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BETTER TRAVEL, STRONGER GRID.

February 8, 2018

TO: EVSTAKEHOLDER.GROUP@BPU.NJ.GOV
FR: Pam Frank, ChargEVC
RE: Answers to third round of questions posed by Staff

Please find below answers to and /or comments on questions posed by BPU staff. We have attached the ChargEVC study as part of our answers to these questions. Many of the questions asked are covered in detail in the study.

Task 1.1 Questions

1 USDOE – AFDC Findings

1.1 Are the analysis and findings of the USDOE AFDC and ANL accurate and supported by other independent analysis? If so, please cite why? If not, please cite why not?

ChargEVC has not done an exhaustive cross-comparison between the USDOE AFDC and ANL studies with other work, but we find their overall conclusions to be consistent with our own research on this question.

As summarized in our response to the first group of questions posed by BPU staff, a simple analysis confirms that vehicles "fueled" with electricity are fundamentally more efficient than average vehicles fueled with gasoline. Promotion of EVs can therefore be viewed as either an EE or an energy conversation measure, especially when primary fuel supplies are considered.

Although the ChargEVC study did not examine efficiency in particular, it did look at relative CO2 emissions, which scale strongly with basic efficiency (and fuel-specific emissions intensity) in the overall process. CO2 reductions can therefore be used as a high-level proxy for overall efficiency. The ChargEVC study found that based on the current generation fleet, EVs are 69% to 79% cleaner (on a CO2 basis, with the exact percentage depending on emission accounting method). This aligns roughly with projected EV efficiency improvements noted in numerous other studies.

It should be noted that one of ChargEVC's members, the New Jersey Clean Cities Coalition (NJCCC), is required to regularly interact with USDOE, Argonne and other national labs to provide feedback based on actual experience and to assist in making their tools as user-friendly and accurate as possible. As part of the Clean Cities national network, NJCCC also has direct access to the designers of these tools and has expressed a willingness to assist the NJBPU in tailoring these tools to BPU needs and to the specific conditions that exist in NJ.

1.2 Should the NJBPU run the ARL GREET model for several different types of EV, ICE vehicles and other alternative fuel vehicles under different New Jersey driving conditions for various New Jersey electric generation mixes? Or not?

The ARL GREET model would require a significant investment of time and resources to generate results that are specific to New Jersey conditions. Those conclusions are likely to be further reinforcement of analysis already completed so the incremental value for the required time and resources is not clear.

The ChargEVC impact study characterized market impact looking specifically at various EV adoption scenarios in NJ, based on a detailed dispatch simulation model of the PJM wholesale market, and provides the same range and granularity of results that the GREET model would provide.

1.3 If the Rutgers LESS energy efficiency evaluation shows favorable results for PEVs under NJ driving conditions and a NJ energy mix, how should that information be leveraged by the BPU to accelerate the pace of EV adoption in NJ? If not what actions should be taken by BPU?

As demonstrated by the ChargEVC study and numerous other studies, EVs have impact far beyond efficiency. We do not believe the board needs to restrict itself to consideration of EVs only within that context.

The ChargEVC study demonstrated that there are likely to be both RATE and INFRASTRUCTURE impacts from widespread EV adoption. Those potential impacts are clearly within BPU authority, and worthy of consideration by the regulated utilities and additional stakeholders. The BPU should proceed with consideration of and action upon, a wide variety of EV-related issues as justified by both EE and energy conservation matters they already address.

As noted in our answer to question 1.1, there are a variety of studies that all confirm the same point: EVs are a more efficient use of energy than traditional gasoline fueled vehicles. The Rutgers' study is further confirmation of that consensus.

2 **Energy Efficiency**

2.1 Would an EV fueled by electricity from the current New Jersey electric generation sources be more efficient, less efficient or the same level of energy efficiency than the EV's noted in the ANL analysis? If so why? If not, why not?

See our answer to question 1.1.

