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Additional submitted attachment is included below.

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NATIONAL FUEL CELL RESEARCH CENTER
Irvine, CA 92697-3550

Phone: (949) 824-1999
Fax: (949) 824-7423

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California Energy Commission
Dockets Office, MS-4
Re: Docket No. 19-ERDD-01
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: CEC Draft Research Concept: Docket Number 19-ERDD-01

The National Fuel Cell Research Center (NFCRC) submits these comments to the California Energy Commission (Commission) regarding the January 21, 2021 Workshop to Discuss Research into Clean Energy Alternatives to Diesel Backup Generator Systems (Workshop).

I. Introduction

As discussed with the Commissioners in the January 21 workshop, the primary barrier to adoption of commercially available diesel alternatives today is policy and regulatory support, rather than further research.

II. Research, Development and Demonstration (RD&D) Ideas/Concepts for Consideration

The NFCRC recommends that the Commission support the following areas to acknowledge the importance of including fuel cells and hydrogen in long-term resilience plans and strategies in California.

1. **Pilots to demonstrate 100% renewable data centers (both primary and backup power with all storage required) – starting with a containerized data center;**

2. **Pilot demonstrations of integrated solar, wind, battery & fuel cell microgrid systems for data centers;**

3. **Alternative backup power generation designs, e.g., use distributed generators for both primary and backup power generation (focused on RD&D in switchgear, controls, and design for reliability);**

4. **Integrated power and cooling for data centers, e.g., high temperature fuel cells with absorption chilling and/or dehumidification;**

5. **Alternative data center designs for distributed generation, e.g., Microsoft idea of "in-rack" generation (by fuel cell, flow battery, …) to eliminate the need for back-up generation;**

6. **Hydrogen ecosystem – renewable hydrogen and oxygen from data centers shared with other uses (e.g., vehicles, forklifts, wastewater treatment, ammonia plant);**

7. **Reversible solid oxide cells plus solar/wind power using the natural gas grid for long-term storage;**

8. **Renewable electrolysis & biogenic hydrogen production demonstrations to engender cost reduction; and**

9. **Investigations into reliability and resiliency of pipeline delivery of fuel, e.g., delivery of renewable hydrogen via pipeline to meet data center requirements.**

III. Comments on RD&D Recommendations

California is annually beset by extreme heat, blackouts and wildfires—while continuing to also grapple with a global pandemic. The resulting air quality emergencies are impacting the lives of millions of Californians.[1] The Commission must support the use of long-duration, clean, resilient microgrids and backup power sources in policies and programs before circumstances worsen. Clean fuel cells and hydrogen systems should be able to create resiliency where the absence of firm and backup power resources and intermittent renewable energy systems have failed at the expense of the environment and public health and safety. The Commission has many resilient, clean generation options to replace diesel combustion generators including fuel cell systems, which systems provide the ideal replacement technology in the RD&D recommendations.

1. **Pilots to demonstrate 100% renewable data centers (both primary and backup power with all storage required) – starting with a containerized data center.**

   The NFCRC recommends that the Commission prioritize addressing local air quality impacts in research initiatives for diesel alternatives, in addition to GHG reduction benefits of alternative energy resources.

   Fuel cells are uniquely qualified to serve 24-7-365 power generation as well as backup generation requirements. Due to high operating efficiency and continuous operation, non-combustion fuel cell systems generate electricity that is cleaner than

[1] Erin Allday, San Francisco Chronicle, *Coronavirus, wildfires combine to create a Bay Area respiratory catastrophe* August 21, 2020. Available at: https://www.sfchronicle.com/bayarea/article/Coronavirus-wildfires-combine-to-create-a-Bay-15501136.php; Maria Heeter, Sacramento Bee, *What are the biggest fires in California history? LNU, SCU lightning complexes join the list* August 22, 2020. Available at: https://www.sacbee.com/news/california/fires/article245153875.html.

the utility grid network—resulting in reduced GHG emissions, as proven by substantial data from many jurisdictions and particularly in CPUC reports from the Self-Generation Incentive Program. [2]

A 2018 UCI Advanced Power and Energy Program assessment[3] showed that stationary fuel cell systems can achieve greenhouse gas and air quality co-benefits, which is an essential capability for technology choice within the pursuit of environmental quality goals. This assessment resulted in the following conclusions:

- By off-setting emissions from combustion technologies, fuel cell systems are ideally suited to balance intermittent wind and solar power on the grid while maximizing the GHG and air quality co-benefits of renewable energy.
- The use of fuel cell systems yields improvements in both ozone and $PM_{2.5}$ in key areas of California associated with high populations and unhealthy levels of pollution including the South Coast Air Basin, San Francisco Bay Area, and Central Valley.

