Appendix B:

STAFF REPORT: INITIAL STATEMENT OF REASONS

PROPOSED FUEL CELL NET ENERGY METERING GREENHOUSE GAS EMISSION STANDARDS REGULATION

Public Process for Development of the Proposed Regulation

State of California

AIR RESOURCES BOARD

Release Date: October 22, 2019

This appendix includes materials from three public workshops and a working group meeting held by California Air Resources Board (CARB) staff to inform the development of the Fuel Cell Net Energy Metering (NEM) Greenhouse Gas Emissions Regulation. The public notice, presentation slides, and any supporting materials for each workshop and working group meeting are provided here, and this appendix includes comment letters received by CARB in response to each workshop and working group meeting. All workshop and working group meeting information and materials are also posted on CARB's Fuel Cell NEM Program Public Meetings webpage (https://ww2.arb.ca.gov/our-work/programs/stationary-fuel-cell-net-energy-metering/meetings-workshops).

Table of Contents

Workshops Related to Fuel Cell Net Energy Metering Greenhouse Gas Emission Standards Regulation:

May 30, 2017: Workshop to Discuss Proposed Fuel Cell Net Energy Metering Greenhouse Gas Emission Standards Methodology
- Public Notice
- Staff Presentation
- Public Comments

November 28, 2017: Workshop to Discuss Proposed Fuel Cell Net Energy Metering Greenhouse Gas Emission Standards Using the California Public Utilities Commission's 2017 Avoided Cost Calculator (ACC)
- Public Notice
- Staff Presentation
- Draft Regulation Order
- Public Comments

February 13, 2018: Working Group Meeting to Discuss 2017 ACC
- Public Notice
- Calculating GHG Emission Standards
- Revised Draft Regulation
- Public Comments

July 8, 2019: Workshop to Discuss Proposed Fuel Cell Net Energy Metering Greenhouse Gas Emission Standards Methodology
- Public Notice
- Staff Presentation
- Discussion Draft
- Public Comments

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Matthew Rodriquez
Secretary for
Environmental Protection

Edmund G. Brown Jr.
Governor

May 12, 2017

TO: All Interested Parties

SUBJECT: NOTICE OF PUBLIC WORKSHOP TO DISCUSS GREENHOUSE GAS EMISSION REGULATORY OPTIONS FOR THE FUEL CELL NET ENERGY METERING PROGRAM ADMINSITERED BY THE CALIFORNIA PUBLIC UTILITIES COMMISSION

Air Resources Board (ARB/Board) staff invites you to participate in a public workshop to discuss options to establish greenhouse gas (GHG) emission reduction standards for fuel cell "customer-generators" participating in the California Public Utilities Commission's (CPUC) Fuel Cell Net Energy Metering (NEM) Program. ARB will be developing a regulation to establish GHG emission reduction standards for the program and to meet its responsibilities under Assembly Bill 1637 (Low, Stats. 2016, ch. 658).

AB 1637 directs ARB to establish a schedule of annual GHG emission reduction standards for the Fuel Cell NEM program in consultation with the California Energy Commission (CEC). ARB is further directed to update the schedule of standards every three years.

The emission reduction standards are to ensure that participating fuel cell resources reduce GHG emissions relative to the displaced electrical grid resources, including any renewable resources, and account for both procurement and operation of the electrical grid. Staff will use the information gathered at this workshop and throughout the rulemaking process to develop a proposed regulation and supporting rulemaking documents.

The public workshop will be held at the time and location shown below:

Date:	May 30, 2017
Time:	1:30 PM
Location:	Sierra Hearing Room Cal/EPA Building 1001 I Street, 2nd Floor Sierra Hearing Room Sacramento, CA 95814
Directions:	http://www.calepa.ca.gov/EPABldg/location.htm

Website and Meeting Materials

The workshop will be webcast for those unable to attend in person. The broadcast can be accessed on the day of the workshop at: http://www.calepa.ca.gov/broadcast/. During the workshop, the webcast audience may submit questions and comments using the following e-mail address: sierrarm@calepa.ca.gov.

An agenda and other materials for the workshop will be posted on ARB's Fuel Cell Net Energy Metering, Greenhouse Gas Emission Standard webpage, at https://www.arb.ca.gov/energy/nem/nem.htm, prior to the workshop.

If you require special accommodation for the workshop or need this document in an alternate format (e.g. Braille, large print) or another language, please contact Gary Collord, Air Pollution Specialist, at (916) 324-5548 or via e-mail at gary.collord@arb.ca.gov as soon as possible, but no later than 5 business days before the workshop. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

We welcome and appreciate your participation in this public workshop. If you have any questions regarding this workshop or the draft regulation, please contact Gary Collord, Air Pollution Specialist, at (916) 324-5548, or by e-mail at gcollord@arb.ca.gov.

Sincerely,

/s/

Wes Ingram, Chief
Project Assessment Branch

cc: Dave Mehl, Manager
Energy Section

Gary Collord
Air Pollution Specialist
Energy Section

Fuel Cell Net Energy Metering GHG Emission Standards

May 30, 2017

Governing Legislation

Assembly Bill 1637 (Low, 2016):

- Effective January 1, 2017
- Extends the CPUC's Fuel Cell Net Energy Metering (NEM) program tariff through 2021
- Increases individual system eligibility to 5 MW, and extends overall program cap to 500 MW over existing installed capacity
- Directs ARB to establish annual GHG emission reduction standards for "customer-generators" participating in Fuel Cell NEM program
- GHG standards are to reduce emissions relative to grid resources, including renewable resources, and account for both procurement and electrical grid operation

Fuel Cell NEM Background

- Program designed to continue market growth for on-site fuel cell electrical generation
- Oversight by CPUC with IOU program administration
- Customer-generators receive generation rate credits and avoid "nonbypassable" utility charges for onsite energy consumption
- Incentives amount to approximately $200k/MW of installed capacity
- Historical annual growth of about 8 MW of installed capacity (total of 97 MW to date)

Fuel Cell NEM Background Cont'd

- Eligible fuel cell technologies must reduce GHG emissions and meet ARB's Distributed Generation (DG) Certification Program requirements for criteria pollutants
- Program works in tandem with CPUC's SGIP, which provides financial incentives for various DG technologies
- Prior legislative directive to use the GHG standard developed for the SGIP for the Fuel Cell NEM (350 kg CO2/MWh)

Key Considerations

- Marginal energy resource mix and displacement assumptions
- Role of renewable resources in the resource mix
- Line Losses
- Grid response to small load changes
- Utility procurement considerations and RPS program progress
- Interpretation of "emission reduction versus grid resources"

Potential Bases of GHG Standard

Method	Basis	kg CO2e/MWh
1	Displacement of combined-cycle gas turbine (CCGT) power plants (Marginal grid resource)	*400*
2	Displacement of CCGT generation with a 25% renewable energy adjustment (RPS target of 25% by January 1, 2017)	*300*

Recommended Test Procedures

- Staff is proposing to include advisory test methods and testing parameters for carbon dioxide, methane, and nitrous oxide in the regulation:
  - Carbon Dioxide: ARB Test Method 100
  - Methane: US EPA Method 3C
  - Nitrous Oxide: ARB Test Method MLD 136

Regulation Development Schedule

Ongoing	Discussions with CEC and CPUC staff
Spring 2017	Conduct public workshops
Fall 2017	Start of formal 45-day public review period for proposed regulation
Winter 2017	ARB Board Meeting

Contact Information

Gary Collord
Energy Section
(916) 324-5548
gary.collord@arb.ca.gov

Dave Mehl, Manager
Energy Section
(916) 323-1491
dave.mehl@arb.ca.gov

RE: Comments on Fuel Cell Net Energy Metering May 30, 2017 Public Workshop

Capstone Turbine Corporation appreciates the opportunity to provide these comments regarding the California Air Resources Board's ("ARB") Public Workshop on May 30, 2017 to discuss emission standards for criteria pollutants and annual greenhouse gas (GHG) emissions that will be used to determine system eligibility for the Fuel Cell Net Energy Metering program as amended by AB 1637 last year. Capstone Turbine Corporation is the world's leading producer of low-emission microturbine systems headquartered and manufactured in Chatsworth and Van Nuys, California. A Capstone microturbine is an advanced technology, small combustion turbine used to generate electricity at the location of the end-use customer. Capstone microturbines are used throughout the world in commercial, institutional and industrial applications. Customers use our systems to save money through more efficient energy usage.

These comments should be considered in light of Assembly Bill 36 (Nazarian), which is currently moving through the legislative process. AB 36 would make the Fuel Cell NEM program technology neutral, allowing any technology that meets the GHG and criteria pollutant emissions standards to participate in the program. In particular, any test methods selected should be inclusive of any potentially eligible technology.

Test Methods

Staff proposed using ARB Test Method 100 for Carbon Dioxide, US EPA Method 3C for Methane, and ARB Test Method MLD 136 for Nitrous Oxide. It is not clear why these methods were selected over the test methods that are already established for stationary power generation equipment, such as Federal Regulation Title 40, Chapter I, Subchapter C, Part 60 and South Coast Air Quality Management District methods.

For testing CO_2, it is not clear why this method is being proposed as Method 100 is already an approved alternative method in cases where EPA methods are applied. The test method applicable for combustion turbines and microturbines is CARB's Method 3.

For testing methane, the US EPA Method 3C appears to measure methane that is leaked into the atmosphere during transportation or from sites that include municipal waste (e.g., landfills), rather than emissions from stationary power generation equipment.

For testing nitrous oxide, ARB Test Method MLD 136 is a method generally employed on vehicles**:** "Procedure for Determination of Nitrous Oxide in Automotive Exhaust by Fourier Transform Infrared Spectroscopy." This test method is not compatible with inverter-based technologies. This is in part due to the requirement to test with a dynamometer. There are already well-established test methods for stationary sources of NOx. Test methods applicable for combustion turbines and microturbines are CARB's Method 20 or Federal Regulation Title 40, Chapter I, Subchapter C, Part 60, Subpart KKKK.

GHG Standard

ARB proposed two potential bases of GHG standard but also expressed openness to additional methods in comments made at the public workshop. We believe the legislative intent is to have CEC and ARB determine the emissions rate that represents clean distributed energy resources offsetting higher emission grid resources. Proposed Method 1 simply uses displacement of a combined-cycle gas turbine power plant as the marginal grid resource, but does not account for line losses. In California, transmission and distribution losses averaged 7% in 2014 and should be factored into the ARB's methodology. Proposed Method 2 applies a 25% adjustment to account for an RPS target of 25% by January 1, 2017. There is no need to factor in the target RPS as the GHG emissions comparison should be made to the actual emissions profile of the grid resources – not the targeted profile. If the distributed energy resource is cleaner than the actual grid, then it is an improvement over the grid. The GHG standard is to be updated on a regular basis, so as the grid becomes cleaner, the standard will adjust appropriately.

Sincerely,

Jen Derstine
Director of Strategy, Policy and Distributor Development
Capstone Turbine Corporation

Comment Log Display

Below is the comment you selected to display.
Comment 2 for Fuel Cell NEM Program (fuelcellstandard-ws) - 1st Workshop.

First Name: Mike
Last Name: Levin
Email Address: MLevin@fce.com
Affiliation: FuelCell Energy, Inc.

Subject: FCE Comments on FC NEM Emission Reduction Standards
Comment:

On behalf of FuelCell Energy, Inc. (FCE) I appreciate this opportunity to provide comments following on the May 30, 2017 workshop held to discuss emission reduction standards for fuel cell customer-generators participating in the California Public Utilities Commission (CPUC) Fuel Cell Net Metering (FC NEM) Program. For the reasons discussed below, FCE recommends that the ARB formally endorse and adopt the emission standards developed by the CPUC for projects participating in the Self-Generation Incentive Program (SGIP).

Background

FCE is the largest manufacturer of combined heat and power fuel cells in the United States, and has deployed fuel cells throughout the state of California in a wide variety of applications at private and institutional locations. The fuel cell technologies FCE employs provide clean baseload power using natural gas or biofuel, and are helping California meet its ambitious greenhouse gas (GHG) emissions reduction targets by displacing high-carbon power plant emissions. FCE has and continues to pioneer new and transformative fuel cell technologies and applications, and is working with customers to develop larger scale projects enabled by the California Legislature's decision in Assembly Bill 1637 (AB 1637) to allow participation in NEM by fuel cell systems sized up to 5 MW.

AB 1637 directs ARB to establish a schedule of annual GHG emission reduction standards to determine eligibility for the FC NEM program in consultation with the California Energy Commission, and to update the schedule of standards every three years. The statutory requirement provides that the emission reduction standard must ensure that each fuel cell "reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid." (PU Code §2827.10(b)(2))

The ARB has suggested that key considerations in setting the AB 1637 emission reduction standard include marginal energy resource mix and displacement assumptions, role of renewable resources, line losses, grid response to small load changes, utility procurement and RPS progress, and interpretation of "emission reduction versus grid resources." As some parties at the May 30, 2017 workshop pointed out, another relevant consideration is that the standard will only apply for three years, and that the FC NEM program is only available to projects that commence operation before December 31, 2021.

FCE's Recommendation

Upon review of the language of AB 1637 and discussion with ARB staff and stakeholders at the May 30, 2017 workshop, FCE strongly supports adoption of the current SGIP program emission reduction standard as the standard for the FC NEM program.

The SGIP program emission reduction standard was established in Decision 15-11-027, after extensive discussion of factors virtually identical to the key considerations identified by ARB staff. It clearly meets the statutory requirement by establishing a reasonable benchmark for ensuring that eligible projects will reduce GHG emissions compared to grid resources, including renewable resources, displaced by the fuel cell. The SGIP emissions standard (described in pages 54-55 of the SGIP Handbook) adjusts by year, as summarized below:

SGIP GHG Eligibility Emissions Factors, kgCO2/MWh

Application Year	2016	2017	2018	2019	2020
10-Year Average	350	347	344	340	337

We also recommend adoption of the methodology adopted for the SGIP program for evaluation of GHG impact for actual projects, including assumed value of carbon content of natural gas, assumed efficiency of offset thermal sources in combined heat and power, and calculation of GHG impact using fuel, power, and thermal measurements that use instruments that are already part of a typical power project. Adding requirements for measurements of N2O and methane adds cost and complexity to projects which is unnecessary given the extremely low levels of these species in fuel cell exhaust, and the difficulty of measuring such low levels.

Adopting the SGIP standard, as described above, for the first three year period prescribed under AB 1637 will comply with the statutory requirement, provide a reasonable analytical basis for the standard, save the ARB staff and interested stakeholders further time and effort essentially duplicating the work that resulted in Decision 15-11-027, and provide continuity and stability for

program participants.

We appreciate the Board's consideration of these comments.

Attachment:

Original File Name:

Date and Time Comment Was Submitted: 2017-06-14 15:35:25

If you have any questions or comments please contact Office of the Ombudsman at (916) 327-1266.

Board Comments Home

CONTACT US

(800) 242-4450 | helpline@arb.ca.gov
1001 I Street, Sacramento, CA 95814
P.O. Box 2815, Sacramento, CA 95812

JOINT FUEL CELL PARTIES:
NATIONAL FUEL CELL RESEARCH CENTER; BLOOM ENERGY; DOOSAN FUEL CELL AMERICA; LG FUEL CELL SYSTEMS
Comments on Fuel Cell Net Energy Metering Program
Greenhouse Gas Emission Standard
June 14, 2017
Request for Comments Issued June 1, 2017

The Joint Fuel Cell Parties (National Fuel Cell Research Center, Bloom Energy, Doosan Fuel Cell America, and LG Fuel Cell Systems, Inc.) submit these comments to the California Air Resources Board regarding the Fuel Cell Net Energy Metering Program Methodology for the Greenhouse Gas (GHG) Emission Standard.

I. Introduction

GHG-reducing fuel cells are a unique technology needed to complement and manage the high penetration of intermittent solar and wind, cornerstones for achieving the California 40% GHG emissions reduction goal by 2030.

Fuel cells address simultaneously the mitigation of CO_2, criteria air pollutants, and short-lived climate pollutants – co-benefits which are all direct or indirect goals of California's statewide Integrated Resource Planning. [1]

For CO_2 reduction, the high fuel-to-electrical efficiency of fuel cells significantly reduces the carbon emitted per megawatt-hour, and fuel cells have the capability to be configured for the capture, concentration, and storage of the resulting CO_2. The 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. Fuel cells are operating today on biogas, further contributing to the reduction of carbon emissions. This represents an immediate benefit that may be further expanded as the market for biogas and other renewable fuels (e.g., renewable hydrogen) evolves to make cost-effective and accessible renewable gas supplies widely available. Particularly important, as the renewable gas supply evolves, fuel cells are the only technology that will operate on renewable hydrogen with zero emissions, while at the same time enabling massive capture and storage of renewable power that would otherwise be curtailed. In this mode, the fuel cell will be a firm (24/7) 100% load-following renewable and zero emissions generator.

For criteria air pollutant reductions, fuel cells have the distinct attribute of emitting virtually zero criteria pollutants.

[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/General.aspx?id=7890

For short-lived climate pollutant reductions, fuel cells are an ideal technology to mitigate emissions because fuel cells:

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

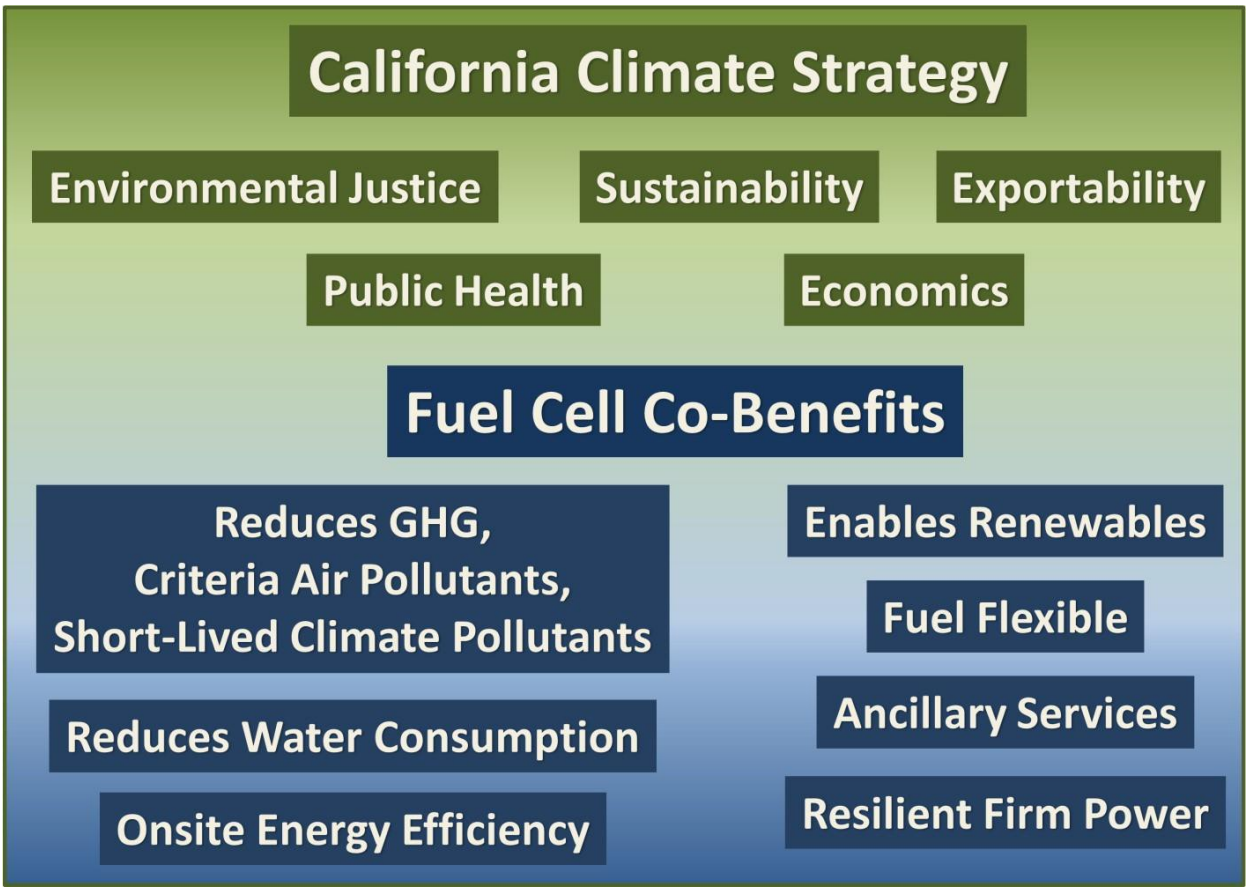


Figure 1: Climate Change Co-Benefits of Fuel Cells

Fuel cells have highly dynamic dispatch capabilities to (1) manage the diurnal and seasonal power demand variations, (2) handle intermittencies associated with solar and wind power generators, and (3) increase the maximum penetration of renewable resources that can be accommodated in the utility grid network. [2,3] These capabilities will result in maximum sustainability and additional GHG reductions through the integration of renewables with transportation electrification.

[2] 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.

[3] 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.

In addition to generating electrical power, stationary fuel cells have the capability to cogenerate a thermal product. This option, referred to as Combined Cooling, Heat, and Power (CCHP), is designed to capture and utilize the heat produced by the fuel cell for the provision of cooling, heat, hot water, or steam. It 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 judicious design, 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 displaced 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 uniquein 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]

Stationary fuel cells can be used to improve the quality of power provision and infrastructure where it is truly needed, while also contributing to cleaner air and improved health of citizens. In fact, fuel cells are suitable for citing near or even inside buildings, due to virtually zero pollutant emissions, an acoustically benign attribute, and the avoidance of the challenges related to permitting and zoning.

II. Comments

A. Key Considerations

1. <u>Marginal energy resource mix and displacement assumptions</u>

We strongly encourage the California Air Resources Board (CARB) to adopt the most technically accurate methodology for estimating the marginal energy resource mix that would be displaced by fuel cell systems operating under the net energy metering tariff.

The resource mix on the margin, i.e. the resource mix that an electricity provider would increase or decrease in response to energy demand, is the appropriate reference as the resource mix that the fuel cell would displace. Long-term and must take contracts (non-marginal resources) are not altered based upon the use of fuel cells on the customer's side of the meter.

[4] Darrow, K., et al., Catalog of CHP Technologies 2015: Available at http://www.epa.gov/sites/production/files/2015-07/documents/catalog_of_chp_technologies.pdf (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): p. 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.

Significant research and development related to the historical, current and future marginal energy resource mix in California has already been accomplished and is already in widespread use in support of California policy goals. We expressly encourage the use of statewide, complete annual hourly data (8760 hours) for characterizing the marginal energy resource mix for use in determining the GHG emissions requirements for fuel cell systems operating under the net energy metering tariff.

Several examples of technically accurate methodologies for marginal energy resource mix assessment are currently available for CARB to use directly or to pattern their analyses after. One example is the publicly available avoided cost calculator (ACC) developed by Energy + Environment Economics (E3).[7] This tool is used for assessing the impacts of utility energy efficiency measures (which are identical in effects on the grid to behind-the-meter power generation from a fuel cell). This ACC tool has been updated in 2016 with thorough documentation of the methodology that is publicly available for scrutiny and use.[8] A second example that accurately determined the hourly marginal resource mix for an entire year is the analysis accomplished by Itron in their 2014-2015 Self-Generation Incentive Program (SGIP) Impacts Evaluation.[9] Another example is that of WattTime, a nonprofit organization that combines real-time data from grid operators and the U.S. EPA to determine accurate marginal grid emissions that reflect the dynamics of the grid.[10]

All of these examples use data from the California Independent System Operator (CAISO), and other balancing authorities that serve California, to accurately calculate the statewide hourly marginal resource mix for an entire year (with various assumptions). These data should be available to CARB in this year and all subsequent years to enable a regular update of the GHG emissions standard (e.g., every three years as required by statute).

2. Role of renewable resources in the resource mix

We strongly encourage CARB to use grid operations data and analyses as described above to accurately account for the hourly contribution of renewable power generators to the marginal resource mix. All of the methodologies introduced above include thorough and accurate consideration of the renewable power contribution to the marginal resource mix.

[7] California Public Utilities Commission, Energy + Environment Economics, Energy Efficiency Calculator, available on-line at: https://www.ethree.com/public_proceedings/distributed-energy-resources-der-avoided-cost-proceedings/

[8] Brian Horii, et al., Energy + Environment Economics, Avoided Costs 2016 Interim Update, available on-line at: http://www.cpuc.ca.gov/General.aspx?id=10710, August 1, 2016.

[9] 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/

[10] http://watttime.org/

We discourage the use of an arbitrary renewable power generation factor, or a factor that scales with the renewable portfolio standard or annual renewable energy percentage, because none of these factors take into account the dynamics of renewable power generation on the grid or accurately reflect the contribution of these resources to power generation on the margin. Rather, we encourage the hourly marginal generation resource mix approaches outlined above together with regularly updated data from balancing authorities to accurately account for renewable power marginal contributions and dynamics on the grid.

Distributed generation and fuel cell systems do not prevent the building of renewable power plants. To the contrary, rather than displacing renewable resources, fuel cells are clean distributed generators that are required to facilitate the deployment of renewables. Based on grid simulation studies at UCI's Advanced Power and Energy Program, fueled, controllable and dynamic power generation such as that produced by fuel cells is required to achieve high levels of renewables.[11,12,13]

Fuel cell technology, with unprecedented low criteria pollutant emissions that enable installation even in the most restrictive of air quality permitting regions, also provides firm power generation to areas of significant grid congestion, preventing the need for additional centralized generation capacity and transmission equipment. These installations offset traditional grid infrastructure and support the installation of additional renewable power systems.

In addition to the direct displacement of central power emissions, firm clean power generation can provide the additional benefit of locally complementing the diurnal variation and intermittent generation profile of renewable power systems. Fuel cells can be used to stabilize this profile, and displace existing baseload, load-following, and peaking power plants that would otherwise be required to address the diurnal and intermittent characteristics associated with renewable power. If distributed, firm power generation resources are not installed, the grid will be forced to curtail renewable power during periods of low power demand or high renewable generation due to grid reliability concerns.

[11] *Dispatch of Fuel Cells as Transmission Integrated Grid Energy Resources to Support Renewables and Reduce Emissions* (2015). Applied Energy, Vol. 148, pp. 178-186 (Brendan Shaffer, Brian Tarroja, and Scott Samuelsen).

[12] *Exploration of the Integration of Renewable Resources into California's Electric Systems Using the Holistic Grid Resource Integration and Deployment (HiGRID) Tool* (2013). Energy, Vol. 50, pp. 353-363 (Josh Eichman, Fabian Mueller, Brian Tarroja, Lori Schell, and Scott Samuelsen).

[13] *Solar Power Variability and Spatial Diversification: Implications from an Electric-Grid Load Balancing Perspective* (2013). International Journal of Energy Research, pp. Vol. 37, No. 9, pp. 1002–1016 (Brian Tarroja, Fabian Mueller, and Scott Samuelsen).

3. **Line losses**

We recommend that line losses be included in the calculation of the GHG standard. It is technically accurate to use line losses in the calculations since all of themarginal resources that fuel cell systems would displace are subject to line losses that are required to deliver the power to the customer. The statewide loss factor should be a load weighted average of all utility service area loss factors based upon the most up to date California Energy Demand Adopted Forecast from the California Energy Commission.

4. **Grid response to small load changes**

We strongly encourage the use of marginal resource mix calculations based upon data for annual hourly performance of the California grid, as described above. If this approach is adopted, then the grid response to small load changes will be accurately assessed. We discourage the use of grid average emissions or any other factor that aggregates the emissions of resources that are not affected by small load changes (e.g., must-take or non-load following resources) with those that are actually on the margin. Because data on grid operations at hourly intervals is available, we also discourage using less granular data (e.g., monthly) for establishing the GHG Standard.

5. **Interpretation of "reduces greenhouse gas emissions compared to the electrical grid resources"[14]**

We encourage CARB to set a standard that clearly demonstrates that net energy metered fuel cell systems will reduce emissions compared to the marginal mix of grid resources that would otherwise have been dispatched. We recommend that the GHG standard be set on point lower than the exact level of emissions which the grid marginal resources would have produced, rather than at an arbitrarily lower number or arbitrarily decided percentage reduction.

B. Recommended Test Procedures

The inclusion of relevant greenhouse gases in the GHG standard methodology in addition to carbon is relevant and appropriate. We support the inclusion of N_2O and methane in the GHG standard, as the statute directs the Board to establish a GHG reduction (i.e. CO_2e) standard rather than a CO_2 reduction standard. We urge the Board to ensure that whatever testing is required for these additional GHGs are appropriate for use with stationary fuel cells. The methods presented in Slide 7 of the Fuel Cell Net Energy Metering GHG Emission Standards Workshop presentation were neither designed nor appropriate for measuring emissions from stationary power generation systems. Emissions of N_2O and methane from

[14] PU Code 2827.10(b)(2) The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid.

fuel cell systems are so low that they are typically below detection limits of standard testing. While these gases contribute negligibly to total GHG emissions from fuel cells, we understand the need for a direct comparison of emissions from fuel cells to that of marginal grid resources and will work with Staff to ensure that testing requirements are appropriate and accurate.

We strongly encourage type certification of fuel cell systems in a manner that is similar to the CARB distributed generation (DG) certification program. Individual on-site measurement of fuel cell system performance would be costly because the systems are small and distributed. Testing on a site by site basis would not add value.

III. Conclusion

GHG-reducing fuel cells are considered the cleanest, most efficient distributed energy resource for firm, controllable, and dispatchable power. When operating on natural gas, fuel cells reduce GHG compared to generation from the current grid and generate virtually zero criteria pollutant emissions. When using renewable bio fuels, they are carbon neutral. With renewable hydrogen as a fuel source, fuel cells emit zero GHGs. In addition, fuel cells operate in a virtual water balance, with no significant consumption of water in normal operations.

