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Draft 2019 New Jersey Energy Master Plan
Policy Vision to 2050
Comments of the National Fuel Cell Research Center
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The National Fuel Cell Research Center (NFCRC) appreciates the opportunity to submit written comments in the stakeholder feedback process for the draft 2019 New Jersey Energy Master Plan (EMP) document, as solicited by the New Jersey Board of Public Utilities (BPU) on June 10, 2019.

The NFCRC facilitates and accelerates the development and deployment of fuel cell technology and fuel cell systems; promotes strategic alliances to address the market challenges associated with the installation and integration of fuel cell systems; and educates and develops resources for the various stakeholders in the fuel cell community. The NFCRC was established at the University of California, Irvine by the U.S. Department of Energy (DOE) and the California Energy Commission (CEC) with the goal of both developing and transitioning to a form of power generation that is both energy efficient and environmentally sensitive. The DOE has recognized the significance of the NFCRC efforts in bringing government agencies, business and academia together to develop effective public-private alliances - in the case of the NFCRC, in order to develop advanced sources of power generation, transportation and fuels.

As the BPU and other agencies develop the draft EMP, the NFCRC would like to underscore the importance of a systematic transition, rather than an immediate transition, to achieve the goal of 100% clean energy usage by 2050. Throughout these comments, the NFCRC emphasizes that:

1. **The EMP should propose solutions that provide maximum greenhouse gas (GHG) emissions reductions. Fuel cells reduce emissions and displace more carbon than low-capacity factor renewables and diesel-based backup power generators, according to accurate and fact-based emissions calculations.**

2. **Consideration of air quality, in addition to reducing the carbon footprint and GHG emissions, is imperative to ensure the greatest benefits to all communities in the State of New Jersey.**

3. **New Jersey should consider the importance of building resiliency and reliability in the electricity system in any energy policy throughout the EMP, which benefits customers, the grid, local communities, and emergency services, and that is consistent with New Jersey's policy goals under the new normal of climate change and grid disruptions for maintaining electricity supply and reliability.**

Strategy 2: Accelerate Deployment of Renewable Energy and Distributed Energy Resources

10) Which policy mechanisms do you recommend the state implement to lower the cost of capital for in-state renewable energy power generation?

11) What policy, legislative, or regulatory mechanisms can New Jersey develop to ensure that it can most cost-effectively pursue a 100% carbon neutral power sector?

New Jersey must fully value the attributes of a portfolio of carbon neutral DER. This valuation should be technology neutral and focus on attributes required to achieve state energy requirements together with economic and environmental objectives. These attributes include grid services; reduction of greenhouse gas and criteria pollutant emissions; reduction of water and land usage and waste; and improvement of resiliency, efficiency, and air quality. Moving from capacity-based incentives to tariffs that value broad social and technical clean energy attributes will result in the best payback for New Jersey's energy investments, customers and communities.

Significant reductions in GHG emissions are achieved with fuel cell systems through:

1. The combination of high efficiency and extremely high capacity factor results in the displacement of more GHG emissions than equivalent sized intermittent resources Note that the most significant previous GHG and criteria air pollutant reductions achieved in the California Self-Generation Incentive Program were made by fuel cells operating on natural gas).[1]
2. Built-in, always-on resiliency (eliminating the need for back-up power including diesel generators),
3. Unlike combustion technologies, fuel cells use natural gas only as a source hydrogen and can be readily adapted to use renewable-derived hydrogen once that fuel is available on the market. As a result, fuel cells do not represent a long-term commitment to fossil fuels as will make a seamless transition to renewable fuels.