[2] *SGIP 2016-2017 Self-Generation Incentive Program Impact Evaluation Report.* Submitted by Itron to Pacific Gas & Electric Company and the SGIP Working Group, September 28, 2018. Available at: https://www.cpuc.ca.gov/General.aspx?id=7890

[3] *Air Quality and GHG Emission Impacts of Stationary Fuel Cell Systems,* An Assessment Produced by the Advanced Power and Energy Program at the University of California, Irvine, March 2018, available at: http://www.apep.uci.edu/Research/whitePapers/PDF/AQ_Benefits_Of_Stationary_Fuel_Cells_BenMAP_Final_041718.pdf

2. **Pilot demonstrations of integrated solar, wind, battery & fuel cell microgrid systems for data centers.**

   Microgrids that include solar and/or wind power generation coupled to battery energy storage and fuel cell systems offer opportunities to eliminate polluting diesel backup generation and reliably meet power demands during grid outages and public safety power shutoff (PSPS) events. These integrated renewable microgrids that include fuel cells for reliability and long-duration backup power could not only support data centers but also any application that desired lower emissions and renewable-based power generation with high reliability and resiliency.

3. **Alternative backup power generation designs, e.g., use distributed generators for both primary and backup power generation focused on RD&D in switchgear, controls, and design for reliability.**

   The Commission must recognize that there are options to using diesel generators that will fit most sites; different technologies may be needed at different sites depending upon individual project specifications. Stationary fuel cell systems can provide both continuous power and seamless transition to backup power generation in many circumstances. Lines of research must address the broader need for permanent, local resilience and grid hardening that could be engendered with a different paradigm of local generation that can meet load both under grid-connected and non-grid-connected (islanded) operating conditions. RD&D investments in the switchgear, controls, and design for reliability that could couple the distributed energy resources to the grid and to the loads is needed.

4. Alternative data center designs for distributed generation, e.g., Microsoft idea of "in-rack" generation (by fuel cell, flow battery, …) to eliminate the need for back-up generation.

Previous Commission recommendations to use diesel generators in data centers creates a significant air pollution problem with corresponding negative environmental, health, and safety impacts that are caused by all such diesel generators. The Commission has a responsibility to consider other paradigms and technologies for grid hardening and resilience and is right to conduct transparent due diligence before supporting large-scale polluting generation in the near-term. The NFCRC urges the Commission to not wait until 2022 to address the need for clean generation alternatives, as newly procured diesel generators will be used for the next twenty years or more.

The NFCRC recommends that the Commission consider modernizing the grid and hardening the grid, rather than placing polluting temporary solutions at data centers, critical facilities and substations. Large-scale fuel cell systems could be sited to provide baseload power at substations and then transition to backup power for critical loads whenever needed (e.g., during PSPS events or other grid outages). Ideally, fuel cell systems would be sited in microgrids for customers and communities while also serving this important backup power role for the utility grid network. RD&D investments in distributed fuel cells, flow batteries, or other "in-rack" options for locally producing data center power are needed to address this.

5. Integrated power and cooling for data centers, e.g., high temperature fuel cells with absorption chilling and/or dehumidification.

The integration of combined heat and power ("CHP") can enhance the air quality and GHG benefits of fuel cells by providing an effective and efficient mechanism to reduce emissions from traditional thermal generation methods (e.g., industrial boilers and process heat, commercial space and water heating).

The value of local air quality should be considered for pilot projects from CARB DG-certified technologies to be truly cost-competitive with diesel temporary generation. The comparison of strictly capital costs is erroneous and does not account for other benefits provided by fuel cell systems that operate continuously both behind-the-meter and in front-of-the-meter, including local air quality benefits, which should be of the highest priority right now for public health and safety.

Reductions in pollutant emissions, notably of NO_x, achieves improvements in ground-level ozone and $PM_{2.5}$ in both summer and winter. The economic value of avoided health impacts from air quality improvements is significant and estimated here to be $2,145,950 for a summer day and $1,572,330 for a winter day.

RD&D investments into the integrated use of power generation equipment and heat recovery and conversion equipment are required. Investments into the integration options, designs, and technology for providing combined heat and power, combined cooling and power, and combined dehumidification and power are needed.

6. **Hydrogen ecosystem – renewable hydrogen and oxygen from data centers shared with other uses (e.g., vehicles, forklifts, wastewater treatment, ammonia plant).**

Fuel cell systems avoid adverse local community impacts caused by diesel generators. DER such as fuel cell and electrolysis systems that provide clean, efficient energy conversion produce a wide range of energy, environmental, and economic benefits for many different industries and applications that should receive environmental value because of the significant value they provide to California and its citizens. RD&D is needed into the potential use of hydrogen production and conversion equipment together with reconversion to electricity and use as a fuel in transportation and integrated with the potential for co-production of oxygen and its use in the ecosystem itself, or in adjacent oxygen demand circumstances.

7. **Renewable electrolysis & biogenic hydrogen production demonstrations to engender cost reduction.**

Fuel cell systems are fuel flexible and can operate on biogas, hydrogen, or natural gas, an advantage that offers significant reliability and environmental benefits in comparison to the higher volumetric energy density fuels, such as diesel fuel. Renewable hydrogen can be produced in a multitude of ways including renewable electricity used in electrolysis, renewable heat in thermochemical water splitting, and renewable biomass and biogas conversion via an array of conversion technologies and systems. These systems could produce renewable fuels locally so that backup power systems would not depend upon truck delivery of fuel and the additional transportation associated emissions in connection with diesel fuel delivery required for diesel generators. While on-site production and storage of hydrogen would require more space than diesel fuel on an energy basis, such storage is (1) entirely feasible (when required), (2) required in lesser amounts due to the high efficiency of fuel cell systems, and (3) required in lesser amounts because not all of the fuel must be available on-site (due to the high reliability and resilience of the gas system). RD&D into the production of renewable hydrogen from both renewable electricity, renewable heat, and biogenic pathways is needed to advanced technologies especially aimed at the reduction in capital and operating costs for these technologies.

