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NFCRC Comments on the 2017 Draft Integrated Policy Report

Attached are the comments of the National Fuel Cell Research Center (NFCRC), submitted on the Draft Integrated Energy Policy Report Docket #17-IEPR-01.

Additional submitted attachment is included below.

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California Energy Commission
MS Dockets Office, MS-4
Re: Docket No. 17-IEPR-01
1516 Ninth Street
Sacramento, CA 95814-5512

Re: 2017 Draft Integrated Energy Policy Report

The National Fuel Cell Research Center (NFCRC) submits these comments to the Draft Integrated Energy Policy Report Docket #17-IEPR-01 of the California Energy Commission (CEC) Integrated Energy Policy Report (IEPR) to affirm and emphasize the importance of recognizing firm power and GHG-reducing fuel cells as critical to complement and manage the high penetration of intermittent solar and wind, cornerstones in achieving the California 40% GHG emissions reduction goal by 2030.

I. Introduction

California requires an optimal portfolio of clean energy resources to enable the utilization of an increasingly high penetration of renewables. In addition to compelling environmental attributes, fuel cells have the highly dynamic dispatch capabilities needed to (1) manage the diurnal variation, constrained capacity factor, and intermittencies associated with solar and wind power generators, and (2) increase the maximum penetration of renewable resources that can be accommodated in the utility grid network.

Fuel cells are considered the cleanest, most efficient distributed energy resource (DER) for utility procurement and firm power. Power generation produced through natural gas combined cycle (NGCC) combustion turbine power plants today meets the majority of electricity demand in California, but with (1) the emission of criteria pollutants (e.g., NOx), and (2) efficiencies limited by heat engine constraints. When using natural gas, fuel cells reduce GHG,[1] generate virtually zero criteria pollutant emissions, and operate with high efficiency. Fuel cells also operate in a virtual water balance. To illustrate, the use of a 400kW fuel cell system to generate combined heat and power for a building can save over one million gallons of water annually,

[1] *Final Report: SGIP 2014-2015 Impacts Evaluation Report.* Submitted by Itron to SoCalGas and the SGIP Working Group, September 29, 2016. http://www.cpuc.ca.gov/sgip/

compared to the water required to generate the same amount of electricity at a central power plant. When operated on biogas or renewable hydrogen, fuel cell systems produce dispatchable power with zero greenhouse gas and zero criteria pollutant emissions.

II. Comments

A. Chapter 3: Increasing the Resiliency of the Energy Sector

The NFCRC supports the recommendations outlined in "*Hydrogen Production From Electrolysis of Water:"*

> *One pathway for preserving the value of excess renewable electricity is to use it in the electrolysis of water. This involves the use of electricity to split water molecules into hydrogen and oxygen gases. The hydrogen can be stored more cheaply than electricity in a battery and can be used on demand in fuel cells. These fuel cells convert the hydrogen back into electricity, whether for stationary applications or to power fuel cell electric vehicles.*[2]

While biogas and biomass provide short-term resources of renewable hydrogen, in the long-term, renewable hydrogen is projected to be sourced by capturing otherwise curtailed solar and wind power and, through electrolysis, generate renewable hydrogen. The natural gas distribution system is immediately available as a resource to store and distribute this "Power-to-Gas (P2G)" supply of renewable hydrogen. At some point, dedicated hydrogen pipelines are likely to serve as the storage and distribution resource. P2G supports the ubiquitous exportability of stationary fuel cell generation across a spectrum of applications associated with a zero-carbon grid.

The NFCRC would like to request a correction in the same *"Hydrogen Production From Electrolysis of Water"* section. On page 115 of the IEPR, the quote from PR Newswire "*At UC Irvine, the portion of renewable energy used in the campus microgrid increased from 3.5 percent to 35 percent by implementing a power-to-gas strategy"* should read *"At UC Irvine, the portion of renewable energy used in the campus microgrid* ***could increase*** *from 3.5 percent to 35 percent by implementing a power-to-gas strategy.*[3]

The IEPR further acknowledges that curtailed renewable generation can serve as another source of renewable hydrogen in the section "*Use excess renewable electricity productively*."