As the grid evolves, California will not reach high penetrations of renewables without a technology that provides clean, firm, renewable, and load-following power.

Establishing an accurate GHG standard for the net energy metering of fuel cell systems is very important to the near-term and long-term market for fuel cell systems. The GHG standard will assure and confirm the GHG reducing features of fuel systems compared to the mix of all other technologies that could have otherwise been used to provide the energy services (power, heating, cooling) that clean distributed fuel cell systems provide. The GHG standard can also facilitate the evolution of fuel cell installations over time to make them increasingly GHG emissions free, as the standard is updated every 3 years in an accurate manner. The most accurate way to establish such a GHG emissions standard is to use and build upon the significant previous scientific research and development that has already occurred todetermine the marginal resource mix. The methodology used by CARB to establish the GHG emissions standard should assess the annual hourly (all 8760 hours of the year) marginal resource mix based upon grid operations data in the appropriate year, as described above.

The Joint Fuel Cell Parties appreciate the opportunity to comment on the development of a Fuel Cell Net Metering GHG Standard through the above recommendations to facilitate this evolution.

Sincerely,

/s/ *Jack Brouwer*

Dr. Jacob Brouwer, Associate Director
National Fuel Cell Research Center
Associate Professor of Mechanical and Aerospace Engineering
University of California, Irvine

/s/ *Rodger McKain*

Rodger McKain
Senior Consultant
LG Fuel Cell Systems, Inc.

/s/ *Derek Hildreth*

Derek Hildreth
Head of North American Sales and Strategy
Doosan Fuel Cell America

/s/ *Erin Grizard*

Erin Grizard
Senior Director, Regulatory and Government Affairs
Bloom Energy

Pacific Gas and Electric Company

Fariya Ali
Expert Representative
State Agency Relations

77 Beale Street, B13S
San Francisco, CA 94105
(415) 973-8406
fxao@pge.com

June 14, 2017

Dave Mehl
Manager, Energy Section
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

RE: PG&E Comments on Public Workshop to Discuss Greenhouse Gas Emission Standards for the Fuel Cell Net Energy Metering Program

Pacific Gas and Electric Company (PG&E) appreciates the opportunity to provide feedback on methodologies the Air Resources Board (ARB) should consider for establishing greenhouse gas (GHG) emission reduction standards for fuel cell "customer-generators" participating in Net Energy Metering Service for Fuel Cell Customer-Generators (NEMFC), as required by Assembly Bill 1637 (Low, Statutes of 2016).

PG&E appreciates ARB staff's ongoing efforts to engage stakeholders, including through the May 30, 2017 workshop. PG&E recognizes that this topic is complex and disagreement in how to structure this methodology will exist. However, it is critical to *accurately* assess the marginal resource mix and displacement assumptions, including a realistic appraisal of the renewable resources currently on the margin and likely future scenarios.

In the following sections PG&E offers input on the methodologies proposed by ARB staff at the May 30th workshop and recommends two alternative options.

I. ARB PROPOSED METHODOLOGIES

The ARB's proposed methodologies as described in staff's presentation resulted in two different GHG standards:

- 400 kg CO2e/MWh, using displacement of combined cycle gas turbine (CCGT) power plants as the marginal resource, and;
- 300 kg CO2e/MWh, using displacement of CCGT generation with a 25% renewable energy adjustment (Renewable Portfolio Standard (RPS) target of 25% by January 1, 2017)

While these methodologies are logical and have the benefit of being simple, each of these approaches will result in less than accurate calculations of the GHG emissions factor for marginal resources because they assume the displaced resource for fuel cells would be either a CCGT or a combination of a CCGT and 25% renewables mix. They do not correctly reflect the marginal emissions in California, including the seasonal and diurnal patterns; and ARB's first proposed standard will significantly overestimate the GHG emissions on the margin, especially when averaged over the expected life of a fuel cell resource.

PG&E appreciates staff's proposed methodologies as an appropriate starting point for discussion but believes that they could be improved upon with a more data-driven approach that includes other important considerations. When deciding an accurate methodology for calculating GHG emissions, it is important to establish a standard that allows for forecasting while also taking into account the growth and effects of renewables on the grid.

II. PG&E PROPOSED ALTERNATIVE METHODOLOGIES

In order to set GHG emissions standards that are based on a more accurate and realistic marginal resource mix, PG&E proposes either of the following two methodologies in lieu of ARB's proposed approaches:

(1) E3's 2016 Avoided Cost Calculator (ACC) model (preferably with one modification); or,

(2) PG&E's 2017 General Rate Cast (GRC) Phase II Price Model.

These public, alternate methodologies use inputs not considered in ARB's proposed methodologies such as load and generation quantities, electric and natural gas prices, variable operations and maintenance cost, and the price of GHGs. To account for the fact that average marginal emissions are expected to decline with time, the emissions standard should use an expected emissions factor calculated as of five years after the installation date (e.g. 2022, for fuel cells installed in 2017). If the emissions standard instead uses a factor calculated as of the installation date, a fuel cell that had the same GHG emissions as the grid in 2017 would be displacing *lower-emitting* resources in later years (as the RPS targets increase), and would counter, rather than enhance the state's goals.

More stakeholders may be familiar with E3's 2016 ACC model (produced in the Integrated Distributed Energy Resources (IDER) proceeding at the California Public Utilities Commission) than with PG&E's 2017 Price Model (produced in its 2017 GRC Phase II proceeding). These alternate methodologies diverge in only minor ways and either would result in a similar GHG emissions factor calculation that is more accurate to that produced by ARB's proposed methodologies. These models are explained in more detail in Attachment A, including the benefits and shortcomings of each.

PG&E's believes ARB should consider both models equally viable when determining the adoption of an appropriate methodology going forward. However, PG&E currently recommends its 2017 GRC Phase II Price Model because it more accurately estimates marginal heat rates than the ACC model which tends to overestimate heat rates (as seen in Figures 1-3 in Attachment A). PG&E's model is also calibrated against actual market results. If the ACC model is modified to address the over-estimation issue, then

PG&E supports use of the ACC model in this regulation as it may be more widely accepted by all stakeholders.

III. CONCLUSION

PG&E strongly suggests that the GHG standards for NEMFC should be based on the methodology that provides the most accurate and realistic assessment of the marginal resource mix to be displaced. PG&E urges ARB to consider both the E3 model and PG&E's model as more accurate options and is available to meet with staff to discuss both models in detail. We look forward to collaborating with all stakeholders in this process.

Please feel free to contact me if you have any questions or concerns.

Sincerely,

/s/

Fariya Ali

Expert Representative, State Agency Relations
Pacific Gas and Electric

Cc: Gary Collord (gary.collord@arb.ca.gov)

Attachment A: Description of PG&E's Proposed Alternative Methodologies

1. E3's 2016 ACC Model

   A. Explanation of the model: The 2016 version of the Avoided Cost Calculator is a spreadsheet-based model used in the IDER proceeding to calculate marginal costs and GHG emissions.[1] The model uses 2015 Day-Ahead (DA) and Real-Time (RT) prices in the California Independent System Operator (CAISO) market to develop an 8760 pattern of marginal effective heat rates (in units of million British Thermal Units (MMBtu) per megawatt hour (MWh)),[2] which when multiplied by the marginal emissions rate of a gas-fired resource in tons per MMBtu yields marginal GHG emissions in t/MWh (metric tons per MWh). With the caveat listed in the next section PG&E considers this historical snapshot to be an accurate measure of the 2015 marginal GHG emissions rates, and the calculation could be easily updated to incorporate data from 2016 using the sources identified in the model.

   For future periods, the ACC model relies on E3's RPS Calculator[3] to compute changes to the marginal heat rates through 2020. For years after 2020, the ACC model assumes that the 8760 "shape" of heat rates and therefore emissions will remain constant, while costs escalate according to forward curves or, when those are not available, inflation.

   The model adjusts the marginal heat rate when prices are either very high or very low, as explained on page 35 of the 2016 Avoided Cost Methodology (see Footnote 1). First, the maximum heat rate is capped at a value of 12,500 Btu/kWh (i.e. any heat rate above 12,500 is reset to 12,500). Second, any negative heat rate (which results from a price less than the variable operations and maintenance (VOM) cost) is set to zero for the purpose of calculating marginal GHG emissions, while any heat rate between 0 and 6,900 is set to 6,900.

   B. Benefits of the model: The ACC model has some significant benefits compared to choosing an annual emissions rate based on an assumed marginal combined cycle generator, with or without an adjustment for RPS penetration:

      i. It produces a defensible marginal GHG emissions rate by hour for historical periods, and can be updated with new data annually.

      ii. It is based on publicly available data, and the models are all publicly available Excel spreadsheets that can be run by virtually any stakeholder.

[1] Available at https://www.ethree.com/public_proceedings/distributed-energy-resources-der-avoided-cost-proceedings/
[2] The marginal effective heat rate is defined as (P – VOM)/(G + GHG), where P is the DA price in $/MWh, VOM is the variable operations and maintenance (O&M) cost in $/MWh, G is the gas price in $/MMBtu, and GHG is the cost of California Carbon Allowances (in $/t) times the conversion factor 0.053 t/MMBtu.
[3] Available at http://www.cpuc.ca.gov/RPS_Calculator/

iii. The model produces defensible forecasts of marginal emissions rates for future years through 2020.

iv. The ACC model is the CPUC's official avoided cost model used for all distributed energy resource cost-effectiveness analysis. Therefore, using the ACC model would provide for consistency with how the CPUC values distributed energy resources.

C. Shortcomings of the model: The ACC model does have some shortcomings relative to its use by ARB for this regulation, which are unlikely to be addressed formally until 2018:

i. The adjustment of historical heat rates when they are between 0 and 6,900 may bias the emissions rates upwards, in that marginal heat rates of combined cycle generators are actually as low as 2,500, close to their minimum generation level.[4] This bias is likely to grow larger with time, as more renewable generation increases the number of hours in which fossil generation is at or close to its minimum levels and prices in the DA market are close to (but above) zero.[5] PG&E therefore recommends that the minimum heat rate be set to 2,500 in the model.

ii. Both historical and forecasted heat rates (and therefore calculated GHG emissions) do not correct for hydrologic conditions in the historical year. All forecasted heat rates based on the extremely dry year 2015 will therefore be biased even higher, while forecasts based on the extremely wet historical year 2017 will be biased low..

iii. The forecast part of the model is not calibrated against actual market results.

2. PG&E's 2017 GRC Phase II Marginal Cost Model

A. Explanation of the model: PG&E's 2017 GRC marginal cost model (the PG&E GRC cost model) is a spreadsheet-based model used in PG&E's GRC Phase II proceeding (as well as other Time of Use (TOU)-related proceedings, such as the TOU Periods Order Instituting Rulemaking (OIR) and the Matinee Energy Pricing Pilot) to calculate marginal costs.[6] The model fits an Effective Market Heat Rate (EMHR) curve to a weighted average of historical 2010-2016 DA and RT

[4] See slides 16-18 in the February 13, 2007 CAISO presentation on Modification of Incremental Heat Rate Calculation, available at http://www.caiso.com/1b83/1b837e306f1d0.pdf

[5] For example, in the first three months of 2017, the calculated heat rate using DA prices at the PG&E Default Load Aggregation Point (DLAP) assuming a VOM of $0.50 was between 0 and 6,900 in 1161 out of 2160 hours, or 54% of the time. The ACC model would assign a marginal heat rate of 6,900 for each of those hours, which is an overestimate.

[6] Detailed description is in Chapter 2 testimony in Exhibit PG&E-9, Vol 1, available by searching for GRC Phase II Testimony from PG&E filed on 12/02/16 at https://pgera.azurewebsites.net/Regulation/search

prices in the CAISO market, with the EMHR assumed to depend on Adjusted Net Load,[7] modified to account for ramp rate and start-up costs. This model's definition of EMHR is identical to the definition used in the ACC model, except that it uses a higher VOM cost derived from the 2009 California Energy Commission (CEC) Cost of Generation Report. While the PG&E GRC cost model was not designed to calculate marginal GHG emissions, it can easily be modified to do so by adding a single column to each of the historical and forecast tabs, multiplying the EMHR by the afore-mentioned conversion factor of 0.053 t/MMBtu (with a floor of zero and optionally a cap corresponding to the same 12,500 heat rate cap as the ACC model). Thus the PG&E GRC cost model will yield similar estimates of historical GHG emission rates to those of the ACC model, except between heat rates of 0 and 6,900 in which range PG&E considers the GRC model to be more accurate. Also similar to the ACC model, the PG&E GRC cost model's inputs can be easily updated to incorporate data from 2016 using the sources identified in the model.

For future periods, the PG&E GRC cost model relies on *annual* forecasts from the RPS Calculator, but 8760 *shapes* for load and generation from the 2014 Long-Term Procurement Planning (LTPP) proceeding to compute marginal heat rates through 2024. For years after 2024, PG&E would make the same assumption as does the ACC model after 2020, namely that the 8760 "shape" of heat rates and therefore emissions will remain constant, while costs escalate according to forward curves or, when those are not available, inflation.

B. Benefits of the model: The PG&E GRC cost model also has some significant benefits compared to ARB's proposed methodologies, many of which it shares with the ACC model:

   i. It produces a defensible marginal GHG emissions rate by hour for historical periods, and can be updated with new data annually.

   ii. It is based on publicly available data, and the models are all publicly available Excel spreadsheets that can be run by virtually any stakeholder.

   iii. The model produces defensible forecasts of marginal emissions rates for future years through 2024 (i.e., four years further out than the ACC model).

   iv. The calculations for historical and forecast periods use the same underlying model, so they are self-consistent.

   v. The model is calibrated against actual market results in the CAISO, and is very robust as evidenced by out-of-sample tests.

C. Shortcomings of the model: The PG&E GRC cost model also has some shortcomings:

[7] Adjusted Net Load is equal to gross (or metered) load, less utility-scale renewables (wind and solar, geothermal, biomass/biogas and small hydro), nuclear, and a smoothed function of large hydro generation. It represents the amount of load that must be met by thermal resources plus unspecified imports.

i. The model is not as well socialized as the ACC model, and therefore more stakeholders would have a steeper learning curve to run it. However, it is notable that both the Office of Ratepayer Advocates (ORA) and Solar Energy Industries Association (SEIA) have accepted the model's forecasts of marginal energy costs in testimony in the GRC Phase II proceeding.

ii. The PG&E GRC cost model was developed by PG&E. E3 is a consulting company that maintains many models, including the ACC model and the RPS Calculator, which are used in public regulatory proceedings and has a more robust support system in place to respond to questions and maintenance needs.

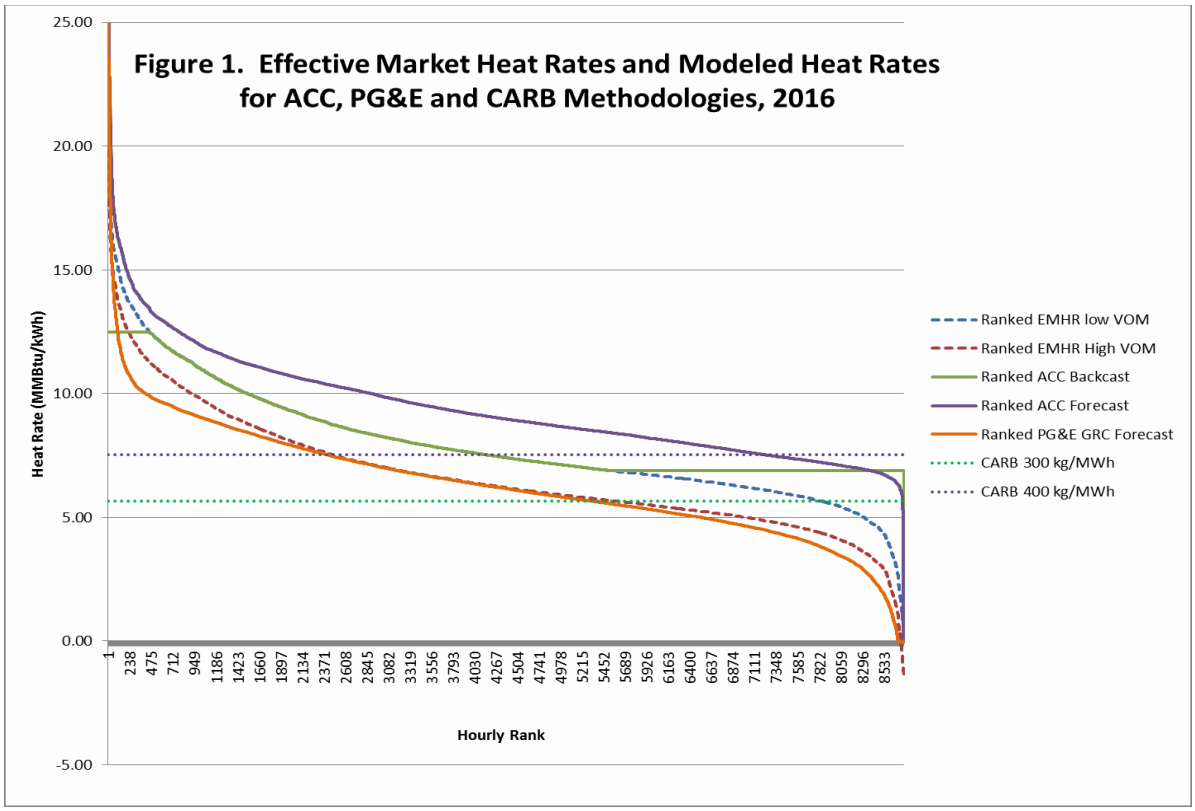
3. Comparison of Market Heat Rates and Modeled Heat Rates for ARB, ACC and PG&E Methodologies

Figures 1 and 2, below, show the historical Effective Market Heat Rate (EMHR) for PG&E's service territory compared to modeled heat rates corresponding to the two ARB proposals, as well as the ACC and PG&E GRC models. In each Figure, the upper dashed line represents the EMHR assuming a low VOM (as used in the ACC model); while the lower dashed line represents the EMHR assuming a higher VOM (as used in the PG&E GRC model). The green solid line represents the modeled *historical* heat rate that would be obtained with the ACC model if its 2015 CAISO data had been replaced by 2016 data, while the solid purple line is the ACC model's *forecast* 2016 heat rate. The solid orange line is the PG&E GRC model's forecast 2016 heat rate. Finally, the dotted purple and green lines represent ARB's two proposals, converted to heat rates by dividing the kg/MWh values by the conversion factor 53 kg/MMBtu.

Table 1 shows the average GHG emissions rate for the methodologies discussed above, for the years 2016 and 2022 (2017 is not included because only the first five months of data are available). Here, ARB High is the ARB methodology assuming a marginal CCGT; ARB Low accounts for the renewable energy adjustment.

Table 1: Average GHG Emissions Rates in 2016 and 2022

Year	ARB High	ARB Low	ACC Backcast	ACC Forecast	PG&E GRC Forecast
2016	400	300	437	502	338
2022	400	254		350	286



In both Figures, the 400kg/MWh value clearly overestimates marginal heat rates using either of the VOM values, while the ACC forecast curves also overestimate marginal heat rates, especially for 2016. The PG&E GRC forecast tracks the high-VOM EMHR fairly closely. While PG&E has not had the opportunity to modify the ACC model by reducing the minimum heat rate from 6,900 to 2,500 (or from 6.9 to 2.5 in these Figures), we note that such a modification would bring the ACC model results closer to the market heat rate curves at the right side of the figures, yielding lower and, PG&E believes, more accurate heat rate and therefore marginal emissions rates.

Finally, Figure 3 shows just the modeled EMHR for the ARB, ACC and PG&E methodologies for the year 2022. For this Figure, the lower ARB estimate is reduced to (400*0.635) = 254 kg/MWh to account for the 36.5% RPS mandate as of 2022. For 2022 there is no historical data to compare to; PG&E merely notes that the current ACC model (i.e., with a 6,900 minimum heat rate) yields significantly higher heat rates than either the PG&E GRC model or the lower ARB methodology.

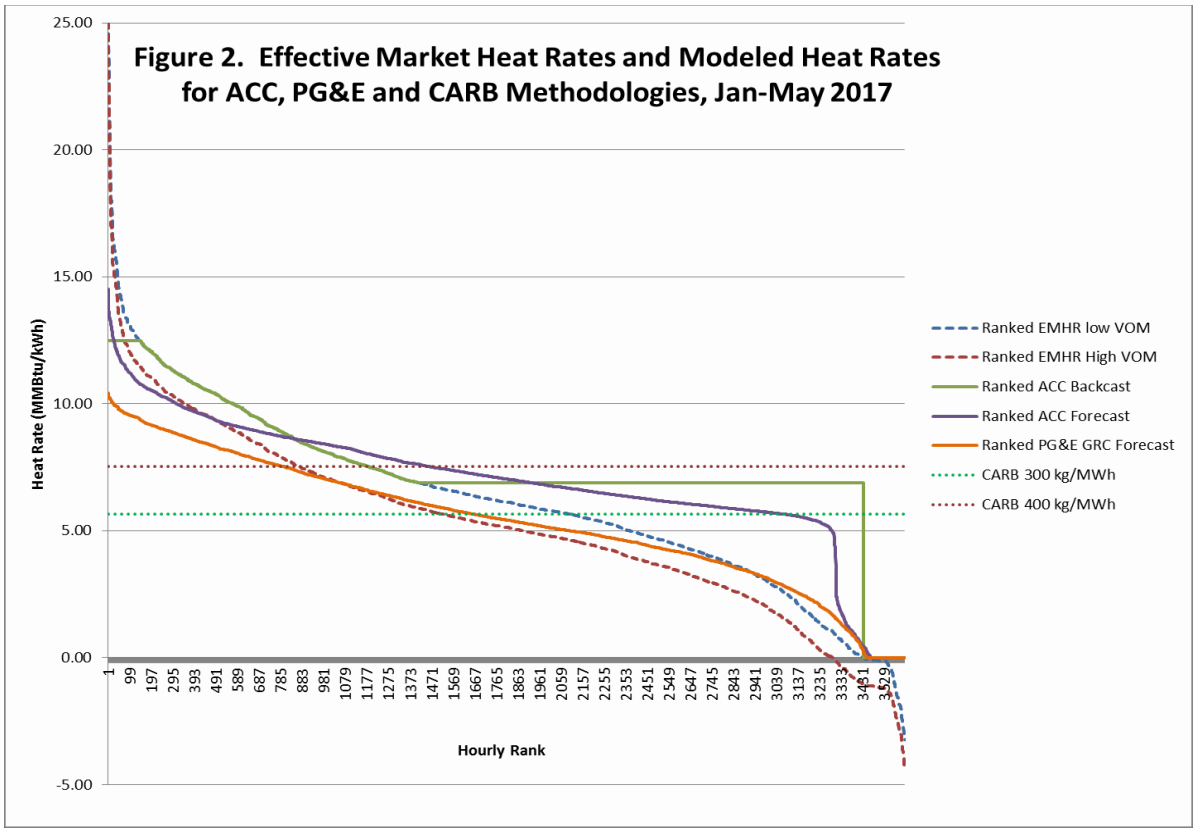


Figure 2. Effective Market Heat Rates and Modeled Heat Rates for ACC, PG&E and CARB Methodologies, Jan-May 2017
Heat Rate (MMBtu/kWh)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Hourly Rank
Ranked EMHR low VOM
Ranked EMHR High VOM
Ranked ACC Backcast
Ranked ACC Forecast
Ranked PG&E GRC Forecast
CARB 300 kg/MWh
CARB 400 kg/MWh

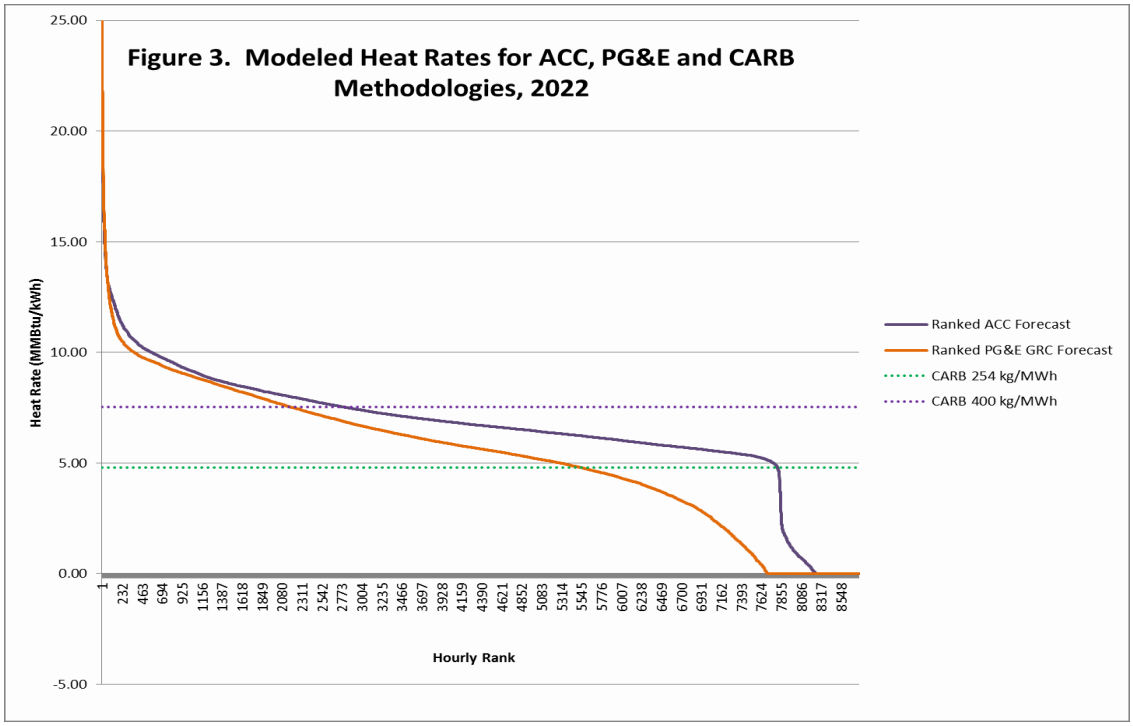


Figure 3. Modeled Heat Rates for ACC, PG&E and CARB Methodologies, 2022
Heat Rate (MMBtu/kWh)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Hourly Rank
Ranked ACC Forecast
Ranked PG&E GRC Forecast
CARB 254 kg/MWh
CARB 400 kg/MWh

Comments by EtaGen on the GHG Emissions Reduction Standard for the Fuel Cell NEM Program

Adam Simpson
CPO & Founder
EtaGen, Inc.
adam.simpson@etagen.com

John Igo
Senior Product Manager
EtaGen, Inc.
john.igo@etagen.com

Pierson Stoecklein
Senior Gov. Affairs Manager
EtaGen, Inc.
pierson.stoecklein@etagen.com

June 14th, 2017

Comments by EtaGen on the GHG Emissions Reduction Standard for the Fuel Cell NEM Program

I. Introduction

Driven by its mission to bring affordable, reliable, and clean power to the world, EtaGen has developed advanced power generation technology that unlocks the full potential of distributed generation. EtaGen's "linear generator" uses a low-temperature reaction of air and fuel to drive magnets through coils to efficiently produce electricity -- providing customers an unmatched combination of economic value, resiliency, and GHG savings.

California consistently leads the nation in establishing progressive clean energy policies which serve as an example for many other states to follow. As such, it is of the utmost importance that accurate data and comprehensive methodologies are employed in order to determine the GHG Emissions Reduction Standard (the "GHG Standard") that will govern eligibility in the Fuel Cell NEM program ("FC NEM"). While EtaGen's linear generator technology differs from fuel cells in the manner by which fuel is converted into electricity, both technologies efficiently and cleanly produce electricity at the distributed scale. EtaGen's linear generator technology is not currently eligible under the existing FC NEM, however, as noted by California Air Resources Board ("CARB") Staff during the workshop held on May 30, 2017, Assembly Bill 36 is currently moving through the legislature and would convert FC NEM into a technology neutral program while retaining the GHG Standard set by CARB at the conclusion of this process. Because this standard would therefore apply to a broader group of clean, EtaGen has a direct interest in this proceeding and appreciates the opportunity to provide comments

II. Comments

Interpretation of AB 1637

As modified by Assembly Bill 1637,[1] Section 2827.10 of the Utility Code provides the following guidance for establishment of the GHG Standard:

[1] EtaGen was one of two major stakeholders engaged with legislative staff in negotiations on the GHG emissions standard included in AB 1637.

2827.10(b)(2) "The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid."

Two elements are critical to understanding the intent of the above provision. The first element pertains to the language, "reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces." This language was meant to ensure that the GHG standard is based on all grid resources that are displaced (i.e., no longer needed to supply electricity to the grid) by the reduction in demand on the grid from the behind-the-meter (BTM) fuel cell generation. Accordingly the GHG Standard should be based on the displaced marginal grid resources. The phrase, "including renewable resources", was meant to ensure that renewable resources are accounted for in the GHG Standard if they are marginal grid resources and also displaced.

The second element relates to the language, "accounting for both procurement and operation of the electrical grid." This language was meant to ensure that the GHG Standard accounts for all grid-related aspects associated with the electricity displaced by BTM fuel cell generation. Since BTM generation displaces electricity that would otherwise have been purchased from the electrical grid, and this electricity inherently has associated transmission and distribution losses ("T&D losses" or "line losses"), this language is meant to ensure that line losses are included in the GHG Standard.

Accordingly, when determining the GHG Standard, it is incumbent on CARB to account for line losses and to limit its analysis to displaced marginal grid resources.

Renewable Procurement & Curtailment

The potential impact of BTM generation could potentially have on renewable generation is dictated by two factors, renewables procurement and renewables curtailment, each of which is addressed separately below.

