Comment Letter #22

National Fuel Cell Research Center Comments
South Coast AQMD Stationary and Mobile Source Control Measures
Draft 2022 Air Quality Management Plan
June 13, 2022

The National Fuel Cell Research Center (NFCRC) appreciates the opportunity to recommend that the South Coast Air Quality Management Plan (AQMP) should include fuel cell systems as preferred resources for electric generation in the AQMP for immediate reductions of NOx and other criteria air pollutant emissions.

I. INTRODUCTION

The NFCRC (1) facilitates and accelerates the development and deployment of fuel cell technology and systems; (2) promotes strategic alliances to address the market challenges associated with the installation and integration of fuel cell systems; and (3) 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 to develop advanced sources of power generation, transportation, and fuels and has overseen and reviewed thousands of commercial fuel cell applications.

These comments will address the following control measures:

- **L-CMB-03: NOx Reductions from Permitted Non-Emergency Internal Combustion Engines [NOx]**
- **L-CMB-04: Emission Reductions from Emergency Standby Engines [NOx, VOCs]**
- **L-CMB-05: NOx Emission Reductions from Large Turbines [NOx]**
- **L-CMB-06: NOx Emission Reductions from Electricity Generating Facilities**

II. COMMENTS

A. L-CMB-03: NOx Reductions from Permitted Non-Emergency Internal Combustion Engines [NOx]

The NFCRC recommends the inclusion of zero and near-zero emission fuel cell systems to replace non-emergency internal combustion engines as a Control Method in L-CMB-03.

Fuel cell systems that can run on stored hydrogen—scalable to the required runtime—and have been commercially deployed since the early 2000s. There are more than 5,000 telecommunication and cable network facility locations using fuel cell systems for backup power in North America, hundreds of which are in California serving power requirements ranging from under 200 Watts to over 10kW in urban, rural, and remote

settings. Other fuel cell systems that are used for cellular tower backup power can run on a mixture of methanol/water fuel, which can reduce total system footprint for extended runtime (beyond 72 hours). Higher power fuel cell systems (200 kW and larger) that use biogas, hydrogen or natural gas for both continuous and backup power are also being used today by telecommunications providers such as AT&T,[1] Cox,[2] and Verizon.[3] These systems are grid-connected and seamlessly take over the load during a grid outage. These systems have operated for weeks at a time during extended outages in the Northeast and continue to operate as long as fuel is reliably delivered in underground pipeline infrastructure or is locally available in storage.

Plug Power hydrogen PEM fuel cell systems are designed to start in the same amount of time as the diesel generators that they are currently replacing.[4] Forty (40) data centers in the U.S. are using Bloom Energy fuel cell systems instead of diesel generators, including those at eBay, AT&T, Equinix, Apple, and JP Morgan.[5] Each component in the Bloom Energy Server architecture is built with native redundancy of the component, which assures 99% uptime.[6]

Plug Power has over 90 installations using stored liquid hydrogen for material handling customers that consume over 24 tons of hydrogen daily. This same type of hydrogen distribution and storage system will be used in future data center primary and backup power applications. Further, while the actual footprint of the diesel engines alone may be smaller than the footprint of the equivalent power of fuel cell systems, additional space is required for diesel fuel storage. Even if the diesel fuel is stored underground, nothing can be stored or built above the underground diesel tanks, necessitating additional footprint.

B. L-CMB-04: Emission Reductions from Emergency Standby Engines [NOx, VOCs]

The NFCRC supports the use of zero and near-zero emission fuel cell systems as a Control Method in L-CMB-04 to replace emergency standby engines and immediately reduce NOx and VOCs.