> *California is likely to have significant and increasing amounts of renewable electricity. Along with development of increasing amounts of regional markets, flexible resources, storage, controlled and/or bidirectional charging, California should continue to explore means to exploit this excess electricity by desalination*

[2] *Draft Integrated Energy Policy Report,* California Energy Commission, October 13, 2017, at 115.
[3] *Id., at 115.*

> *and/or conversion to hydrogen either to fuel stationary or mobile fuel cells or storage power.*[4]

As the dynamic operation and management of the grid increases, the deployment of fuel cell systems throughout the state will be required to directly complement the high use of intermittent renewable power generation by providing increasingly valuable ancillary services such as ramping, capacity, voltage and frequency support, and the required reliability and stability.[5,6] These attributes of stationary fuel cell technology serve as a primary example of exportability, and rate structures are needed to compensate this clean, load-following resource.

B. Chapter 4: Accelerating the Use of Distributed Energy Resources on the California Grid"

Chapter 4 should include references to fuel cell systems as DER with the unique attributes needed for clean, firm power on the increasingly renewable grid. As yet another example of exportability, large-scale fuel cell systems are deployed today on the utility side of the meter to create grid support solutions where transmission is constrained or increased reliability is sought. Referred to as "Transmission Integrated Grid Energy Resource" or "TIGER" stations, these DER are providing clean, 24/7, load-following power generation to complement the increasing deployment of intermittent solar and wind resources and support low emission grid reliability in locations where it is most needed – including disadvantaged communities. Examples range from a 15MW system in Connecticut, to a 30MW system in Delaware, to a 59MW system in Seoul, Korea.

C. Chapter 9: Renewable Gas

While there are references to renewable gas and hydrogen in fuel cells in Chapter 9, the IEPR should further clarify three unique benefits to the State from further deployment of fuel cells using either resource. When used in fuel cells, renewable gas and hydrogen simultaneously addresses the mitigation of CO_2, criteria air pollutants, and short-lived climate pollutants – co-benefits which are all direct or indirect goals of integrated energy and resource planning in California. In addition, the energy density of fuel cell DER significantly reduces the land footprint required for renewable, onsite generation, allowing for deployment in high density areas and increased acreage available for habitat restoration and preservation.

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[4] *Id.* at 121.

[5] Maton, Jean-Paul, Zhao, Li, and Brouwer, Jacob, *Dynamic modeling of compressed gas energy storage to complement renewable wind power intermittency*, International Journal of Hydrogen Energy, Volume 38, pp. 7867-7880, 2013.

[6] Shaffer, Brendan, Tarroja, Brian, Samuelsen, Scott, *Dispatch of fuel cells as Transmission Integrated Grid Energy Resources to support renewables and reduce emissions*, Applied Energy, Volume 148, 15 June 2015, Pages 178-186.

CO_2 reduction: The high fuel-to-electrical efficiency of fuel cell DER significantly reduces the carbon emitted per megawatt-hour, and fuel cells have the capability to capture, concentrate, and store the resulting CO_2 that is generated. The unusually high operating temperatures of fuel cells enable the cogeneration of heat, steam, or chilled water, thereby displacing conventional carbon emitting sources such as grid electricity, natural gas boilers, and natural gas furnaces.

Criteria pollutants: Fuel cells have the distinct attribute of emitting virtually zero criteria pollutants.

Short-lived climate pollutants: Fuel cell systems are an ideal resource to mitigate emissions because fuel cells:

- Generate electricity and heat from methane sources otherwise vulnerable to seepage such as landfills, water resource recovery facilities, refineries and dairies.
- Capture and use exhaust heat to produce chilled water, thereby displacing traditional chlorofluorocarbons (CFC)-based systems and the associated leakage.

Renewable Natural Gas and Biogas

Fuel cell DER are operating today on biogas, further contributing to the management of carbon and therefore represent an immediate benefit that may be further expanded as the market for biogas evolves to make cost-effective and accessible renewable biogas supplies widely available.