Renewable Procurement

An often debated question that arises when determining displaced emissions factors in California is whether and to what extent BTM fuel-based generation reduces the amount of renewable energy that is procured by Investor Owned Utilities ("IOUs") as part of the state's Renewable Portfolio Standard ("RPS"). A common response is that, since BTM generation reduces demand on the grid, the IOUs can purchase less renewable energy in order to meet their RPS targets. This logic is inherently flawed for two reasons. First, pursuant to California Public Utilities Commission ("CPUC") rulemaking, BTM generation is not considered in IOU capacity planning processes and, therefore, could not impact renewable procurement.[2] Second, in 2013, passage of Assembly Bill 327 changed the law such that the RPS percentage is now a floor, not a cap, thereby giving utilities the authority to contract/purchase an amount of renewable energy greater than the mandated RPS percentage (in the event that there is lower demand).[3]

Just as reductions in demand from energy efficiency improvements do not impact renewable energy procurement, reductions in demand from BTM fuel-based generation also do not impact renewable energy procurement. For these reasons, it would be improper and inaccurate to include any adjustments to the GHG Standard based on the RPS or any other perceived potential impacts on renewables procurement.

Renewable Curtailment

Renewable resources bid into the CAISO market at or close to $0 per MWh and, therefore, are almost always below the clearing price. There are, however, rare

---

[2] *See* Order Instituting Rulemaking to Integrate and Refine Procurement Policies and Consider LongTerm Procurement Plans, R. 13-12-010 (Dec. 19, 2013), *available at* http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M147/K780/147780118.PDF

[3] *See* Assembly Bill 327, at page 5 of 32, http://www.leginfo.ca.gov/pub/13-14/bill/asm/ab_0301-0350/ab_327_bill_20131007_chaptered.pdf

occasions in which renewables are curtailed. Aside from self-scheduled outages, renewable curtailment occurs due to: (1) insufficient system-wide demand after the clearing of must-take resources such as nuclear and qualified facilities (referred to herein as "system-demand curtailment events"), and (2) local congestion constraints that limit the flow of power from typically remote renewable plants to a given load center (referred to herein as "congestion curtailment events"). Since BTM generation reduces demand on the grid, the frequency of both types of curtailment events could increase.

Publicly available CAISO data can be used to quantify the potential impact of BTM generation on the amount of system-demand curtailment events. CAISO's daily "Wind and Solar Curtailment Report"[4] provides the daily and year-to-date ("YTD") amount of curtailed renewable generation while CAISO's "Daily Renewables Watch"[5] breaks down the daily cleared generation resources by type and amount, which can be aggregated to provide a YTD breakdown. Table 1 (see below) summarizes the YTD generation and renewables curtailment information available in the aforementioned reports. The YTD (as of 6/8/2017) amount of renewables curtailed due to both types of events was 282,767 MWh, which amounts to only 0.305% of CAISO total generation.[6] It should be noted that, according to CAISO, the majority of renewable curtailment events occur in March, April, and May, so extrapolating this number for the entire year would most likely overestimate the annual amount of renewables curtailed.[7] To investigate the potential impact that BTM fuel cell generation could have on renewables curtailment, we will use the hypothetical scenario in which FC NEM is fully subscribed over this same time period (158 days, from 1/1/17-6/8/17). The maximum amount of electricity that could have been generated YTD by 500 MW of BTM fuel cells is 1,896,000 MWh (500 MW x 100% capacity factor x 158 days / 365 days x 8760 hours/year). With this reduction in

[4] *See* http://www.caiso.com/Documents/Wind_SolarReal-TimeDispatchCurtailmentReportJun08_2017.pdf, at Page 3.
[5] *See* http://www.caiso.com/market/Pages/ReportsBulletins/DailyRenewablesWatch.aspx
[6] Referred to as "Economic - System" events in the reports, which are described as "market dispatch of generators with economic bids to mitigate system wide oversupply."
[7] *See* Integrating High Penetration Renewable Energy into the CAISO Market (April 19, 2016), at Page 4, https://energy.gov/sites/prod/files/2016/08/f33/Shucheng%20Liu.pdf.

total CAISO generation, the amount of renewables curtailment would have increased to 0.312% (282,767 / (92,624,732 - 1,896,000)).

Table 1. CAISO generation and curtailment summary, 1/1/17-6/8/17.

CAISO YTD, 6/8/2017	Generation (MWh)	% of Total
Generation		
Renewables	23,306,488	25.2%
Nuclear	7,238,809	7.8%
Thermal	21,508,575	23.2%
Imports	25,703,343	27.7%
Large Hydro	14,867,517	16.1%
Total	**92,624,732**	**100.0%**
Renewables Curtailed	**282,767**	**0.305%**

Given this small difference (only 0.006 percentage points) and the fact that the program is not yet fully subscribed, EtaGen recommends assuming zero impact on curtailment of renewable generation for purposes of calculating the GHG Standard.

Line Loss Factor

As previously discussed, the intent of the the relevant emissions standard language in AB 1637 was to include all operational aspects associated with the electricity displaced from the grid by BTM fuel cell generation. Since BTM generation displaces electricity that would have otherwise been purchased from the electrical grid, and this electricity inherently has associated line losses, it is essential that they are included in the GHG Standard. Additionally, inclusion of line losses in the GHG Standard is consistent with other state-supported distributed generation programs (e.g., the Self Generation Incentive Program) and the World Resources Institute's GHG Guidelines report.[8]

There have been several methodologies used to quantify line losses across the various state programs. EtaGen recommends that CARB use the methodology adopted by the CPUC in its SGIP Decision, in which the CPUC calculated a statewide line loss factor of

[8] http://www.wri.org/sites/default/files/pdf/ghgprotocol-electricity.pdf

8.4%, inclusive of losses from the transmission, sub-transmission, and distribution levels as well as congestion.[9] Given the soundness of the methodology and the wide-ranging support it received from numerous distributed generation stakeholders, EtaGen recommends that CARB adopt the same methodology and standard as adopted in the SGIP Decision.

Displaced Marginal Heat Rates

Natural gas plants comprise nearly all marginal energy resources in California; a fact acknowledged by the CPUC in their SGIP Decision which, as a basis for their avoided GHG emissions factor, adopted heat rates from the CEC's "Thermal Efficiency of Gas-Fired Generation in California: 2014 Update".[10] EtaGen agrees with the CPUC's decision to utilize this CEC report, but disagrees with the CPUC's down-selection of data. Table 2 shows the gas-fired power plant performance data from the CEC report that was used in the SGIP Decision. The SGIP Decision adopted the use of *combined-cycle* heat rates for "load-following plants" and *peaker* heat rates for "peaker plants", which were then weighted to give an avoided GHG emissions factor (weighting is discussed in the next section).[11] The CPUC correctly noted that cogeneration facilities are not displaced by BTM generation because they are qualified facilities but the CPUC improperly ignored the displaced generation from *aging* and *other* facilities. As shown in Table 2, both *aging* and *other* facilities had higher capacity factors than *peaker* facilities, so it is unclear why these two types of plants were ignored. EtaGen recommends that CARB utilize the most recent update of the CEC's thermal efficiency report and incorporate all displaced natural gas facilities (i.e., *combined cycle*, *peaker*, *aging*, and *other* facilities) per the methodology described in detail below.[12]

---

[9] *See* Decision Revising the Greenhouse Gas Emission Factor to Determine Eligibility to Participate in the Self-Generation Incentive Program, D.15-11-027 (Nov. 19, 2015), *available at* http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M156/K044/156044151.PDF ("SGIP Decision").
[10] *Available at* http://www.energy.ca.gov/2014publications/CEC-200-2014-005/CEC-200-2014-005.pdf.
[11] Quotes are used to refer to terminology specific to the SGIP Decision and italic is used to refer to terminology specific to CEC Thermal Efficiency reports.
[12] *Available at* http://www.energy.ca.gov/2016publications/CEC-200-2016-002/CEC-200-2016-002.pdf

Table 2. CA natural gas-fired power plants summary statistics for 2013 (from CEC report)

	Capacity (MW)	Share of Capacity	GWh	Share of GWh	Capacity Factor	Heat Rate (Btu/KWh)
Total Natural Gas	50,779	100.0%	129,766	100.0%	29.2%	8,537
Combined-Cycle	19,676	38.7%	87,361	67.3%	50.7%	7,205
Aging	15,851	31.2%	7,589	5.5%	5.5%	11,413
Cogeneration	6,117	12.0%	29,859	23.0%	55.7%	11,459*
Peaker	7,418	14.6%	3,310	2.6%	5.1%	10,268
Other	1,717	3.4%	1,647	1.3%	11.0%	9,504

Table 3 shows the gas-fired power plant performance data from the most-recent CEC Thermal Efficiency (2015 Update) report, which is based on 2014 generation data. Consistent with the SGIP Decision, EtaGen recommends using the *combined cycle* heat rate of 7,329 Btu/kWh for "load-following plants." However, EtaGen recommends using a load-weighted average heat rate of *peaker*, *aging*, and *other* facilities for "peaker plants." The load-weighted average heat rate for "peaker plants" is 10,951 Btu/kWh, as shown in Table 4 (note that heat rates shown in Tables 2 and 3 are not adjusted for line losses).

Table 3. CA natural gas-fired power plants summary statistics for 2014 (from CEC report)

	Capacity (MW)	Share of Capacity	GWh	Share of GWh	Capacity Factor	Heat Rate (Btu/KWh)
All Categories of Natural Gas	48,067	100.0%	129,498	100.0%	30.8%	8,513
Cogeneration	5,850	12.2%	28,013	21.6%	54.7%	11,244
Noncogeneration Natural Gas Totals	42,217	87.8%	101,485	78.4%	27.4%	7,760
Combined-Cycle	19,675	40.9%	89,411	69.1%	51.9%	7,329
Aging	13,315	27.7%	6,226	4.8%	5.3%	11,776
Peaker	8,337	17.3%	4,288	3.3%	5.9%	10,415
Other	890	1.9%	1,560	1.2%	20.0%	9,131

Table 4. Load-weighted average capacity factors and heat rates for "peaker plants".

	GWh	Share of GWh	Capacity Factor	Heat Rate (btu/kWh)
Aging	6,226	52%	5.3%	11,776
Peaker	4,288	36%	5.9%	10,415
Other	1,560	13%	20.0%	9,131
Load-Weighted Average			**7.4%**	**10,951**

Weighting of Marginal Heat Rates

Using the heat rates for "load-following plants" and "peaker plants" provides proxies for the marginal resource resources displaced by reductions in grid demand, but a model is needed to determine the percentage of the hours each type of resource is displaced. EtaGen agrees with the acknowledgement in the SGIP Decision that "the contribution of load-following and peaker plants must be weighted to account for the approximate amount of time spent operating on the margin."[13] However, EtaGen strongly disagrees with the SGIP Decision of 10% weighting for peaker plants. This value was taken from CAISO's "2014 Annual Report on Market Issues and Performance" and is based on the capacity factor of peaker plants, and not the amount of time spent operating on the margin.[14] Peaker plant average capacity factor is not an appropriate model for the fraction of hours per year any "peaker plant" is on the margin because it does not take into account wholesale pricing dynamics or part-load operation.

Table 5 shows the three categories of "peaker plants" from CEC's 2014 QFER data with the highest capacity factors and with greater than 10 MW of capacity. Since these plants had the highest capacity factors, they therefore had the highest number of hours in which they cleared the CAISO market marginal price. Accordingly, this reflects that the *peaker* plant operated at least 30.2% of the hours per year, the *aging* plant operated at least 24.2% of the year, and the *other* plant operated at least 33.5% of the year. The minimum number of operating hours for these plants is more than three times the 7.4% load-weighted average capacity factor for all "peaker plants" shown in Table 4. This example, while simplified, illustrates the fundamental flaw in using average capacity

[13] *See* SGIP Decision at p. 22 (emphasis added).
[14] *See* 2014 Annual Report on Market Issues and Performance (June 2015), *available at* http://www.caiso.com/Documents/2014AnnualReport_MarketIssues_Performance.pdf.

factor to represent the fraction of hours per year that any "peaker plant" is on the margin -- it simply does not capture when *any* "peaker plant" is operational, let alone the marginal resource.

Table 5. Highest capacity factor "peaker plants" with capacity > 10 MW.

Type	CEC Plant ID	Capacity Factor	Heat Rate (Btu/kWh)
Peaker	G0220	30.2%	9,980
Aging	G0274	24.2%	10,563
Other	G0679	33.5%	8,554

Given that average capacity factor is not an appropriate model, and since EtaGen does not have access to historic hourly marginal plant data or advanced forward-looking dispatch models, EtaGen recommends that CARB utilize IOU tariffs for weighting the heat rates of marginal resources because the tariffs are designed to capture real pricing dynamics. Table 6 shows the time periods for energy charge and demand charge pricing across the main commercial tariffs in the major IOUs.[15]

Table 6. IOU tariff pricing time periods.

	Terminology	Summer Weekdays (non-holiday)	Winter Weekdays (non-holiday)	Weekends & Holidays	Hours per Year	% Total Hours
PG&E, E-19	Off-Peak	9:30 pm - 8:30 am	9:30 pm - 8:30 am	All hours	5,475	62%
	Partial -Peak	8:30 am - 12 pm, 6 pm - 9:30 pm	8:30 am - 9:30 pm	N/A	2,515	29%
	Peak	12 pm - 6 pm	N/A	N/A	771	9%
SCE, TOU8	Off-Peak	11 pm - 8 am	9 pm - 8 am	All hours	5,218	60%
	Mid-Peak	8 am - 12 pm, 6 pm - 11 pm	8 am - 9 pm	N/A	2,772	32%
	On-Peak	12 pm - 6 pm	N/A	N/A	771	9%
SDG&E, AL TOU	Off-Peak	10 pm - 6 am	10 pm - 6 am	All hours	4,717	54%
	Semi-Peak	6 am - 11 am, 6 pm - 10 pm	6 am - 5 pm, 8 pm - 10 pm	N/A	2,860	33%
	On-Peak	11 am - 6 pm	5 pm - 8 pm	N/A	1,183	14%

Given that the IOU tariffs distinguish between peak, part-peak, and off-peak time periods for pricing (albeit with slightly differing terminology), EtaGen recommends using

[15] PG&E E19: https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-19.pdf.
SCE TOU8: https://www.sce.com/NR/sc3/tm2/pdf/ce54-12.pdf.
SDG&E AL TOU: http://regarchive.sdge.com/tm2/pdf/ELEC_ELEC-SCHEDS_AL-TOU.pdf.

a load-weighted average number of hours per year for each of these three time periods. Table 7 shows the load-weighted number of hours per year and fraction of hours per year for each of the three time periods based on the IOU loads shown in Table 2 (the same IOU loads that were used in the SGIP Decision for determining the 8.4% line loss factor). It is important to note that the percent of hours per year of the partial-peak time period (30.3%) is nearly equivalent to the individual capacity factors for the highest capacity factor "peaker plants" shown in Table 5.

Table 7. Load-weighted time periods for the major IOUs.

Load-Weighted Avg.	Hours per Year	% Hours
Off-Peak	5,295	60.4%
Partial-Peak	2,656	30.3%
Peak	809	9.2%

Proposed FC NEM Emissions Factor & Methodology

EtaGen respectfully recommends setting the GHG Standard at 474 kg/MWh, based upon the following methodology:

Displaced Marginal Heat Rates before Line Losses

Off-peak:	7,329 Btu/kWh	(SGIP Decision methodology, 2014 CEC QFER data)
Peak:	10,951 Btu/kWh	(2014 CEC QFER data)
Part-peak:	9,140 Btu/kWh	(average of off-peak and peak heat rates)

Line Loss Factor

8.4% (SGIP Decision)

Displaced Marginal Heat Rates after Line Losses

Off-peak:	8,001 Btu/kWh
Peak:	11,955 Btu/kWh
Part-peak:	9,978 Btu/kWh

Weighting of Marginal Heat Rates

Off-peak: 60.4% of the hours

Peak: 9.2% of the hours

Part-peak: 30.3% of the hours

Average Displaced Heat Rate

8,956 Btu/kWh = 8,001 Btu/kWh x 60.4% + 11,955 Btu/kWh x 9.2% + 9,978 Btu/kWh x 30.3%

Natural Gas Emission Factor

53 kg CO2 per MMBTU of natural gas (SGIP Decision)

Average Displaced Emissions Factor

474.7 kg/MWh = 8,956 Btu/kWh x 53 kg/MMBTU x 1/1,000 units conversion

III. Conclusion

EtaGen appreciates the opportunity to provide comments on the GHG Standard for eligibility in the FC NEM program.

Respectfully submitted,

_____/s/_____

Adam Simpson, PhD
CPO & Founder
EtaGen, Inc.
186 Constitution Drive
Menlo Park, CA 94025
adam.simpson@etagen.com

Dated June 14th, 2017

JOINT FUEL CELL PARTIES:
NATIONAL FUEL CELL RESEARCH CENTER; BLOOM ENERGY; DOOSAN FUEL CELL AMERICA; LG FUEL CELL SYSTEMS
Comments on Fuel Cell Net Energy Metering Program
Greenhouse Gas Emission Standard
June 14, 2017
Request for Comments Issued June 1, 2017

The Joint Fuel Cell Parties (National Fuel Cell Research Center, Bloom Energy, Doosan Fuel Cell America, and LG Fuel Cell Systems, Inc.) submit these comments to the California Air Resources Board regarding the Fuel Cell Net Energy Metering Program Methodology for the Greenhouse Gas (GHG) Emission Standard.

I. Introduction

GHG-reducing fuel cells are a unique technology needed to complement and manage the high penetration of intermittent solar and wind, cornerstones for achieving the California 40% GHG emissions reduction goal by 2030.

Fuel cells address simultaneously the mitigation of CO_2, criteria air pollutants, and short-lived climate pollutants – co-benefits which are all direct or indirect goals of California's statewide Integrated Resource Planning. [1]

For CO_2 reduction, the high fuel-to-electrical efficiency of fuel cells significantly reduces the carbon emitted per megawatt-hour, and fuel cells have the capability to be configured for the capture, concentration, and storage of the resulting CO_2. The 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. Fuel cells are operating today on biogas, further contributing to the reduction of carbon emissions. This represents an immediate benefit that may be further expanded as the market for biogas and other renewable fuels (e.g., renewable hydrogen) evolves to make cost-effective and accessible renewable gas supplies widely available. Particularly important, as the renewable gas supply evolves, fuel cells are the only technology that will operate on renewable hydrogen with zero emissions, while at the same time enabling massive capture and storage of renewable power that would otherwise be curtailed. In this mode, the fuel cell will be a firm (24/7) 100% load-following renewable and zero emissions generator.

For criteria air pollutant reductions, fuel cells have the distinct attribute of emitting virtually zero criteria pollutants.

[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/General.aspx?id=7890

For short-lived climate pollutant reductions, fuel cells are an ideal technology to mitigate emissions because fuel cells:

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

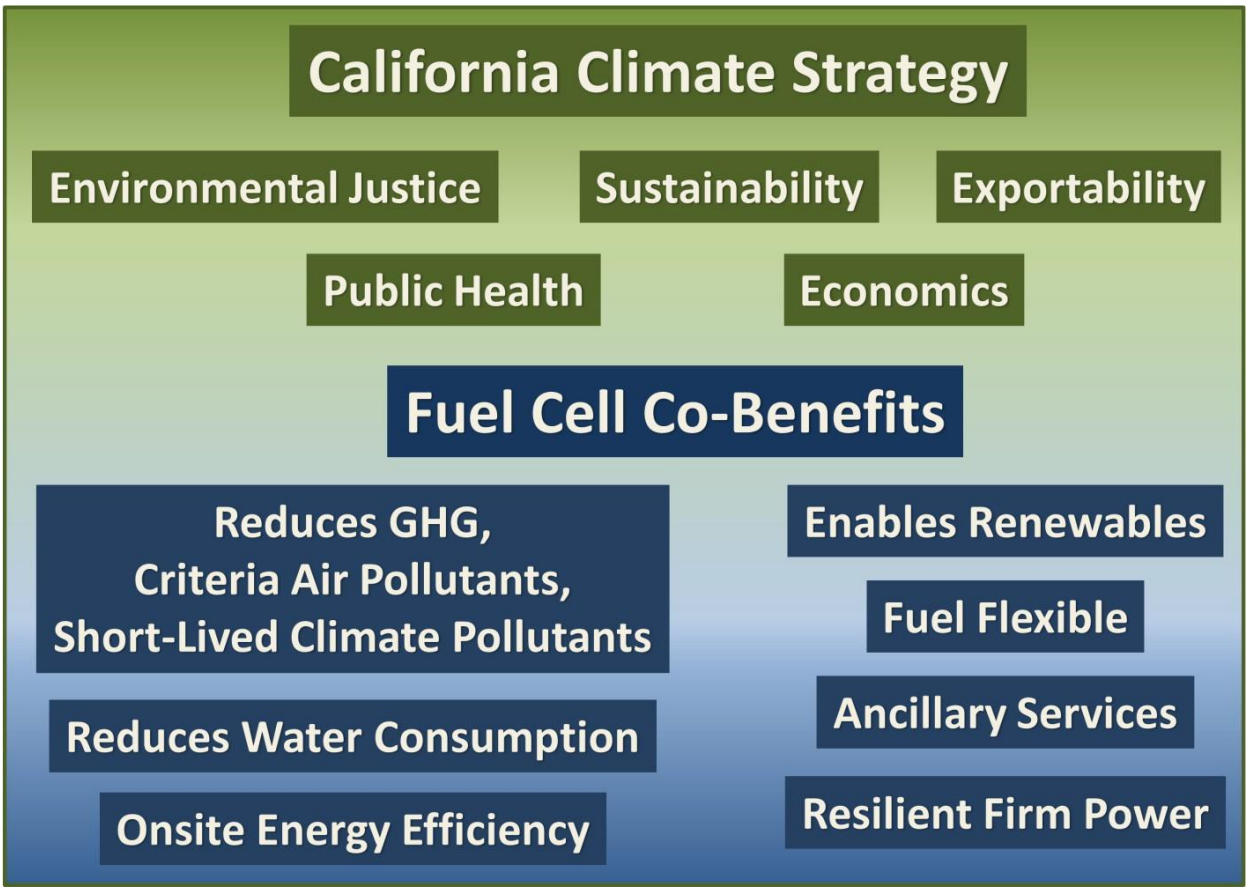


Figure 1: Climate Change Co-Benefits of Fuel Cells

Fuel cells have highly dynamic dispatch capabilities to (1) manage the diurnal and seasonal power demand variations, (2) handle intermittencies associated with solar and wind power generators, and (3) increase the maximum penetration of renewable resources that can be accommodated in the utility grid network. [2,3] These capabilities will result in maximum sustainability and additional GHG reductions through the integration of renewables with transportation electrification.

[2] 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.

[3] 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.

In addition to generating electrical power, stationary fuel cells have the capability to cogenerate a thermal product. This option, referred to as Combined Cooling, Heat, and Power (CCHP), is designed to capture and utilize the heat produced by the fuel cell for the provision of cooling, heat, hot water, or steam. It 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 judicious design, 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 displaced 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 uniquein 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]

Stationary fuel cells can be used to improve the quality of power provision and infrastructure where it is truly needed, while also contributing to cleaner air and improved health of citizens. In fact, fuel cells are suitable for citing near or even inside buildings, due to virtually zero pollutant emissions, an acoustically benign attribute, and the avoidance of the challenges related to permitting and zoning.

II. Comments

A. Key Considerations

1. <u>Marginal energy resource mix and displacement assumptions</u>

We strongly encourage the California Air Resources Board (CARB) to adopt the most technically accurate methodology for estimating the marginal energy resource mix that would be displaced by fuel cell systems operating under the net energy metering tariff.

The resource mix on the margin, i.e. the resource mix that an electricity provider would increase or decrease in response to energy demand, is the appropriate reference as the resource mix that the fuel cell would displace. Long-term and must take contracts (non-marginal resources) are not altered based upon the use of fuel cells on the customer's side of the meter.

[4] Darrow, K., et al., Catalog of CHP Technologies 2015: Available at http://www.epa.gov/sites/production/files/2015-07/documents/catalog_of_chp_technologies.pdf (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): p. 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.

Significant research and development related to the historical, current and future marginal energy resource mix in California has already been accomplished and is already in widespread use in support of California policy goals. We expressly encourage the use of statewide, complete annual hourly data (8760 hours) for characterizing the marginal energy resource mix for use in determining the GHG emissions requirements for fuel cell systems operating under the net energy metering tariff.

Several examples of technically accurate methodologies for marginal energy resource mix assessment are currently available for CARB to use directly or to pattern their analyses after. One example is the publicly available avoided cost calculator (ACC) developed by Energy + Environment Economics (E3).[7] This tool is used for assessing the impacts of utility energy efficiency measures (which are identical in effects on the grid to behind-the-meter power generation from a fuel cell). This ACC tool has been updated in 2016 with thorough documentation of the methodology that is publicly available for scrutiny and use.[8] A second example that accurately determined the hourly marginal resource mix for an entire year is the analysis accomplished by Itron in their 2014-2015 Self-Generation Incentive Program (SGIP) Impacts Evaluation.[9] Another example is that of WattTime, a nonprofit organization that combines real-time data from grid operators and the U.S. EPA to determine accurate marginal grid emissions that reflect the dynamics of the grid.[10]

All of these examples use data from the California Independent System Operator (CAISO), and other balancing authorities that serve California, to accurately calculate the statewide hourly marginal resource mix for an entire year (with various assumptions). These data should be available to CARB in this year and all subsequent years to enable a regular update of the GHG emissions standard (e.g., every three years as required by statute).

2. Role of renewable resources in the resource mix

We strongly encourage CARB to use grid operations data and analyses as described above to accurately account for the hourly contribution of renewable power generators to the marginal resource mix. All of the methodologies introduced above include thorough and accurate consideration of the renewable power contribution to the marginal resource mix.

[7] California Public Utilities Commission, Energy + Environment Economics, Energy Efficiency Calculator, available on-line at: https://www.ethree.com/public_proceedings/distributed-energy-resources-der-avoided-cost-proceedings/

[8] Brian Horii, et al., Energy + Environment Economics, Avoided Costs 2016 Interim Update, available on-line at: http://www.cpuc.ca.gov/General.aspx?id=10710, August 1, 2016.

[9] 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/

[10] http://watttime.org/

We discourage the use of an arbitrary renewable power generation factor, or a factor that scales with the renewable portfolio standard or annual renewable energy percentage, because none of these factors take into account the dynamics of renewable power generation on the grid or accurately reflect the contribution of these resources to power generation on the margin. Rather, we encourage the hourly marginal generation resource mix approaches outlined above together with regularly updated data from balancing authorities to accurately account for renewable power marginal contributions and dynamics on the grid.

Distributed generation and fuel cell systems do not prevent the building of renewable power plants. To the contrary, rather than displacing renewable resources, fuel cells are clean distributed generators that are required to facilitate the deployment of renewables. Based on grid simulation studies at UCI's Advanced Power and Energy Program, fueled, controllable and dynamic power generation such as that produced by fuel cells is required to achieve high levels of renewables.[11,12,13]

Fuel cell technology, with unprecedented low criteria pollutant emissions that enable installation even in the most restrictive of air quality permitting regions, also provides firm power generation to areas of significant grid congestion, preventing the need for additional centralized generation capacity and transmission equipment. These installations offset traditional grid infrastructure and support the installation of additional renewable power systems.

In addition to the direct displacement of central power emissions, firm clean power generation can provide the additional benefit of locally complementing the diurnal variation and intermittent generation profile of renewable power systems. Fuel cells can be used to stabilize this profile, and displace existing baseload, load-following, and peaking power plants that would otherwise be required to address the diurnal and intermittent characteristics associated with renewable power. If distributed, firm power generation resources are not installed, the grid will be forced to curtail renewable power during periods of low power demand or high renewable generation due to grid reliability concerns.

[11] *Dispatch of Fuel Cells as Transmission Integrated Grid Energy Resources to Support Renewables and Reduce Emissions* (2015). Applied Energy, Vol. 148, pp. 178-186 (Brendan Shaffer, Brian Tarroja, and Scott Samuelsen).

[12] *Exploration of the Integration of Renewable Resources into California's Electric Systems Using the Holistic Grid Resource Integration and Deployment (HiGRID) Tool* (2013). Energy, Vol. 50, pp. 353-363 (Josh Eichman, Fabian Mueller, Brian Tarroja, Lori Schell, and Scott Samuelsen).

[13] *Solar Power Variability and Spatial Diversification: Implications from an Electric-Grid Load Balancing Perspective* (2013). International Journal of Energy Research, pp. Vol. 37, No. 9, pp. 1002–1016 (Brian Tarroja, Fabian Mueller, and Scott Samuelsen).

3. **Line losses**

We recommend that line losses be included in the calculation of the GHG standard. It is technically accurate to use line losses in the calculations since all of themarginal resources that fuel cell systems would displace are subject to line losses that are required to deliver the power to the customer. The statewide loss factor should be a load weighted average of all utility service area loss factors based upon the most up to date California Energy Demand Adopted Forecast from the California Energy Commission.

4. **Grid response to small load changes**

We strongly encourage the use of marginal resource mix calculations based upon data for annual hourly performance of the California grid, as described above. If this approach is adopted, then the grid response to small load changes will be accurately assessed. We discourage the use of grid average emissions or any other factor that aggregates the emissions of resources that are not affected by small load changes (e.g., must-take or non-load following resources) with those that are actually on the margin. Because data on grid operations at hourly intervals is available, we also discourage using less granular data (e.g., monthly) for establishing the GHG Standard.

5. **Interpretation of "reduces greenhouse gas emissions compared to the electrical grid resources"[14]**

We encourage CARB to set a standard that clearly demonstrates that net energy metered fuel cell systems will reduce emissions compared to the marginal mix of grid resources that would otherwise have been dispatched. We recommend that the GHG standard be set one point lower than the exact level of emissions which the grid marginal resources would have produced, rather than at an arbitrarily lower number or arbitrarily decided percentage reduction.

