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PROJECT NO. 49125

REVIEW OF ISSUES RELATING	§	**BEFORE THE**
	§	**PUBLIC UTILITY COMMISSION**
TO ELECTRIC VEHICLES	§	**OF TEXAS**

COMMENTS OF THE ENVIRONMENTAL DEFENSE FUND

Environmental Defense Fund of Texas, Inc. ("EDF") files these comments in response to the questions presented by the Staff of the Public Utility Commission of Texas ("Commission" or "PUCT") as published in the Texas Register on December 27, 2019.[1] EDF is a non-profit, non-partisan, non-governmental environmental organization that combines law, policy, science, and economics to find solutions to today's most pressing environmental problems. EDF appreciates the opportunity to provide these comments.

INTRODUCTION

The lion share of Texas' robust and growing economy and 28 million citizens are in the state's largest metropolitan areas, which are Houston-Galveston-Brazoria, Dallas-Ft. Worth, San Antonio and Austin. Each of these areas face significant air quality challenges. They are ozone nonattainment or near-nonattainment areas and large communities within them that have large concentrations of air toxics and particulates which adversely affect human health. These urban centers also are home to most of the state's greenhouse gas emissions. Vehicles are the largest sources of emissions in these areas. They emit, for example, approximately two-thirds of the NOx and VOCs that chemically react to form ozone.[2]

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[1] 44 TexReg 8384-8385 (Dec. 7, 2019).

[2] See Revisions To The State Of Texas Air Quality Implementation Plan For The Control Of Ozone Air Pollution Emissions Inventory For The 2015 Eight-hour Ozone Standard Nonattainment Areas at https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2019_EI_SIP_2015OzoneNAAQS/19111SIP_EI_2015Ozone_HGB-DFW-Bexar_SIP_proposal.pdf, Tables 2-1, 2-2 and 2-3, showing emissions inventories for Dallas-Fort Worth (DFW), Houston-Galveston (HG) and Bexar County ozone nonattainment areas. For example, non-road and on-road mobile sources were 74%, 60% and 58% of annual

Electric vehicles ("EVs") have the potential to substantially reduce emissions of carcinogens, greenhouse gases, and precursors to urban & regional ozone pollution. They virtually eliminate tailpipe emissions, which means they can eliminate emissions within polluted urban areas and thus play a pivotal role in solving many of the ozone and particulate matter challenges that the state faces. Electric vehicles charged with clean energy resources such as wind and solar power will provide even higher emission reduction benefits because the total emissions associated vehicles include tailpipe pollution as well as those pollutants emitted in the production, transportation, and processing of oil and gas to make gasoline, diesel, CNG, and propane. EDF analyses show that tailpipe emissions account for approximately a third of the total emissions associated with a typical vehicle and the remaining two-thirds are associated with the production, transportation, and processing of the fuels used to power them. Hence, charged wisely with clean generation resources and at times of the day when the grid is underutilized, EVs can save money for both EV users and users of the broader electric grid. For example, with controls, incentives and knowledge, EVs can be charged at night in Texas when electricity generated by clean energy resources is plentiful and electricity costs less.

Whereas many stakeholders likely will focus on light duty passenger vehicles to make the point about the environmental and economic benefits of EV adoption, in these comments, EDF offers insights pertaining to medium and heavy-duty vehicles as well. Specifically, EDF has analyzed ownership costs and emissions footprints for a variety of working electric vehicles, including transit and school buses, vans and shuttles, and short and long-haul trucks. We find that several vehicle classes and associated duty cycles are ripe for electrification by virtue of the fact that they have favorable total cost of ownership compared to their diesel and CNG counterparts,

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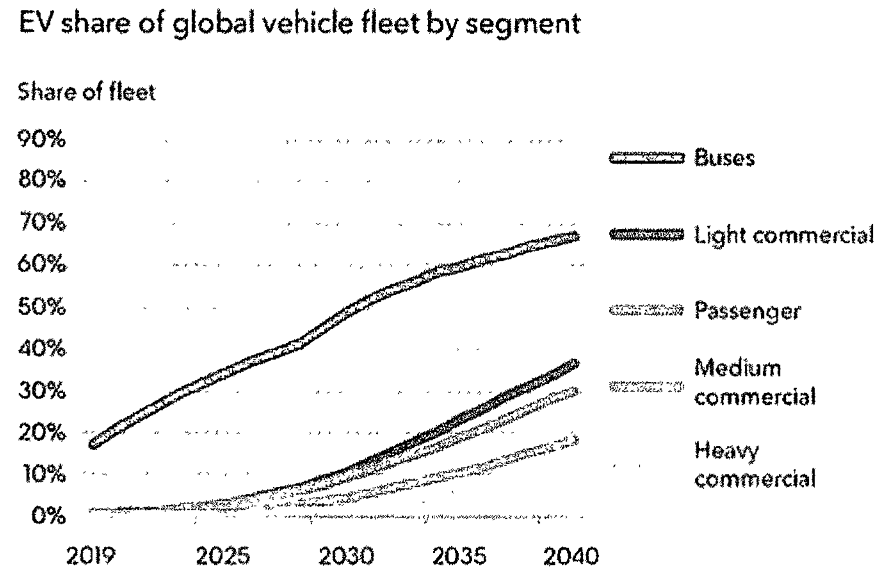
NOx emissions for DFW, HG and Bexar County, respectively, in the 2019 Ozone State Implementation Plan inventory.

and technology is sufficiently developed to allow for the transition, whereas others will require more technology innovation, experience, and product options. However, EDF anticipates that these barriers will be overcome within a decade, thereby positioning the vast majority of medium and heavy-duty vehicles to be powered by clean electricity. This analysis should help inform the Commission as to the likelihood of which vehicles are likely to experience growth in electrification compared to others. In the meantime, it is important to note that a number of companies already have committed to start making this transition within the next 10 years.[3] The following graph shows an estimate as to the potential growth of different segments of EVs as they are expected to grow over the next 20 years:



Source: BloombergNEF. Note: Commercial vehicle adoption figures include the main markets of China, Europe, and the U.S.

To achieve the robust opportunity that exists for EVs to provide consumer and environmental benefits, EVs and their chargers will need to have control and communications technology, accurate price signals to provide incentives for off-peak charging, and appropriate

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[3] Please see https://runonless.com/profiles/fleet-info.

policies to ensure that the charging occurs in a way that does not increase peak demand and instead makes the grid more reliable and resilient. Fortunately, there is growing evidence from real world applications and scholarly research to indicate that EVs can achieve very high levels of penetration while significantly reducing coincident system peaks, increasing utilization of existing generation, transmission and distribution capacity, and lowering system costs for all electricity consumers, not just EV owners. On the other hand, if EV owners do not have adequate incentives or capability to respond to price signals, the result may be an increase in both emissions and grid-related costs. As such, the Commission should prioritize appropriate price signals and enabling technology in order to create an opportunity for EVs and their chargers to be a grid resource.

RESPONSES TO QUESTIONS

GENERAL DATA

1. The Commission requests that parties provide current data sources and projections for the expected deployment of electric vehicles in Texas over the next ten years. If available, the data sources should attribute the projections by vehicle class (i.e., personal, commercial short-haul including fleets and buses, and commercial long-haul electric vehicles).