The "*On-Site or Grid Connected Electricity Generation*" section should also more clearly identify the broad advantages of non-combustion fuel cells over traditional combustion technologies. When operated on biogas, fuel cells generate electricity and heat (and bio hydrogen if appropriately configured) with zero net carbon emissions and negligible air pollutants. Today over 30% of the power generated by fuel cells in California is produced from biogas.

The NFCRC supports the IEPR initiative to increase the utilization, and thus availability, of renewable natural gas from biogas. One of the major attributes of fuel cells is the capability to operate on biogas (sourced from water resource recovery facilities, landfills, food processing plants, confined animal feeding operations, and other sites processing organic waste via anaerobic digestion), renewable natural gas, or mixtures of both. We urge the Commission to recommend policies that allow for diverse end uses of renewable gas, including electricity generation through both onsite as well as pipeline-directed gas supply, rather than recommending that policies strictly encourage renewable gas use in the transportation sector. Diversifying end uses of renewable gas will ensure that projects to develop gas supply are financeable and robust in the face of market uncertainties, and fuel cells are poised to provide an efficient and environmentally friendly long-term market for renewable gas use.

An important component to a sustainable future is the availability of biogas, and the infrastructure to utilize the biogas in the State of California. A recent report from the

California Energy Commission has mapped the biogas resources in the state and the pathways for the utilization of the biogas[7] and its many associated co-benefits. Fuel cells represent a key clean technology for the utilization of the biogas and the production of renewable electricity and heat, and (as appropriate) the generation of bio-hydrogen. New research and development initiatives, focused on the development of biogas resources and infrastructure, should be implemented and should continue to be a focus for renewable onsite electricity generation.

<u>Renewable Hydrogen</u>
As renewable hydrogen evolves in the future as the principal strategy to capture and store energy that would otherwise be curtailed, fuel cell resources will operate directly on renewable hydrogen to complement and manage the intermittency of solar and wind.

To this end, the NFCRC recommends edits to the following section of "*On-Site or Grid Connected Electricity Generation:*"

> *Fuel cells are another more electrically efficient alternative to gas combustion electricity generation technologies, producing zero air emissions and having a quick start-up. Fuel cells can be more capital cost-intensive, though, and are less tolerant to biogas contaminants, requiring higher quality gas cleaning. Nevertheless, CARB-certified distributed generation technologies, such as microturbines or fuel cells, can significantly reduce NOx emissions compared to internal combustion-based power generation.*[8]

It is important that this section include methods to address the current challenge of the high cost of renewable hydrogen, which is particularly important for reducing the cost of hydrogen produced from renewable electrolysis. Strategies to significantly increase demand and thereby reduce costs via economies of scale should be pursued in California. These will likely require non-traditional ideas beyond a focus on increasing light duty Fuel Cell Electric Vehicle demand, to also investigating and supporting the use of hydrogen as a fuel for heavy duty trucking, port operations, shipping, and rail applications. Additionally, the CEC should consider encouraging the use of renewable hydrogen in various industrial applications such as (1) petroleum refineries to meet a portion of their current demand (hydrogen is widely used by refineries to produce petroleum distillate fuels), and (2) industrial end-uses of hydrogen, such as metal sintering, annealing, and welding, powering life-support systems and computers in space environments, and the production of plastics and pharmaceuticals.

California would also benefit from a stronger IEPR support statement in the *"Renewable Hydrogen"* section concerning the opportunities provided by tri-generation:

> *Renewable hydrogen can also be produced from biomethane and biogas. The Orange County Sanitation District, for example, operates a facility that can use biogas from a wastewater treatment plant to simultaneously produce electricity, heat, and hydrogen.*

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[7] *Air Quality and Greenhouse Gas Emissions Impact Assessment from Biomass and Biogas Derived Transportation Fuels and Electricity and Heat Generation, California Energy Commission*, CEC-500-2016-022, March, 2015.
[8] *Draft Integrated Energy Policy Report,* California Energy Commission, October 13, 2017, at 273.