B. Recommended Test Procedures

The inclusion of relevant greenhouse gases in the GHG standard methodology in addition to carbon is relevant and appropriate. We support the inclusion of N_2O and methane in the GHG standard, as the statute directs the Board to establish a GHG reduction (i.e. CO_2e) standard rather than a CO_2 reduction standard. We urge the Board to ensure that whatever testing is required for these additional GHGs are appropriate for use with stationary fuel cells. The methods presented in Slide 7 of the Fuel Cell Net Energy Metering GHG Emission Standards Workshop presentation were neither designed nor appropriate for measuring emissions from stationary power generation systems. Emissions of N_2O and methane from

[14] PU Code 2827.10(b)(2) The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid.

fuel cell systems are so low that they are typically below detection limits of standard testing. While these gases contribute negligibly to total GHG emissions from fuel cells, we understand the need for a direct comparison of emissions from fuel cells to that of marginal grid resources and will work with Staff to ensure that testing requirements are appropriate and accurate.

We strongly encourage type certification of fuel cell systems in a manner that is similar to the CARB distributed generation (DG) certification program. Individual on-site measurement of fuel cell system performance would be costly because the systems are small and distributed. Testing on a site by site basis would not add value.

III. Conclusion

GHG-reducing fuel cells are considered the cleanest, most efficient distributed energy resource for firm, controllable, and dispatchable power. When operating on natural gas, fuel cells reduce GHG compared to generation from the current grid and generate virtually zero criteria pollutant emissions. When using renewable bio fuels, they are carbon neutral. With renewable hydrogen as a fuel source, fuel cells emit zero GHGs. In addition, fuel cells operate in a virtual water balance, with no significant consumption of water in normal operations.

As the grid evolves, California will not reach high penetrations of renewables without a technology that provides clean, firm, renewable, and load-following power.

Establishing an accurate GHG standard for the net energy metering of fuel cell systems is very important to the near-term and long-term market for fuel cell systems. The GHG standard will assure and confirm the GHG reducing features of fuel systems compared to the mix of all other technologies that could have otherwise been used to provide the energy services (power, heating, cooling) that clean distributed fuel cell systems provide. The GHG standard can also facilitate the evolution of fuel cell installations over time to make them increasingly GHG emissions free, as the standard is updated every 3 years in an accurate manner. The most accurate way to establish such a GHG emissions standard is to use and build upon the significant previous scientific research and development that has already occurred todetermine the marginal resource mix. The methodology used by CARB to establish the GHG emissions standard should assess the annual hourly (all 8760 hours of the year) marginal resource mix based upon grid operations data in the appropriate year, as described above.

The Joint Fuel Cell Parties appreciate the opportunity to comment on the development of a Fuel Cell Net Metering GHG Standard through the above recommendations to facilitate this evolution.

Sincerely,

/s/ *Jack Brouwer*

Dr. Jacob Brouwer, Associate Director
National Fuel Cell Research Center
Associate Professor of Mechanical and Aerospace Engineering
University of California, Irvine

/s/ *Rodger McKain*

Rodger McKain
Senior Consultant
LG Fuel Cell Systems, Inc.

/s/ *Derek Hildreth*

Derek Hildreth
Head of North American Sales and Strategy
Doosan Fuel Cell America

/s/ *Erin Grizard*

Erin Grizard
Senior Director, Regulatory and Government Affairs
Bloom Energy

DATE: November 15, 2017

TO: All Interested Parties

SUBJECT: **Notice of Public Workshop to discuss Greenhouse Gas Emission Standards for the Fuel Cell Net Energy Metering Program administered by the California Public Utilities Commission**

California Air Resources Board (CARB/Board) staff invite you to participate in a public workshop to discuss the development of greenhouse gas (GHG) emission standards for fuel cell "customer-generators" participating in the California Public Utilities Commission's (CPUC) Fuel Cell Net Energy Metering (NEM) Program. CARB staff is developing a regulation to establish GHG emission standards for the program to meet its responsibilities under Assembly Bill 1637 (Low, Stats. 2016, ch. 658).

AB 1637 directs CARB to establish a schedule of annual GHG emission standards for the Fuel Cell NEM program in consultation with the California Energy Commission (CEC). CARB is further directed to update the schedule of standards every three years.

The emission standards are to ensure that participating fuel cell resources reduce GHG emissions relative to the displaced electrical grid resources, including any renewable resources, and account for both procurement and operation of the electrical grid. Staff will use the information gathered at this workshop and throughout the rulemaking process to develop a proposed regulation and supporting rulemaking documents.

The public workshop will be held at the time and location shown below:

Date:	November 28, 2017
Time:	2:00 PM
Location:	Coastal Hearing Room Cal/EPA Building 1001 I Street, 2nd Floor Sacramento, CA 95814
Directions:	http://www.calepa.ca.gov/EPABldg/location.htm

Website and Meeting Materials

The workshop will be webcast for those unable to attend in person. The webcast can be accessed on the day of the workshop at: https://video.calepa.ca.gov/. During the workshop, the webcast audience may submit questions and comments using the following e-mail address: coastalrm@calepa.ca.gov.

An agenda and other materials for the workshop will be posted prior to the workshop on CARB's Fuel Cell Net Energy Metering, Greenhouse Gas Emission Standard webpage, at https://www.arb.ca.gov/energy/nem/nem.htm.

If you require special accommodation for the workshop or need this document in an alternate format (e.g. Braille, large print) or another language, please contact Keith Roderick, Air Resources Engineer, at (916) 327-7838 or via e-mail at keith.roderick@arb.ca.gov as soon as possible, but no later than 5 business days before the workshop. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

We welcome and appreciate your participation in this public workshop. If you have any questions regarding this workshop or the regulatory amendment process, please contact Keith Roderick, Air Resources Engineer, at (916) 327-7838, or by e-mail at keith.roderick@arb.ca.gov.

Sincerely,

/s/

Wes Ingram, Chief
Project Assessment Branch

cc: Dave Mehl, Manager
Energy Section

Keith Roderick
Air Resources Engineer
Energy Section

FUEL CELL NET ENERGY METERING GHG EMISSION STANDARDS

November 28, 2017

Governing Legislation

Assembly Bill 1637 (Low, 2016):

- Effective January 1, 2017
- Extends the CPUC's Fuel Cell Net Energy Metering (NEM) program tariff through 2021
- Increases individual system eligibility to 5 MW, and extends overall program cap to 500 MW over existing installed capacity
- Directs ARB to establish annual GHG emission reduction standards for "customer-generators" participating in Fuel Cell NEM program
- GHG standards are to reduce emissions relative to grid resources, including renewable resources, and account for both procurement and electrical grid operation

Fuel Cell NEM Background

- Program designed to continue market growth for on-site fuel cell electrical generation
- Oversight by CPUC with IOU program administration
- Customer-generators receive generation rate credits and avoid "nonbypassable" utility charges for onsite energy consumption
- Incentives amount to approximate $200k/MW of installed capacity
- Historical annual growth of about 8 MW of installed capacity (total of 97 MW to date)

Fuel Cell NEM Background Cont'd

- Eligible fuel cell technologies must reduce GHG emissions and meet ARB's Distributed Generation (DG) Certification Program requirements for criteria pollutants
- Program works in tandem with CPUC's SGIP, which provides financial incentives for various DG technologies
- Prior legislative directive to use the GHG standard developed for the SGIP for the Fuel Cell NEM (350 kg CO2/MWh)

Key Considerations

- Marginal energy resource mix and displacement assumptions
- Role of renewable resources in the resource mix
- Line Losses
- Grid response to small load changes
- Utility procurement considerations and RPS program progress
- Interpretation of “emission reduction versus grid resources”

Stakeholder Feedback

- Base standard on model that predicts marginal mix
- Include line loss savings
- Revise testing parameters

Emission Standards

- Based on CPUC's Avoided Cost Calculator
- Includes line loss savings

Year	Annual GHG Emission Standard (kg CO2e/MWh)
2017	375
2018	364
2019	353
2020	342
2021	337

Recommended Test Procedures

- Staff will include advisory test methods for carbon dioxide and methane in the staff report:

  - Carbon Dioxide: ARB Test Method 100
  - Methane: ARB Test Method 100

Regulation Development Schedule

Ongoing	Discussions with CEC and CPUC staff
Fall 2017	Conduct public workshop
Winter 2017	Start of formal 45-day public review period for proposed regulation
Spring 2018	ARB Board Meeting

Contact Information

Dave Mehl, Manager
Energy Section
(916) 323-1491
dave.mehl@arb.ca.gov

Keith Roderick
Energy Section
(916) 327-5548
keith.roderick@arb.ca.gov

Draft Regulation Order

Subchapter 10. Climate Change
Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions
Subarticle 5.2. Fuel Cell Net Energy Metering
Greenhouse Gas Emission Standard

§ 95408. Purpose

The purpose of this regulation is to implement section 2827.10(b) of the Public Utilities Code.

§ 95409. Applicability

The provisions of this Article shall apply to participants in the Fuel Cell Net Energy Metering program.

§ 95410. Definitions and Acronyms

(a) For the purposes of this Article, the following definitions apply.

(1) **"Carbon Dioxide equivalent or CO2e"** means the 100-year global warming potential values for greenhouse gases as stated in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change in section 2.10.2.

(2) **"Greenhouse Gas or GHG Emissions"** means the combined emissions of carbon dioxide and methane.

(3) **"Megawatt-hour or MWh"** means a unit of energy equivalent to one megawatt of electricity in alternating current form supplied for one hour.

§ 95411. Greenhouse Gas Emission Standard

The annual greenhouse gas emission standards for eligibility in the Fuel Cell Net Energy Metering Program shall be:

Year	Annual GHG Emission Standard (kg CO2e/MWh)
2017	375
2018	364
2019	353
2020	342
2021	337

December 20, 2017

Via online filing

Dave Mehl
Manager, Energy Section
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Subject: Comments on Greenhouse Gas Emission Standards for the Fuel Cell Net Energy Metering Program

Dear Mr. Mehl:

Sierra Club and Earthjustice write to express our serious concerns with ARB's proposed greenhouse gas ("GHG") emissions standard for Fuel Cell Net Energy Metering ("FC-NEM"). Assembly Bill ("AB") 1637 tasked ARB with establishing a GHG emissions standard that would ensure GHG reductions from qualifying fuel cells. The bill analysis for AB 1637 states that the new FC-NEM GHG standard would improve on the existing GHG standard in the Self-Generation Incentive Program ("SGIP") and "is expected to be lower than the existing [SGIP] standard at the outset."[1] Yet in contravention of AB 1637's legislative intent, the FC-NEM GHG standard proposed by ARB is significantly higher than the SGIP standard. The 2017 first-year emissions rate for SGIP-eligible fuel cells is 332 kg CO_2/MWh; for FC-NEM, by contrast, the proposed limit is only 375 kg CO_2/MWh.[2] Additionally, all SGIP resources consuming natural gas must use a minimum of 25 percent biomethane in 2018, increasing rapidly to 50 percent by 2019 and to 100 percent by 2020.[3] ARB's proposed standard contains no renewable natural gas requirements.

---

[1] Bill Analysis Before the Assembly Committee on Natural Resources, p. 2 (Aug. 30, 2016), available at https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160AB1637.

[2] *Compare* Decision ("D.")15-11-027, Decision Revising the Greenhouse Gas Emission Factor to Determine Eligibility to Participate in the Self-Generation Incentive Program Pursuant to Public Utilities Code Section 379.6(b)(2) as Amended by Senate Bill 861, Appendix B (Nov. 23, 2015), available at http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M156/K044/156044151.PDF *with* ARB Draft Regulation Order § 95411 (Nov. 15, 2017), available at https://arb.ca.gov/energy/nem/draft_regulation_order_11-28-17.pdf.

[3] D.16-06-055, Decision Revising the Self-Generation Incentive Program Pursuant to Senate Bill 861, Assembly Bill 1478, and Implementing Other Changes, p. 21 (June 23, 2016), available at http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M163/K928/163928075.PDF.

Given that the California Public Utilities Commission ("CPUC") had a similar mandate to ensure SGIP resources would "achieve reductions in emissions of greenhouse gases,"[4] there is no legitimate justification for ARB to propose a substantially more permissive GHG standard for FC-NEM. Indeed, by providing retail rates for energy production from natural gas, ARB estimates that program incentives will amount to approximately $200,000 per megawatt, or $100 million for FC-NEM as a whole.[5] In exchange for this significant subsidy, eligible projects should provide meaningful environmental value and facilitate achievement of California's aggressive GHG reduction requirements. Unfortunately, as currently proposed, the FC-NEM GHG standard amounts to a counterproductive subsidization of fossil fuels that will increase GHG pollution.

To ensure the FC-NEM program achieves meaningful GHG reductions, Sierra Club and Earthjustice recommend ARB make the following changes to the proposed GHG standard:

1) Require Annual Emissions Verification and Testing to Maintain Eligibility for FC-NEM.

Verification and testing are critical to the integrity of the FC-NEM program. The electrical conversion efficiency of fuel cells degrades over time. Annual verification and re-certification are fundamental to ensuring that resources that remain in the program continue to provide GHG reductions as the grid becomes increasingly decarbonized. Accordingly, the GHG standard should be revised to include a requirement that ARB will annually verify the emissions rate of fuel cells that wish to remain eligible for FC-NEM to ensure the resource qualifies for the upcoming year's emission standard. ARB can then communicate the results of emissions testing to the CPUC to ensure resources that no longer meet the GHG standard do not receive retail rate payments for exported energy.

2) Account for Actual Renewable Penetration in Setting GHG Threshold.

The proposed GHG standard was derived from the E3 Avoided Cost Model. The model assumes that renewable penetration increases in accordance with minimum Renewables Portfolio Standard ("RPS") requirements, with a 27 percent RPS assumed in 2017, a 29 percent RPS in 2018, a 31 percent RPS in 2019, a 33 percent RPS in 2020, and a 35 percent RPS in 2021.[6] The reality is much different. California's Investor-Owned Utilities ("IOUs") are well ahead of minimum RPS procurement requirements. The CPUC now forecasts that average actual IOU RPS compliance will be 38 percent in 2017, 42 percent in 2018, 47 percent in 2019 and 50 percent in 2020.[7]

---

[4] Cal. Pub. Util. Code § 379.6(b)(1).

[5] ARB Presentation, *Fuel Cell Net Energy Metering GHG Emissions Standards,* slide 3 ("Fuel Cell NEM Background") (Nov. 28, 2017), available at https://arb.ca.gov/energy/nem/fc_nem_presentation_11-28-17.pdf.

[6] 2017 Avoided Cost Model, Emissions Tab, Row 36, available at http://www.cpuc.ca.gov/General.aspx?id=5267.

[7] CPUC RPS Homepage, available at http://www.cpuc.ca.gov/RPS_Homepage/.

The failure to account for actual RPS deployment violates the requirements of the FC-NEM statute. California Public Utilities Code Section 2827.10(b)(2) provides that "[t]he greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource … reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid."[8] In neglecting to account for actual IOU procurement of renewable resources, the proposed GHG standard is inconsistent with this requirement. Because the proposed threshold is premised on a much lower level of RPS procurement than is actually deployed, application of the current standard will result in significant increases in GHG emissions. The proposed GHG standard for FC-NEM must be revised to account for the higher existing and forecast percentages of IOU RPS procurement to ensure FC-NEM resources actually result in GHG emissions reductions.

3) Account for Renewable Curtailment in Setting GHG Threshold.

FC-NEM would facilitate the addition of 500 MW of baseload fossil fuel resources onto the grid. Yet the E3 avoided cost calculator used to derive the GHG eligibility threshold assumes that "natural gas is the marginal fuel in all hours."[9] This assumption improperly ignores the reality of increases in renewable curtailment, curtailment that baseload resources like fuel cells would exacerbate. The California Independent System Operator ("CAISO") reported in May 2017 that renewable curtailment rose from 187,000 MWh in 2015 to over 308,000 MWh in 2016 and that, "during certain times of the year, it's not unusual to curtail 20 to 30 percent of solar capacity."[10] Reliance on a model that ignores renewable curtailment serves to artificially inflate the proposed GHG standard. This standard must be revised downward to account for renewable curtailment that is both currently projected to occur, and that would be exacerbated by the potential addition of 500 MW of baseload fuel cells.

4) Require FC-NEM Resources to Increasingly Utilize Renewable Natural Gas.

While legislation requiring the CPUC to update its GHG eligibility threshold for SGIP did not require fuel cells to utilize renewable natural gas, the CPUC nonetheless phased-in a renewable natural gas requirement because "California's long term GHG reduction goals require actions that will push natural gas fueled technologies further in their GHG reductions. The need to support market transformation of zero emission fuels argues for adopting a zero emission fuel blending requirement in SGIP."[11] The SGIP biogas requirements phase-in renewable natural gas as follows:

[12]

[8] Cal. Pub. Util. Code § 2827.10(b)(2).
[9] E3 Avoided Costs 2017 Interim Update, p. 34 (Sept. 11, 2017), available at http://www.cpuc.ca.gov/General.aspx?id=5267 (2017 Avoided Cost Interim Update Documentation).
[10] CAISO, Fast Facts, Impacts of Renewable Energy on Grid Operations, available at https://www.caiso.com/Documents/CurtailmentFastFacts.pdf.
[11] D.16-06-055, p. 20 (June 23, 2016).
[12] D. 16-06-055, p. 21 (June 23, 2016).

Table 3: Biogas Fuel Blending Requirement

Program Application Year	% Biogas Requirement
2016	0%
2017	10%
2018	25%
2019	50%
2020	100%

ARB should apply the same requirements here. Indeed, the need for renewable natural gas requirements applies with greater force today than when the CPUC issued its SGIP Decision. Since then, California passed Senate Bill ("SB") 32, which set the aggressive requirement of reducing GHG pollution to 40 percent below 1990 levels by 2030.[13] ARB's recently adopted 2017 Climate Change Scoping Plan also recognized that "[r]educing demand for natural gas, and moving toward renewable natural gas, will help California achieve its 2030 climate target."[14] Yet by failing to require renewable gas, the proposed GHG standard would *increase* natural gas demand by incentivizing deployment of 500 MW of natural gas-reliant distributed resources. Adding renewable natural gas requirements similar to the CPUC's SGIP is needed to ensure FC-NEM reduces the demand for fossil gas and thereby facilitates achievement of California's aggressive 2030 GHG reduction requirement.

Thank you for your consideration of these comments. We look forward to working with ARB to develop a more robust GHG emissions standard.

Respectfully,

/s/ *Alison Seel*

Alison Seel
Sierra Club
2101 Webster St., 13th Floor
Oakland, CA 94612
Telephone: (415) 977-5737
Email: alison.seel@sierraclub.org

Matthew Vespa
Earthjustice
50 California St., Suite 500
San Francisco, CA 94111
mvespa@earthjustice.org
Telephone: (415) 217-2123
Email: mvespa@earthjustice.org

[13] SB 32, The California Global Warming Solutions Act of 2006: emissions limit (Sept. 08, 2016).
[14] ARB, California's 2017 Climate Change Scoping Plan, p. ES-11 (Nov. 2017).

Comments by EtaGen on the Second Public Workshop of the GHG Emissions Reduction Standard for the Fuel Cell NEM Program

Introduction

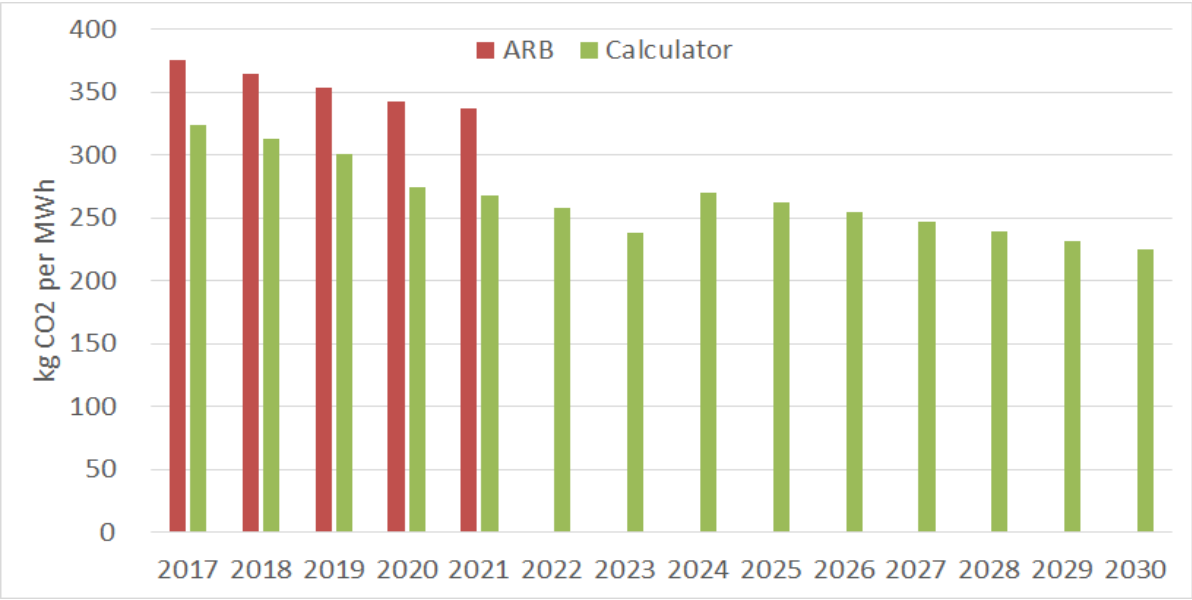
Driven by its mission to bring affordable, reliable, and clean power to the world, EtaGen has developed advanced power generation technology that unlocks the full potential of distributed generation. EtaGen's linear generator technology uses a low-temperature reaction of air and fuel to drive magnets through coils to efficiently produce electricity -- providing customers an unmatched combination of economic value, resiliency, and GHG savings.

EtaGen has been an active participant in these proceedings and appreciates the opportunity to submit comments in response to the Second Workshop held by the Air Resources Board ("ARB").

Comments

EtaGen asks for clarification on several discrepancies between the CPUC's Avoided Cost Calculator ("Calculator") and the avoided emissions factors proposed by ARB in the Draft Regulation Order.

The plot below shows the avoided emissions factors from the Calculator (tab "Emissions", row 60, and starting in column D, converted to kg/MWh below) and those proposed by ARB. Why do the emissions factors not match? Why do the avoided emission factors from the calculator increase in 2024? What, if any, inputs to the Calculator were modified by ARB? What are the transmission and distribution losses that are used? In order for stakeholders to be able provide constructive feedback, it would be especially useful for ARB to state these assumptions.



In addition to the aforementioned questions about the Calculator used by ARB, EtaGen strongly disagrees with discounting the avoided emission factors by the Renewable Portfolio Standard ("RPS") percentage. Discounting the avoided emission factor by the RPS percentage has been

proposed in CPUC rule makings based on the argument that, since behind-the-meter ("BTM") fuel-based generation reduces demand on the grid, the IOUs can purchase less renewable energy in order to meet their RPS targets. However, this logic is inherently flawed for two reasons. First, pursuant to California Public Utilities Commission ("CPUC") rulemaking, BTM generation is not considered in IOU capacity planning processes and, therefore, could not impact renewable procurement.[1] Second, in 2013, passage of Assembly Bill 327 changed the law such that the RPS percentage is now a floor, not a cap, thereby giving utilities the authority to contract/purchase an amount of renewable energy greater than the mandated RPS percentage (in the event that there is lower demand).[2]

Just as reductions in demand from energy efficiency improvements do not impact renewable energy procurement, reductions in demand from BTM fuel-based generation also do not impact renewable energy procurement. For these reasons, it would be improper and inaccurate to include any adjustments to the avoided emissions factors based on the RPS or any other perceived potential impacts on renewables procurement.

Conclusion

In order to provide transparency around the avoided emission factors and encourage more productive feedback from stakeholders, EtaGen believes that it is important for the ARB to explain the following:

1) The assumptions and inputs used by ARB to determine the proposed avoided emissions factors (e.g., modifications to the Calculator, line losses, etc…)
2) The reasoning for assuming that BTM generation displace long-term renewable procurement by IOUs

EtaGen appreciates the opportunity to provide feedback to the ARB and looks forward to their response.

Respectfully submitted,

_____/s/_____

Adam Simpson, PhD
CPO & Founder
EtaGen, Inc.
186 Constitution Drive
Menlo Park, CA 94025
adam.simpson@etagen.com

Dated December 20, 2017

---

[1] *See* Order Instituting Rulemaking to Integrate and Refine Procurement Policies and Consider LongTerm Procurement Plans, R. 13-12-010 (Dec. 19, 2013),*available at* http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M147/K780/147780118.PDF

[2] *See* Assembly Bill 327, at page 5 of 32, http://www.leginfo.ca.gov/pub/13-14/bill/asm/ab_0301-0350/ab_327_bill_20131007_chaptered.pdf

JOINT FUEL CELL PARTIES:
NATIONAL FUEL CELL RESEARCH CENTER; BLOOM ENERGY;
DOOSAN FUEL CELL AMERICA; LG FUEL CELL SYSTEMS
Comments on Fuel Cell Net Energy Metering Program Second Public Workshop:
Greenhouse Gas Emission Standards
December 22, 2017
Request for Comments Issued November 28, 2017

The Joint Fuel Cell Parties (National Fuel Cell Research Center, Bloom Energy, Doosan Fuel Cell America, and LG Fuel Cell Systems, Inc.) submit these comments to the California Air Resources Board (CARB) regarding the Fuel Cell Net Energy Metering (NEM) Program Greenhouse Gas (GHG) Emission Standards.

I. Introduction

GHG-reducing stationary fuel cell technology is a unique technology needed to complement and manage the increasingly high penetration of intermittent solar and wind power generation in California. Together, stationary fuel cell power, solar power, and wind power are the cornerstones for achieving California's 40% GHG emissions reduction goal by 2030, and simultaneously mitigating CO_2, criteria air pollutants, and short-lived climate pollutants – co-benefits which are all direct or indirect goals of California's statewide Integrated Resource Planning efforts.[1]

The Joint Fuel Cell Parties (Joint Parties) thank CARB staff for the work to develop a GHG emission reduction standard for the Fuel Cell NEM Program. In the following comments, the Joint Parties offer requests for refinements to the proposal put forth in the November 2017 workshop on this topic, and look forward to continued productive conversations with staff to ensure that an accurate standard is set.

II. Comments

A. Key Considerations

1. <u>Development of a CARB methodology</u>

The Joint Parties strongly encourage the California Air Resources Board to adopt the most technically accurate methodology for estimating the marginal energy resource mix that would be displaced by fuel cell systems operating under the NEM tariff, as

[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/General.aspx?id=7890

provided by statute. The Joint Parties have previously recommended using the avoided cost calculator as a resource for hourly emissions data, and would like to clarify that the recommendation was not to exclusively use the avoided cost calculator to calculate the GHG emission standard. The CARB fuel cell NEM website refers to "Marginal Annual Emissions in the Avoided Cost Calculator" and the "Long-Run Marginal Emissions Rate" tab. Because the tab did not exist in June 2017 when the Joint Parties submitted comments and, given that the rate is explicitly designed and designated as a long-run marginal emissions factor, the Joint Parties find that this "Long-Run Marginal Emissions Rate" is not applicable to the fuel cell annual standard.

The Joint Parties have encouraged use of the hourly marginal generation resource mix in the avoided cost calculator, together with regularly updated data from balancing authorities, as a method to accurately account for renewable power marginal contributions and grid dynamics. Based on CARB's expertise, the Joint Parties do not encourage this as a substitute for a methodology developed by CARB. Rather, the Joint Parties request that CARB calculate the fuel cell GHG emission standard by leveraging the data on hourly generation heat rates available in the avoided cost calculator, and without the RPS adjustment.

Role of renewable resources in the resource mix

The Joint Parties strongly recommend that CARB use grid operations data and analyses as described above to accurately account for the hourly contribution of renewable power generators to the marginal resource mix. The Joint Parties oppose the use of the factor that scales with the renewable portfolio standard that is included in the avoided cost calculator methodology for the purpose of the fuel cell NEM annual GHG standard. This factor does not account for the dynamics of renewable power generation on the grid at a specific time, nor does it accurately reflect the contribution of this factor to power generation on the margin and therefore is not applicable to the fuel cell standard.

Fuel cell systems do not preclude the building of renewable solar and wind power plants. On the contrary, controllable and dynamic fuel cell power generation is required to facilitate, manage, and expand the deployment of intermittent solar and wind resources.[2,3,4]

[2] *Dispatch of Fuel Cells as Transmission Integrated Grid Energy Resources to Support Renewables and Reduce Emissions* (2015). Applied Energy, Vol. 148, pp. 178-186 (Brendan Shaffer, Brian Tarroja, and Scott Samuelsen).

[3] *Exploration of the Integration of Renewable Resources into California's Electric Systems Using the Holistic Grid Resource Integration and Deployment (HiGRID) Tool* (2013). Energy, Vol. 50, pp. 353-363 (Josh Eichman, Fabian Mueller, Brian Tarroja, Lori Schell, and Scott Samuelsen).

[4] *Solar Power Variability and Spatial Diversification: Implications from an Electric-Grid Load Balancing Perspective* (2013). International Journal of Energy Research, pp. Vol. 37, No. 9, pp. 1002–1016 (Brian Tarroja, Fabian Mueller, and Scott Samuelsen).

The decision to install renewable power generation is primarily made today on the basis of applicable policy framework (e.g., GHG reduction goals) and lowest cost of energy.[5] Since the cost of solar power (especially) and wind power have dropped significantly in recent years, more and more of these resources will be adopted and installed regardless of fuel cell generating capacity. Fuel cell technology is therefore substituting for the higher emitting, combustion-based load following and peaker-plants on the grid today.

Even so, the fuel cell NEM policy calls for an annual standard based on the operation of the grid during each year. The procurement of renewables in the future does not impact how that grid operates today. The annual standard will include renewables that are currently operating.