2.2 Would an EV fueled by a New Jersey electric generation mix meet the definition of conserving energy in the definition for energy efficiency as set forth at N.J.S.A. 48:3-98.1? If so why? If not, why not?

EVs can carry out similar functions as those identified that fall under the definition of energy efficiency as set forth in 48:3-98.1.

It has been well established that vehicles powered by electricity are a much more efficient way of fueling transportation than the existing internal combustion energy. The US fleet average is approximately 22.1 MPG which represents approximately 5,200 BTUs per mile on average. An average Battery Electric Vehicle (BEV) on the market today travels 3.5 miles/kWh, which, for a power plant with an average 35% efficiency, represents approximately 2,785 BTUs per mile. When comparing primary energy sources, and accounting for all relevant efficiencies, an EV gets 1.86 times as many miles from every unit of energy as an average gasoline vehicle. Further, the efficiency of the EV is improved due to regenerative braking, avoidance of energy consumption when the vehicle is not moving.

> ***Last, the EE statues and programs were a means to an end, specifically intended to reduce consumer costs and related air emissions. Increased use of EVs helps achieve both objectives. Please see the attached study for further information on quantified benefits with regard to consumer costs and reduced air emissions.***

2.3 Would an EV fueled by a New Jersey electric generation mix meet the definition of using less electricity or natural gas in the definition for energy efficiency as set forth at N.J.S.A. 48:3-98.1? If so why? If not why not?

See our answer to questions 1.1, 1.2, 2.1, and 2.2 above.

EVs are more efficient than gasoline fueled vehicles, and can be considered an energy CONSERVATION measure. Beyond efficiency and conservation, however, there are numerous other reasons for board engagement on EVs, including potential impact on rates, impacts on infrastructure, the potential for generation of significant consumer net savings, and significant reductions of emissions, among others.

Please see the ChargEVC study for more details on net benefits.

3 Electric System Impacts

3.1 What could be the expected percentage increase in electric energy attributable to EVs result in by 2015, 2030 and 2050?

The increase in electricity attributable to EVs within a given time frame is directly related to assumptions on EV adoption, including the mix of BEVs and Plug In Hybrid Vehicles (PHEVs). Please see our attached study, which models several adoption scenarios and accompanying electric grid impacts.

As an example, under the highest levels of adoption considered in the ChargEVC study, about 28% of NJ's electricity would be used to charge EVs at the highest point of electrification. The ChargEVC study includes detailed information about electricity use as a function of EV adoption for every year from 2018 to 2050.

3.2 What could be the expected impacts and costs on generation, transmission and distribution systems 2025, 2030 and 2050?

Please see our attached study which quantifies expected impacts and costs on generation, transmission and distribution systems over 2035 and 2050 time frames. The impacts and costs are quantified across several scenarios related to assumptions about EV adoption and further, whether or not charging is managed or not managed - "natural."

The study concluded that there are reductions in electricity costs due to more optimal aggregate load which potentially reduces the wholesale cost of electricity, combined with dilution of fixed costs over larger MWHR-volume. These effects combine to deliver savings to utility customers as a result of increased EV adoption.

Also as noted in the study, there are several other economic benefits (beyond utility rate impacts) that accrue, especially for EV owners that benefit from lower operating expenses.

4 Grid Integration, Demand Response and Vehicle to Grid (V2G)

4.1 What is the state of technology that could allow the EV to be utilized as a demand response technology? What is the availability of the technology now and how/when will that availability evolve?

While ChargEVC did not study EVs as a demand response asset (in the traditional curtailment sense), our study demonstrates the benefits to managing how, when and where charging happens on the electric distribution system.

In particular, the ChargEVC study quantifies the benefit of "managed charging", which assumes that most residential charging transactions are spread across the entire "off-peak" period, which delivered an average of 28% more net benefit than scenarios where managed charging is not used (i.e. natural charging).

Technology exists today in both EVs and EVSE that controls when charging occurs. Further, power levels can be adjusted. However, this type of technology is a simple form of managing charging that can, for instance, be used to work in conjunction with off-peak tariffs or TOU rates offered by utilities. As more EVs come into the market, a much more granular approach will be required in order to ensure optimal charging in the aggregate, in such a way that carries maximum benefits for the ratepayer.