Although EDF has not developed projections for the deployment of EVs in Texas over the next ten years, as discussed above, EDF has developed an analytical tool to compare the costs of owning buses and trucks by fuel source. This model should help the Commission and other interested stakeholders discern which types of large electric trucks and buses are likely to enter the market sooner.[4]

In addition to being cost-effective particularly as their production increases, the use of EVs also will reduce the emission of key pollutants. To prepare the following analysis, EDF used a modified version of the Greenhouse gases, Regulated Emissions, and Energy use in Transportation

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[4] EDF will share its model with the Commission and other interested parties, including the directions for using the model and the references used to support the model, on request.

(GREET) model developed by Argonne National Laboratory to compare the emissions footprints of diesel, compressed natural gas (CNG) and electric vehicles by several pollutants.[5] We updated the model to reflect the ERCOT generation mix and new understanding about methane emission rates.[6] For illustration, we present results for a common transit bus driven 48,000 miles per year and charged with 100% clean electricity in Figure 1. Our results using GREET show lifecycle emissions impacts for upstream vehicle and fuel production as well as in-use operations.

Figure 1 and Table 1 show emissions benefits from switching fuel for a transit bus from diesel or CNG to EVs and the impacts of switching from diesel to CNG. While switching from diesel to CNG has been viewed as a cost-effective solution for reducing nitrogen oxides (NOx) emissions, switching to CNG from diesel can result in increased volatile organic compound (VOC) and sulfur oxides (SOx) emissions and provides less reduction of greenhouse gases (GHG) than realized with a switch to EVs.

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[5] https://greet.es.anl.gov/.

[6] https://www.edf.org/climate/methane-studies.

Figure 1: Air pollutant emissions by fuel type .

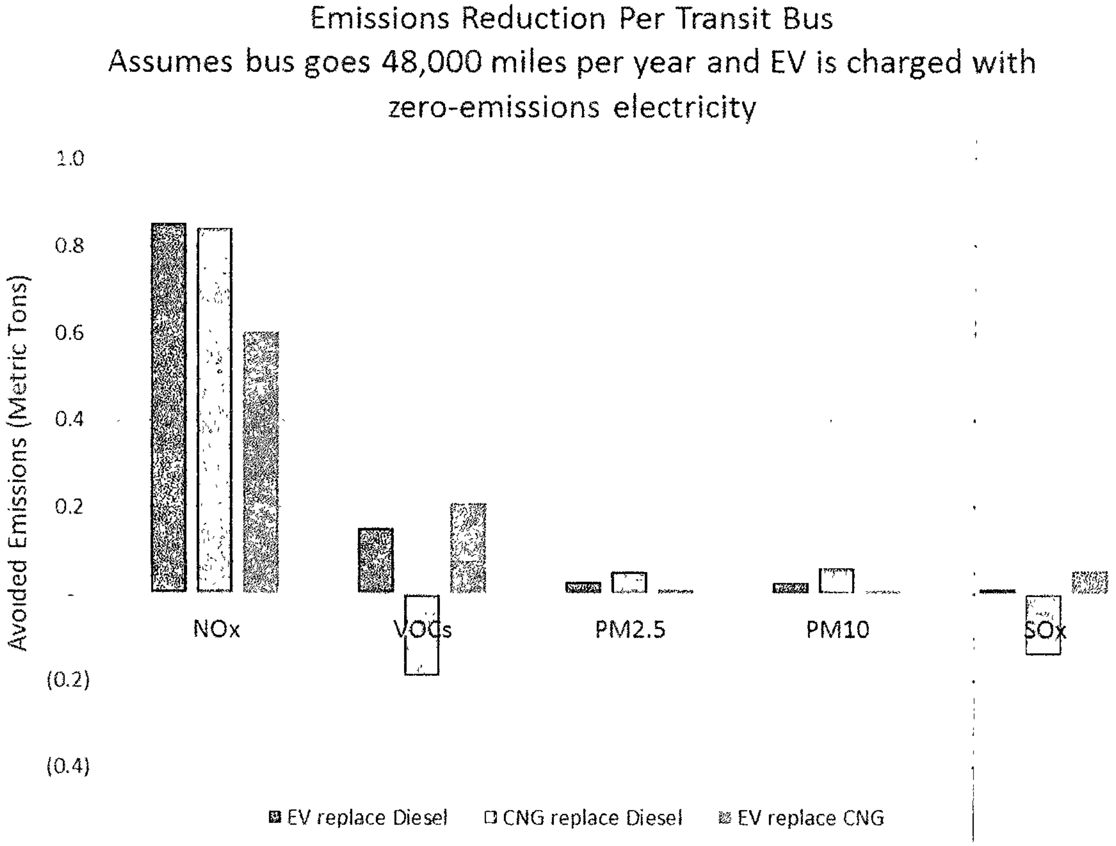


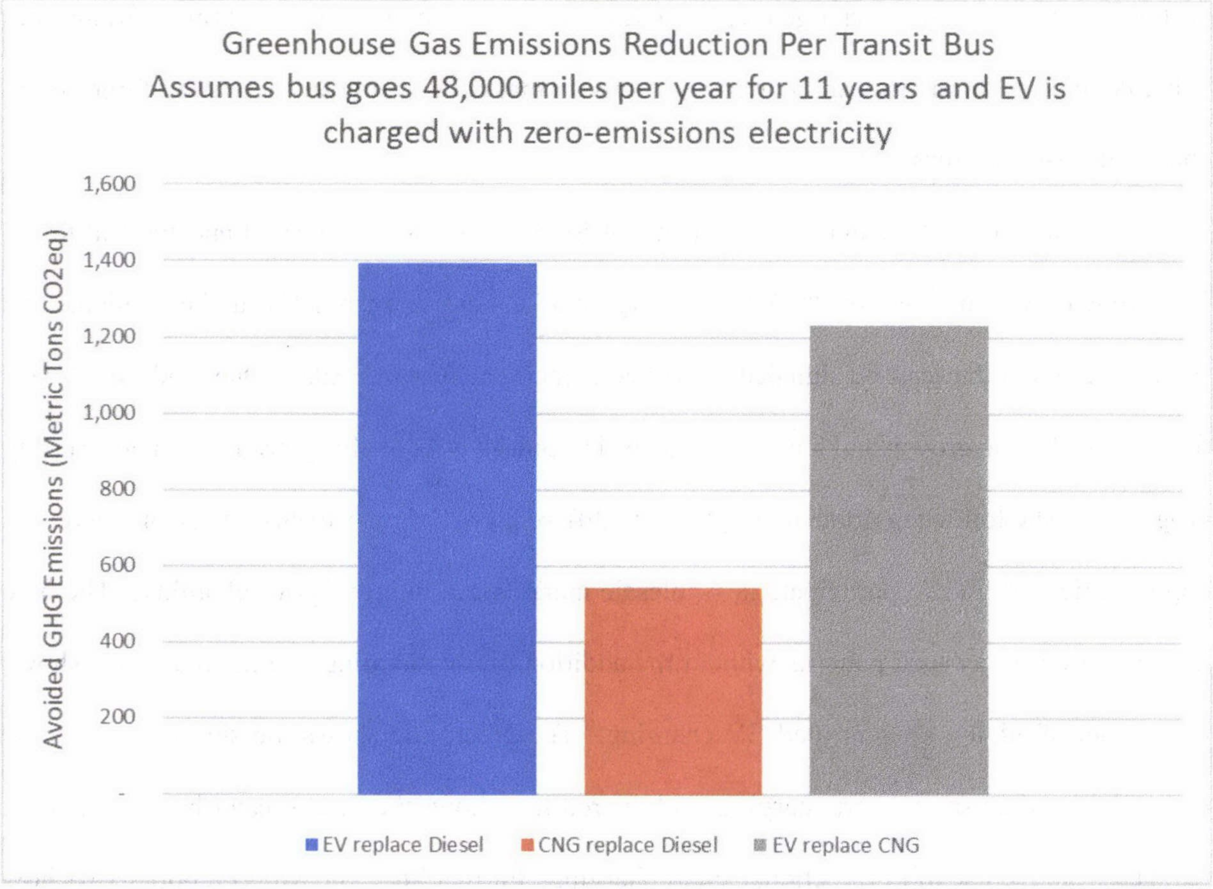
Table 1: Emissions Reduction Benefit Per Transit Bus with Conversion to EV, based on 11 Years of Usage at 48,000 Miles Per Year (metric tons)