Fuel cell systems, with virtually zero emission of criteria pollutants, enable continuous power generation in the most restrictive of air quality permitting regions, and provide firm power generation to areas of significant grid congestion, thereby avoiding the need for additional centralized and peaking generation capacity, and associated transmission and distribution infrastructure. In addition, in as much as these fuel cell systems use renewable fuels, they contribute to additional GHG reductions and to renewable portfolio standards. Pless et al.[6] thoroughly analyzed the economics of investment in distributed energy resources that included natural gas (NG) and renewable (RE) power generators, and concluded that "The findings consistently suggest that NG-RE hybrid distributed systems are more favorable investments in the applications studied relative to their single-technology alternatives when incentives for renewables are available."[7] This economic argument bolsters the technical argument that distributed fuel cell systems can operate dynamically to complement intermittent renewable energy systems.

2. <u>GHG emission standard should be updated every three years as mandated</u>

In the November 28 workshop, CARB proposed a period of five years for updating the GHG emission standard. This assumes that the standard is only needed for each year that a new project can be interconnected under the NEM tariff, through 2021. Chaptered Assembly Bill 1637 mandates that the State Air Resources Board *"shall establish a schedule of annual greenhouse gas emissions reduction standards for a fuel cell electrical generation resource for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a) and shall update the schedule* ***every three years***

[5] Afanasyeva, Svetlana, Breyer, Christian, Engelhard, Manfred, The Impact of Cost Dynamics of Lithium-Ion Batteries on the Economics of Hybrid PV-Battery-Gas Turbine Plants and the Consequences for Competitiveness of Coal and Natural Gas-Fired Power Plants, 10th International Renewable Energy Storage Conference, March 15-17, 2016.

[6] Pless, Jacquelyn, Arent, Douglas J., Logan, Jeffrey, Cochran, Jaquelin, Zinaman, Owen, Quantifying the value of investing in distributed natural gas and renewable electricity systems as complements: Applications of discounted cash flow and real options analysis with stochastic inputs. Energy Policy, volume 97, pp. 378–390, 2016.

[7] *Id.*

with applicable standards for each intervening year."[8] The Joint Parties urge CARB to follow this mandate in the GHG emission standard that it determines for two reasons. First, releasing updates to the standard in three-year increments will allow for more accurate estimates of the grid mix at that time. Second, because the tariff will be available to a customer for the life of a project (often more than ten years), this standard will need to be updated every three years for the duration of all projects interconnected under this provision, beyond 2021.

3. **Rollover of GHG emission reductions**
   While fuel cell generation systems operate over many years, system efficiencies are typically not flat. Instead they can follow a saw-tooth performance characteristic with an efficiency profile that slowly degrades over time, and then benefits from spikes in efficiencies as system components are replaced. The Joint Parties request that, recognizing the way that fuel cells operate, if a fuel cell system provides a reduction in emissions beyond the required standard for a given year, these additional emission reductions should accumulate and be available for compliance in future years. This concept is similar to the banking across compliance periods that is allowed for procurement under the Renewable Portfolio Standard program and for emissions reductions under Cap and Trade. Similar to these programs, allowing this for fuel cell systems has the benefit of encouraging early action in GHG reductions beyond the level of the standard, which is critical to the State's ability to meet its near-term GHG reduction goals, while also accommodating the distinctive operational profile of fuel cell systems.

4. **CARB authority for regulating emissions**
   The Joint Parties recommend that CARB, as the expert in the operation of fuel cells and regulation of emissions, should establish and enforce the guidelines for how fuel cell systems meet the GHG standard. The Joint Parties believe that CARB does indeed have the statutory authority under which to do this. Public Utilities Code Section 2827.10 (b)(1) states that CARB is to establish "greenhouse gas emissions reduction standards for a fuel cell electrical generation resource." The specific reference to the fuel cell as the resource to achieve the mandated GHG reductions provides authority in describing how fuel cell systems will meet the standard provided.

III. Conclusion

Establishing an accurate GHG standard for the net energy metering of fuel cell systems is critically important to the near-term and long-term market for fuel cell systems. A GHG

[8] Assembly Bill No. 1637, CHAPTER 658: *An act to amend Sections 379.6 and 2827.10 of the Public Utilities Code, relating to energy.* [Approved by Governor September 26, 2016. Filed with Secretary of State September 26, 2016.]

standard defined and enforced by CARB will assure and confirm the utilization of the superior benefits of the GHG-reducing features of fuel systems versus the mix of all other technologies that would have otherwise been used to provide the energy services of power, heating, and cooling. An accurate GHG standard can also support and facilitate the evolution of fuel cell systems to make them increasingly GHG emissions-free, particularly if the standard is updated every three years. The most accurate methodology to establish such a GHG emissions standard is to use and build upon the significant previous scientific research and development that has already occurred to determine the marginal resource mix. The methodology used by CARB to establish the GHG emissions standard should assess the annual hourly (all 8760 hours of the year) marginal resource mix based upon data from balancing authorities in the appropriate year, as described above.

The Joint Fuel Cell Parties appreciate the opportunity to comment on the development of a Fuel Cell Net Metering GHG Standard through the above recommendations to facilitate this evolution.

Sincerely,

/s/ *Jack Brouwer*

Dr. Jacob Brouwer, Associate Director
National Fuel Cell Research Center
Professor of Mechanical and Aerospace Engineering
University of California, Irvine

/s/ *Rodger McKain*

Rodger McKain
Senior Consultant
LG Fuel Cell Systems, Inc.

/s/ *Derek Hildreth*

Derek Hildreth
Head of North American Sales and Strategy
Doosan Fuel Cell America

/s/ *Erin Grizard*

Erin Grizard
Senior Director, Regulatory and Government Affairs
Bloom Energy

Bloomenergy®

December 22, 2017

Dave Mehl
California Air Resources Board
1001 I Street
Sacramento, CA 95814
VIA Online submission

Dear Dave,

Bloom Energy (Bloom) thanks ARB staff for their work in developing the greenhouse gas (GHG) emissions reduction standard for the fuel cell net energy metering (FC NEM) tariff. We appreciate the reliance on hourly marginal emissions factors that reflect grid operations in a granular way and the inclusion of GHGs beyond CO_2 in the standard. Below we request two adjustments to the current proposal and more information on how non-CO_2 GHGs are incorporated.

Limit to a three-year outlook

Bloom requests that the proposed regulation be amended to include only GHG emissions reduction standards for three years, as stipulated in statute, rather than providing five years of standards through 2021. The statute that established the process for setting the GHG reduction standards that fuel cells must meet in order to interconnect under the fuel cell net energy metering tariff requires that *"The State Air Resources Board, in consultation with the Energy Commission, shall establish a schedule of annual greenhouse gas emissions reduction standards for a fuel cell electrical generation resource … and shall update the schedule every three years with applicable standards for each intervening year."*[1] Additionally, statute states that *"[a] fuel cell customer-generator shall be eligible for the tariff established pursuant to this section only for the operating life of the eligible fuel cell electrical generating facility."*[2]

This means that, while the tariff availability to newly installed projects currently expires on December 31, 2021, projects already on the tariff will remain on the tariff for their full operating lifetime. Bloom's projects operate for at least 10 years, therefore standards must be set beyond 2021 (in three year increments) in order to provide clear direction on continued tariff eligibility. Having regular and frequent updates ensures that fuel cells will continue to reduce GHGs as the grid changes and also allows the ARB to provide accurate values based on near term information, rather than heavily relying on long term forecasts in a rapidly changing energy market.

Remove Renewable Portfolio Standard (RPS) adjustment

Bloom expressly disagrees with the use of an adjustment to the marginal generation resource assessment that scales with the RPS because it makes the

[1] Public Utilities Code 2827.10 (b) (1)
[2] Public Utilities Code 2827.10 (g)

GHG emissions reduction standard more speculative and less accurate and is inconsistent with the statutory direction to set annual standards. The recently published methodology in the avoided cost calculator incorporates an RPS adjustment in what is labeled as a "Long Run Marginal Emissions Factor". The FC NEM tariff requires an annual standard that a project must meet each year to ensure that project continues to reduce GHGs every year as grid operations change and California's policies drive further adoption of low carbon energy sources. Because this standard will be applied to each project each year and is updated over the lifetime of a project, speculation about the grid emissions over the full project lifetime is not needed. The process of regular and frequent updates will ensure that the effects of the RPS will be taken into account in each update. Because of the very nature of an annual standard, taking a long run view of emissions effects is incorrect in this case and this RPS adjustment should not be included. In addition, incorporating current information into the GHG standards is another key benefit of the frequent short run updates, and it should be a priority to closely examine assumptions for accuracy as the standards are updated every three years rather than relying on long term assumptions.

The RPS adjustment currently included in the marginal emissions factor calculation in the avoided cost calculator is not accurate for calculating either a short-run or long-run marginal emissions factor. The documentation accompanying the avoided cost calculator states that "when a distributed resource saves a kWh of electricity, the utility consequently procures 0.5 kWh less renewable energy (under a 50% RPS)."[3] This is not only an overly simplistic view of year-to-year RPS compliance, but also contradicts available information. The PUC recently authorized the investor-owned utilities (IOUs) to not issue solicitations for RPS resources. The PUC's Decision clearly outlines that the IOUs "forecast exceeding RPS requirements through at least the 2017-2020 compliance period"[4] and that "Based on PG&E's, SCE's, and SDG&E's current stated RPS compliance positions, it is reasonable to approve of PG&E's, SCE's, and SDG&E's requests not to hold 2017 RPS solicitations."[5] Therefore it is incorrect to assume that future projects in IOU territories under the FC NEM tariff would drive reduced procurement of RPS resources.

Further, as the California Energy Commission observed in a March 2016 Staff Report, "Future construction of renewables may not just be driven by legislative mandate, but also by cost competition. In this environment, generation procurement and the mix of grid resources will change dramatically and alter the process of estimating grid displacement".[6] This likelihood is further demonstrated by market prices for wholesale power purchases and the price of renewable energy purchases. Intercontinental Exchange (ICE) data for NP-15 CAISO future prices indicates the average day-ahead price for 2018-2022 to range between $35 and $40/MWh[7] while a recent NREL report indicates utility scale solar levelized cost of

[3] Avoided Costs 2017 Interim Update, September 11, 2017, page 39.

[4] D.17-12-007, Finding of Fact #2, page 65.

[5] D.17-12-007, Conclusion of Law #2, page 67.

[6] "Estimating Near-Term Grid Operation and Marginal Resource Efficiency for California Electricity," California Energy Commission Staff Report, March 2016, CEC-200-2016-003, page 4.

[7] Derived from Intercontinental Exchange daily settlement prices for CAISO NP-15 Day-Ahead Peak and Off-Peak Fixed Price Future contracts on November 8, 2017 through November 30, 2017. See

energy to range from $30 to $40/MWh in 2017 with expected reductions into the future.[8]

In addition, in its Integrated Resource Planning process, the PUC has undertaken a study of future energy portfolios in the context of ensuring the state meets its GHG reduction goals. Current modeling indicates that energy procurement to meet proscribed GHG reduction targets results in renewable procurement percentages within the State's energy portfolio that are higher than the RPS mandate, while the natural gas generation would continue to contribute a significant portion of State's energy portfolio.[9] The evolving market dynamics in California suggest that it is possible, or even likely, that future renewable procurement will be driven through economic competition and/or efforts to meet GHG reduction goals rather than primarily through the current RPS mandate. Therefore, because ARB need only publish standards for three years and does not need to speculate what will happen beyond 2019, and because future procurement decisions will be impacted by factors beyond RPS requirements, an RPS adjustment is not needed nor warranted in the annual emissions factors for the FC NEM tariff.

Provide CO_2e methodology

Bloom's understanding is that non-CO_2 GHGs are included in the proposed GHG standards, as is appropriate based on statutory direction to develop a GHG reduction standard rather than a CO_2 reduction standard. We request detail as to how these are calculated and incorporated into the proposed GHG standards to ensure these benefits are accurately incorporated into the methodology.

Bloom thanks the Board for the opportunity to submit these comments in response to the second FC NEM workshop and will continue to engage and provide resources that will lead to the development of an accurate, data-driven GHG standard for the FC NEM tariff to ensure that the GHG-reducing contributions of fuel cell installations in California continue to be accurately accounted for as they help the state meet its GHG reduction goals.

Respectfully,

Erin Grizard
Senior Director, Regulatory and Government Affairs

---

https://www.theice.com/products/6590362/CAISO-NP-15-Day-Ahead-Peak-Fixed-Price-Future and https://www.theice.com/products/6590423/CAISO-NP-15-Day-Ahead-Off-Peak-Fixed-Price-Future for product descriptions.

[8] U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017,page 43, https://www.nrel.gov/docs/fy17osti/68925.pdf

[9] Proposed Reference System Plan, CPUC Energy Division, September 18, 2017, slide 58. fhttp://cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/AttachmentA.CPUC_IRP_Proposed_Ref_System_Plan_2017_09_18.pdf

California Air Resources Board posted this bulletin on 01/30/2018

Fuel Cell NEM Working Group Meeting

California Air Resources Board (CARB) staff invites you to participate in a working group meeting to discuss the California Public Utility Commission's (CPUC) Avoided Cost Calculator (ACC) as the basis for the Fuel Cell Net Energy Metering (NEM) greenhouse gas (GHG) emission standards.

Background Information:

AB 1637 directs CARB to establish a schedule of annual GHG emission standards for the Fuel Cell NEM program in consultation with the California Energy Commission (CEC). Over the past 8 months, CARB staff has held workshops to solicit stakeholder input on what metric(s) should be used to determine the Fuel Cell NEM GHG emission standards. The majority of the stakeholder comments requested that CARB use CPUC's ACC to develop the standards. Energy and Environmental Economics (E3) has been contracted by the CPUC to develop the ACC; and CPUC uses the ACC to determine the effectiveness of demand-side electricity programs.

CARB staff circulated a draft Fuel Cell NEM GHG emission standard regulation with emission standards that are based on the ACC. Since that time, CPUC has updated the ACC. CARB staff plans to modify the draft regulation to reflect the marginal emission rates in the 2017 version of the ACC.

Meeting Discussion:

At this meeting, CARB, CPUC, and E3 staff will present a brief overview of and background information on the ACC, especially focusing on how the ACC addresses renewable resources, followed by an open discussion. Staff will use information gathered through this working group process to develop the final draft Fuel Cell NEM GHG emission standards.

DATE: February 13, 2018
TIME: 10:00 A.M. to Noon
LOCATION: Cal/EPA Building
1st Floor, Training Room 1
1001 I Street
Sacramento, CA 95814

CLEARING CALIFORNIA SKIES FOR 50 YEARS

CARB is the lead agency for California's fight against climate change, and oversees all air pollution control efforts in the state to attain and maintain health-based air quality standards.

Learn more at www.arb.ca.gov.

CALIFORNIA AIR RESOURCES BOARD

Calculation of Annual Fuel Cell NEM GHG Emission Standards

GHG standard = 2017 ACC average CO_2 short ton/MWh for each year * 2000 lbs/short ton * 0.4536 kg/lb * CO_2e/CO_2 conversion factor (1.000962)

CO_2e/CO_2 conversion factor = average of CO_2e/CO_2 annual conversion factors for years 2011 through 2015 = 1.000962

Annual CO_2e/CO_2 conversion factor = (Total CO_2e emissions from all in-State natural gas combined cycle power plants that report through the Mandatory GHG Reporting Regulation (MRR), using the Second IPCC Assessment Report global warming potential for CH_4) / (total CO_2 emissions from all in-State natural gas combined cycle power plants that report through MRR)

= 1.000957 for 2011
= 1.000961 for 2012
= 1.000967 for 2013
= 1.000965 for 2014
= 1.000959 for 2015

The 2017 Avoided Cost Calculator (ACC) and supporting documentation are available via the links below.[1]

- 2017 ACC (Excel)
- ACC User Manual
- 2017 ACC Update (Word)

The average CO_2 short ton per MWh for each year is located in the “Emissions” tab, row 59, above the table titled “Long-Run Marginal Emission Rate.”

[1] This document has been updated to include a functioning link to the 2017 ACC. (March 25, 2019)

February 12, 2018

Draft Regulation Order

Subchapter 10. Climate Change
Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions
Subarticle 5.2. Fuel Cell Net Energy Metering
Greenhouse Gas Emission Standards

§ 95408. Purpose

The purpose of this regulation is to implement section 2827.10(b) of the Public Utilities Code.

§ 95409. Applicability

The provisions of this Article shall apply to participants in the Fuel Cell Net Energy Metering program.

§ 95410. Definitions and Acronyms

(a) For the purposes of this Article, the following definitions apply.

(1) **"Carbon dioxide equivalent" or "CO_2e"** means the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas when calculated using the individual global warming potentials as specified in the "global warming potential" definition of this article.

(2) **"Global warming potential"** or **"GWP"** means the ratio of the time-integrated radiative forcing from the instantaneous release of one kilogram of a trace substance relative to that of one kilogram of a reference gas, i.e., CO_2. The GWP values for this regulation are as specified in Table A-1 to Subpart A of Title 40, Code of Federal Regulations Part 98 as published to the Federal Register on October 30, 2009.

(3) **"Greenhouse gas emissions" or "GHG emissions"** means the combined emissions of carbon dioxide and methane.

(4) **"Megawatt-hour" or "MWh"** means the electrical energy unit of measure equal to one million watts of power supplied to, or taken from, an electric circuit in alternating current form steadily for one hour.

§ 95411. Greenhouse Gas Emission Standards

The annual greenhouse gas emission standards for eligibility in the Fuel Cell Net Energy Metering Program shall be:

Year	Annual GHG Emission Standard (kg CO_2e/MWh)
2017	324
2018	313
2019	301

Jessica Melton
Representative
State Agency Relations

1416 L Street, Suite 280
Sacramento, CA 95814
(916) 386-5712
Jessica.Melton@pge.com

February 28, 2018

Dave Mehl
Manager, Energy Section
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

RE: PG&E Comments on ARB Draft Regulation Setting a GHG Standard for Fuel Cell Net Energy Metering Program Eligibility

Pacific Gas and Electric Company (PG&E) appreciates the opportunity to provide feedback on the above-referenced draft regulation, which satisfies Public Utilities Code Section 2827.10(b), creating the obligation on the part of Air Resources Board (ARB) to regularly publish greenhouse gas (GHG) emissions standards for use under the California Public Utilities Commission (CPUC)'s net metering tariffs for fuel cells. As it exists today, PG&E's Net Energy Metering Fuel Cell (NEMFC) tariff requires fuel cells to meet the GHG emissions standards developed by the ARB, once those standards have been approved and implemented by the CPUC.

PG&E appreciates ARB staff's ongoing efforts to engage stakeholders, including through the February 13, 2018, workshop. PG&E recognizes that this topic is complex and disagreement over how to set NEMFC annual GHG standards will exist. PG&E notes that the standards in the latest draft are based on the CPUC-adopted 2017 Avoided Cost Calculator (ACC), as recommended by PG&E and many other stakeholders. The ACC will likely produce the most accurate publicly available estimate of annual average emissions on a per-megawatt-hour basis for electricity used in California. To ensure that a fuel cell reduces GHG emissions during its life (about 10 years), the emissions from the fuel cell must be less than the ARB emissions standard. PG&E agrees that the values provided in the ARB draft regulation are a good measure of average annual marginal emissions in California.

PG&E suggests the ARB include GHG emissions values for additional years in the regulation. Doing so would give the CPUC more flexibility to design a program that is less complex, easier for customers to understand, more economical for utilities to implement, and

provides more financial certainty for customers. For example, rather than measuring customer emissions annually, the CPUC could determine a 10-year value that could be verified at the time of installation. This provides certainty and simplicity for the customer. Such a program would deliver at least the same GHG emissions reductions while achieving more customer acceptance.

PG&E believes the ACC can provide a richer set of data to support CPUC tariff design (as seen in Table 1 of the Attachment) and is available to meet with staff to discuss in detail. We look forward to continuing to collaborate with all stakeholders in this process.

Please feel free to contact me if you have any questions or concerns.

Sincerely,

/s/

Jessica Melton

Representative, State Agency Relations
Pacific Gas and Electric

Attachment: Description of PG&E's Proposed Annual and Ten-Year Forward Average Marginal Emissions Rates

Explanation of Table 1: The table was developed using the same version of the ACC model used to develop the original Subarticle 5.2 GHG standards (see rows 58-61 on tab "Emissions").

Table 1

Annual and Ten-Year Forward Average Marginal Emissions Rates from ACC Model v1

			268.83	261.49	254.59	249.56	245.27	241.89	240.48	235.94	232.16	229.14
(matches CPUC proposal 396.40												
	Long-Run Marginal Emission Rate											
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027

Via online filing

Dave Mehl
Manager, Energy Section
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Re: Support of Revised Greenhouse Gas Emissions Standards for the Fuel Cell Net Energy Metering Program

Dear Mr. Mehl:

Sierra Club and Earthjustice write to express our support for the Air Resource Board's ("ARB") revised greenhouse gas emissions standard for Fuel Cell Net Energy Metering ("FC-NEM"). We support ARB's decision to base the standard off of the estimated long-run marginal emissions rate calculated by E3's Avoided Cost Calculator, and believe the standard will ensure the use of qualifying fuel cells reduces overall greenhouse gas emissions. Additionally, in order to help the Public Utilities Commission ("PUC") implement ARB's standard, we urge ARB to clarify that qualifying fuel cells are required to re-certify their compliance with each calendar year's new annual standard each year that the fuel cells seek incentives.

Assembly Bill 1637 requires ARB to ensure the FC-NEM greenhouse gas limit "reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces."[1] Modeling the marginal avoided emissions from a behind-the-meter resource, as the authorizing legislation calls for, necessarily requires generalizations. While E3's avoided cost model does rely on simplifications and assumptions about utility procurement and resource dispatch, we believe they are well-reasoned and justified. As ARB staff stated during the February 13, 2018 working group meeting, adding additional detail to the model is an endeavor with diminishing returns. Indeed, just as some stakeholders may argue for revised modeling assumptions that would function to weaken the proposed standard, accounting for other factors, such as increased renewable curtailment from an additional 500 MW of baseload resources from the fuel cell NEM program, would lower the proposed standard. Ultimately, Sierra Club and Earthjustice agree with ARB

[1] Cal. Pub. Util. Code § 2827.10(b)(2).

that the Avoided Cost model used here is a rigorous and reasonable method for estimating avoided emissions and setting the greenhouse gas standard.

We do strongly recommend ARB explicitly clarify in the regulation that a fuel cell must perform better than the applicable annual greenhouse gas standard each year in order to continue to be eligible for FC-NEM compensation. ARB is required to update the schedule of annual greenhouse gas emissions reduction standards every three years. [2] Over the operating life of a fuel cell, ARB's greenhouse gas limit can be expected to continue to fall annually, reflecting increasing renewable penetration on the grid. At the same time, the fuel cell will age and its efficiency will degrade. It is therefore critical that fuel cells continue to demonstrate annually that they are in compliance with the greenhouse gas limit. Furthermore, because ARB is required by law to update the standard every three years, it is not permissible or possible to establish an average greenhouse gas emissions limit that would extend over the life of the equipment.

The greenhouse gas standard ARB sets will be implemented by the PUC. Clarifying that ARB's "annual" standard is a yearly compliance obligation will facilitate the PUC's faithful implementation of ARB's intention. We recommend ARB add a definition to section 95410 of the proposed regulation specifying that "annual greenhouse gas emissions standard" means the maximum level of a fuel cell's emissions, measured each year that it seeks incentive payments.

Sierra Club and Earthjustice encourage ARB to approve the revised standard, and send the FC-NEM program to the Public Utilities Commission for implementation. Thank you for consideration of these comments.

Respectfully,

/s/ Alison Seel

Alison Seel
Sierra Club
2101 Webster St., Suite 1300
Oakland, CA 94612
Telephone: (415) 977-5773
Email: alison.seel@sierraclub.org

Matthew Vespa
Earthjustice
50 California St., Suite 500
San Francisco, CA 94111
mvespa@earthjustice.org
Telephone: (415) 217-2123
Email: mvespa@earthjustice.org

[2] Cal. Pub. Util. Code § 2827.10(b)(1).

JOINT FUEL CELL PARTIES:
NATIONAL FUEL CELL RESEARCH CENTER; BLOOM ENERGY;
DOOSAN FUEL CELL AMERICA; FUELCELL ENERGY; LG FUEL CELL SYSTEMS
Comments on Fuel Cell Net Energy Metering Program February 13, 2018 Working Group Meeting

March 2, 2018

The Joint Fuel Cell Parties (National Fuel Cell Research Center, Bloom Energy, Doosan Fuel Cell America, FuelCell Energy Inc. and LG Fuel Cell Systems, Inc.) submit these comments to the California Air Resources Board (CARB) regarding the February 13, 2018 working group meeting to discuss the California Public Utility Commission's (CPUC) Avoided Cost Calculator (ACC) as the basis for the Fuel Cell Net Energy Metering (NEM) greenhouse gas (GHG) emission standards.

I. Background Information

AB 1637 directed CARB to establish a schedule of annual GHG emission standards for the Fuel Cell NEM program in consultation with the California Energy Commission (CEC). Over the past eight months, CARB staff has held workshops to solicit stakeholder input on what metric(s) should be used to determine the Fuel Cell NEM GHG annual emission standards.

To clarify, the majority of the past stakeholder comments requested that CARB use the CPUC's ACC as a source for annual hourly grid data, and not as a source of the annual standard itself. As CARB states on the workshop meeting notice, the CPUC uses the ACC to determine the effectiveness of long-term demand-side electricity programs, that is, the avoided cost of such programs. Further, in the intervening months since June 2017, when comments were initially filed, E3 updated the ACC as part of a proceeding at the CPUC independent of the ARB's efforts to set a GHG standard for Fuel Cell NEM. The new update shows an emissions calculation in addition to the avoided cost calculation that incorporates a long-run renewable factor of (1-RPS%), to account for future utility demand for renewable power in a long-term analysis of emissions which we refer to as the "RPS Build Margin factor" hereafter. As we describe below, this long-term emissions factor is inappropriate for development of the annual standard for Fuel Cell NEM.

II. Comments

A. <u>The Energy+Environmental Economics Avoided Cost Calculator Well Predicts Grid Marginal Emissions with California Renewable Policies</u>

The fuel cell community believes that the ACC of E3 is an accurate, publicly available tool for understanding and simulating the California electricity market and marginal resource dynamics and their associated emissions. The ACC tool simulates and

estimates the marginal emissions of the electric grid today and uses sound assumptions for projecting the marginal resources and associated emissions rates well into the future, with current California policies that support the increasing installation and operation of renewable power and energy storage. The ACC tool produces electric grid marginal emissions for each hour (8760 total) of the years 2016 – 2046. In each of these years the ACC tool well predicts the expected dynamic operation of the natural gas-fired load-following combined cycle and simple cycle power plants as they operate in concert with all of the expected renewable power generation and energy storage expected in future years. Important to this discussion, the model accounts for renewable capacity and renewable power production and energy storage dynamics sufficient to meet California policy goals (e.g., 33% renewable portfolio standard (RPS) by 2020, 50% RPS by 2030). The model also accounts for renewable power curtailment in future years.[1]

All of the above features of the ACC tool are appropriate and well-suited to use for establishing the schedule of annual greenhouse gas emission reduction standards. In addition, all of the above features well address the legislative requirements and intent of the chaptered Assembly Bill 1637, Section 2 (b) (2):

> *"The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid."*

B. Including an RPS Build Margin Factor to Determine Long-Run Marginal Emissions Rate is Not Applicable to the NEM Standard

Because the ACC tool was developed for purposes of evaluating the impacts of energy efficiency measures that are installed in one year and are effective for a period of 20 years (or more), the tool also predicts the "long-run" marginal emissions rate. This long-run marginal emissions rate appropriately accounts for the impacts of an energy efficiency measure upon the long-term utility electricity demand and requirements for purchasing renewable energy in the future. To account for the impacts of the one-time certification of energy efficiency measures upon future utility renewable purchases, a factor was appropriately introduced into the ACC tool. This factor, the "RPS Build Margin factor" is used to produce the ACC results for "Long-Run Marginal Emissions," which are the appropriate standards for evaluating a one-time certification of technology that has a long lifetime.

However, **the Fuel Cell NEM policy calls for an annual standard which will be applied to a project each year**. Because eligibility is not automatic for the lifetime of a project, a long-run view of marginal emissions is not appropriate for this standard. Rather, the annual NEM standard should ratchet down every year with the actual marginal emissions rates (accounting for load-following combined cycle and simple cycle

[1] "If the implied heat rate is calculated to be at or below zero, it is then assumed that the system is in a period of overgeneration, and therefore the marginal emission factor is correspondingly zero as well."
E3 ACC Overview, p 35.

power plants operating in concert with renewables) for each year. The application of the RPS Build Margin factor to produce the Long-Run Marginal Emissions Rate in the ACC is not applicable to the fuel cell annual standard.

The parties encourage CARB to correctly calculate the fuel cell GHG emission standard by leveraging the data in the ACC tool regarding hourly marginal generation heat rates without applying the Long Run RPS Build Margin factor. This factor is not applicable to an annual standard and should not be included.

The procurement of renewables in the future is incorporated into the marginal resource emissions rates via sophisticated forecasting of how the increasing RPS requirement will affect the operation of the marginal generating resources (i.e., load-following power plants) in each year.[2] Therefore, the marginal emissions rates that are provided by the ACC tool without the RPS Build Margin factor are directly applicable to an annual standard that will progressively include all of the renewables that will operate on the grid each year into the future.