DIESEL GENERATOR REPLACEMENT

Stationary fuel cell systems offer a means to improve resiliency by not only providing continuous local clean power and thermal energy, but also to seamlessly transition to islanding operation to serve dedicated loads. This resilient operation replaces both diesel backup generators as well as other dirtier 24-7-365 power generation technologies on the grid with the same installation. This type of resilient fuel cell operation has occurred

[1] AT&T Progress Toward our 2020/2025 Goals, at 4. Available at: https://about.att.com/content/dam/csr/sustainability-reporting/PDF/2017/ATT-Goals.pdf
[2] Doosan Fuel Cell America Project Profile: Cox Communications. Available at: http://www.doosanfuelcellamerica.com/en/news-resources/project-profiles/
[3] GreenTech Media, Verizon's $100M Fuel Cell and Solar Power Play, April 30, 2013. Available at: https://www.greentechmedia.com/articles/read/verizons-100m-fuel-cell-and-solar-power-play
[4] Available at: GenSure Hydrogen Fuel Cell Backup Power - Plug Power
[5] Available at: https://resources.bloomenergy.com/data-centers
[6] Id.

through wildfires, hurricanes, super storms, earthquakes, and other grid outage events in California, the Northeast, and around the world.

Commercial fuel cell systems are available on the market and have been deployed to replace diesel generators for utility backup power, government communication networks, and telecommunications applications that scale from below 1kW to multi-MW capacities for nearly two decades.

ACHIEVING NOX EMISSIONS REDUCTIONS WITH FUEL CELL SYSTEMS

- The combination of high efficiency and extremely high-capacity factor results in the displacement of more GHG emissions than equivalent nameplate-sized intermittent renewable resources. Note that the most significant previous NOx, other criteria air pollutant and greenhouse gas (GHG) emissions reductions achieved in the California Self-Generation Incentive Program were made by fuel cells operating on natural gas.[7]
- Fuel cells are an integral part of a resilient, always-on energy system and are capable of islanding to serve critical loads in the event of a grid outage, eliminating the need for backup diesel generators and their emissions.
- Unlike combustion technologies that are only efficient at very large scale, stationary fuel cell systems are an efficient scalable resource with global project sizes ranging from under 1 kW to 78 MW[8]. As a result, fuel cells improve overall system efficiency at any size, behind-the-meter and in-front-of-the-meter.
- Unlike combustion technologies, fuel cells electrochemically convert fuel so that there is no opportunity to produce and emit criteria air pollutants.
- Fuel cell systems are fuel flexible, operating today on biogas, hydrogen and natural gas, so that they do not represent a long-term commitment to fossil fuels and will facilitate a seamless transition to renewable fuels.

A 2018 UC Irvine Advanced Power and Energy Program assessment[9] showed that stationary fuel cell systems can achieve air quality and GHG co-benefits. 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 air quality and GHG co-benefits of renewable energy.

[7] *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

[8] H2 View, George Heynes, "*New 78.96 MW hydrogen fuel cell power plant opens in South Korea,"* November 3, 2021. Available at: New 78.96MW hydrogen fuel cell power plant opens in South Korea (h2-view.com)

[9] *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

- The use of fuel cell systems yields improvements in both ozone and $PM_{2.5}$ concentrations 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 San Joaquin Valley.
- 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).
- Reductions in pollutant emissions, notably of NOx, 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.

C. L-CMB-05: NOx Emission Reductions from Large Turbines [NOx]

The NFCRC supports the use of zero and near-zero emission fuel cell systems to replace large turbines as a non-combustion Control Method for L-CMB-05.

Benefits of fuel cell systems include the provision of 24/7, clean, firm, load-following power at close to 100% capacity factors. Importantly, this high capacity factor corresponds to the production of clean, renewable electric energy (MWh) per unit of power capacity (MW) that is on the order of five (5) times that of solar power systems (assuming a 20% capacity factor for solar) and on the order of three (3) times that of wind power systems (assuming a capacity factor of 30% for wind). Thus, investments in fuel cell capacity produce vastly more renewable energy compared to wind or solar power systems per unit of capacity installed. This translates into substantially more GHG reductions per MW installed. Unlike investments in solar and wind power systems, installations of fuel cell systems can be used by the utility to (1) support local capacity and spinning reserve requirements that are used for grid reliability, and (2) serve as an alternative to costly utility system transmission and distribution upgrades. In addition, the energy density of fuel cell systems significantly reduces the land footprint required for onsite generation. Typically, only one acre is required for one MW of generation, allowing for operation of clean power generation in high density areas and increased acreage available for habitat restoration and preservation in dense urban environments.