New Jersey should recognize that states, such as California, with a substantial deployment of intermittent and diurnal varying renewables with low capacity factors are experiencing challenging grid stability issues and gaps in power generation. The use of short-duration energy storage technologies (mostly lithium ion battery systems) to address these gaps has resulted in increased emissions on the California grid.[2, 3] Reversible fuel cells or electrolyzers can also serve as a controllable load that correspondingly helps the grid manage instances of overproduction from

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

[2] *Id.*

[3] MQRI– California ISO, Greenhouse Gas Emission Tracking Report, February, 2018. Available on-line at: https://www.caiso.com/Documents/GreenhouseGasEmissions-TrackingReport-Feb2018.pdf

renewable resources to produce a renewable hydrogen fuel for storage and later electricity production or for fuel cell vehicles. While battery energy storage is necessary, the inclusion of clean, 24/7 load-following generation is also required for a successful conversion to 100% clean energy.[4] Fuel cells are perfectly suited to serve this role.

Benefits of fuel cell systems include the provision of 24/7, clean, load-following power at close to 100% capacity factors. Importantly, this high capacity factor corresponds to the production of clean, renewable electric energy (MWh) per unit of power capacity (MW) that is on the order of six (6) times that of solar power systems (assuming a 15% capacity factor for solar) and on the order of three (3) times that of wind power systems (assuming a capacity factor of 30% for wind). Thus, investments in fuel cell capacity produce vastly more renewable energy than wind or solar power systems per unit of capacity installed. This translates into substantially more GHG reductions per MWh. Unlike investments in solar and wind power systems, installations of fuel cell systems can be used by the utility to (1) support local capacity and spinning reserve requirements that are used for grid reliability, and (2) serve as an alternative to costly utility system transmission and distribution upgrades to this system. In addition, the energy density of fuel cell systems significantly reduces the land footprint required for onsite generation, typically only one acre for one MW of generation, allowing for operation in high density areas and increased acreage available for habitat restoration and preservation.

Strategy 4: Reduce Energy Consumption and Emissions from the Building Sector

16) What policy, legislative, or regulatory mechanisms can New Jersey develop to successfully transition the building industry to develop net zero carbon construction? Over what timeline should the building industry seek to make this transition? What incremental goals and milestones should it set?

[4] Davis, *et. al., Net-Zero Emissions Energy Systems,* Science **360**, 1419 (2018) 29 June 2018

17) What barriers exist that could hinder successful implementation of new net zero carbon construction?

18) What policy, legislative, or regulatory mechanisms can New Jersey develop to incentivize and accelerate the transition from oil, propane, and natural gas heating systems to electrified heating systems? Please consider appropriate mechanisms for residential, commercial and industrial buildings. Over what timeline is this achievable? Please also consider incremental milestones for the different fuels and technologies.

A technology neutral policy approach is critical to reducing energy consumption and emissions in the building sector. New Jersey needs multiple approaches to achieve the goal of decarbonizing buildings. For example, current research at the University of California, Irvine regarding the effectiveness of electric residential heating and cooling from heat pumps has resulted in initial findings that electric heat pumps may increase GHG emissions to the extent that heating demand is out of sync with renewable electricity production. This is generally the case given that the primary demand for heating is at night and during the winter. The result is that heating is mostly used at night – when renewable solar is not available – and the increased nightly heating demand creates increased GHG from reliance on dirtier, less efficient generators. Similarly, there are seasonal challenges with only relying on one technology to provide electricity and heat; the preponderance of heating is required in winter when significantly less solar is available.

Fuel cells for power and heat generation are unique non-combustion solutions that reduce greenhouse gas emissions in commercial, industrial, multi-unit residential buildings and other facilities.[5] Combined heat and power and all-electric fuel cell systems offer substantial benefits that include:

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

The emissions reduction potential associated with cooling equipment in various building types is already being realized today by those using fuel cell systems. The combined cooling, heating and power capability of stationary fuel cells to capture and utilize heat produced by the fuel cell for the provision of cooling, heating, hot water, or steam results in overall fuel cell system efficiencies (electrical power generation and use of the captured thermal energy) ranging from 55% to 80% and, with a superior design and well-matched loads, exceeding 90%. All-electric and combined heat and power fuel cell systems reduce greenhouse gas emissions and have negligible criteria air pollutant emissions.