4.2 V2G: Is two-way communication of the EV to the grid a commercially available technology or not? If so why? If not why not? What is the availability of the technology now and how/when will that availability evolve?

While V2G communication is available under trial or pilot configurations, the number of EVs that enable this type of communication is extremely limited. We expect more EVs coming into the market

to have V2G capability and ChargEVC would encourage pilot projects to explore this technology and resulting costs and benefits further.

V2G will EXPAND the already substantial benefits provided by expanding "managed charging" to include "peak shaving" rather than just "trough filling". As an example, the ChargEVC study identified that if HALF the New Jersey light duty fleet were to plug in around 6PM, and each had 20kwhrs to "share" through a V2G transaction, that would provide over 60GWHrs of energy during peak times. That is enough to power the entire state, at peak time, for three full hours.

Developing managed programs now create a foundation for adding more sophisticated V2G applications in the future. Beyond V2G, there is also substantial potential benefit to V2-home (V2H) to provide resiliency value.

4.3 Could the EV electric customer access the energy markets directly, through an aggregator or Network Operations Center (NOC), through the electric utility or blockchain?

Yes, but those are not the only methods.

4.4 If the EV could be utilized as a demand response technology in a two-way communication with the grid, distribution and/or transmission, would the EV meet the definition of demand side management in N.J.S.A. 48:3-51?

Yes. Technically, as V2G technology matures, it will allow EVs to participate as a distributed energy resource that reduces demand overall, especially coincident peak.

4.5 What are the types and levels of benefits to the grid of EVs in a demand response program and what would be the overall costs to develop and implement this program?

Answering this question depends on the definition of demand response.

Traditionally, demand response implies curtailment methods, and that is not the only mechanism by which EVs could contribute to the energy markets. As noted above, EVs in general, especially through managed charging and V2G technologies, could be substantial distributed energy resources that reduce costs overall, and support optimized grid loading, including demand reduction. Attempting to constrain EV impact into a traditional demand response structure limits understanding the full scope of impact that EVs might provide.

As noted in the example illustrated in 4.2, EVs should be considered a powerful distributed energy resource with a potentially large impact due to the large amount of energy involved. Managed charging frameworks, and V2G in particular, are preferable and more appropriate frameworks for considering EV impact than pure demand response.

4.6 If the EV could be utilized as a demand response technology, should the BPU consider changes to demand charges? If so why? If not why not?

ChargEVC offers no answer to this question as this is a highly complex area with multiple issues and is best considered as part of an overall rate review.

4.7 Should the BPU consider the use of telematics (such as Con Edison's SmartCharge New York program) in any demand response program and to address changes to demand charges. If so why? If not why not?

See our answer to question 4.5.

The SmartCharge program in New York provides several interesting examples of the information elements of EV charging technology. It is only one example of what is possible, and should not be taken as an appropriate framework for considering EV demand impact or rates.

Vehicle charging is as much an information transaction as it is an exchange of energy, and both policies and programs should be considered within that context. It is the nature of the information exchange that will determine the effectiveness and value of EVs as dynamic distributed energy resources.

4.8 If the EV is not using less electricity or natural gas per the definition for energy efficiency as set forth at N.J.S.A. 48:3-98.1 and the EV could be utilized as demand response for the EV to meet the definition of demand side management in N.J.S.A. 48:3-51, what could be the expected impacts on the grid for increased generation capacity by 2025, 2030 and 2050? What could be the level of costs and over what timeframe?

Please refer to the ChargEVC study, which addresses the impact of EVs on generation capacity over time. Additional details are available upon request.

4.6 If there is an increase in electric energy usage from the increase in EV but not a generation capacity increase because of demand response of EV what would the increase efficiency of the grid be in 2025, 2030 and 2050? If not why not?