C. Analysis Demonstrating How an Annual GHG Emissions Standard Will Work

The latest version (2017) of the ACC tool produces an accurate estimate of the hourly (8,760 hours per year) carbon dioxide (CO_2) emissions for each year between 2016 and 2046. Figure 1 presents the average annual marginal CO_2 emissions rates produced by the latest ACC tool for the two cases of: (1) marginal emissions, i.e., no application of the RPS Build Margin factor (blue curve), and (2) Long Run emissions, i.e., application of the RPS Build Margin factor (orange curve). Note that the CO_2 emissions for the case of not applying the RPS Build Margin factor (blue curve) are roughly between and sometimes lower than the main load following power plants (combined cycle and simple cycle gas turbines). This accurately reflects the fact that the installation of a fuel cell (which effectively reduces load) primarily results in the reduction of power demand from these load-following power plants operating on the margin. The fact that the marginal emissions (without the Long-Run RPS Build Margin factor applied) are sometimes lower than the most efficient combined cycle load following power plant indicates the effects of renewable power generation on the margin. That is, these average annual marginal emissions rates (without the RPS Build Margin factor applied) already account for the impacts of all of the current and forecasted renewable power generators on marginal emissions rates. In cases of high renewable power use, the installation of a fuel cell primarily results in the displacement of emissions from combined cycle and simple cycle gas turbine power plants and also results in the displacement of some renewable power.

[2] The ACC includes "adjustments to the hourly energy price profile using the CPUC RPS calculator to account for projected increases in renewable generation. RPS calculator implied heat rate changes by month/hour are incorporated into the price shape for 2020. Adjustments prior to 2020 are linearly interpolated, and adjustments after 2020 are held at the 2020 levels." E3 ACC Overview, pp. 34-35.

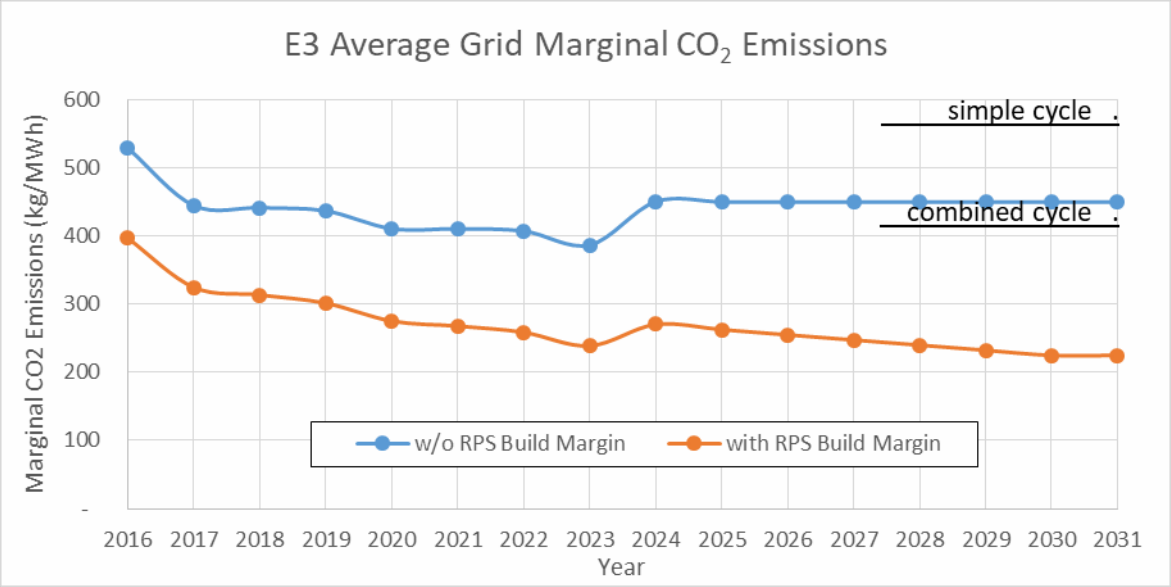


Figure 1. ACC Average Annual Marginal Emissions rates

Also shown in Figure 1 is the Long-Run Marginal Emissions produced by the ACC tool by application of the RPS Build Margin factor (orange curve). This curve multiplies the marginal emissions rate produced by the ACC tool by the RPS Build Margin factor which is 1 minus the expected annual RPS percentage for each year (that is, 33% in 2020, 50% in 2030, and linearly interpolated for all intervening years).

Figure 2 presents a high estimate (for the case that marginal grid emissions meet the 2017 E3 predictions) and low estimate (a hypothetical case in which marginal grid emissions are found to be lower over time as E3 updates the ACC tool) of realized marginal emissions over time and the corresponding annual Fuel Cell NEM standard that would be developed for each case. Note that for an annual standard, the standard for emissions from the fuel cell systems that will qualify for the Fuel Cell NEM tariff will always ratchet down with the realized marginal emissions rates of the utility grid network. In addition, in future years, the emissions of all NEM qualifying fuel cell systems installed under this GHG standard will be forced to be below those that the grid would otherwise produce with all of the deployed renewable power generation systems. Thus, for an annual standard, application of a Long-Run RPS Build Margin factor (which is only applicable for a lifetime type (one-time) certification process) is erroneous and must not be applied. The annual standard by itself will always force NEM qualifying fuel cell systems to produce less emissions than the grid would otherwise have produced if the fuel cell system was not installed.

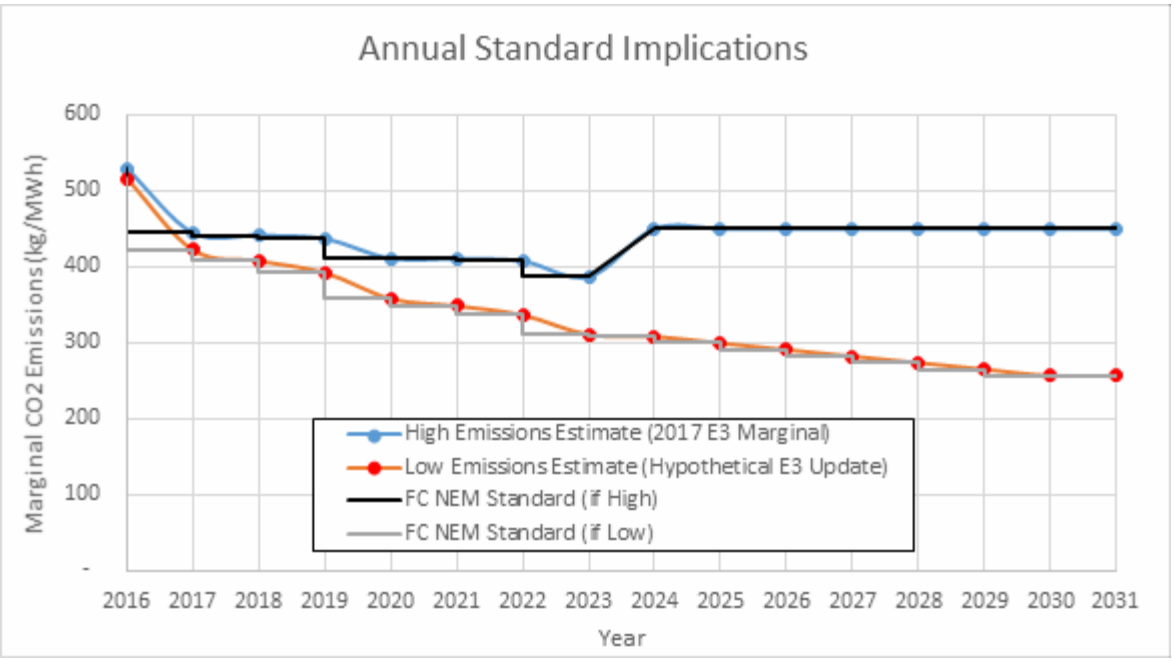


Figure 2. Implications of an annual NEM standard for a case that actual marginal grid emissions follow the 2017 E3 Marginal Emissions rate in ACC tool (blue), and a case that actual marginal grid emissions are found to be lower as E3 updates the ACC tool over time (red).

III. Conclusion

Establishing an accurate GHG standard for the net energy metering of fuel cell systems in the near-term is critically important for a resilient and clean grid today. The Joint Fuel Cell Parties appreciate the opportunity to comment on the development of a Fuel Cell Net Metering GHG Standard through the above recommendations to facilitate this evolution and look forward to continued productive conversations with staff to ensure that an appropriate, technically justified and correct standard is set.

Sincerely,

/s/ *Jack Brouwer*

Dr. Jacob Brouwer, Associate Director
National Fuel Cell Research Center
Professor of Mechanical and Aerospace Engineering
University of California, Irvine

/s/ *Rodger McKain*

Rodger McKain
Senior Consultant
LG Fuel Cell Systems, Inc.

/s/ *Derek Hildreth*

Derek Hildreth
Head of North American Sales and Strategy
Doosan Fuel Cell America

/s/ *Erin Grizard*

Erin Grizard
Senior Director, Regulatory and Government Affairs
Bloom Energy

/s/ *Jennifer Arasimowicz*

Jennifer Arasimowicz
Senior Vice President,
General Counsel and Corporate Secretary
FuelCell Energy, Inc.

Bloomenergy

March 2, 2018

Dave Mehl
California Air Resources Board
1001 I Street
Sacramento, CA 95814
VIA Online submission

Dear Dave,

Bloom Energy (Bloom) thanks ARB staff for their work in developing the greenhouse gas (GHG) emissions reduction standard for the fuel cell net energy metering (FC NEM) tariff and for convening the February 13 working group to discuss the Avoided Cost Calculator (ACC). The ACC accurately calculates and forecasts the marginal emissions, accounting for renewables operating and procured, of the grid *prior to* multiplying the marginal emissions rate by a factor of (1-RPS%) to determine the "Long-run Emissions Factor". In addition to our previous comments filed December 22, 2017, Bloom provides the following evidence that the calculation without the Long Run (1-RPS%) factor appropriately takes into account both the operation and procurement of electrical grid resources, including renewable resources, for the purposes of this annual FC NEM GHG standard.

The Avoided Cost Calculator incorporates renewable resources in its market-based marginal emissions rate

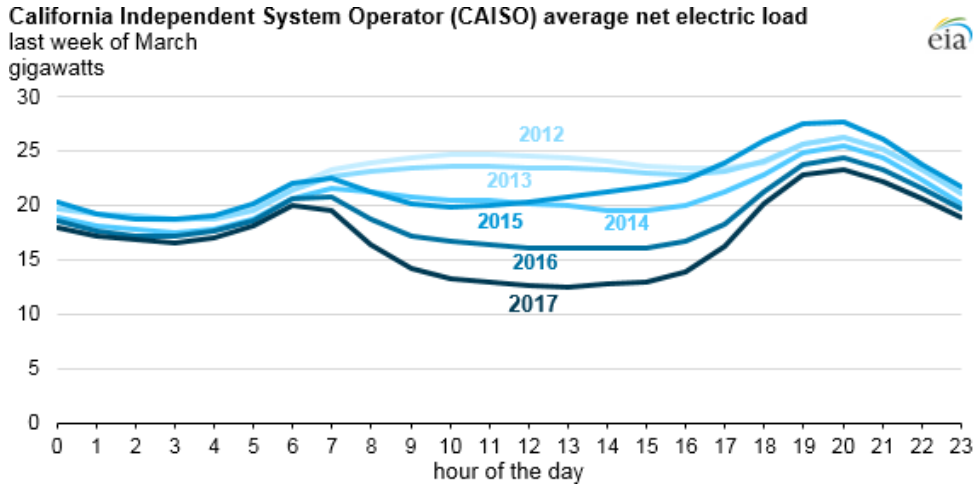
The ACC accurately incorporates the impact of operating and forecasted renewable resources on the marginal emissions rate in three ways: 1) through the impact of these resources on the overall market heat rate curve; 2) through the use of the CPUC RPS (Renewable Portfolio Standard) calculator to account for RPS procured renewable energy and 3) through the use of a zero marginal emissions rate in hours where overgeneration occurs, indicating that a zero emission resource is the CAISO market's marginal generation unit in that hour.

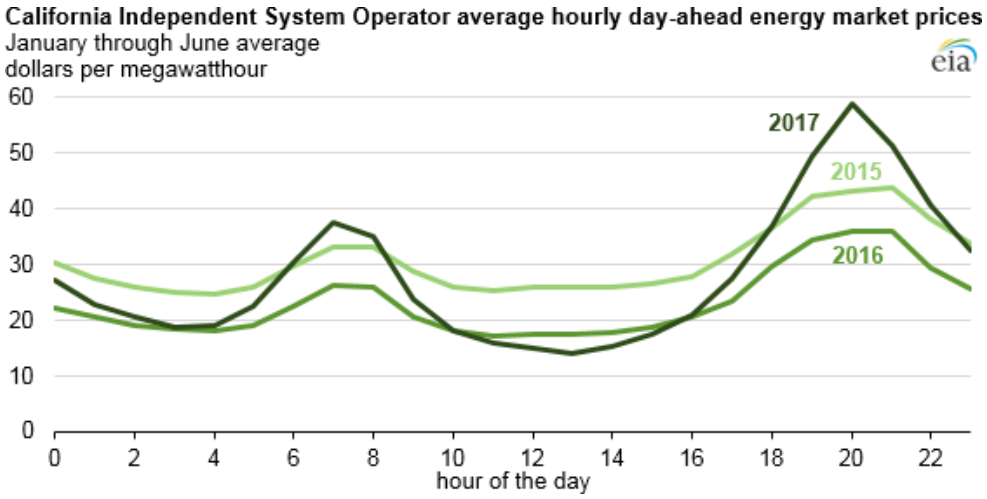
First, the overall market heat rate curve in the ACC incorporates renewable resources. This is the case because the heat rate curve is based on CAISO energy market forward prices through 2023.[1] CAISO energy market prices are based on the price bid by the marginal generator dispatched to meet load. This marginal generator reflects renewable generation already operating in the market because this generation reduces the need for the dispatch of other resources with higher heat rates, such as relatively inefficient natural gas.

The fact that renewable generation impacts CAISO market energy prices can be seen in the chart below produced by the U.S. Energy Information Administration (EIA).[2] The first shows that the CAISO's average hourly "net load" fluctuates during

[1] Energy and Environmental Economics, Inc. *Avoided Costs 2017 Interim Update.* September 11, 2017. pp. 14-16. (E3 ACC Overview)
[2] See https://www.eia.gov/todayinenergy/detail.php?id=32172

the day depending on 1) customer load and 2) the level of renewable generation output. Net load, therefore, is relatively low both during the night, when most customers are asleep, and during the afternoon hours, when solar generation output is greatest. Critically, the second chart shows that CAISO energy prices are also low during the hours of greatest solar generation output, reflecting the relatively low demand for natural gas generation and the relatively high efficiency of the marginal natural gas-fired generator during those hours. Market prices and market heat rates derived from those prices, therefore, clearly reflect renewable generation operating in the market.





The specific market prices used in the ACC reflect renewable generation in that, without existing renewable generation operating, a higher heat rate/higher emission resource would have been used and would have led to higher market prices. The E3 overview of the ACC summarizes this link between market prices and marginal emissions: “The link between higher market prices and higher emissions rates is

intuitive: higher market prices enable lower-efficiency generators to operate, resulting in increased rates of emissions at the margin."[3]

Secondly, in addition to capturing the effect of operating renewable resources in the market by using CAISO energy market forward prices, the ACC includes "adjustments to the hourly energy price profile using the CPUC RPS Calculator to account for projected increases in renewable generation. The RPS calculator implied heat rate changes by month/hour are incorporated into the price shape for 2020. Adjustments prior to 2020 are linearly interpolated, and adjustments after 2020 are held at the 2020 levels."[4]

Thirdly, the ACC also explicitly accounts for the hours in which renewables generation (or another zero emission resource) is the marginal generator. The ACC documentation states that, "if the implied heat rate is calculated to be at or below zero, it is then assumed that the system is in a period of overgeneration and therefore the marginal emission factor is correspondingly zero as well."[5] In other words, the ACC accounts for hours in which renewables generation drives the marginal emission rate to zero, and these zero marginal emission hours are reflected in the market-based annual marginal emission rate results produced by the model (i.e. prior to application of the (1-RPS%) factor).

Thus, the market heat rate curve from which the ACC derives the marginal emission rate not only includes existing renewables generation implicitly embedded in the market energy prices (i.e. operation), it also includes additional forecasted RPS resources that will be added to the grid in the coming years (i.e. procurement), and overgeneration/curtailment happening now and forecasted into the future as renewables penetration increases (i.e. operation and procurement). The operation and procurement of renewables that are displaced by new generation (fuel cells) is accounted for in the ACC marginal calculation, and as the grid evolves over time and the ACC is updated, each new set of standards (released every three years) will reflect the most recent data available on grid operation and procurement.

The Fuel Cell NEM program will not affect future procurement decisions

Investor owned utilities require customers with on-site generation to pay monthly "reservation capacity" standby charges for the right to use power from the utility grid when necessary, unless exempt under specific Net Energy Metering tariffs. Such a policy implies that utilities are assuming they will need to provide the capacity to serve these customers. Insofar as Bloom is aware, the capacity is still procured despite the fee treatment of the tariff.

In addition, unlike the implications of E3's statement "When a distributed resource saves a kWh of electricity, the utility consequently procures 0.5 kWh less renewable energy (under a 50% RPS)… and so the resulting net GHG impact must be adjusted by (1 minus the RPS%),"[6] future procurement of renewable energy by

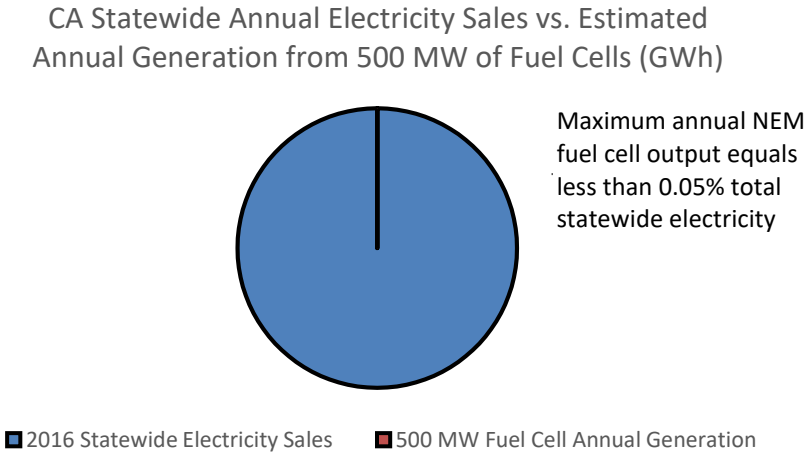
[3] E3 ACC Overview, pp. 34-35.
[4] E3 ACC Overview, pp. 90-91.
[5] E3 ACC Overview, p. 35.
[6] E3 ACC Overview, p. 39.

load serving entities is not simply a function of sales and the RPS percentage, with banked RECs carrying forward indefinitely until being used to meet a future RPS obligation. In practice, the timing and quantity of procurement of new renewable energy supplies depends on multiple factors and uncertainties. As described in PG&E's 2017 RPS Procurement Plan:

> In addition to retail sales forecasts,… PG&E's long-term demand for new RPS-eligible project deliveries is driven by: (1) PG&E's current projection of the success rate for its existing RPS portfolio, which PG&E uses to establish a minimum margin of procurement; and (2) the need to account for PG&E's risk-adjusted need, including any Voluntary Margin of Procurement ("VMOP") as determined by PG&E's stochastic model.

PG&E employs a stochastic model to determine its risk-adjusted need to procure renewable energy to meet its RPS obligations. PG&E's stochastic model considers the following impacts on its RPS position: 1) Retail Sales Uncertainty, 2) Project Failure Variability, 3) Curtailment, and 4) RPS Generation Variability. The resulting stochastically-adjusted gross RPS position, which PG&E uses to inform its application of REC bank balances and potential additional renewable energy procurement is redacted from public RPS Plan documents, but presumably differs from the physical net short position calculated without considering these risks.

To put the potential impact of the Fuel Cell NEM program on future renewable energy procurement in context, 250 MW of fuel cells operating at a 90% capacity factor would reduce statewide electricity sales by less than 1% (2 GWh/yr vs 260 TWh/yr in 2016).[7]



[7] See California Energy Commission. *Mid Case Revised Demand Forecast*. Submitted January 22, 2018. http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-03/TN222323_20180122T142259_CEC_2017_Revised_Baseline_STATEWIDE_Mid_Demand_Case.xls

It is likely that this impact, or even twice as much assuming 500 MW of fuel cells (the entire size of newly authorized installations under the program through 2021), falls within the range of risk-adjusted needs estimated using a stochastic modeling approach. The effect of fuel cells being eligible for net energy metering is likely to be within the noise of factors determining the renewable energy procurement decisions of load serving entities and will not impact their procurement decisions.

Conclusion

Taken together, these arguments point to removal of the Long Run (1-RPS%) factor from the emissions calculation. In compliance with the statute, using the ACC to calculate marginal emissions, and releasing standards every three years which allows for updated data and forecasts to be incorporated, does provide an accurate "compar[ison] to the electrical grid resource, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both the procurement and operation of the electrical grid."[8]

Bloom thanks the Board for the opportunity to submit these comments and will continue to engage and provide resources that will lead to the development of an accurate, data-driven GHG standard for the FC NEM tariff to ensure that the GHG-reducing contributions of fuel cell installations in California continue to be accurately accounted for as they help the state meet its GHG reduction goals.

Respectfully,

Erin Grizard
Senior Director, Regulatory and Government Affairs

[8] Fuel Cell Net Energy Metering Statute, PU Code 2827.10 (b)(2).

Date:
March 2, 2018

To:
California Air Resources Board

Prepared by:
WattTime

Subject:
Comment Docket for Fuel Cell-NEM Working Group Meeting

Background

The Fuel Cell Net Energy Metering (NEM) program allows fuel cells in California that use non-renewable fuels to participate in net metering programs. The stated goal of the program, per California Public Utilities Code § 2827.10 is to "encourage the development of eligible fuel cell electrical generating facilities" and "achieve reductions in emissions of greenhouse gases." To be eligible for the NEM program the fuel cells must meet emissions standards developed by the California Air Resources Board (CARB). WattTime, an environmental nonprofit specializing in applying electricity emissions factors to optimize emissions reductions, is concerned that the current proposed implementation plan may face an environmental integrity risk due to its reliance on nonstandard emissions measurement techniques, which are not in line with comparable California programs. In alignment with California's goals, WattTime believes the fuel cell NEM standard should be used to incentivize fuel cells when and if they are in fact reducing emissions of greenhouse gases. To achieve this, the standard should directly compare whether electricity from a fuel cell or the grid has lower emissions.

CARB, with input from stakeholders, has proposed using the California Public Utility Commission's (CPUC) Avoided Cost Calculator (ACC) as the basis of the emissions standard used to determine eligibility for the fuel cell NEM. The ACC forecasts hourly marginal emissions rates for every year through 2046 based on heat rate and predicted fuel costs. CARB is proposing using the annual average of the hourly marginal emissions rate (line 59 of the Emissions tab of the ACC) to determine eligibility for the fuel cell NEM program. This value will be updated on a regular schedule.

Separately, under the instruction of the CPUC, WattTime is working a large number of stakeholders, including utilities, on proposed accurate real-time marginal emissions rates for the SGIP energy storage program. Those stakeholders have reached consensus on the correct means to measure marginal emissions rates, based on Energy and Environmental Economics (E3)'s work in consultation with knowledgeable experts at WattTime, PG&E, Itron, and E3 itself. The State of California, through Public Utilities Code Section 769, encourages "coordinating existing commission-approved programs, incentives, and tariffs to maximize the locational benefits and minimize the incremental costs of distributed resources." It may be therefore appropriate to use the marginal emissions values developed for SGIP in the fuel cell NEM program as well, further aligning distributed resource incentive programs in California. Marginal emissions values for the SGIP program will be available on an hourly or even five-minute basis to ensure batteries are used to charge during times when the grid is cleanest and dispatch when the grid is dirtiest.

1. Emission Standard Calculation Methodology

The calculation of the annual aggregate marginal rate in the ACC used to determine eligibility for the fuel cell NEM program includes an important set of assumptions including heat rate, fuel costs, and details about the California Renewable Portfolio Standard (RPS).

WattTime agrees that the fundamental approach used to calculate the marginal emissions rates developed by E3 for the ACC is scientifically sound. However, based on conversations WattTime has had with E3, it is our understanding that these marginal emissions were calculated based on applying heat rates and fuel costs to day-ahead hourly electricity locational marginal prices, not the hourly average of five-minute real-time electricity locational marginal prices. Based on modeling WattTime has been performing for the SGIP energy storage program, WattTime has concluded that this creates a systematic bias that over-predicts marginal emissions rates. At a minimum, WattTime recommends updating the ACC, and to use the same methodology but applied using LMP data from the real-time market, a more accurate methodology for calculating marginal emissions.

2. Renewable Energy Portfolio Adjustment

The marginal emissions rate calculated in the ACC was reduced by a factor equal to the RPS standard during that year. WattTime believes this adjustment factor does not accurately reflect the actual operation of the grid and associated emissions at any point in time. The RPS adjustment is justified in the *Avoided Cost 2017 Interim Update* by stating

> "This RPS adjustment is necessary because California's RPS policy is based on retail sales of electricity. When a distributed resource saves a kWh of electricity, the utility consequently procures 0.5 kWh less renewable energy (under a 50% RPS). This RPS that the utility no longer procures would have offset GHG emissions itself, and so the resulting net GHG impact must be adjusted by (1 minus the RPS%)."

While this adjustment may make sense for the *cost* calculations the ACC is designed for, the percentage of renewable energy on the grid, as mandated by the RPS, has little bearing on the marginal *emissions* rate. The RPS is intended to ensure that a certain percentage of the total delivered energy, on an annual kWh basis, is renewable. While the RPS mandate could certainly influence the marginal emissions rate, it would do so by decreasing net load. There is no scientific basis for assuming this would reduce marginal emissions by a quantity equal to the RPS percentage. Artificially lowering the marginal emissions rate by the fixed RPS standard percentage risks causing the program to not accurately distinguish between fuel cells that would and would not decrease greenhouse gas emissions. WattTime opposes this not only because it would not meet the stated program goals, but because it would be reasonably likely to lead higher overall emissions in the state by incentivizing dirtier plants to operate.

Eliminating the RPS adjustment factor would also bring the marginal emissions rate calculation in line with the SGIP methodology, aligning incentives across different distributed resources. If this is not done, CARB should explain why the question of whether a fuel cell is reducing emissions should be calculated with different emissions rates than the exactly comparable question of whether a battery is reducing emissions. Scientifically speaking, there is no basis for these calculations to be different.

To achieve the program goals, it is important to correctly measure whether fuel cells are cleaner than the marginal power plants they displace. WattTime recommends eliminating the RPS adjustment to the marginal emissions rate in the ACC before it is used to determine eligibility for the fuel cell NEM program.

3. Hourly Marginal Emissions Rates

The most accurate means of ensuring that a fuel cell is cleaner than the grid would be to compare real-time fuel cell emissions with real-time marginal emissions rates of the grid. The ACC includes hourly marginal emissions, for both historical and future year. These values can and should be used to assess whether a fuel cell will be cleaner than the grid, based on predicted operational values on an hour by hour basis.

Summary of Recommendations

1. Include an updated methodology for more accurately calculating marginal emissions rates based on the hourly average of real-time prices instead of day-ahead values.
2. Remove the RPS multiplier from the marginal emissions rate as this does not accurately reflect the actual marginal emission rate of the grid and the displaced generator.
3. Consider using hourly marginal emissions rates to determine eligibility for the fuel cell NEM to ensure that fuel cell operation is cleaner than grid.

About WattTime

WattTime is a nonprofit subsidiary of the Rocky Mountain Institute founded in 2014 by UC Berkeley researchers to give energy customers the freedom to choose the power they consume. WattTime seek to give organizations the information they need to make smart energy decisions. WattTime's analytical approaches are built on research at Carnegie Mellon and UC Berkeley and make us uniquely qualified to conduct avoided emissions analyses and other environmental impact assessments with a high degree of accuracy.

Thank you for considering our comments. Please reach out to WattTime with any questions.

Contact:

Henry Richardson
Project Manager, Analyst
henry@watttime.org
415.300.7475

Gavin McCormick
Executive Director
gavin@watttime.org
857.540.3535

TECHNET
THE VOICE OF THE INNOVATION ECONOMY

California and the Southwest |
Telephone 805.234.5481
915 L Street, Suite 1270, Sacramento, CA 95814
www.technet.org | @TechNetUpdate

March 2, 2018

Mr. David Mehl
Industrial Strategies Division
Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Fuel Cell Net Energy Metering

Dear Mr. Mehl

TechNet, who represents the leading technology and innovation companies, appreciates the opportunity to comment on this proceeding. TechNet supports ARB's development of a greenhouse gas (GHG) standard for fuel cell net energy metering (FC NEM) projects. However, we are concerned that the standard, as proposed in the February 13, 2018 draft regulation, will hamper the burgeoning clean tech market. Instead, we recommend that the GHG standard be tied to the current emission profile of the grid and the current state of fuel cell technology.

In recent years, California has taken major policy steps toward achieving its air quality goals. The extension of FC NEM and the passage of AB 617 demonstrate the state's commitment to combating criteria air pollutant emissions through the deployment of new energy technologies, such as fuel cells. These policies are further cementing California's status as the global leader in the development and deployment of distributed generation fuel cells.

As a result of these polices, the clean tech industry as a whole is gaining strength. Advances in fuel cell technologies have resulted in even greater efficiencies in energy conversion, making them the most efficient commercially available method to convert any form of gas to electricity. Additionally, technology costs are dropping significantly, due to advances in manufacturing and the economies of scale associated with increased demand.

All of this progress, however, could be threatened by CARB's recent proposal. The proposal will require that fuel cells meet an unprecedented GHG standard based on long-term (20 years and more) assumptions. Presuming the operation of the grid in the future, without allowing for the possibility of technologies to advance in the near term, could lead to the unintended consequence of stifling markets. Although fuel cells will continue to improve in efficiency and capability, the proposed standard would prematurely curtail those efforts and cause the state to lose a

TECHNET
THE VOICE OF THE
INNOVATION ECONOMY

critical tool to meeting its air quality and GHG standards. **We recommend that staff use the most accurate and available data to determine what is on the grid today to set the baseline for this *annual* standard.** As the grid gets cleaner, through new technologies and statutorily set goals, fuel cell technologies will also have to improve. Using an annual standard provides an accurate comparison to what is happening in real time, while also leaving the risk and reward to the technologies that can keep pace.