In this system, treated biogas from an anaerobic digester is run through a high-temperature fuel cell, which produces the hydrogen. [9]

This technology is based on a high-temperature fuel cell that internally reforms biogas (or natural gas) into hydrogen to support the generation of electricity at the stack. By injecting more fuel, excess hydrogen is produced that can then be extracted as a transportation fuel, or other use. Due to the synergies captured by the process, tri-generation systems provide economical, technical, and environmental benefits that should be referenced in the draft IEPR. For example, tri-generation can produce distributed hydrogen with a lower carbon signature, and at costs below that of current methods (i.e., large-scale natural gas steam methane reformation).[10,11] When operated on biogas, tri-generation results in the production of renewable bio-hydrogen, directly supporting the growing California hydrogen fueling network with renewable hydrogen.

III. Conclusion

Distributed Resource Planning allows for GHG-reducing fuel cells to be included in bidding for all utility-scale procurements. Fuel cells provide unique co-benefits that should also be embraced in the IEPR as DER. The ability of fuel cells to provide constant, high quality reliable power has increasing importance beyond environmental quality, an example of which is the reliance on electronics by essential industries such as banking, communications, manufacturing, and telecommuting. There are additional concerns that the vulnerability of an aging electrical grid in many locations could result in increasing susceptibility to outages. Because grid outages result in significant costs and other detriments, the ability of fuel cells to quietly operate as a building's primary source of power in concert with the grid and to continue operating independent of the grid is particularly beneficial to consumers who must have constant availability of high quality power to maintain critical operations. Examples include data centers, banks, hospitals, grocery stores, first responders, and government agencies. Fuel cells have successfully demonstrated this capability during recent regional grid outages (e.g., September 2011 San Diego County) and major natural disasters (e.g., Superstorm Sandy and Hurricane Irene) by sustaining power to essential telecommunication technologies, grocery stores, and storm shelters.[12]

The Distributed Generation (DG) model has the potential to introduce new sources of pollutant emissions into urban airsheds with large populations, thereby raising concerns for human health in areas of California that include the South Coast Air Basin (SoCAB), and San Joaquin Valley,[13] both of which currently suffer from degraded air quality and face major challenges in achieving clean air for the citizens that live and work within their boundaries. This is particularly true for

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[9] *Draft Integrated Energy Policy Report,* California Energy Commission, October 13, 2017, at 276

[10] Leal and Brouwer, ASME Journal of Fuel Cell Science and Technology, Vol 3, pp. 137- 143, 2006.

[11] Margalef, Brown, Brouwer, and Samuelsen, Journal of Power Sources, Vol 196, pp. 2055- 2060, 2011.

[12] 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.

[13] Carreras-Sospedra, M., et al., *Central power generation versus distributed generation-An air quality assessment in the South Coast Air Basin of California*. Atmospheric Environment.

economically disadvantaged communities that are often disproportionately burdened by air pollution. Therefore, the unique combination of attributes that fuel cells provide (firm, clean, reliable, and efficient power) for many different industries and applications afford, as well, a wide range of environmental, health and economic benefits that have significant value to the State. Further development of renewable gas and hydrogen resources is critical to the full realization of these benefits.

As the grid evolves, California will not reach a 100% renewable goal without a technology that provides clean, firm, renewable, and load-following power. While electric battery technology will be valuable, P2G and hydrogen storage technology will be the anchor required to capture, store, and utilize the vast majority of otherwise curtailed renewable resources. Fuel cells are the one technology that has evolved to (1) utilize renewable hydrogen, (2) provide the clean, 24/7 load-following capability required to manage and buffer the dynamics of solar and wind, and (3) achieve the combined goals of both zero criteria pollutant and greenhouse gas emissions. In the preceding comments, the NFCRC has expressed in more detail, both support and further recommendations for policy that encourages this logical grid evolution.

Respectfully submitted,

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