New Jersey should also consider the importance of resiliency while evaluating how to decarbonize the building sector. Many of New Jersey's healthcare providers and vital industries (e.g., data centers, advanced manufacturing) require this type of 24-7-365 clean energy. Momentary losses of electricity to these commercial and industrial facilities are immensely damaging, potentially impacting the health and well-being of citizens and costing

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

thousands-of-dollars per each minute that critical loads are dropped. Access to critical electric infrastructure, especially in areas of utility capacity constraints, is a prerequisite to attracting these industries and retaining them in the State, as well as meeting their growing electricity needs.

Fuel cells decarbonize buildings and do so while providing always-on, reliable power. With greater than a 95% capacity factor, fuel cell systems are uniquely designed to serve these 24-7-365 needs. Due to high operating efficiency, fuel cells generate electricity that is cleaner than the grid - resulting in reduced GHG emissions. Fuel cells generate this clean electricity with no combustion and thus virtually no smog-causing criteria air pollutants that harm human health. In fact, by merit of their high capacity factor and the marginal generation that they displace, fuel cells are essential to decarbonizing buildings for key sectors of New Jersey's economy that also require always-on power and are the most effective technology commercially available for reducing the air quality impacts of the electricity and heating systems.

The NFCRC notes that the public health impacts related to air quality should also be an essential component of the EMP. Because fuel cells use a non-combustion reaction to generate energy, they do not emit the pollutants that create air quality problems like SO2, NOx, and Particulate Matter.

Strategy 5: Modernize the Grid and Utility Infrastructure

19) How should New Jersey approach the modernization of the current utility model (e.g., decoupling or performance incentives, rate design, smart grid technology, demand response)

In modernizing the grid, New Jersey should consider the use of load-following, non-combustion DER for general grid support and to increase reliability and resiliency. Utility-scale procurements of DER such as fuel cell systems can provide unique co-benefits. Fuel cell systems are deployed today on the utility-side of the meter to create grid support solutions where transmission or distribution infrastructure or clean, 24/7, load-following power generation to complement the increasing deployment of intermittent solar and wind resources, and to support grid reliability in locations where it is most needed – including disadvantaged communities.

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

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

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

A modern grid and utility infrastructure incorporate resiliency and microgrids into energy planning. When paired with storage, wind, solar, demand response, and other technologies, fuel cell systems can serve as the backbone for microgrids that integrate numerous distributed energy resources and controls. Microgrids that use fuel cell systems as baseload power are able to immediately disconnect from the grid and island (operate autonomously) from the larger grid when circumstances demand (e.g., grid outage). The fuel cell installation innately operates as an energy management system, with critical loads for backup power already identified and immediately followed in the event of an outage. A fuel cell system can smoothly transition from the grid to fully power the load during a grid outage, without interruption to the end user, and to seamlessly re-connect to the grid when its power is restored. Fuel cells can be, but do not need to be, connected to a storage device to provide these and other resiliency benefits.

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

There are many valid methods for quantifying the benefits of resiliency. Industrial Economics, Incorporated (IEc) comprehensively calculated the resiliency benefits derived from the partnership between the New York State Energy Research and Development Authority (NYSERDA) and the Governor's Office of Storm Recovery to improve electric system performance and resilience.[6] Specifically, IEc utilized a robust, publicly available approach to estimate the resiliency benefits of a specific microgrid that included:

- NREL's Interruption Cost Model to estimate the cost of outages to C&I customers;
- FEMA's Benefit-Cost Analysis to estimate the costs of degraded fire, police, and emergency services as a proxy for value of lives saved during a power interruption; and
- IMPLAN to estimate the regional economic costs of an outage, including damage to local infrastructure, lost productivity, and reduced wages.