	NOx	VOCs	PM2.5	PM10	SOx	GHGs
EV replace Diesel	0.9	0.2	0.03	0.03	0.01	1,393
CNG replace Diesel	0.8	(0.2)	0.05	0.06	(0.14)	543
EV replace CNG	0.6	0.2	0.01	0.01	0.05	1,233

The values in Table 1 for the reduction of greenhouse gases are shown graphically in Figures 1 & 2. In presenting what we consider to be "midpoint" results, we note that there is considerable uncertainty about the growth in the use of transit buses, the growth of zero-emissions electricity generation capacity and the extent to which EVs will be charged with clean sources of electricity.

In Texas there is a significant opportunity to charge vehicles at times when there is ample wind generation capacity, a practice that can increase the emission reduction benefits of switching to EVs while increasing the utilization of existing zero-emissions generation capacity.

Figure 2: Avoided Greenhouse Gas Emissions Per Transit Bus with Conversion to EV, based on 11 Years of Usage at 48,000 Miles Per Year (metric tons)



2. **Please provide any current data sources and information on the expected amount of new load attributable to electric vehicles over the next ten years. If available, the data sources should attribute this load by vehicle class (i.e., personal, commercial short-haul including fleets and buses, and commercial long-haul electric vehicles).**

While EDF does not provide projections here, it is important to note that any scenario analysis must take into consideration that load from EVs added to the ERCOT system will be flexible in time of charging (i.e., able to be shifted away from peak demand) and also may be flexible in continuity of charging (i.e., able to be interrupted on a moment's notice without undermining customer needs or expectations). Such "smart charging" practices are critical to maintaining a reliable grid at least cost. Whether the Commission implements time-of-use ("TOU") rates for electric utilities both inside and outside the ERCOT region will determine the extent to which load associated with charging EVs will be shifted as customers seek to reduce the cost of electricity needed to charge their vehicles. There are strong examples of time-variant rates being coupled with controls and communications so that consumers can "set-it-and-forget-it" to charge at off-peak times.

Studies of the Midcontinent Independent System Operator ("MISO") and the California Independent System Operator ("CAISO") energy markets indicate that EVs can be a reliable and flexible resource that can be signaled to reduce coincident system peaks. One study for MISO found that EV load growth and load shape can be influenced effectively by pricing and other utility programs.[7] The following graph highlights how different price signals to customers and increased opportunities for EVs to participate in wholesale markets can improve grid reliability. The blue line shows customer load patterns without the addition of EV charging and the black line shows the impact of adding uncontrolled EV charging. The green line shows the significant benefits realized from the use of smart charging, and the red line shows the even greater benefits that are realized from the use of bi-directional smart charging. Furthermore, the MISO report shows how EV load shape is changing with the adoption of TOU rates, and how best to collect load data from customers who use newly adopted EV-specific tariffs.

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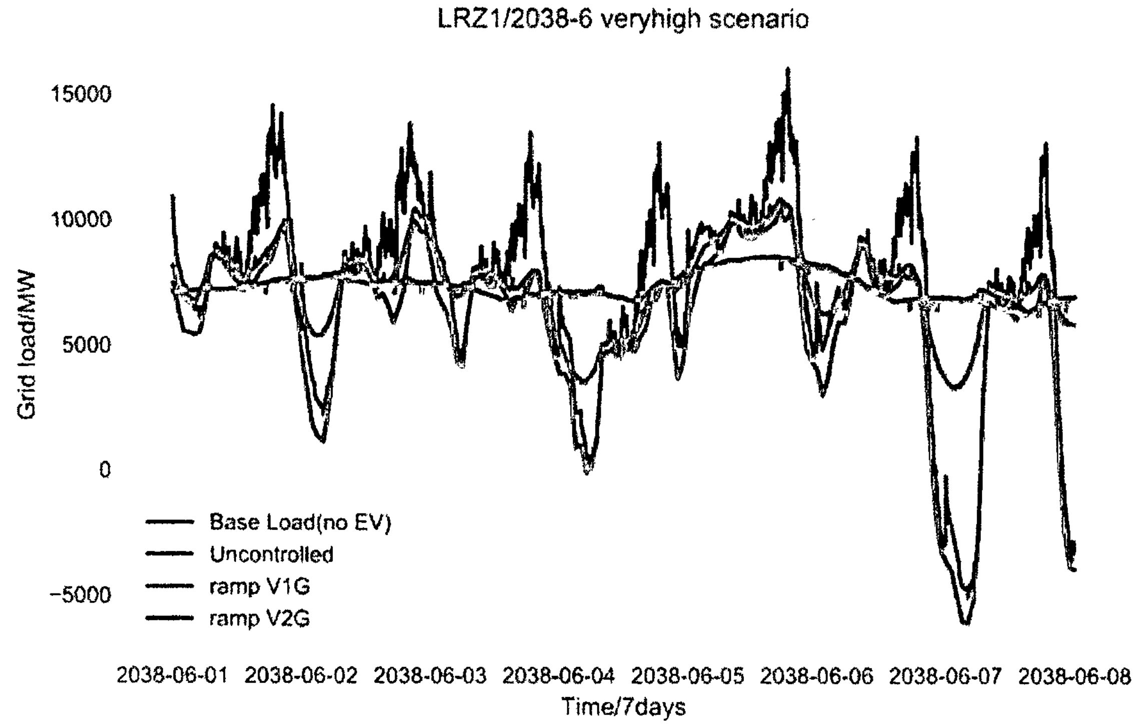
[7] Jeffery Greenblatt, Cong Zhang, and Samveg Saxena, Quantifying the Potential of Electric Vehicles to Provide Electric Grid Benefits in the MISO Area. Final report to the Midcontinent Independent System Operator Inc. (Available at https://cdn.misoenergy.org/Quantifying%20the%20Potential%20of%20Electric%20Vehicles%20to%20Provide%20Electric%20Grid%20Benefits%20in%20the%20MISO%20Area354192.pdf).