TechNet thanks ARB staff for their efforts in developing this plan as well as for the opportunity to provide comments. If you have any questions, you can reach me at adeveau@technet.org or (805) 234–5481.

Sincerely,

Andrea Deveau
Vice President
State Policy and Politics

Fuel Cell NEM Workshop

California Air Resources Board sent this bulletin at 06/24/2019 02:37 PM PDT

Having trouble viewing this email? View it as a Web page.

CALIFORNIA AIR RESOURCES BOARD

Fuel Cell NEM Workshop

The California Air Resources Board (CARB) invites you to participate in a workshop to discuss the proposed methodology for determining the Fuel Cell Net Energy Metering (NEM) greenhouse gas (GHG) emission standards.

DATE: July 8, 2019
TIME: 10:00 a.m. to Noon
LOCATION: California Environmental Protection Agency
California Air Resources Board | Sierra Hearing Room
1001 I Street Sacramento, California 95814

Purpose of the Workshop

At this meeting, CARB staff will present a brief overview of and background information on their proposed Fuel Cell NEM emission standards calculation methodology, followed by an open discussion. This workshop is intended to provide information and solicit feedback on the calculation methodology.

Following the workshop, stakeholders will have an opportunity to provide written comments during an informal comment period, which will conclude at 5:00 p.m. Pacific time on Monday, July 22, 2019.

All interested stakeholders are invited to attend. For those unable to attend in person, the workshop will be webcast.

Relevant materials will be available on CARB's Stationary Fuel Cell Net Energy Metering "Meetings and Workshops" webpage prior to the workshop.

Workshop Information

Background Information

Assembly Bill 1637 directs CARB, in consultation with the California Energy Commission, to establish a schedule of annual GHG emission standards for the Fuel Cell NEM program. CARB staff has held workshops and meetings with stakeholders to solicit input on what data and methods should be used to determine the Fuel Cell NEM GHG emission standards, and the latest proposal reflects this input.

More Information

CLEARING CALIFORNIA SKIES FOR 50 YEARS

CARB is the lead agency for California's fight against climate change, and oversees all air pollution control efforts in the state to attain and maintain health-based air quality standards. Learn more at www.arb.ca.gov.

Fuel Cell Net Energy Metering GHG Emission Standards

JULY 8, 2019

Workshop Materials and Comments

- This presentation and other materials are posted on our webpage: https://ww2.arb.ca.gov/our-work/programs/stationary-fuel-cell-net-energy-metering/meetings-workshops
- Presentation webcast: https://video.calepa.ca.gov/
- During this workshop, e-mail questions to: sierrarm@calepa.ca.gov
- Following the workshop, please submit written comments by 5:00 p.m. Pacific time on Monday, July 22, 2019 via our webpage: https://ww2.arb.ca.gov/our-work/programs/stationary-fuel-cell-net-energy-metering/meetings-workshops

Assembly Bill (AB) 1637 (Low, 2016)

- Effective January 1, 2017
- Extends the CPUC's Fuel Cell Net Energy Metering (NEM) program tariff through 2021
- Increases individual system eligibility to 5 MW, and extends overall program cap to 500 MW over existing installed capacity
- Directs CARB to establish annual GHG emission reduction standards for "customer-generators" participating in Fuel Cell NEM program
- GHG standards are to reduce emissions relative to grid resources that would be displaced, including renewable resources, and account for both procurement and electrical grid operation

Background

- CARB has been tasked with developing GHG emission standards for the Fuel Cell NEM program
  - Implementation overseen by the CPUC with IOU program administration
- Eligible fuel cell technologies must reduce GHG emissions relative to the grid resources being displaced and meet CARB's Distributed Generation (DG) Certification Program requirements for criteria pollutants
- Customer-generators receive generation rate credits and avoid nonbypassable utility charges for onsite energy consumption
- Prior to AB 1637, the Fuel Cell NEM GHG eligibility standard used the SGIP standards

Key Objectives

- Comply with AB 1637 legislative mandate
- Encourage availability and deployment of fuel cells to promote GHG reductions and local air quality benefits
- Transition away from diesel as a distributed generation resource
- Promote replacement of fossil fuels with renewable gas over time
  - 2017 Scoping Plan Update stated the need to move away from natural gas toward cleaner fuels
- Align with other State policies to achieve legislatively-mandated climate goals and cleaner electricity grid

Previously Considered Methodologies (1 of 2)

- May 2017 Proposal: Use the average emission rate of combined cycle plants located in California
- May 2017 Proposal: Use the average emission rate of combined cycle plant located in California with a 25 percent renewable adjustment
- November 2017 Proposal: Use the 2017 Avoided Cost Calculator (ACC)
- May 2018: CPUC released the 2018 ACC

Previously Considered Methodologies (2 of 2)

Method	Basis	Kg CO2e/ MWh	Standards year	Proposal Date
	Displacement of CCGT generation with a 25% renewable energy adjustment (RPS target of 25% by January 1, 2017)	300	2017	May 2017
	2017 ACC modified with emission tab	324	2017	November 2017
	2018 ACC	444	2017	Released May 2018

Avoided Cost Calculator (ACC)

- CPUC ACC developed by E3 for the CPUC to evaluate the cost effectiveness of energy efficiency programs
- 2017 ACC included a 1-RPS factor to account for how behind-the-meter distributed generation changes procurement of renewable generation
- 2018 ACC did not include the RPS factor due to over-procurement of renewables
- E3 recommended that CARB should not use the 2018 version of the ACC to determine an emission reduction standard
- CARB determined the ACC not viable for Fuel Cell NEM standard development

Proposed Fuel Cell NEM Methodology

- Start with 2017 estimated power plant marginal emission rate for California combined and simple cycle power plants (414 kg CO_2e/MWh, CEC data)
- Determine the number of hours in a year the cost of generation is zero using 2017 CAISO data (110 hours)
  - When cost of generation is zero, it is assumed that renewable generation is on the margin
- Adjust 2017 marginal emission rate by the percent of time the cost generation is zero
- Reduce the standard by 2.5 percent per year through 2022
  - Setting standard through 2022 allows for update “every three years”
- Update standard for 2023 based on most recent public data, not to exceed 2022 standard

Current Emission Standards Proposal

	2017	2018	2019	2020	2021	2022
CARB Proposal ($kgCO_2e/MWh$)	409	399	389	379	370	360

Considerations for Setting Fuel Cell NEM Emission Standards

- Projected marginal emission rates are always an estimate
- Operation of the electrical grid is highly complicated and changes rapidly
- Use of 2017 public data ties the base year to actuals
- Declining standard ensures fuel cells reduce GHG emissions compared to the electrical grid resources being displaced (including renewables)
  - Annual reduction rate aligns with expectations of legislatively-mandated emission reduction efforts to achieve cleaner electricity grid

Next Steps and Additional Information

- Please submit written comments by 5:00 p.m. Pacific time on Monday, July 22, 2019 via our webpage: https://ww2.arb.ca.gov/our-work/programs/stationary-fuel-cell-net-energy-metering
- Present regulation to the Board before the end of 2019
- Regulation effective in 2020
- For additional information on Fuel Cell NEM, visit our webpage or email energy@arb.ca.gov
- Contact:

Carey Bylin	Keith Roderick
916-445-1952	916-327-7838
carey.bylin@arb.ca.gov	keith.roderick@arb.ca.gov

Preliminary Discussion Draft

Subchapter 10. Climate Change
Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions
Subarticle 5.2. Fuel Cell Net Energy Metering
Greenhouse Gas Emission Standards

§ 95408. Purpose

The purpose of this regulation is to implement section 2827.10(b) of the Public Utilities Code.

§ 95409. Applicability

The provisions of this Article shall apply to participants in the Fuel Cell Net Energy Metering program.

§ 95410. Definitions and Acronyms

(a) For the purposes of this Article, the following definitions apply.

(1) **"British Thermal Unit"** or **"Btu"** means the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at about 39.2 degrees Fahrenheit.

(2) **"Carbon dioxide"** or **"CO_2"** means the most common of the six primary greenhouse gases, consisting on a molecular level of a single carbon atom and two oxygen atoms.

(3) **"Carbon dioxide equivalent" or "CO_2e"** means the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas when calculated using the individual global warming potentials as specified in the "global warming potential" definition of this article.

(3) **"Global warming potential" or "GWP"** means the ratio of the time-integrated radiative forcing from the instantaneous release of one kilogram of a trace substance relative to that of one kilogram of a reference gas, i.e., CO_2. For 2011 through 2020 data years, the GWP values used for emissions estimation and reporting are as specified in Table A-1 to Subpart A of Title 40, Code of Federal Regulations (CFR) Part 98 as published to the Federal Register on 10/30/2009. For data years 2021 and onward, the GWP values are as specified in the Table A-1 to Subpart A of Title 40 Code of Federal Regulations Part 98 as published to the CFR on 12/11/2014, which is hereby incorporated by reference.

(4) **"Greenhouse gas" or "GHG "** means carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other fluorinated greenhouse gases.

(5) **"Megawatt-hour" or "MWh"** means the electrical energy unit of measure equal to one million watts of power supplied to, or taken from, an electric circuit steadily for one hour.

§ 95411. Greenhouse Gas Emission Standards

The annual greenhouse gas emission standards for eligibility in the Fuel Cell Net Energy Metering Program shall be:

Year	Annual GHG Emission Standard (kg CO_2e/MWh)
2017	409
2018	399
2019	389
2020	379
2021	370
2022	360

§ 95412. Greenhouse Gas Emission Standards Methodology

(a) Beginning in 2022, and every three years thereafter, the Executive Officer shall calculate the annual greenhouse gas emission standards for the next three years and publish them on the CARB website using the following process. The calculation will be performed the second Monday of November and published on the CARB website within five business days.

(1) Calculate the standard for the calendar year following the year in which the tri-annual update is occurring using the following equation:

$$FCNEM_{y+1,} = CSC\ ER_{y-1} * 0.001 * 53.07 * \frac{8760 - HR0_y}{8760} * 1.000962$$

Where:

$FCNEM_{y+1}$ = FCNEM emission standard for year *y+1* ($kgCO_2e$/MWh)

y = Calendar year in which the update is occurring

CSC ER_{y-1} = Heat rate for combined/simple cycle gas power plants for year *y-1* or the most recent year that data is available from the most recently published California Energy Commission Thermal Efficiency of Gas-Fired Generation in California[1] (MMBtu/MWh)

0.001 = Conversion factor Btu/kWh to MMBtu/MWh

53.07 = Conversion factor MMBtu/MWh to $kgCO_2/MWh$

8760 = Number of hours in a year

$HR0_{y-1}$ = Hours the day-ahead price of generation was at or below $0.00 for year y-1 or the most recent year that data is available from the most recently published CAISO Annual Report on Market Issues and Performance for day-ahead market prices[2]

1.000962 = CO_2e/CO_2 conversion factor[3]

(2) Calculate the standard for the calendar year two years after the year in which the tri-annual update is occurring using the following equation:

$$FCNEM_{y+2} = FCNEM_{y+1} * 0.975$$

Where:

$FCNEM_{y+2}$ = FCNEM emission standard for year *y+2* ($kgCO_2e/MWh$)

y = Calendar year in which the update is occurring

0.975 = Adjustment to reduce annual GHG emission standard by 2.50 percent

(3) Calculate the standard for the calendar year three years after the year in which the tri-annual update is occurring using the following equation:

$$FCNEM_{y+3} = FCNEM_{y+2} * 0.975$$

[1] Thermal Efficiency of Natural Gas-Fired Generation Reports
https://ww2.energy.ca.gov/almanac/electricity_data/Thermal_Efficiency_reports.html
[2] Annual Report on Market Issues and Performance
http://www.caiso.com/market/Pages/MarketMonitoring/AnnualQuarterlyReports/Default.aspx
[3] Calculation of Annual Fuel Cell NEM GHG Emission Standards
https://ww3.arb.ca.gov/energy/nem/2-13-18/calculating_ghg_emission_standards.pdf

Where:

$FCNEM_{y+3}$ = FCNEM emission standard for year *y+3* ($kgCO_2e/MWh$)

y = Calendar year in which the update is occurring

0.975 = Adjustment to reduce annual GHG emission standard by 2.50 percent

(4) If in any year $FCNEM_{y+1}$, as calculated per 95412(a)(1), is greater than $FCNEM_y$, $FCNEM_{y+1}$ shall be calculated as follows:

$$FCNEM_{y+1} = FCNEM_y * 0.975$$

Where:

$FCNEM_{y+1}$ = FCNEM emission standard for year *y+1* ($kgCO_2e/MWh$)

y = Calendar year in which the update is occurring

0.975 = Adjustment to reduce annual GHG emission standard by 2.50 percent

Doosan Fuel Cell America, Inc.
195 Governor's Highway
South Windsor, CT 06074
T - 860 727 2200

David Giordano, Government Relations & Business Development

Doosan Fuel Cell America, Inc.

Comments on the July 8, 2019 California Air Resources Board, Public Workshop to discuss the Fuel Cell Net Energy Metering, Greenhouse Gas Emission Standard, Calculation Methodology

July 22, 2019

Doosan Fuel Cell America appreciates the opportunity to provide comments to the California Air Resources Board (CARB) on the materials presented at the July 8, 2019 public workshop to discuss the methodology for calculating the Fuel Cell Net Energy Metering (NEM) greenhouse gas (GHG) emission standards. Doosan supports both the recommended methodology and the acknowledgement that fuel cell systems are critical to California energy and environmental policy objectives.

Doosan is a global leader in providing clean, continuous-duty, cost-competitive stationary fuel cell energy systems. Our PureCell® systems operate 24/7 with high efficiency and ultra-low emissions, allowing our customers to generate their own electricity and heat on-site while reducing their utility expenses and environmental emissions.

The Doosan Corporation is a global company with 42,000 employees and worldwide revenue of more than $16 billion. Our global businesses span a range of products and services in infrastructure support and power generation, including nuclear power, steam turbines, power plant boilers, water desalination, construction equipment, machine tools and engines for a variety of applications.

Our PureCell® Model 400 fuel cell systems operate more than 500 units worldwide producing over 230 MW with many more coming on line in the next year. The reliability and resiliency attributes of our fuel cells are felt during grid outages where our systems continue to run, providing essential electricity and heat to critical facilities. Such was the case in northeast during winter storm Alfred in 2011 and Superstorm Sandy in 2012. Doosan fuel cells kept the lights on during these critical times of need.

The State of California has been one of the most important markets for the emerging fuel cell sector, and non-combustion fuel cells are contributing greatly to the State's goals of reducing greenhouse gas emissions, improving air quality, reducing peak load, and improving the reliability of the electric utility system. Doosan fuel cells are currently supplying clean and secure power to a diverse set of customers in the U.S. such as hospitals, universities,

Doosan Fuel Cell America, Inc.
195 Governor's Highway
South Windsor, CT 06074
T - 860 727 2200

manufacturers, municipalities and high schools, supermarkets, residential buildings and waste water treatment plants as well as other technology companies.

Stationary fuel cell applications offer these customers a clean and efficient method of producing energy that provide resiliency, reliability and price stability, while reducing stress on the electric grid. A wider deployment for distributed generation (DG) will lead to clean, efficient electric generation and will alleviate the need for additional transmission facilities, when developed where the demand is needed.

Doosan Fuel Cell America supports the work that CARB has put in to come up with a data-driven methodology to develop the GHG standard. We feel that it is important to set a standard that conforms with the true intent of the original legislation which was to encourage and expand the use of fuel cell systems for environmental benefits and GHG emission reduction. This standard supports the use of fuel cells and all their benefits.

Fuel cells emit no criteria air pollutants and improve air quality in local communities. Currently, potential customers are choosing between the grid and dirty diesel generators. Fuel Cell NEM will now allow them to select non-combustion fuel cell technology. There is a need, now more than ever, for additional resiliency in California and fuel cell systems are the only non-combustion reliable energy source. The implementation of Fuel Cell NEM is critical and timely especially with current wildfire and microgrid legislation. In the long run fuel cells will lead to cheaper, cleaner and more reliable power in California.

Bloomenergy™

July 22, 2019

Keith Roderic
Industrial Strategies Division
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Dear Mr. Roderic,

Thank you for the opportunity to comment on the California Air Resource Board's (ARB) proposed Green House Gas ("GHG") Emission Standards for fuel cell net energy metering. Bloom Energy ("Bloom") appreciates the ARB's ongoing efforts to advance this shared vision through the technically rigorous, data-driven methodology used to arrive at the proposed emission standards as required by AB 1637. This proposal creates the certainty for non-combustion, always-on fuel cells like Bloom's Energy Servers to continue playing an integral role in reducing GHGs and criteria air pollutants, displacing dirty diesel generators, increasing resiliency, and achieving the state's clean and renewable energy goals.

Legislative Goals of AB 1637

Assembly Bill 1637 (Low, 2016), effective January 1, 2017, extended the California Public Utilities Commission's (CPUC) Fuel Cell Net Energy Metering (FC-NEM) program through 2021.[1] This legislation specified that:

> *(1) Not later than March 31, 2017, the State Air Resources Board, in consultation with the Energy Commission, shall establish a schedule of annual greenhouse gas emissions reduction standards for a fuel cell electrical generation resource for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a) and shall update the schedule every three years with applicable standards for each intervening year.*
>
> *(2) The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical*

[1] California Assembly Bill No. 1637, Chapter 658, September 26, 2016.

generation resource displaces, accounting for both procurement and operation of the electrical grid.

To summarize, as the enabling legislation and accompanying legislative analysis make clear, AB 1637 directs ARB to establish a standard for fuel cell generators running on natural gas to reduce GHG emissions as compared to the procurement and operation of electrical grid, and specifically indicates renewables be included in the comparison between the grid and the fuel cell generation.[2] ARB is directed to set annual standards, updating this analysis every 3 years.

ARB Proposed GHG Standard and Methodology Meets this Directive

ARB's July 8, 2019 proposed FC-NEM standard accurately and effectively complies with this statue.[3] Specifically, it utilizes a data-driven methodology that is consistent with the directive:

- Current grid emissions: The 2017 estimated emissions from California Energy Commission (CEC) data for combined and simple cycle power plants are the most-up-to-date estimates of the marginal emissions for the generation resource that always-on fuel cells displace.
- Renewables: Using California Independent System Operator (CAISO) pricing data when the cost of generation is zero is an effective estimate for when renewables are on the margin and properly reflects the current operation of the grid.
- Annual updates: The proposed standard is set annually and updated every three years to incorporate new grid operations and market realities.
- Increasing performance requirement: The 2.5% annual reduction in the emission standard through 2022 will drive innovation and accurately reflects the trends expected in future grid operation, including plant retirement, additional curtailment, and technology innovation with new generators coming online.

The Proposed Standard and Methodology Fosters Increased Benefits from Fuel Cells

This GHG standard will provide the accurate, clear guidance necessary for California's hospitals, universities, data-centers, and other commercial and industrial customers to deploy fuel cells to achieve their clean energy goals while simultaneously supporting the state's GHG reduction, air quality, and resiliency goals, including:

- ***Reducing GHGs***: Thanks to their non-combustion process, fuel cells generate clean electricity at the highest efficiencies of any technology commercially available. This feature, combined with the fact that fuel cells are located onsite, lessens the state's reliance on large combustion power plants that inefficiently burn gas and result in further waste due to

[2] https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160AB1637#, Pg 7
[3] https://ww2.arb.ca.gov/index.php/sites/default/files/2019-07/fcnem_discussiondraft_20190710.pdf

losses caused by transporting the electricity long distances to load centers. Indeed, the third party impact evaluation of the Self-Generation Incentive Program—a CPUC program established in the wake of the 2001 energy crisis to reduce reliance on centralized grid resources—found that all-electric fuel cells reduced GHGs more than any other technology: over 100,000 metric tons of CO2e reduced in 2016 and 2017 combined.

- ***Virtually eliminating criteria air pollutants***: AB 193 provided additional impetus to a key state objective: addressing criteria air pollutants. Due to its non-combustion electricity generation process that results in negligible NOx, SOx, and VOCs, ARB has certified Bloom's Energy Servers under its Distributed Generation regulation. With over 140 installations that total more than 70 MWs in SB 535 designated Disadvantaged Communities, Bloom is proud to efficiently generate clean electricity while protecting air quality for all Californians. Fuel cells are uniquely able to provide these benefits, which align with California's commitments to environmental justice and equity, including SB 350, AB 617, and SB 535.

- ***Providing unparalleled resiliency***: Fuel cells are the only technology able to meet the 24-7-365 energy demands for critical facilities like hospitals and emergency centers, as well as for commercial and industrial customers—sectors that are particularly difficult from which to reduce emissions. With their modular, redundant architecture, all-electric fuel cells offer multiple resiliency benefits, including indefinite operation, undergrounded fuel supply lines, and in-situ maintenance. Additionally, fuel cells serve as the always-on backbone for microgrids that integrate numerous distributed energy resources such as solar, wind, and batteries. Bloom has installed over 75 microgrids to provide data centers, hospitals, and emergency centers with truly resilient power.

  These benefits have directly translated into resilient performance in real-world disaster and grid interruption events. Bloom fuel cells have powered through over 500 grid outages, including a 6-hour grid outage in Albany, NY. In California, fuel cells supplied critical load power to a healthcare facility during triple-digit temperature heat waves that triggered outages for 57,000 customers in Southern California in 2018; Bloom systems also withstood the Sonoma fires in 2018, the 6.0 magnitude Napa earthquake in 2014, and even when a bulldozer was accidently dropped on them at a customer site in 2016.

  With the new normal of climate caused extreme weather events, combined with California's unprecedented reliance on Public Safety Power Shutoffs that proactively de-energize lines for multiple days, the resiliency benefits of fuel cells are more critical than ever.

- ***Advances California's long-term energy and climate goals***.

  In addition to the GHG reduction, criteria air pollutant elimination, and resiliency benefits fuel cells have already provided, this innovative technology is foundational to assisting California in reaching its world-leading climate reduction, air quality, and clean energy goals in the future.

  - *SB 1383:* This seminal legislation requires a 40 percent reduction in methane (CH4)—a potent GHG that has a global warming potential 56 times greater than CO2 over a

20 year time frame—by 2030.[4] Methane currently accounts for approximately 9 percent of California's overall GHG emissions, largely from agricultural, landfill, wastewater treatment, and food separation sources.[5] Methane is the main feedstock for fuel cells. Rather than flaring, venting, or burning this resource, fuel cells can convert this potent GHG into renewable electricity, virtually without criteria air pollutants.

- *AB 617:* Passed in 2017, this legislation requires statewide reductions in criteria air pollutants, especially in historically disadvantaged and heavily impacted communities across the state.[6] Given their modular architecture, microgrid capabilities, and clean air benefits, fuel cells are the perfect match to displace diesel generators—one of the dirtiest and most inefficient sources of electricity generation—in the overarching strategy to accomplish AB 617's goals. On average, each 1 MW of diesel generators that Bloom Energy Servers displaces results in substantial air quality benefits—see Figure 1. To date, Bloom has displaced more than 6.5 MW worth of diesel generators at customer sites across California, resulting in more than 1 million pounds in CO2 reductions, in addition to the criteria air pollutants avoided.

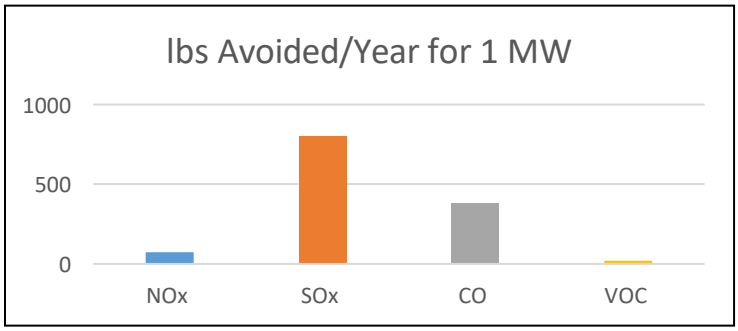


Figure 1

- *SB 100:* Requiring retail electricity purchases to be 100 percent clean (60 percent renewable and 40 percent zero carbon) by 2045, SB 100 continues California's leadership in decarbonizing the electricity sector. Fuel cells help California integrate additional intermittent renewables—such as wind and solar—onto the grid. The variable production nature of these resources are a reliability challenge; baseload resources are essential to smoothing the peaks and valleys. Fuel cells are the only non-combustion baseload generator, and as such, have a critical role to play in reaching SB 100's goals.

Conclusion

[4] https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/global-warming-potentials
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383
[5] https://ww3.arb.ca.gov/cc/inventory/data/graph/bar/bar_2016_by_ghg.png
[6] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617

Bloom commends ARB for the rigorous process to accurately determine the GHG emissions reduction standard appropriate for an always-on, behind the meter fuel cell. This standard is key to ensure that fuel cells running on natural gas continue to help the state and customers reduce GHGs, achieving our climate change goals. Without this policy certainty that fuel cells reduce GHGs, fuel cell projects will almost certainly be delayed or even stopped—meaning that California businesses and communities must turn to higher emitting resources to supply both always-on and back-up electricity to meet their needs. Additionally, without this certainty, fuel cell manufacturers will lose critical resources necessary to scale existing solutions and pursue emerging opportunities: higher efficiencies, biogas, renewable hydrogen, and microgrids. This standard exemplifies a best practice in policy design: a data-driven, continually updated performance standard that incentivizes innovation for a technology that is foundational to meeting California's ambitious methane reduction, air quality, clean and renewable energy, and environmental justice goals.

Sincerely,

Erin Grizard

NATIONAL FUEL CELL RESEARCH CENTER
Comments July 8, 2019 Public Workshop to Discuss the
Fuel Cell NEM GHG Emission Standard Calculation Methodology

July 22, 2019

The National Fuel Cell Research Center (NFCRC) submits these comments to the California Air Resources Board (CARB) on the materials presented at the July 8, 2019 public workshop to discuss the methodology for calculating the Fuel Cell Net Energy Metering (NEM) greenhouse gas (GHG) emission standards. The NFCRC supports both the recommended methodology and the acknowledgement that fuel cell systems are critical to meet California energy and environmental policy objectives.

I. Background Information

Enabling Legislation Direction:

Assembly Bill 1637 (Low, 2016), effective January 1, 2017, extended the CPUC's Fuel Cell Net Energy Metering (FC-NEM) program through 2021.[1] This legislation directed CARB (California Air Resources Board) to:

1. Establish annual GHG emission reduction standards for customer-generators participating in the Fuel Cell NEM program; and
2. Do so by accounting for both procurement and operation of the electrical grid, including renewable resources.

The relevant statute language is:

(b) (1) Not later than March 31, 2017, the State Air Resources Board, in consultation with the Energy Commission, shall establish a schedule of annual greenhouse gas emissions reduction standards for a fuel cell electrical generation resource for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a) and shall update the schedule every three years with applicable standards for each intervening year.

(2) The greenhouse gas emissions reduction standards shall ensure that each fuel cell electrical generation resource, for purposes of clause (iii) of subparagraph (A) of paragraph (3) of subdivision (a), reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, accounting for both procurement and operation of the electrical grid.

AB 1637 directed CARB to establish a schedule of annual GHG emission standards for the Fuel Cell NEM program in consultation with the California Energy Commission (CEC). Over the past two years, CARB staff has held workshops to solicit stakeholder input on what metric(s) should be used to determine the fuel cell NEM GHG annual emission standards.

[1] California Assembly Bill No. 1637, Chapter 658, September 26, 2016.

II. Comments

A. The Proposed Fuel Cell NEM Emission Standards Presented by CARB is Data-Driven and Technically Validated.

The NFCRC supports the GHG Emission Standard for Fuel Cell NEM that was proposed by CARB in the July 8 workshop and meeting materials. To reiterate, the AB 1637 statute calls for fuel cell generators to reduce GHG emissions compared to grid-supplied electricity accounting for the actual resource mix used for grid electricity and specifically calls out renewables to be included in the comparison between the grid and the fuel cell generation. The statute calls for this comparison between customer-generation and the grid to be established and updated in annual standards. The methodology detailed in the discussion draft now uses third-party resources and reports from CARB, the California Energy Commission (CEC) and the California Independent System Operator (CAISO) to set and update the GHG standard. We strongly support the use of this public data to tie the base year to actual emission rates.

The current proposed standard follows the legislative intent of AB 1637, as described above, which calls for an annual standard to be applied to a project each year. Because eligibility is not automatic for the lifetime of a project, an annual view of marginal emissions is appropriate for this standard. By decreasing the annual fuel cell NEM standard every year based upon actual marginal emissions rates, the standard now accounts for the evolving dispatch profiles of load-following combined cycle and simple cycle power plants operating in concert with renewables for each year.

B. Fuel Cell NEM is Critical to Achieving the State's Goals of SB 100, AB 617 and Increased Resiliency.

As recognized at the July 8 workshop, finalizing this fuel cell NEM standard is important to enabling the further deployment of fuel cell systems. Because of their non-combustion operation and high capacity factor, fuel cell systems decrease GHG emissions more than the grid and other renewable resources. In order to achieve the objectives in SB 100, California needs multiple resources that can balance intermittent renewables while also reducing GHG emissions.

As non-combustion distributed energy resources, fuel cell systems also greatly improve air quality in local communities and are critical to meet the goals of AB 617. Consistent with CARB's objective in the workshop presentation, fuel cells displace traditional emergency backup generators that emit criteria air pollutants and GHG, including diesel generators. The generation of always-on, zero criteria pollutant emission power is especially critical given that the majority of California currently suffers from poor air quality and faces major challenges in achieving clean air for the many citizens that live and work within these areas, including in economically disadvantaged communities that are often disproportionately burdened by air pollution.