D. L-CMB-06: NOx Emission Reductions from Electricity Generating Facilities

The NFCRC support the use of zero and near-zero emission fuel cell systems to supplement or offset electricity generating facilities as a Control Method for L-CMB-06.

The AQMP must include the use of load-following, non-combustion fuel cell systems for general grid support and to increase reliability and resiliency. Utility-scale procurements

of fuel cell systems can provide unique co-benefits. Fuel cell systems are deployed today on the utility-side of the meter to create grid support solutions where transmission or distribution infrastructure or clean, 24/7, load-following power generation to complement the increasing deployment of intermittent solar and wind resources, and to support grid reliability in locations where it is most needed – including disadvantaged communities. The size of these utility-side-of-the-meter fuel cell installations range from 3 MW to 78 MW.

Fuel cell systems support the utility grid network and can also provide ancillary services such as:

1. Peak demand reduction;
2. Power quality;
3. Grid frequency and voltage support;
4. Capacity and spinning reserve;
5. Avoidance of expensive transmission and distribution system upgrades; and
6. Fast ramping and load-following.

The installation and operation of fuel cell systems in a highly dynamic utility grid network environment: 1) directly complements intermittent renewable power generation, 2) improves the reliability and stability of a grid utilizing a high penetration of renewable power generation, and 3) causes no challenging need for increasing storage or other grid infrastructure.

With a substantial deployment of intermittent and diurnal varying renewables with relatively low capacity factor power generation, California is experiencing challenging grid reliability issues and capacity shortfalls in power generation. In the November 2 CARB 2022 Scoping Plan Electricity Sector Technical Workshop presentation for the California Public Utilities Commission (CPUC), Edward Randolph emphasized the need for clean, firm resources to fully decarbonize the grid. While battery energy storage is necessary, the inclusion of clean, 24/7 load-following generation is also required for a successful conversion to 100% clean energy.[10] Fuel cells and hydrogen are perfectly suited to serve these roles and are the most cost-effective means for storing massive amounts of electricity for long durations due to separate power and energy scaling. The use of short-duration energy storage technologies (mostly lithium-ion battery systems) to-date has resulted in increased emissions on the California grid.[11, 12] Some of these emissions increases can be eliminated with better rate design and enforcement, which should be pursued. Nonetheless, reversible fuel cells or fuel cells and electrolyzers coupled with hydrogen storage should also be considered, especially for large magnitude and long duration energy storage because they can also serve as controllable loads that correspondingly help the grid manage instances of overproduction from renewable

[10] Davis, *et. al., Net-Zero Emissions Energy Systems,* Science **360**, 1419 (2018) 29 June 2018
[11] Id.
[12] MQRI– California ISO, Greenhouse Gas Emission Tracking Report, February, 2018. Available on-line at: https://www.caiso.com/Documents/GreenhouseGasEmissions-TrackingReport-Feb2018.pdf

resources to produce a renewable hydrogen fuel for energy storage and later electricity production or for electrification of transportation via fuel cell electric vehicles.

LAND USE

As an example of the decreased land use that can be achieved using fuel cell systems for electric generation, Doosan has installed 30.8 MW of fuel cells for district heating and electricity for 71,500 homes in the City of Busan, Korea. This system can also operate when the grid goes down and is configured in a tiered structure and sited on only one acre of land; an equivalent 30 MW solar farm could require more than 75 acres and would produce as little as 1/6th the amount of electric energy and zero heat. In the event of a grid outage, the Doosan fuel cell system is capable of an immediate transition to full grid independent power.[13]

Another example is a 59 MW FuelCell Energy power plant located at Gyeonggi Green Energy south of Seoul, Korea. This system produces 440 million kilowatt-hours of electricity per year and supplies district heating, all on just 5.2 acres of land.

III. CONCLUSION

The NFCRC greatly appreciates the opportunity to comment on the draft AQMP and encourages the SCAQMD to consider including fuel cell systems in multiple control measures. Fuel cell systems around the world are providing backup and prime power behind the meter, replacing emergency standby engines and large turbines, and in-front-of-the-meter generating electricity at utility scale.

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[13] Available at: electric-load-following-capability-of-the-purecell-model-400_en.pdf (doosanfuelcellamerica.com)