Another study published by the Institute of Electrical and Electronics Engineers ("IEEE") presents results from detailed power flow modeling of a distribution grid with high penetration of EVs. It recommends that the "path forward for high EV penetration includes a combination of innovations in TOU rate designs, long-term load forecasting to plan grid reinforcement, and a distributed energy resource (DER) management system with local dynamic price signals to optimize the grid for EVs and other DERs."[8] In California, the state's utilities are working with state agencies to forecast DER load growth down to the distribution level of the grid, and, at the direction of the California Public Utilities Commission, are adopting policies and practices to ensure grid reliability and consumer choice as more DERs are adopted.[9]

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[8] Coignard, J., MacDougall, P., Stadtmueller, F., and Vrettos, E., Will Electric Vehicles Drive Distribution Grid Upgrades?: The Case of California., IEEE Electrification Magazine, 7(2), 46-56, June 2019 (available at https://ieeexplore.ieee.org/document/8732007).

[9] See the California PUC Distribution Resources Plan (R.14-08-013) proceedings at https://www.cpuc.ca.gov/General.aspx?id=5071.

In addition to time-variant tariffs, controls and education programs, EVs have been shown to participate successfully in demand response programs, such as the demonstration by BMW with California utility Pacific Gas & Electric ("PG&E").[10] Similarly, eMotorWerks has aggregated more than 10,000 EV chargers to provide demand response service to the California ISO.[11] However, this capability is not enough in itself - the ability to engage EVs in providing demand response to support reliability in the ERCOT region will depend on ERCOT's willingness and ability to enable aggregated load resources to provide demand response services for the grid.[12] In non-ERCOT regions, the willingness of electric utilities to incorporate this growing capability into their operations also will be important.

As load is shifted to non-peak times, it can increase the capacity factor of the transmission and distribution grid as well as generation resources. The net result is to increase overall efficiency of both transmission and distribution resources and allow fixed costs to be allocated over a larger number of kWh which can reduce the cost per kWh of electricity delivered to retail customers.[13] From a generation perspective, the increased charging of EVs in off-peak hours will increase net load on the ERCOT system as this consumption takes advantage of plentiful clean West Texas wind energy. In addition, this additional off-peak load will reduce the idling of other generators that ramp down which will make them more efficient and less polluting. As noted above, the

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[10] See Julia Piper, BMW and PG&E Prove Electric Vehicles Can Be a Valuable Grid Resource, Greentech Media (June 20, 2017) (available at https://www.greentechmedia.com/articles/read/bmw-and-pge-prove-electric-vehicles-can-be-a-valuable-grid-resource).

[12] Julian Spector, EMotorWerks Is Using Its Network of 10,000 EV Chargers to Bid into Wholesale Markets, Greentech Media (Sept. 25, 2018 (available at https://www.greentechmedia.com/articles/read/emotorwerks-wholesale-markets-ev-charger-network).

[12] This issue was considered by the Demand Side Working Group in 2011-2014. While this effort ultimately supported the adoption of NPRR 555, Load Resource Participation in Security-Constrained Economic Dispatch (adopted July 3, 2003) (available at http://www.ercot.com/mktrules/issues/NPRR555), this was limited to allowing load serving entities to bid aggregated loads they serve into SCED, but did not allow third-party aggregators to bid their aggregations into SCED.

[13] *See* Jason Frost, Melissa Whited, and Avi Allison, Electric Vehicles are Driving Electric Rates Down, Synapse Energy Economics, Inc. (February 2019) (available at https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf).

flexibility of EV charging load also provides the opportunity to use the demand response potential of these chargers to provide a cost-effective tool to match demand with electricity generation on the grid, which can be especially helpful to the integration of increased intermittent renewable resources.

The end result is that the new load attributable to the growth of electric vehicles has the potential not only to improve the economics of the transmission and distribution grid, but also to lower the cost of managing an increasingly dynamic grid, lower the cost of integrating variable renewable resources,[14] and, as EVs and other distributed energy resources are better integrated into the electric grid, reduce the need to expand infrastructure.[15]

3. **Please identify any anticipated load "hot spots" in the state for electric vehicle charging. Please specify whether these hot spots are expected to result from personal, commercial short-haul, or commercial long-haul electric vehicle deployment and charging.**

For the purposes of these comments, EDF interprets the term "hot spots" as those areas where higher concentrations of EVs could require distribution system upgrades to provide reliable service. As other utilities in the country have already seen, the development of "hot spots" tends not to be an issue in reality. In a joint report filed by PG&E, Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E), they reported that of the more than 400,000 EVs deployed in their territories, only 618 (or 0.15%) required any service line or distribution service upgrade.[16]

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[14] International Council on Clean Transportation – Literature Review on Power Utility Best Practices regarding Electric Vehicles. 2016. (https://www.theicct.org/sites/default/files/publications/Power-utility-best-practices-EVs_white-paper_14022017_vF.pdf).

[15] See, e.g., Demand Side Economics, Valuing Distributed Energy Resources in Texas (November 2019) (available at file:///C:/Users/micha_000/SkyDrive/Documents/PDF%20Documents/Client%20Files/TAEBA/Valuing%20DERs%20in%20ERCOT%20final.11.13.19.pdf).

[16] *Order Instituting Rulemaking to Consider Alternative-Fueled Vehicle Programs, Tariff, and Policies,* California Public Utilities Commission Rulemaking 13-11-007, Compliance Filing of Pacific Gas and Electric Company (U 39 E), Southern California Edison Company (U 338 E) and San Diego Gas & Electric

One could expect potential "hot spots" to be business locations that are converting their vehicle fleets to electric vehicles from traditionally fueled vehicles. In fact, many large companies are already committing to convert their fleet to EVs. Local initiatives, such as EVolve Houston, are providing opportunities for large Texas-based companies, such as HEB and PepsiCo, to share their successes and lessons learned in transitioning to EVs.[17] However, businesses with a fleet of vehicles are not likely to switch from their current vehicles to new EVs without ensuring they have adequate electric service to meet their needs. As a result. the transition will be gradual, and the local utility can be expected to have adequate opportunity communicate with their customers and investigate whether any additional infrastructure investment is required.

One of the key tools a utility can use to address potential "hot spots" from the growth of EVs is to encourage the charging of EVs at non-peak times through the development of TOU pricing. In non-ERCOT regions and areas within ERCOT that are not open to retail competition, the ability to develop these rates for retail customers is more direct than in the areas of the ERCOT region that are open to retail competition. In the first instance, an integrated utility can design retail TOU or critical peak pricing that includes the cost of transmission and distribution infrastructure as well as the cost of energy.

In areas of ERCOT that are open to retail competition, retail electric providers already offer TOU retail plans, but the development of those plans is limited, as a practical matter, by the lack of TOU rates for the underlying transmission and distribution utility expenses. If the Commission were to approve TOU rates for transmission and distribution utilities, this would enable the retail electric providers to increase the economic signals in their TOU retail rates to better encourage

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Company (U 902 M) Pursuant to Ordering Paragraph 12 of D.16-06-011 at 12 (April 2, 2019) (Joint IOU Load Research Report) (available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=228787-14&DocumentContentId=60075).

[17] https://www.evolvehouston.org

consumers to shift their electric consumption to lower cost times. This is an opportunity that the Commission can address through more innovative ratemaking.