8. Investigations into reliability and resiliency of pipeline delivery of fuel, e.g., delivery of renewable hydrogen via pipeline to meet data center requirements.

Forty (40) data centers in the U.S. are using Bloom Energy fuel cell systems, including at eBay, AT&T, Equinix, Apple, and JP Morgan.[4] Each component in the Bloom Energy Server architecture is built with native redundancy of the component, which assures 99% uptime.[5] eBay installed six (6) MW of Bloom Energy fuel cell systems to provide primary, onsite, reliable power matched to the operational requirements of the data center and to meet their sustainability requirements. The system provides 100% of electricity demand while drastically reducing carbon footprint with a redundant, modular architecture. This system architecture replaces large and expensive backup diesel generators and UPS components. During a 2015 grid outage, eBay reported that a utility fault dropped the 138,000V utility grid

[4] Available at: https://resources.bloomenergy.com/data-centers
[5] Id.

connection while the fuel cell systems worked flawlessly with no impact to their power supply.[6]

Most backup power demands can be met with stationary fuel cell systems because of the small footprint required for the energy conversion equipment and no need for fuel delivery (when fueled by natural gas). Hydrogen fuel that could be supplied via underground former natural gas pipelines is significantly more reliable than the above-ground electric grid. It may be possible, as a result, that pipeline gas delivery could meet the reliability demands of data centers, hospitals, and other end-uses that require high reliability. If the underground delivery of fuel could be proven sufficiently reliable, then on-site fuel storage could also be eliminated for backup power applications, which would require less space (land) compared to diesel generators and diesel fuel storage. In addition, on-site stored diesel fuel has the potential to leak and contaminate soils and groundwater. If the fuel cell systems are built into the site, then they both offset the grid power (and related GHG and criteria air pollutant emissions) and achieve a seamless transition to backup power during grid outages.

While there may be refueling infrastructure challenges at some locations, hydrogen refueling infrastructure in most cases is no more limited than traditional diesel or propane delivery services and in some cases is more readily accessible during major outages due to demand. Substantial investment has been made in refueling infrastructure in the last ten years. There are multiple companies that provide hydrogen refueling services: fuel cell systems can be refueled directly by

[6] Available at: http://casfcc.org/PDF/Fuel_Cells_For_Resilience_And_Decarbonization_In_California_050120.pdf

hydrogen suppliers such as Air Products,[7] and Air Liquide,[8] or third-party providers like IGX,[9] CAT5 Resources[10] and NDSI.[11] Some fuel cell companies also have their own internal hydrogen refueling service capabilities.

RD&D is needed to investigate the reliability potential of pipeline delivery of gaseous fuel in underground pipe networks and into the ability of the current natural gas system to be transformed into one that transmits, distributes, stores and delivers renewable gases of all types, including biogases and renewable hydrogen.

9. Reversible solid oxide cells plus solar/wind power using the natural gas grid for long-term storage.

Solid oxide fuel cells and electrolyzers are fuel flexible and are potentially able to operate in fuel cell mode on hydrogen, biogas, methane, natural gas, propane, ammonia, and other hydrocarbon fuels. In electrolysis mode solid oxide cells are able to accomplish co-electrolysis of captured carbon dioxide and water to produce a synthesis gas which is the feedstock required for the production of a multitude of renewable liquid synthetic fuels (e.g., methanol ,DMM, DME). In addition, reversible solid oxide cells could be integrated into the current natural gas system to produce renewable hydrogen that is injected into the natural gas system as hydrogen partially decarbonizing all of the end-uses it was delivered to. This could be done whenever renewable electricity is abundant. Whenever renewable electricity was not abundant, the reversible solid oxide

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[7] https://www.airproducts.com/gases/hydrogen
[8] https://www.airliquide.com/science-new-energies/hydrogen-energy
[9] http://igxgroup.com/products/h2-power/h2-fueling-services/
[10] https://www.cat5resources.com/services/emergency-fuel-delivery/
[11] http://mlipower.com/

cell could operate directly upon the mixture of hydrogen and natural gas that was available at that moment to make electricity.

IV. Conclusion

The NFCRC thanks the Commission for the opportunity to offer comments on policy and approaches to minimize emissions from temporary generation. The best way to address PSPS events and grid outages while improving air quality in California is to replace diesel generators with existing alternatives and to fund fuel cell and hydrogen research topics that can create near-term impact. RD&D into all of these topics is of significant importance for introducing more renewable electricity into the CA electric grid and for beginning the decarbonization of the gas system.

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Respectfully submitted,

/s/ 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