If EVs are used to optimize grid loading, overall asset utilization will go up, including wholesale plant, and transmission and distribution assets. The ChargEVC study addresses this question in part, and additional conclusions about utilization could be developed based on the study research if needed.

5. Electric Vehicle Supply Equipment (EV Charging Station) State of the Competitive Market

5.1 Is vehicle charging a fully competitive market across all market sectors? If not, which market sectors are not competitive and why not? Which market sectors are competitive?

As identified in the ChargEVC study, there are a variety of segments through which charging services are delivered. These segments differ substantially in how EVSE is used, owned, managed, and funded.

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ChargEVC believes that the market is best served by developing an ecosystem of providers, including utilities and competitive solution providers, to meet the diverse and evolving needs of the market. Market needs are likely to change over time. Conditions and needs over the next few years (when the market is still early stage and the EV population is still low) may be very different than conditions and needs that develop and evolve over the longer term.

5.2 If the charging market sections are not competitive should the utilities be allowed to develop managed charging programs for the non-competitive charging market sections? If not why not?

Please see our answer in 6.1 below.

5.3. If the charging market sections are competitive, should the utilities be allowed to develop managed charging programs for the competitive charging market sections? If not why not?

Please see our answer in 6.1 below.

5.4 If the utilities are allowed to develop managed charging programs is there a time limit or other criterion that should be imposed on this participation? If so, what is the timeframe? Should the utility managed charging program have a sunset date?

Please see our answer in 6.1 below.

5.5 If the utilities are allowed to develop managed charging programs, what guidelines should be developed for this participation? If not why not?

Please see our answer in 6.1 below.

6. Utility Role in "Charge Ready"

6.1 Should electric utilities engage in rate-based "Charge Ready" programs? What additional measures beyond Charge Ready are appropriate in non-competitive markets? Should utilities offer rebates on EV chargers or own/operate EV chargers in non-competitive markets?

As outlined in our Roadmap and Study, ChargEVC believe the utility has a role to play in EV market development. These findings in the study justify rate-based investments in EV infrastructure, including but not limited to EV chargers.

Ensuring that everyone has equal and economic access to routine charging is crucial and ChargEVC has demonstrated through its study that increased EV adoption will lead to increased savings for all ratepayers. Further, ChargEVC has demonstrated that managing how, when and where charging occurs increases these benefits significantly.

Public DCFC is an area of particular need, since it has a large impact on EV adoption and is particularly challenging economically due to low utilization. This will continue to be an issue until EV penetration starts to increase. While the market is in its early development stages, there are several ways to ensure coverage. While utilities may own and operate the charging infrastructure in areas of low utilization, the utilities could also provide temporary incentives to ensure economic return for private sector participants that own and operate the charging infrastructure.

In general, as noted above, ChargEVC believes that a full ecosystem of providers is needed, including BOTH utilities and competitive solution providers working together. Utilities have a role to play, especially regarding ensuring responsible grid integration, maximizing public benefit, addressing issues that utilities are uniquely qualified to address, or addressing under-served needs. In parallel, there is a need for competitive solution providers as well. It should also be noted that utilities may be able to contribute beyond the "charge ready" architecture assumed in the question.

Please see the ChargEVC study for more detail.

7. Advanced Metering Infrastructure (AMI) – Smart Grid/Smart Meters

7.1 What policies should the Board establish to take advantage of AMI, Smart Grid/Smart Meters with respect to the EV market?

Metering will be an important of the overall "smart metering" environment, and there are a variety of solutions that are possible ranging from secondary revenue grade meters, to using data from networked EVSE, handling EV charging as a sub-stream within an AMI application, to data from the vehicles themselves.

This issue requires broader consideration and should probably be considered within the context of specific utility filings or other program proposals.

7.2 Would a utility managed charging program support and supplement any smart grid (SG) or automatic meter initiatives (AMI)? If not, why not and what programs should be developed instead of AMI? If so what would be the level and value of the benefit to and from the AMI programs. If not describe why not and what would be the level of value in any other program?

See our answer to 7.1.