EVs are uniquely able to take advantage of TOU rates through the use of smart charging. Not only does modern technology make it easy for an EV owner to set a charging schedule that complies with TOU rates, but the charging technology also can be enabled to respond to signals from third parties that can coordinate EV charging with the needs of the electric grid. This allows not only load shifting, but also load shaping.

An early example of utility TOU programs for EV charging is a pilot conducted by San Diego Gas & Electric (SDG&E). Its TOU charging pilot found that "super off-peak prices appear to be the most important factor influencing an EV driver's charging time decisions and behavior....As the TOU price ratios increase, so too does the cross-price elasticity between the off-peak and super off-peak period. This result indicates that with higher price ratios, reductions in the super off-peak price will result in customers switching more of their EV charging from the off-peak period to the super off-peak period."[18]

Also, the Commission should consider a Pacific Gas and Electric (PG&E) report that studied the potential impact of the growth of EVs on 39 feeders and how TOU rates could address potential loading concerns.[19] The study evaluated feeders with different topologies, customer breakdowns, and historical demand profiles. The feeders are connected to eight different substations and the 39 detailed feeder models are representative of the larger PG&E territory in terms of design, capacity, and nominal voltage. Half of the feeders serve mainly residential

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[18] Nexant, Inc., Final Evaluation for San Diego Gas & Electric's Plug-in Electric Vehicle TOU Pricing and Technology Study at 42 (February 20, 2014) (available at https://www.sdge.com/sites/default/files/SDGE%20EV%20%20Pricing%20%26%20Tech%20Study.pdf).

[19] Coignard, J., MacDougall, P., Stadtmueller, F. and Vrettos, E., 2019. Will Electric Vehicles Drive Distribution Grid Upgrades?: The Case of California. *IEEE Electrification Magazine*, 7(2), pp. 46-56 (available at https://ieeexplore.ieee.org/abstract/document/8732007/).

customers, while the rest serve a mix of industrial, commercial, agricultural, and special load customers. Through the study, it was determined that a shift of 30% of the EV chargers to off-peak charging could avoid 80% of impacts on voltage and feeder capacity.

In addition to implementing TOU rates for utilities in the state, the Commission also can help utilities address potential "hot spots" by ensuring that utilities proactively analyze the strengths and weaknesses on their distribution systems. The County of Los Angeles is an example of this approach where it analyzed a distribution system for its capabilities and identified potential "hot spots". Included in its 2019 Transportation Electrification Blueprint is an example of this level of analysis.[20] This report provides the Commission an example methodology for engaging in this kind of assessment.

The foregoing comments have focused on the impacts of Level 1 and Level 2 chargers. There is no doubt that faster chargers with sharper demand profiles can have more localized impacts. However, these potential issues can be addressed by siting these facilities in locations with higher transmission and distribution capacities as well as the use of storage technologies and smart charging. To realize the opportunities of these strategies though, more transparent information must be made available regarding the capabilities of the transmission and distribution grid and the planning thereof.

4. **Describe the observed or anticipated load profiles and impacts of various types of electric vehicle charging stations (e.g., residential Level 1, Level 2, and Level 3 DC Fast charging) and the class of the vehicle charging (i.e., personal, commercial short-haul including fleets and buses, and commercial long-haul electric vehicles).**

As discussed above in response to Question 3, the load impact of EV charging will depend in large part on the economic price signals provided by the electric utility or retail electric provider

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[20] County of Los Angeles Transportation Electrification Blueprint, 2019, at 69-86 (available at http://isd.lacounty.gov/wp-content/uploads/2019/07/LAC_EV_Transportation_Electrification_Blueprint_Web_RELEASE.pdf.)

that serves the customer at issue. EVs chargers are able to provide both load shifting as well as load shaping that help ensure that EVs are a significant benefit to the electric grid overall. As shown by the MISO study discussed above in response to Question 2, the load shape that results from the increased use of EV chargers will be significantly impacted by the implementation of TOU rates and the use of bi-directional charging.

The National Renewable Energy Lab hosts a database of load profiles for various work vehicles powered by electricity. The FleetDNA database was developed to be a "clearinghouse of commercial fleet vehicle operating data helps vehicle manufacturers and developers optimize vehicle designs and helps fleet managers choose advanced technologies for their fleets."[21]

In addition to the NREL database, several studies have examined both EV load impacts and how pricing programs can be expected to influence EV load shape and magnitude. For example, in their Joint IOU Load Research Report, PG&E, Southern California Edison Company (SCE), and SDG&E reported that load profiles will depend on the underlying rate structure and use of smart charging.[22] Moreover, as noted above regarding the MISO study, the impact of EVs on the grid decline with the additional use of TOU rates and bi-directional smart charging.

5. What, if any, emerging vehicle charging technologies are anticipated to be commercially available in the next ten years that could impact electricity markets in Texas?

A number of utilities are actively piloting vehicle-to-grid (V2G) applications. The increased availability of these technologies and services will, as discussed above in response to Question 2, increase the capacity factor of the transmission and distribution grid as well as generation resources which will benefit all customers. Key studies currently underway include a

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[21] https://www.nrel.gov/transportation/fleettest-fleet-dna.html.

[22] Joint IOU Load Research Report at 2.

study of electric school bus V2G[23] and SDG&E's study regarding the potential use of charging EVs as a virtual power plant.[24] While these pilots are "testing new technology", additional technology innovations continue to be developed and tested. [25]

It is important to note that that several studies have identified constraints that EVs face in providing services in response to dynamic prices include the need for software automation and controls that link to utility resource systems. In addition, minimizing the cost of EV submetering is an important consideration.[26] At the same time, the value proposition for EV operators must not involve unacceptable compromises in driving times or range. As a result, in order to enable the development and deployment of these technologies in Texas, it will be important that the Commission identify key barriers to vehicle-to-grid opportunities and strategies to reduce those barriers.

GRID IMPACTS

6. The Commission requests that parties provide a detailed explanation on the following items:

a. The anticipated impact of electric vehicle charging, including residential and commercial charging stations on the distribution system in the next ten years;

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[23] http://www3.dps.ny.gov/W/PSCWeb.nsf/All/B2D9D834B0D307C685257F3F006FF1D9?OpenDocument. "ConEd in partnership with a local school bus operator, will purchase five electric school buses for use in the White Plains public school district. During the school year, the five electric buses will be used for student transportation. During the summer, the buses will be used as energy storage to meet system needs." See also ConEdison REV Demonstration Project Outline Electric School Bus V2G (June 8, 2018) (available at (http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b94DA14CE-371B-415B-BFBB-D54B2EFD74A1%7d).

[24] http://newsroom.sdge.com/clean-innovative/pilot-project-aims-turn-electric-vehicles-virtual-power-plants, "The project will use parked electric vehicles (EVs) as a collective energy storage reservoir. Essentially, this pilot will test new charging technology, which can draw electricity from EVs plugged into charging stations and feed that energy back into the grid when it's needed. This kind of bi-directional EV charging technology can help maintain grid stability by balancing demand and supply in real time. We are providing technical services and resources to help implement Nuvve's technology on the UC San Diego campus."

[25] For an example, see Nuvve's V2G charger at https://nuvve.com/v2g-chargers/.