The establishment of California policy needed to address resiliency, public safety power shutoffs and wildfire mitigation is accelerating, and fuel cell systems are uniquely designed to help meet these challenges. Non-combustion fuel cells address multiple resiliency needs related to electricity production and backup power. These distributed onsite resources can be used in microgrids, at the utility-scale or for both onsite continuous and backup power in the event of a grid outage or de-energization event. The finalization of the fuel cell NEM standard, and implementation of fuel cell NEM at the CPUC is critical to proceed quickly with projects providing:

- Baseload power in communities with constrained transmission and distribution, including disadvantaged communities or rural locations;
- Continuous and long-duration backup (longer than 48 hours) generation for all sites, including critical services such as hospitals, telecommunications, gas stations, and grocery stores;
- Underground fuel lines that eliminate the vulnerability to weather and risk of sparks from traditional poles and wires infrastructure;
- Time to build, uptime, and recovery time that are all faster than the electric utility grid network can achieve;
- Leading power density: fuel cells produce the largest quantity of zero emissions electricity in proportion to their equipment footprint compared to any technology currently on the market.

III. Conclusion

Establishing an accurate GHG standard for the net energy metering of fuel cell systems in the near-term is critically important for a clean and resilient grid today, and to accelerate the improvement of air quality and reduction of carbon emissions in California. The NFCRC appreciates CARB's recognition of this important function of fuel cells, and we appreciate the opportunity to comment on the proposed methodology for a Fuel Cell Net Metering GHG Standard to enable meeting these objectives. We look forward to finalizing the standard in the coming months.

Sincerely,

/s/ *Jack Brouwer*

Dr. Jacob Brouwer, Director
National Fuel Cell Research Center
Professor of Mechanical and Aerospace Engineering
University of California, Irvine

C C D C

CALIFORNIA CLEAN DG COALITION

July 22, 2019

California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Preliminary Discussion Draft Fuel Cell Net Energy Metering Greenhouse Gas Emission Standards

California Air Resources Board:

The California Clean DG Coalition (CCDC) appreciates the opportunity to provide these comments on the Preliminary Discussion Draft Fuel Cell Net Energy Metering (NEM) Greenhouse Gas (GHG) Emission Standards. CCDC is an ad hoc group interested in promoting the ability of distributed generation (DG) system manufacturers, distributors, marketers and investors, and electric customers, to deploy DG. Its members represent a variety of DG technologies including combined heat and power (CHP), renewables, gas turbines, microturbines, reciprocating engines, and storage.[1] Through these comments, CCDC requests that the California Air Resources Board (CARB) modify the Draft 2030 Update to affirm the role of CHP in contributing to greenhouse gas (GHG) emission reduction goals, and supporting the integration of more renewable generation into the California grid.

Inclusion of Line Loss Factor

One of the major benefits of distributed generation is the avoidance of electrical transmission and distribution (T&D) losses. CCDC encourages CARB to include a T&D loss factor in setting the 2017 emissions factor. California's Self Generation Incentive Program uses a "line loss factor" of 8.4%.[2] Using this factor, the 2017 emissions standard would increase from 409 kg/MWh to 446 kg/MWh. Appropriate corresponding adjustments should also be made to the proposed GHG emission standards for years 2018 through 2022.

---

[1] CCDC is currently comprised of Cal Microturbine; Capstone Turbine Corporation; Caterpillar, Inc.; Clearway Energy; Cummins, Inc.; DE Solutions, Inc.; EtaGen, Inc.; Hawthorne Power Systems; Holt of California; MMR Power; Penn Power Systems; Peterson Power Systems; Solar Turbines, Inc.; and Tecogen, Inc.

[2] https://www.selfgenca.com/documents/handbook/2017

Support for Annual Reduction

CCDC encourages CARB to provide supporting documentation for the 2.5% annual reduction in the standard. This level of reduction implies, based on the logic used to generate the standard, that the number of hours that renewable resources are on the margin is expected to increase from 110 hours in 2017 (1.3%) to 1,138 hours in 2022 (13%), which seems unrealistically high. Given that the standard will be updated for 2023 based on public data, but not to exceed the 2022 standard, CCDC encourages CARB to use a supportable methodology for determining the annual reduction percentage.

Conclusion

CCDC appreciates CARB's consideration of these comments on the Fuel Cell NEM GHG emission standards.

Sincerely,

California Clean DG Coalition

July 22, 2019

Via Online Filing though Air Resource Board Website

Re: Comments on Preliminary Discussion Draft of Fuel Cell Net Metering Greenhouse Gas Emission Standards

The Natural Resources Defense Council, Sierra Club, and Earthjustice write to express our concerns with the most recent iteration of the Air Resources Board's ("ARB") proposed greenhouse gas ("GHG") emissions standard for Fuel Cell Net Energy Metering ("FC-NEM"). Assembly Bill ("AB") 1637 tasked ARB with establishing a GHG emissions standard that ensures only gas-powered fuel cells that reduce GHG pollution are eligible for the approximately $200k/MW of incentives under the FC-NEM program.[1] Instead, the GHG standard proposed in ARB's July 10, 2019 Preliminary Discussion Draft uses a flawed methodology that would allow inefficient and GHG intensive fuel cell projects to qualify. To put ARB's proposed standard in perspective, the California Public Utilities Commission ("PUC") adopted an analogous first-year 2017 GHG threshold of 332 kg CO_2/MWh for fuel cells under the Self-Generation Incentive Program ("SGIP").[2] In contrast, ARB has now proposed a 2017 FC-NEM GHG standard of 409 kg CO_2/MWh.[3] This result contravenes the legislative intent of AB 1637, which is clear that ARB's FC-NEM GHG standard should "be lower than the existing [SGIP] standard at the outset."[4]

The Preliminary Discussion Draft's proposed GHG standard not only violates the legislative intent of AB 1637, but its statutory requirements as well. AB 1637 specifically requires the GHG standard to account for the impact of additional behind-the-meter ("BTM") baseload gas-powered generation on renewable procurement under the Renewables Portfolio Standard ("RPS") from reduced retail energy sales. Yet the proposed standard fails to do so. The methodology also fails to account for increased methane leakage from the deployment of gas-

[1] AB 1637 (amending Pub. Util. Code, § 2827.10); ARB, *Presentation on Fuel Cell Net Energy Metering GHG Emission Standards*, at Slide 3 ("Fuel Cell NEM Background") (Nov. 28, 2017), https://arb.ca.gov/energy/nem/fc_nem_presentation_11-28-17.pdf. With 500 MW of program capacity, the potential incentives under FC-NEM total approximately $100 million.

[2] Decision 15-11-027, *Decision Revising the Greenhouse Gas Emission Factor to Determine Eligibility to Participate in the Self-Generation Incentive Program Pursuant to Public Utilities Code Section 379.6(b)(2) as Amended by Senate Bill 861*, Rulemaking 12-11-005, at Appendix B (Nov. 19, 2015), http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M156/K044/156044151.PDF.

[3] ARB, Preliminary Discussion Draft at 2 (July 10, 2019), https://ww2.arb.ca.gov/sites/default/files/2019-07/fcnem_discussiondraft_20190710.pdf.

[4] Bill Analysis Before the Assembly Committee on Natural Resources at 2 (Aug. 30, 2016), https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160AB1637.

powered fuel cells on the gas distribution system. ARB appears to suggest the lax GHG standard that resulted from these omissions is justified to further objectives that are both outside the scope of AB 1637 and not reasonably achieved through additional fuel cell deployment. For example, ARB states a key objective of its GHG standard development is to help "[t]ransition away from diesel as a distributed resource."[5] Yet because diesel generators only operate in an emergency back-up capacity, they are best displaced by solar and energy storage, not baseload gas resources like fuel cells that typically operate on a continuous 24/7 basis and would increase overall reliance on fossil fuels.

ARB should remedy the flaws in the Preliminary Discussion Draft or in the alternative, revisit the 324 kg CO_2/MWh standard it proposed in February 2018. That proposal, which both Pacific Gas and Electric Company ("PG&E") and environmental groups supported, adopts a lower threshold than the PUC adopted in SGIP and properly accounts for the impact of reduced renewable procurement from increased deployment of BTM gas-powered generation.[6] When also accounting for methane leakage, the 2017 GHG threshold would be 306 kg CO_2/MWh. By contrast, the Preliminary Discussion Draft's standard of 409 kg CO_2/MWh would enable ratepayer money to subsidize inefficient fossil-fueled projects that increase GHG pollution, violating both the legislative intent and letter of AB 1637.

1) The Preliminary Discussion Draft's Methodology for Determining the GHG Standard Violates the Requirements of AB 1637.

The Preliminary Discussion Draft's methodology contains several significant flaws and omissions. First, because California's RPS requirements are determined based on retail electricity sales, the reduction in demand from the 500 MW of baseload behind-the-meter gas resources permitted under the FC-NEM program will reduce RPS procurement obligations. While AB 1637 expressly requires ARB to account for the impact of reduced RPS procurement in determining the FC-NEM GHG standard, the Preliminary Discussion Draft's methodology fails to do so.[7] Instead, the methodology appears narrowly focused on determining the marginal emissions rate of the resource the fuel cell would displace. While the methodology does include an annual 2.5 percent reduction in the GHG threshold, this appears intended to account for reductions in the marginal operational emissions rate as the grid continues to decarbonize.[8]

---

[5] ARB, *Presentation on Fuel Cell Net Metering GHG Emission Standard*, at Slide 5 (July 8, 2019), https://ww2.arb.ca.gov/sites/default/files/2019-07/fcnem_presentation_07082019.pdf.

[6] ARB, Draft Regulation Order (Feb. 12, 2018), https://ww3.arb.ca.gov/energy/nem/2-13-18/revised_draft_reg_order.pdf; PG&E Comments on ARB Draft Regulation Setting a GHG Standard for Fuel Cell NEM Program Eligibility (Feb. 28, 2018), https://www.arb.ca.gov/lists/com-attach/2-fuelcellnemwrkgrp-ws-WysFZANnUV1QMAZz.pdf; Sierra Club and Earthjustice Comments Re: Support of Revised Greenhouse Gas Emissions Standards for the Fuel Cell Net Energy Metering Program, https://www.arb.ca.gov/lists/com-attach/3-fuelcellnemwrkgrp-ws-VyRSPVUxUHEKfgBh.pdf.

[7] Pub. Util. Code, § 2827.10(b)(2) (FC GHG standard established by ARB "reduces greenhouse gas emissions compared to the electrical grid resources, including renewable resources, that the fuel cell electrical generation resource displaces, *accounting for both procurement* and operation of the electric grid") (emphasis added).

[8] ARB, Preliminary Discussion Draft at 4. To the extent this annual reduction purports to account for reduced RPS procurement, it is not supported.

Properly accounting for reduced RPS procurement as required under AB 1637 has a significant effect on the GHG standard. Both the PUC's GHG threshold under SGIP and ARB's earlier proposed 324 kg CO_2/MWh GHG standard, which relied on the PUC's 2017 Avoided Cost Calculator ("ACC"), account for reduced RPS procurement using a 1-RPS factor. ARB appears to suggest it no longer needs to factor in the impact of reduced RPS procurement from increased BTM deployment because the "2018 ACC did not include the RPS factor due to over-procurement of renewables."[9] The reason the 2018 ACC did not include an RPS adder was because the passage of SB 350 made the need to achieve GHG reductions, rather than the need to meet RPS goals, the binding constraint on the electricity sector. In addition, the 2018 ACC was adopted prior to the passage of SB 100, which increased 2030 RPS requirements from 50 to 60 percent. California is not over-procured to meet a 60 percent RPS. Therefore, additional BTM baseload generation will reduce future RPS procurement and ARB must account for this impact in determining the GHG threshold. ARB should either factor avoided RPS procurement into its current methodology or simply follow its previously proposed methodology that yielded a 2017 GHG threshold of 324 kg CO_2/MWh GHG.

The Preliminary Discussion Draft also fails to account for increased methane leakage that will occur from deployment of gas-powered generation on the distribution system.[10] A joint analysis by ARB and the PUC on natural gas leakage estimates the leakage rate of the distribution system at 0.14%.[11] Using a 20-year global warming potential ("GWP") for methane to properly reflect the urgency of the climate crisis, as ARB has used to justify past actions,[12] accounting for

---

[9] ARB, *supra* fn. 5, at Slide 8. ARB also does not explain the basis for E3's recommendation that CARB not "use the 2018 ACC to determine the emission reduction standard" and what if any, alternative approach E3 proposed. *Id.*

[10] The centralized gas generation the fuel cells would often displace are connected to the gas transmission system and therefore do not result in additional methane leakage that occurs from gas-powered resources like fuel cells that are located behind customer meters connected to the gas distribution system.

[11] ARB & PUC, *Joint Staff Report-Analysis of the Utilities' June 15, 2018, Natural Gas Leak and Emission Reports* (Dec. 21, 2018), https://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Safety/Risk_Assessment/Methane_Leaks/2017%20NGLA%20Joint%20Report%2012-21-18.pdf. According to Table 2: Total Emissions by System Category, 2015-2017, in 2017, the volume of methane emissions from Distribution Mains & Services was 1,420 MMscf, and the volume from Distribution Metering and Regulating ("M&R") Stations was 1,334 MMscf, equaling a total of 2,754 MMscf methane leaked from the distribution system. According to Table 5: System-wide Emissions – Throughput Categories, 2015-2017, total gas throughput in 2017 equaled 2,017,306 MMscf. Total distribution system leakage (2,754 MMscf) divided by total throughput (2,017,306 MMscf) equals the 2017 distribution system leakage rate: 0.00136, or 0.14%. This is a conservative estimate. Total distribution system leakage *and* Customer Meter leakage (1,656 MMscf in 2017, according to Table 2) equals to 4,410 MMscf. Divided by total throughput, the combined distribution and customer leakage rate is 0.00218 or 0.22%.

[12] *See, e.g.*, ARB, *Aliso Canyon Methane Leak Climate Impacts Mitigation Program* at 7 (Mar. 31, 2016) ("With this mitigation program, ARB uses the 20-year GWPs for SLCPs assigned by AR 5. These figures properly incorporate current scientific knowledge, underscore the influence of SLCPs as immediate climate-forcing agents, and emphasize the need for immediate action on climate change."), https://ww3.arb.ca.gov/research/aliso_canyon/arb_aliso_canyon_methane_leak_climate_impacts_mitigation_program.pdf?utm_medium=email&utm_source=govdelivery;

methane leakage reduces the GHG standard by approximately 18 kg CO_2e/MWh GHG per year.[13] Accordingly, using ARB's earlier proposed standard of 324 kg CO_2/MWh, which properly accounts for reduced renewable procurement as required under AB 1637, and also accounting for methane leakage, which the earlier standard omitted, yields a GHG standard of 306 kg CO_2/MWh.

The Preliminary Discussion Draft also understates the hours that renewable resources operate as the marginal grid resource by only accounting for 110 hours of negative market pricing. Curtailment can and does occur when market prices are positive. California Independent System Operator ("CAISO") data indicates over 100,000 5-minute intervals, or approximately 1,750 hours of annual renewable curtailment.[14] Also unaccounted for is the additional impact on curtailment from the deployment of 500 MW of baseload behind-the-meter gas generation that typically operates on a continuous basis. These omissions further point to an inflated GHG standard that fails to capture the full extent of GHG pollution resulting from fuel cell deployment.

2) The Majority of the Listed Objectives for the GHG Threshold Are Not Reasonably Achieved Through Additional Fuel Cell Deployment.

ARB appears to attempt to justify adoption of a GHG standard far weaker than that developed by the PUC on the purported grounds that it will meet a series of "Key Objectives."[15] As an initial mater, the only relevant objective is the first: "Comply with AB 1637 legislative mandate." As set forth above, the proposed standard violates both the legislative intent and the letter of AB 1637. The remaining objectives are outside the scope of AB 1637 and, in any event, are not legitimately furthered by additional deployment of fuel cells. For example, one stated objective is to "[t]ransition away from diesel as a distributed generation resource."[16] Diesel generation operates only in the event of an outage. At all other times, energy demand is met by an increasingly decarbonized and renewable grid. Indeed, average grid GHG emissions in PG&E's service territory are 197 kg CO_2/MWh, less than half of the Preliminary Discussion Draft's proposed 2017 GHG standard for fuel cells.[17] Diesel back-up generation should not be replaced with a different fossil-fueled resource that typically operates on a continuous 24/7 basis, particularly where zero emission back-up solar and storage solutions are readily available and

---

https://www.arb.ca.gov/regact/2016/oilandgas2016/oilgasatt2.pdf at 8 (discussing cost per ton of CO2e reductions using 20-year methane GWP).

[13] The CO_2e associated with leakage is calculated by assuming 0.14% of leakage per therm. The amount that would leak per MWh is calculated using the average gas heat content and heat rate of a combined cycle unit (EIA, 2017). The heat rate for a combined cycle unit is used to present a conservative estimate based on the most efficient gas-fired power plant technology. The formula used to arrive at the 18 kg CO_2e/MWh of GHG pollution from methane leakage in the distribution system is: 0.230139 (kg CO_2e/therm) * 76.71 (therms of gas used by combined cycle therm/Mwh). The assumptions supporting this calculation are attached.

[14] CAISO Curtailment Data available at http://www.caiso.com/informed/Pages/ManagingOversupply.aspx.

[15] ARB, *supra* fn. 5, at Slide 5.

[16] *Id.*

[17] PG&E, Fighting Climate Change (last accessed July 22, 2019) (converting lbs to kg), https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/fighting-climate-change/fighting-climate-change.page.

more cost-effective.

Another stated objective of the GHG standard is to "[p]romote replacement of fossil fuels with renewable gas over time."[18] Fuel cells operating off renewable fuel already qualify for the more generous incentives under the existing NEM program (as opposed to FC-NEM) and for incentives under SGIP. Accordingly, a declining GHG threshold under the FC-NEM program in no way functions to incentivize increased use of renewable gas.[19] Moreover, the *potential* supply of biomethane represents less than four percent of total gas demand in California.[20] Limited biogas supplies should be directed at existing difficult to electrify applications rather than to incentivize new, gas-dependent stationary power sources to meet building energy demands that could otherwise be served by an increasingly decarbonized grid.

Increased fuel cell deployment of gas-powered fuel cells also does not "[a]lign with other State policies to achieve legislatively-mandated climate goals and cleaner electricity grid."[21] Stationary fuel cells perpetuate reliance on fossil fuels and are therefore wholly inconsistent with California's decarbonization objectives. In recognition of this reality, the City of Santa Clara has now prohibited interconnection of BTM generation running off fossil fuels, specifically noting that "Bloom fuel cells use natural gas, a non-renewable energy source that continuously emit GHG when they generate power. As a result, *their increased usage would run contrary to the clean energy goals set by the City and State*."[22] Moreover, even when properly calculated, the proposed FC-NEM GHG standard is designed to enable subsidization of projects that are only an incremental improvement from business-as-usual.[23] As the climate crisis grows ever deeper and the need to achieve significant and rapid reductions in GHG pollution more urgent, a GHG threshold that allows public money to enable resources with emissions *over twice* PG&E's grid average is fundamentally at odds with California's aggressive climate goals.

3) The Proposed Self-Perpetuation of the Flawed Methodology in the Preliminary Discussion Draft Should be Stricken.

[18] ARB, *supra* fn. 5, at Slide 5.
[19] Pub. Util. Code, § 2827(b)(11); Pub. Resources Code, § 25741.
[20] *Compare* Amy M. Jaffe *et al.*, *The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute*, STEPS Program, Institute of Transportation Studies, UC Davis, at ix (2016), https://ww3.arb.ca.gov/research/apr/past/13-307.pdf (finding 82 bcf/y of biomethane sources "attractive for private investment," after accounting for substantial state and federal incentives) *with* U.S. Energy Information Administration, *Natural Gas Consumption by End Use* (Release Date: June 28, 2019), https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SCA_a.htm (California gas use in 2017 over 2,110 bcf/y).
[21] ARB, *supra* fn. 5, at Slide 5.
[22] City of Santa Clara, *Silicon Valley Power Advances Commitment to Renewables* (May 9, 2019), http://santaclaraca.gov/Home/Components/News/News/38964/ (emphasis added); City of Santa Clara Resolution No. 19-8701 at 2 (May 7, 2019) (limiting "the interconnection of Parallel Generation to facilities meeting the state criteria for renewable electrical generation facilities for the purpose of limiting greenhouse gas emissions in the City"), https://santaclara.legistar.com/LegislationDetail.aspx?ID=3936721&GUID=54E8FC8C-CE96-4231-A280-479191255D80.
[23] Setting the GHG standard at an improvement from average grid emission rather than the marginal grid resource would be a far better metric to ensure meaningful GHG reductions and ratepayer value from the FC-NEM program.

Unlike earlier iterations of ARB's GHG threshold, the Preliminary Discussion Draft now includes a provision that makes its methodology self-executing in future years. Proposed Section 95412 states:

> Beginning in 2022, and every three years thereafter, the Executive Officer shall calculate the annual greenhouse gas emission standards for the next three years and publish them on the CARB website using the following process. The calculation shall be performed the second Monday of November and published on the CARB website within five business days.[24]

This process improperly forecloses the consideration of new information that merits the revision of the ARB's methodology and its underlying assumptions. ARB should remove this provision from its Preliminary Discussion Draft.

Thank you for your consideration of our concerns. We urge ARB either correct the omissions in the GHG standard proposed in the Preliminary Discussion Draft or adopt a 2017 GHG standard of 306 kg CO_2/MWh, which properly accounts for both reduced RPS procurement as required by AB 1637 and methane leakage. At a minimum, ARB should adopt the 324 kg CO_2/MWh 2017 GHG standard ARB proposed in February 2018.

Respectfully,

Matthew Vespa
Staff Attorney
Earthjustice
50 California Street, Suite 500
San Francisco, CA 94111
Telephone: (415) 217-2123
Email: mvespa@earthjustice.org

Katherine Ramsey
Staff Attorney
Sierra Club
2101 Webster Street, Suite 1300
Oakland, CA 94612
Telephone: (415) 977-5737
Email: katherine.ramsey@sierraclub.org

Merrian Borgeson
Senior Staff Scientist
Climate and Clean Energy Program
Natural Resources Defense Council
111 Sutter Street, 21st Floor
San Francisco, CA
Telephone: (415) 875-6100
Email: mborgeson@nrdc.org

[24] ARB, Preliminary Discussion Draft, § 95412.

Attachment A: Inputs to Calcualte Upstream Emissions From Distribution System of Methane Leakage Only

Distribution Leakage Rate	0.14%	Total Upstream Emissions	0.0002	metric tons CO2e/therm
			0.0177	metric tons CO2e/Mwh
			17.65	kg CO2e/Mwh

Conversions

0.7	kg	=	1	m3
1	m3	=	35.3147	ft3
1	f3	=	0.001037	MMBtu
1	g CH4	=	86	gCO2e
1	therm	=	0.1	MMBtu
1	billion Btu	=	1,000	MMBt
1	t CO2e	=	1,000,000	u g
1	kg	=	1,000	CO2e g
1	t CO2e	=	1,000	kg CO2e

Leakage Emissions

0.14%	=	2.301390146	kg CO2e/MMBtu
		0.230139015	kg CO2e/Therm
		0.0002	metric tons CO2e/Therm

Conversions	
10.37	Therms
1	Mcf

	2017 Average Gas Heat Rate (Btu/kWh)	2017 Average Gas Heat Content (Btu/cubic foot)	Gas Used (cubic feet/kwh)	Gas Used (cubic feet/mwh)	Gas Used (Mcf/mwh)	Gas Used (Therms/mwh)
Steam Generator	10,353	1,034	10.01	10,013	10.01	103.83
Gas Turbine	11,176	1,034	10.81	10,809	10.81	112.08
Internal Combustion	9,120	1,034	8.82	8,820	8.82	91.46
Combined Cycle	7,649	1,034	7.40	7,397	7.40	76.71

Source: https://www.eia.gov/electricity/annhttps://www.eia.gov/electricity/annual/html/epa_07_03.html

Note: Using CC heat rate for our conversions, making the GHGs from leakage conservative.
GWP of Methane drived from most recent IPCC Report. http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf (Table 8.7; with climate cc fb)

ADVANCED ENERGY ECONOMY
the business voice of advanced energy

July 22, 2019

Keith Roderic
Industrial Strategies Division
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Dear Mr. Roderic,

Thank you for the opportunity to comment on the California Air Resource Board's (CARB) proposed methodology to determine the greenhouse gas (GHG) emissions standard for fuel cell net metering. Advanced Energy Economy (AEE) is a national association of business leaders who are making the energy system more secure, clean, and affordable. Advanced energy encompasses a broad range of products and services that constitute the best available technologies for meeting energy needs today and tomorrow, including non-combustion fuel cells.

AEE supported AB 1637, the enabling legislation that extended the Fuel Cell Net Energy Metering program and specified CARB's pivotal role in helping foster this technology by creating an accurate GHG emissions standard. AEE is similarly supportive of the data-driven, technically sound methodology that CARB has proposed in the July 8, 2019 discussion draft. It will reduce GHGs and provide clear guidance to California customers who wish to choose fuel cells for their clean energy, resiliency, and sustainability needs.

This standard will also drive further innovation in California's advanced energy economy, as it provides a clear set of metrics technology manufacturers must meet. With this guidance, these companies can invest in research and development, diversify supply chains, and provide additional training to service technicians, installers, and manufacturing specialists. This investment creates jobs across the entire value chain. In fact, AEE released a CA jobs report just last year that identified over 500,000 in-state advanced energy jobs, and projected a 10% increase in the growth of advanced energy jobs compared to the previous year.

The technological innovation woven into the fabric of California combined with a supportive policy infrastructure have contributed to a robust advanced energy economy in the state. AEE believes this GHG methodology will contribute to the state's continued support and growth of advanced energy generation technologies that will lead to a clean, secure, and affordable energy future and will result in overall benefits to the state's climate change goals.

Sincerely,

Amisha Rai
Managing Director
Advanced Energy Economy (AEE)

Bloomenergy™

July 29, 2019

Keith Roderic
Industrial Strategies Division
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Dear Mr. Roderic,

Thank you for the opportunity to comment on the California Air Resource Board's (CARB) proposed methodology to determine the greenhouse gas (GHG) emissions standard for fuel cell net metering.

Bloom would like to address a few key points to clarify some points other parties raised in their comments:

- Program comparison: The Self Generation Incentive Program (SGIP) is fundamentally different from FCNEM, and consequently it not an appropriate reference. Specifically:
    - SGIP is an incentive program; FCNEM is a tariff.
    - SGIP is available to all technologies, including intermittent resources that are not baseload generators and consequently do not displace dirtier marginal generators (e.g. the combined and simple cycle natural gas plants).
    - The SGIP number is set once, cemented in the program handbook, and does not have a regular update schedule. In contrast, as this FCNEM methodology clearly states, ARB will update it every three years to reflect changing grid and market conditions. The "living" standard that ARB has developed is innovative and reflective of operations, thus making it more accurate and superior to a "fixed time" SGIP model.
    - By 2020, SGIP is only available to fuel cells operating on 100% renewable fuel; in contrast, the FCNEM GHG standard is being developed for natural gas fired generators.

- RPS accounting: The methodology clearly accounts for RPS procurement by using CAISO data to accurately track when renewables are on the margin. Bloom commends ARB for evaluating multiple proposals and eventually selecting a technical, data-driven approach to set the standard. Using 5 minute curtailment data is not appropriate for this purpose, for a variety of reasons:

    - CAISO includes a proviso to anyone seeking to use this data: "These files contain raw data, and while the ISO has reviewed for accuracy, the data is provided as is, and is not considered operational or settlement quality data [emphasis added]." AB 1637 requires ARB to set the standard based upon operation of the grid; as such, this is not an appropriately robust or vetted data set.

    - Doing so may capture curtailments caused by forecasting error. It is well-established that actual supply or demand varies significantly from forecasted for the day-ahead market, and as such, this data set reflects instances where the weather was hotter or colder than expected—not marginal resources displacement caused by behind-the-meter fuel cells.

    - In addition, it may capture curtailments that occur due to an inadequacy of integration resources (e.g. lack of ability to accommodate ramps in renewable generation) or unexpected transmission constraints that prevent delivery of renewable energy—again, curtailments due to congestion and not caused by behind-the-meter fuel cells.

    - Even if ARB still chose to use this dataset, it is not clear how the joint environmental groups reached the conclusion that "California Independent System Operator ("CAISO") data indicates over 100,000 5-minute intervals, or approximately 1,750 hours of annual renewable curtailment."[1] The 2017 CAISO annual data show 26,960 curtailment intervals; the 2018 data show 32,431 intervals.[2]

- Methane leaks: As the ARB methodology clearly states, fuel cells displace combined and simple cycle natural gas plants, which also experience methane leaks. As such, this issue is already accounted for correctly; suggestions to adjust the number based upon methane leaks are baseless.

- Diesel displacement: As power shutoffs and grid outages become more prominent due to climate change, diesel generators will run more frequently. Indeed, demand for diesel

[1] https://www.arb.ca.gov/lists/com-attach/5-fuelcellnemmethod-ws-BWtSJl04BzcEXQBz.pdf
[2] http://www.caiso.com/informed/Pages/ManagingOversupply.aspx

generators has spiked 1,400% in the wake of the new policy to proactively depower electricity lines (Public Safety Power Shutoffs).[3] Given that, according to the California Air Resources Board, operating an uncontrolled 1MW diesel engine for only 250 hours per year would result in a 50% increase in cancer risk to residents within one city block, this technology is fundamental to California's public health and clean energy goals.[4]

Fuel cells are critical to reducing GHGs and criteria air pollutants, displacing dirty diesel generators, and complying with California legislative mandates such as AB 617. Bloom reiterates our appreciation and support for the rigorous, data-driven methodology ARB has laid out for the FCNEM GHG NEM Standard to accomplish these goals.

Sincerely,

Erin Grizard

[3] https://www.sfchronicle.com/business/article/Demand-for-generators-lights-up-as-PG-E-power-14054242.php#
[4] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.441.1007&rep=rep1&type=pdf