[6] https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198

This analysis revealed that, assuming just seven hours of interruption annually, the 20-year net present value of the microgrid configuration analyzed by IEc was estimated at $22.4 million, including the value of healthcare services—such as interruption impacts on survival probability—that would otherwise have been diminished without the microgrid and operational savings from displaced diesel generators. Additionally, the analysis found that a one-day power interruption would result in $5 million in lost sales, $3.1 million in lost regional GDP, and lost wages equivalent to over 32 jobs.[7]

These benefits have directly translated into resilient performance in real-world disaster and grid interruption events. During the four storms that buffeted the East Coast from March 2-22 in 2018, millions of customers lost power, including those served by the electric grid in the vicinity of nine fuel cell microgrid sites. Despite the combined 26 electric utility outages, all fuel cell microgrids maintained power throughout these events. Other fuel cell systems in the Northeast powered critical communications and emergency shelters in the aftermath of these storms. Fuel cells also 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. Additionally, fuel cells withstood the 2019 Con Edison blackout in New York City, Sonoma fires in 2018, the 6.0 magnitude Napa earthquake in 2014, and even when a bulldozer was accidently dropped upon a fuel cell system at a customer site in 2016. Whether grid interruptions are natural or human-caused, fuel cells have a critical role in providing valuable resiliency to all New Jersey residents and ratepayers.

[7] National Association of Regulatory Utility Commissioners, "*The Value of Resiliency for Distributed Energy Resources: An Overview of Current Analytical Practices*," April, 2019.

20) How should NJBPU consider planning and paying for upgrades to the electricity distribution system, including Distributed Energy Resource (DER) connections; EV charging; and utilities' recuperation of cost?

The NFCRC recommends that Distributed Energy Resources (DERs) should be considered and evaluated as a solution for charging electric vehicles (EVs). A co-deployment strategy could reduce the cost to ratepayers, reduce the risk of a grid outage, maximize system efficiency, and maximize environmental benefits. The vast majority of DER deployments, including fuel cell system installations, result in cost savings for the customer in comparison to retail electric rates. In addition, the ability to co-locate clean power generation at the site of a significant new load, like that associated with charging stations for EVs, could lead to additional benefits for ratepayers. These benefits include cost savings associated with infrastructure investment deferrals, peak demand management, reduced emissions, avoided line and conversion/inversion losses, and increased resiliency that should not be overlooked.

"Non-wires" solutions initiatives in New York and Rhode Island have demonstrated that DER deployments can defer or avoid grid upgrades or reinforcements like those required for EV charging infrastructure. These initiatives place DERs specifically in load constrained circuits to take advantage of the locational benefits of clean distributed technologies. In doing so, these DER-based non-wires solutions leverage existing programs to support clean energy, reduce greenhouse gas and criteria pollutant emissions, and decrease the cost of delivering safe and reliable energy to ratepayers.

Co-locating DERs and EV charging creates a new asset class for utilities to use throughout their service territories. These types of assets can be used for peak demand management and load growth management. Instead of managing concerns associated with demand charges, increasing peak demand, or limitations on vehicle charging or vehicle-to-grid discharge, the combination of flexible load and onsite generation can be used to alleviate grid congestion when needed by simply disconnecting the charging load during peak events and exporting generation to the local grid as needed.

As EV adoption increases, demand for grid electricity will increase at certain times and in certain locations where such loads were not originally planned. Without DER assets, such demands will be met by increased production from marginal generators that send power through existing grid infrastructure (e.g., wires, transformers). Marginal generators are primarily natural gas combustion facilities that are environmentally preferable when compared to gasoline or diesel combustion. These generators, however, still produce considerable GHG and pollutant emissions. Existing grid infrastructure may also become constrained and have higher losses as load grows. Using clean DER, such as fuel cell systems, further improves emissions by adding clean generation, instead of serving load growth with older, existing generation capacity, clean DER also alleviates grid constraints, because generation can be placed where load growth occurs.