[26] *See In the Matter of Northern States Power Company's Annual Report on Residential Electric Vehicle (EV) Charging Tariff and Residential EV Service Pilot,* Minnesota Public Utilities Commission Docket Nos. E002/M-15-111 and E002/M-17-817, Compliance Filing (May 31, 2019) (available at https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7bA0BF0F6B-0000-C016-839D-F8267E380A28%7d&documentTitle=20195-153306-01).

If EV charging is added to the electric grid with no coordination with the local electric utility, with no development of appropriate TOU rates, and without any opportunity to recognize the benefits of demand response from these resources, there is a potential that Texas will fail to realize the significant potential benefits EVs can bring to the state's electric grid. It is possible to over-estimate the additional generation resources and transmission and distribution infrastructure that the state could need to serve the electrical demand of new EVs if the Commission fails to ensure that utilities provide appropriate signals to customers regarding when to charge and if ERCOT does not enable the use of the demand response potential from EV chargers. The Commission can expect that an over-investment in infrastructure to serve inflated EV load will result if growth scenarios assume that all new EVs will charge at on-peak times and dramatically impact peak demand and stress on the grid. This approach would adversely impact all customers through higher costs for transmission and distribution system upgrades.

Rather than allow this approach to prevail, EDF respectfully recommends the Commission ensure projections used for planning purposes accurately reflect lessons learned from other jurisdictions. For example, as discussed above, PG&E, SCE, and SDG&E found that a very small fraction (0.15%) of the hundreds of thousands of EVs deployed already in their territories required any service line or distribution service upgrade. Similarly, as shown in the following graph, a study that assumes EV chargers will not be controlled leads to a very different conclusion about potential feeder overloads than a study that recognizes the beneficial impact of customer use of smart charging.[27] The bars on the graph show expected peak-demand impacts for 19 residential feeders with uncontrolled EVs (blue) and controlled EVs (orange). The red dots mark the

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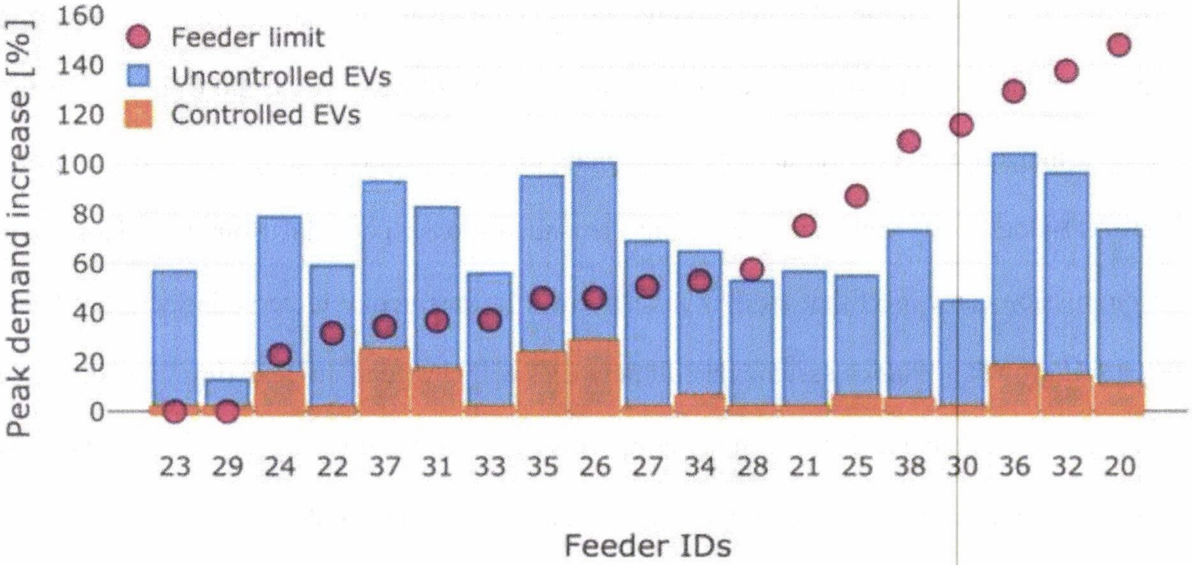
[27] Coignard, J., MacDougall, P., Stadtmueller, F. and Vrettos, E., 2019. Will Electric Vehicles Drive Distribution Grid Upgrades?: The Case of California. *IEEE Electrification Magazine*, 7(2), pp. 46-56 (available at https://ieeexplore.ieee.org/abstract/document/8732007/).

maximum increase possible with the existing grid infrastructure. While the projection of demand based on uncontrolled EV charging would exceed the feeder limit in 11 instances, a projection of demand based on the use of smart charging shows only two feeders could experience load growth that exceeds the feeder limits.



As these studies demonstrate, we can reach high EV penetration without straining our grid, and at a fraction of the cost, by implementing smart grid integration strategies. Programs such as time-of-use rates and local dynamic price signals would promote the shifting of charging to off-peak hours and are key to meeting our clean transportation goals without breaking the bank or sacrificing grid quality. As discussed above in response to Question 3, the use of TOU rates and smart charging technology will be key factors that determine the potential impact EV charging will have on the distribution system over the next ten years. If these strategies are embraced and enacted in a timely manner, the net impact to peak load may be negligible, but the increased capacity factor of both grid utilization and consumption of energy may have the beneficial impact of reducing the cost per kWh of electricity for all customers.

Level 3 chargers have the potential for greater impact on the transmission and distribution grids because they draw more power compared to Level 1 or 2 charges. However, as with other potential large increases of load as utilities already address today, communication between the electric utility and the developer of these charging facilities will be important to minimize the impact (and cost) to develop these fast charging resources. In addition, siting these facilities in locations with higher transmission and distribution capacities as well as the use of storage technologies and smart charging can reduce their potential impact.

EVs and their energy storage capacity are an important class of DERs. The Texas Advanced Energy Business Alliance recently released a study conducted by Demand Side Analytics examining the value of DER in ERCOT.[28] They find "the value of T&D deferral in Texas by incorporating DERs at $344 million per year or $2.45 billion over 10 years ($2019 Present Value). On an annual basis, this represents 8.5% of total T&D infrastructure costs." Furthermore, the study concludes that "DER resources also can provide Texas valuable services by enhancing wholesale market competition and mitigating price spikes in ERCOT." These are potential savings that EVs can help achieve.

b. The anticipated impact of electric vehicle charging stations on the transmission system in the next ten years; and

As EDF's comments have shown, the effective use of EVs and their chargers can provide significant services to the transmission and distribution system and reduce costs that otherwise would be incurred to build additional infrastructure through better utilization of local resources.

