.g., grid outage), for days or weeks as required. These microgrids can therefore create strong resiliency and reliability throughout society in the event of disasters or grid instability. Stand-alone fuel cell systems as distributed energy resources (DER) can also create resiliency outside of a microgrid and provide continuous clean power in addition to islanding connection to critical loads onsite. A fuel cell system can smoothly transition from grid-connected operation to fully power loads during a grid outage, without interruption to the end user.

As mentioned in the *Clean and Renewable Power* comments above, an increase in renewable resources requires 24/7, baseload, load-following power generation to complement the intermittency from seasonal, diurnal and hourly variations of solar and wind power. Microgrids that use fuel cells integrated with renewable resources create a firm, highly reliable and zero emission microgrid. A microgrid's fuel cell enhanced reliability is even more important when considering the recent increased adoption throughout the state of intermittent renewable wind and solar resources which only supply power when the wind blows or the sun shines. In addition, the energy density of fuel cell systems significantly reduces the land footprint required for onsite generation compared to solar and wind power, allowing for deployment in high density areas and leaving increased acreage available for habitat restoration and preservation:

> "Those in search of reliable energy also are likely to find it easier and quicker to site a fuel cell microgrid than many other energy resources. Compared with fossil fuel-fired plants, wind, or solar farms, fuel cells are relatively easy to site. They do not require specialized orientation to operate, or wide swaths of land. They can be sited either outdoors or indoors. This means that fuel cell microgrids are more likely to be accepted within communities, especially in densely populated areas where microgrids are often deployed to bolster grid resilience and reliability... The flexibility and continuous output of fuel cells make them an ideal partner for microgrid installations that seek increase grid reliability while maintaining strict environmental standards."[10]

D. Renewable Gas Is a Critical Decarbonization Pathway

The NFCRC agrees with the CEC and Southern California Gas Company workshop presentations that renewable gas is a critical decarbonization pathway and should be considered in CEC gas and electricity planning, as a way to transition to zero emission buildings using

[10] Microgrid Knowledge, "*Fuel Cell Microgrids: The Path to Lower Cost, Higher Reliability, Cleaner Energy*" copyright 2017, Energy Efficient Markets, LLC.

existing infrastructure. The development of the renewable gas market is an important goal to enable the broadest future building decarbonization, while addressing the limits of lithium-ion technology. There are fuel cell systems being used to decarbonize buildings today that can use these renewable fuels and are only constrained by the availability of the fuels, limiting both the market and the significant GHG, criteria air pollutant and toxic air contaminant emission reductions that can be uniquely achieved by the use of continuous power fuel cell systems.

Renewable wind and solar power generation, fuel cells operating on natural gas, biogas, and renewable hydrogen, and energy storage technologies can all reduce CO_2 and other GHG emissions. **Through the fuel flexibility of fuel cells, and the ability to operate continuously and follow fluctuating electrical (and thermal) loads, fuel cell systems can also provide a critical role in enabling decarbonized buildings.** The growing market and increasing deployment of fuel cell systems, however, are hindered by changing and new regulatory and policy hurdles associated with the availability and development of renewable gas supplies for distributed power generation. Promisingly, solar and wind resources are well-positioned to produce large amounts of renewable hydrogen via a power-to-gas water electrolysis process. The scientific community is increasingly recognizing the important and required role for renewable hydrogen and its derivatives for achieving a zero emissions economy as indicated in a recent *Science* publication.[11] Storage, transmission, distribution, and end-use of this renewable and sustainable hydrogen fuel in the existing gas system may comprise the most cost-effective means of achieving massive and seasonal storage of renewable electricity.

Doosan is currently installing a 50 MW stationary fuel cell system in Korea that will be fueled solely by hydrogen. The hydrogen is a by-product of a petrochemical plant that will be used to operate the fuel cell system with the utility utilizing the electricity produced.

In New York, Bloom Energy has installed multiple fuel cell projects as part of the Con Edison Brooklyn Queens Demand Management and Demand Response Program. [12] The program ultimately avoided nearly $1 billion in ratepayer costs through the use of targeted distributed generation installations. The Program projects include one using solar, storage,

[11] Davis, S., N. Lewis, M. Shaner, S. Aggarwal, D. Arent, I. Azevedo, S. Benson, T. Bradley, J. Brouwer, Y-M. Chiang, C. Clack, A. Cohen, S. Doig, J. Edmonds, P. Fennell, C. Field, B. Hannegan, B. Hodge, M. Hoffert, E. Ingersoll, P. Jaramillo, K. Lackner, K. Mach, M. Mastrandrea, J. Ogden, P. Peterson, D. Sanchez, D. Sperling, J. Stagner, J. Trancik, C-J. Yang, K. Caldeira, *Net-zero emissions energy systems*, Science, Vol. 360, Issue 6396, 29 June 2018.

[12] Brooklyn Queens Demand Management Demand Response Program available at: https://www.coned.com/en/business-partners/business-opportunities/brooklyn-queens-demand-management-demand-response-program

and fuel cell technologies together at a low-income housing development, to optimize the efficiency, reliability, and affordability of the project.

III. Closing Comments

The NFRC appreciates the opportunity to comment on the Joint Agency Workshop on Building Decarbonization as part of the 2019 Integrated Energy Policy Report (IEPR) docket and recommends that the CEC integrate a variety of distributed generation systems on the grid. Fuel cell systems should be part of the strategy recommended to decarbonize buildings and should be a major part of any discussion on decarbonization of the entire economy. In addition, the IEPR should explicitly recommend those decarbonization technologies that also reduce air pollutants and increase resiliency, both of which have direct positive impacts on all California communities.

Respectfully submitted,

Dr. Jack Brouwer
Director
National Fuel Cell Research Center
University of California, Irvine
Irvine, CA 92697-3550
Tel: 949-824-1999 Ext. 11221
E-mail: jb@nfcrc.uci.edu