Another important benefit of a co-located deployment is the avoidance of line losses and transformer or other conversion/inversion losses. Between 5% and 10% of electricity sold through the U.S. is lost in the transmission and distribution system, [8,9] but generating power onsite eliminates these losses. In addition, most DERs, including fuel cells, generate direct current power, the same type of power that a battery uses to charge. Systems can be engineered to allow direct current (DC) charging of vehicles to avoid conversion/inversion losses. Fuel cell systems can also power most lighting, modern appliances, computers, personal electronics and other items using direct DC power.

[8] Gustafson, M.W. and J.S. Baylor, Approximating the System Losses Equation, IEEE Transactions on Power Systems, Vol. 4, No. 3, August, 1989.

[9] Energy Information Agency, U.S. Department of Energy, data available on-line at: https://www.eia.gov/electricity/state/

In comparison, grid power is delivered as an alternating current (AC) that must be converted to direct current in all of these applications, with associated losses that can add up to an additional 10% loss.[10]

Finally, use of high-capacity, resilient DER would allow battery electric buses to charge even in the event of a grid outage further contributing to the emergency preparedness of all communities and especially disadvantaged communities. Fuel cells are among the most reliable forms of power generation available, and serve as the anchor generation for numerous microgrids around the world.

Strategy 6: Support Community Energy Planning and Action in in Low-and Moderate-Income and Environmental Justice Communities

24) How can New Jersey ensure that LMI households and environmental justice communities benefit from the goals and policies established in the Energy Master Plan?

Federal air quality non-attainment zones in New Jersey are disproportionately in low- and moderate-income and environmental justice communities. **The EMP must recognize the immediate impact of criteria air pollutant emissions and address reduction of these emissions alongside carbon emissions reduction.**

Additionally, resilience of the grid and the need for critical backup power should be addressed in these communities. The following are some categories of such customers:

- Critical facilities: Critical service systems and assets are essential to the state, counties, cities and local communities such as police and fire stations, emergency operations centers, medical facilities including hospitals, skilled nursing facilities, nursing homes, blood banks, and health care facilities; schools and day care centers; public and private utilities vital to maintaining or restoring normal services; drinking water and wastewater treatment plants.

[10] Apostolaki-Iosifidou, E., Codani, P., Kempton, W., Measurement of power loss during electric vehicle charging and discharging, Energy, Volume 127, Pages 730-742, 15 May 2017.

We also recommend the inclusion of critical communication hubs and associated equipment as well as traffic lights in major transportation corridors in this list.

- Vulnerable populations: A California definition of vulnerable populations includes, among others, the elderly, children, medical baseline customers, low-income, those with limited English proficiency, and pregnant women. This list should also include those serving such customers—such as paratransit agencies, independent living centers, and low-income housing complexes.
- Customers or areas with an elevated level of risk such as a flood zone as identified by FEMA, and areas where power lines are not under-grounded.

Fuel cells also displace traditional emergency backup generators that emit criteria air pollutants and GHG, including combustion diesel generators. This feature is especially critical given the number of New Jersey residents that currently suffers from poor air quality and the 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.

25) What best practices utilized in other states or municipalities should New Jersey consider to support Community Energy Planning?

New Jersey should consider the Brooklyn Queens Demand Management Demand Response Program that allows ConEdison to plan for and maintain their infrastructure, while supplying reliable energy during peak periods of high demand.[11]

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

Fuel cell companies have installed multiple projects as part of this program. The program ultimately avoided nearly $1 billion in ratepayer costs through the use of targeted DER installations. The program projects in Brooklyn, New York included one using solar, storage, and fuel cell technologies together at a low-income housing development, to optimize the efficiency, reliability, and affordability of the project. Current New Jersey regulation prohibits multiple clean energy technologies from being used behind one customer meter and should be updated to allow for these multi-technology projects that create broad benefit for local communities.

CONCLUSION

The NFCRC appreciates the open public process that New Jersey is using to seek stakeholder input on the EMP. This process can ensure that diverse, clean, and resilient energy systems and programs are included to meet the needs of diverse energy consumers, as well as meet the broader environmental objectives that benefit all residents in New Jersey.

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Respectfully submitted,

/s/

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