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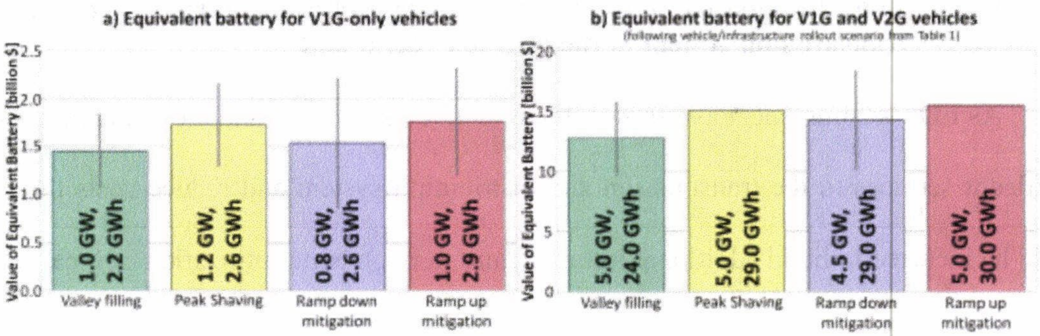
[28] Demand Side Analytics, The Value Of Integrating Distributed Energy Resources In Texas (November 2019) (available at https://www.texasadvancedenergy.org/hubfs/TAEBA%20(2019)/Valuing%20DERs%20in%20ERCOT%20final.11.13.19.pdf).

EVs also have the potential to provide to the electric grid the same benefits as stationary energy storage resources, but at a much lower cost. The following chart shows the capital cost value of equivalent grid-scale stationary storage that provides the same system ramping mitigation capability as EVs.[29] Figure (a) in the chart below shows the equivalent battery size and cost compared to an aggregation of V1G-only vehicles. For valley-filling and ramp-up mitigation, V1G-only vehicles fulfill 1.0 GW of storage-equivalent and provide equivalent capability as \$1.45–\$1.75 billion of stationary storage investment. This represents a substantial cost savings for renewables integration, as equivalent V1G storage capacity is readily achievable at less than \$150 million over uncontrolled charging with today's technology. In a scenario with a mix of V1G- and some V2G-capable vehicles, Figure (b) shows that EVs provide equivalent services of 5.0 GW of stationary storage for valley-filling and ramp-up mitigation, the equivalent of \$12.8–\$15.4 billion in stationary storage investment. Simply stated, EVs with only V1G capabilities can provide a significant amount of valley-filling and ramp-up mitigation for the benefit of the electric grid at much lower costs than deploying new stationary storage. This is an example of the significant benefits that the electric grid can realize through the effective integration of EVs.



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[29] Jonathan Coignard, Samveg Saxena, Jeffrey Greenblatt, and Dai Wang, Environmental Research Letters (May 16, 2018) (available at https://iopscience.iop.org/article/10.1088/1748-9326/aabe97/pdf).

c. **The anticipated impact of electric vehicle charging stations on long-term system planning at the regional transmission organization level, given a widespread adoption scenario.**

EDF has no comments in response to this question beyond our responses to the prior questions.

7. **What is the overall anticipated impact of electric vehicle charging in the next ten years in terms of energy and peak demand? What changes, if any, should be made to energy and peak demand forecasts to incorporate this impact?**

As the Commission considers forecasts and analyses regarding the anticipated impact of EV charging in terms of energy and peak demand, as discussed above, it should recognize that there is a significant opportunity for EVs to be an asset to the electric grid due to the opportunity to shift their load as well as the significant flexibility of their demand. At this early stage of the growth of EVs in Texas, it is difficult to estimate the growth of EVs over a long period such as ten years. Regardless of this uncertainty, early development of TOU rates and increasing the opportunity for demand response and bi-directional charging are no-regrets strategies that will help mitigate the impact of EV growth as discussed above in response to Question 2 and shown by the MISO study cited therein.

8. **What are the capabilities of electric vehicle related technologies, such as vehicle-to-grid, to participate in wholesale electricity markets?**

The potential for EV-related technologies to participate in wholesale markets is a longer-term opportunity in the ERCOT region that should not overshadow the immediate opportunities that already can be realized in the ERCOT market structure with V1G technology. As discussed above in response to Question 2, the current V1G technology can provide significant load shaping benefits as long as the correct pricing signals are in place. In addition, just like any other distributed load or energy storage resources in the market today, there is an immediate opportunity to aggregate these resources to provide demand response service to retail electric providers and even to ERCOT as a participant in Emergency Response Service. However, the limitations ERCOT has experienced to date in its ability to enable the participation of aggregated loads in its Security Constrained Economic Dispatch (SCED) engine continue to be applicable to the potential aggregation of electric vehicles to be subject to economic dispatch. A key limitation is the requirement that individual loads or aggregation of loads may only be bid into the wholesale market by the customers' retail electric provider or other load serving entity.[30]

Today, V1G technologies in other jurisdictions are able to participate in and support the electric grid as an aggregated flexible load resource that can shift their consumption from the electric grid quickly and strategically.[31] These technologies have the potential to be more flexible in their demand response capabilities than many other loads or energy storage resources. The opportunity to provide these demand response and load shifting capabilities can be supported by direct signals to EV chargers (active smart or managed charging), as well as with well-defined time-variant pricing (passive smart or managed charging).

As discussed in response to Question 5 above, there are several pilots under way in other jurisdictions that are evaluating the potential for V2G services to the electric grid. We can expect these and other pilots and studies to demonstrate broader potential services that EVs may provide.[32] In addition, as discussed above in response to Question 6, EVs have the potential to provide the same services to the electric grid as fixed storage resources at much lower cost.

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[30] See NPRR 555, Load Resource Participation in Security-Constrained Economic Dispatch (adopted July 3, 2003) (available at http://www.ercot.com/mktrules/issues/NPRR555). The scope of this NPRR was limited to allowing load serving entities to bid aggregated loads they serve into SCED and did not allow third-party aggregators to bid their aggregations into SCED.

[37] See, e.g., Julian Spector, EMotorWerks Is Using Its Network of 10,000 EV Chargers to Bid into Wholesale Markets, Greentech Media (Sept. 25, 2018 (available at https://www.greentechmedia.com/articles/read/emotorwerks-wholesale-markets-ev-charger-network).

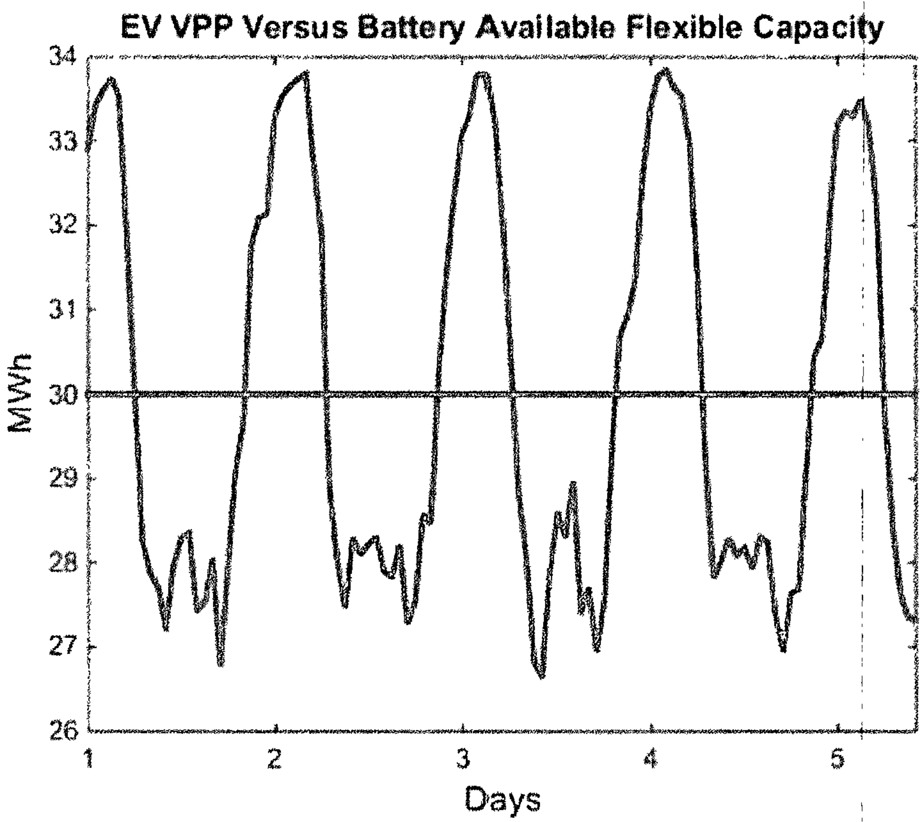
[32] Pecan Street has published studies that show the potential for EVs to provide both vehicle-to-grid and on-site load smoothing and energy cost reduction. *See, e.g.,* Lara-Sophie Christmann et al., A Framework for Integrating Intelligent Mobile Energy Storage into Energy Distribution Systems, 2019 IEEE PES Innovative

The extent to which EVs will be able to participate in wholesale markets may inadvertently be limited due to requirements imposed by ERCOT or utilities. As a result, developing appropriate rules for the participation of EVs in the wholesale market is critical. For example, as the following graph shows, the amount of capacity available from an aggregation of EVs varies as EVs connect and disconnect during the day.[33] When aggregated DERs are modeled for capabilities, an ISO may take one performance capacity measurement as its measurement of potential performance for the resource. However, in the case of EVs, when potential performance is measured can drastically limit the amount of flexibility services aggregated EVs can offer to the grid. The following chart shows how the actual state of charge for an aggregation of EVs with an average 30 MWh capacity can compare with a stationary 30 MWh battery.[34]

Smart Grid Technologies Europe (ISGT-Europe), (September 29 to October 2, 2019 (available at https://ieeexplore.ieee.org/abstract/document/8905494); Chioke Harris and Michael Webber, A temporal assessment of vehicle use patterns and their impact on the provision of vehicle-to-grid services, Environmental Research Letters, Volume 7, Number 3 (September 18, 2012) (available at https://iopscience.iop.org/article/10.1088/1748-9326/7/3/034033); and Qiyun Dang, Electric Vehicle (EV) Charging Management and Relieve Impacts in Grids, 2018 9th IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG) (June 25-28, 2018, and August 30, 2018) (Electronic ISSN: 2329-5767) (available at https://ieeexplore.ieee.org/document/8447802).

[33] MacDougall, Pamela Ann. "The Value of Energy Flexibility: An Assessment of Residential Aggregator Services." (2018) (available at https://lirias.kuleuven.be/1731485?limo=0).

[34] Natural Resources Defense Council, Sustainable FERC, Earthjustice, Association for Energy Affordability, Alliance for Clean Energy New York, and American Wind Energy Association Comments on NYISO's Grid in Transition Draft Whitepaper (July 1, 2019) at 9 (available at https://static1.squarespace.com/static/5c34c6b685ede137995b2e5d/t/5d1cd1a8cdd3850001dba7fe/1562169769769/2019.07.01+NYISO+grid+in+transition+comments.pdf).



The variability of the aggregated EVs compared to the stationary battery means that measurements of potential capability can vary widely even when the same average capability is available. In addition, other studies that have found that a requirement that a resource providing ancillary services be able to provide the same amount of regulation up as regulation down can undermine the opportunity for EVs to participate in grid services.[35] As a result, in order for ERCOT (or a non-ERCOT utility) to enable the maximum potential contribution of aggregated EVs to support the electric grid, it will be important that ERCOT (or the non-ERCOT utility) enable the opportunity for flexible measurements of potential performance.

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[35] Nicholas DeForest, Jason MacDougal, Douglas Black, Day Ahead Optimization of an Electric Vehicle Fleet Providing Ancillary Services in the Los Angeles Air Force Base Vehicle-to-Grid Demonstration, Applied Energy – Distributed Energy & Microgrids Special Issue (January 2018) (available at https://eta-publications.lbl.gov/sites/default/files/la-afb-optimization.pdf).

Other potential barriers to the ability of aggregated EVs to participate in wholesale markets include burdensome metering requirements, limiting aggregations to a single node, and limited opportunity to submit energy offers closer to real-time.[36]

9. Please explain any preferred or best practice facilities siting and design standards for commercial electric vehicle charging stations and why such standards are recommended.

As the Commission considers potential standards for commercial EV chargers and EV charging stations, it is important that the Commission consider the preferred or best practices associated with all charging facilities that can facilitate the positive impacts EVs can have on the electric grid as a whole. Key standards include elimination of burdensome duplicate metering;[37] adoption of communication standards, such as Open Charge Point Protocol (OCPP),[38] and enabling smart charging OpenADR.[39] It is important to have communications standards in place in order to avoid stranded assets and enable the development of the additional services discussed above as well as standards for data formats in utility billing systems (e.g. Open Vehicle-Grid Integration Platform (OVGIP))[40] to enable submetering to be readily incorporated for TOU or advanced charging programs. To scale up advanced charging programs, it is vital that EV charging be implemented with low operational costs as well as managing large data and communication from variety of different vehicle types. Electric Power Research Institutes' OVGIP addresses both of these issues by allowing seamless two-way communication between EVs and the grid operator

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[36] *Id.* at 10-12. There is a potential that some of these issues may be addressed in ERCOT through NPRRs that will be proposed as a result of the work of the Real Time Co-Optimization Task Force and the Battery Energy Storage Task Force if aggregations of resources are allowed to participate in the wholesale market to the same extent as individual resources.

[37] *See* Melissa Whited, Avi Allison, and Rachel Wilson, Driving Transportation Electrification Forward in New York, Synapse Energy Economics, Inc. at 17-23 (June 25, 2018) (available at https://www.synapse-energy.com/sites/default/files/NY-EV-Rate-%20Report-18-021.pdf).

[38] https://www.openchargealliance.org/about-us/appraisal-ocpp/.

[39] https://www.openadr.org/.

[40] https://www.epri.com/#/pages/product/000000003002008705/?lang=en-US.

to manage EV load, incorporating both the drivers' needs as well as open access for all vehicle types. While this platform has been implemented in other utility pilot programs, they often only use one automaker or do not include advanced charging. Xcel Exergy's Charging Perks Pilot will showcase the full potential of this platform by using multiple car manufacturers as well as advanced charging.[41] By testing the value of smart charging services, Xcel Energy will bring a key smart charging technology closer to market. For submetering, the format of the data should be consistent throughout ERCOT at a minimum (and optimally consistent throughout the state). Addressing these issues early in the adoption of EVs will help facilitate the opportunity for EVs and their chargers as well as larger charging facilities to participate in the wholesale market.

CONCLUSION

EDF appreciates the opportunity to provide these comments and looks forward to working with the Commission and interested stakeholders on these issues.

Respectfully submitted,

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[41] https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Charging-Perks-Pilot-Product-Write-Up.pdf.