STATE OF NEW HAMPSHIRE

BEFORE THE NEW HAMPSHIRE PUBLIC UTILITIES COMMISSION

Docket No. DE 20-170

Electrical Vehicle Time of Use Rates

DIRECT TESTIMONY OF CHRISTOPHER R. VILLARREAL

ON BEHALF OF

CLEAN ENERGY NEW HAMPSHIRE AND CONSERVATION LAW FOUNDATION

OCTOBER 13, 2021

TABLE OF CONTENTS

DIRECT TESTIMONY OF CHRISTOPHER R. VILLARREAL FOR CENH AND CLF
CASE NO. DE 20-170

I. INTRODUCTION & QUALIFICATIONS

Q. Please state for the record your name, position, and business address.

A. My name is Christopher Villarreal. I am the President of Plugged In Strategies, located at 9492 Olympia Drive, Eden Prairie, Minnesota, 55347.

Q. On whose behalf is this testimony being offered?

A. I am testifying on behalf of Clean Energy New Hampshire (CENH) and the Conservation Law Foundation (CLF).

Q. Please summarize your experience in the field of utility regulation.

A. I have over 20 years of experience working for and before state regulatory bodies, including nine years as Senior Regulatory Analyst at the California Public Utilities Commission and two years as Director of Policy at the Minnesota Public Utilities Commission. I started Plugged In Strategies in 2017 and since then I have advised state commissions around the country on issues related to rate design, grid modernization, advanced metering infrastructure, interoperability, electric vehicles, distribution system planning, and data access and privacy.

Q. Can you describe your experience with the issues raised in this proceeding?

A. On rate design issues, I worked on a number of rate design policy decisions and proceedings while staff at the California Public Utilities Commission, including assisting the Assigned Commissioner's dynamic pricing guidance issued in Decision 08-07-045[1]

[1] *Application of Pacific Gas and Electric Company To Revise Its Electric Marginal Costs, Revenue Allocation, and Rate Design*, Decision 08-07-045, California Public Utilities Commission (July 31, 2008), https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/85984.PDF.

and development of the Order Instituting Rulemaking that led to a review of existing rate design in California.[2] As Director of Policy for the Minnesota Public Utilities Commission, I participated in the development of the Minnesota Commission's review of its rate design policies.[3]

Additionally, from 2016-2017, I was staff chair of the National Association of Regulatory Utility Commissioners (NARUC) Staff Subcommittee on Rate Design, and lead the effort to publish the NARUC manual on Distributed Energy Resources (DER) Rate Design and Compensation. This document was one of the first comprehensive looks at the impacts rate design has on DER, which includes EVs.

Recently, I facilitated an effort for the Connecticut Public Utilities Regulatory Authority, with funding from NARUC, to look at the interoperability considerations for EV deployment in Connecticut, including the interaction between EVs, electric vehicle supply equipment (EVSE), and the utilities.

My work experience is summarized in my resume, provided as Exhibit CRV-1.

[2] *Order Instituting Rulemaking on the Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations*, Order Instituting Rulemaking, California Public Utilities Commission, Docket No. R.12-06-013 (June 28, 2012), https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/169782.PDF.

[3] *See*, *In the Matter of an Alternative Rate Design Stakeholder Process for Xcel Energy*, Notice Seeking Comment on Procedural Schedule, Minnesota Public Utilities Commission, Docket No. E002/M-15-662 (February 16, 2016), https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={AAB14AE3-EEDF-4188-8AE3-BD5BDA9EE5BA}&documentTitle=20162-118338-01.

DIRECT TESTIMONY OF CHRISTOPHER R. VILLARREAL FOR CENH AND CLF
CASE NO. DE 20-170

Q. Have you testified before the New Hampshire Public Utilities Commission (Commission) or participated as an expert in any other proceeding before this Commission?

A. I have not testified before the Commission, but I did participate in several workshops before the Commission in Docket No. IR 15-296, Investigation into Grid Modernization.

Q. Have you testified before any other commission?

A. Yes, I have previously testified before the Michigan Public Service Commission and the South Carolina Public Service Commission. In general, I testified regarding utility distribution system planning efforts and the role of DER, including EVs, on those planning efforts.

Q. What is the purpose of your testimony?

A. I am testifying on behalf of CENH/CLF regarding the electric vehicle (EV) rate design proposals of Liberty Utilities, Unitil, and Eversource in DE 21-170.

Q. **What is being considered in this docket?**

A. In its Order of Notice establishing this docket, the Commission stated that these proceedings raise issues "related to whether the EV TOU rate proposals to be developed and filed are consistent with the rate design standards delineated in Order No. 26,394; whether those EV TOU rate design proposals are likely to result in just and reasonable electric rates, as required by RSA 374:2 and RSA 378:5 and :7; and whether the EV TOU rate design proposals are consistent with the New Hampshire Energy Policy defined in RSA 378:37."

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibit:

Exhibit CRV-1: Resume of Christopher R. Villarreal

II. TESTIMONY OVERVIEW

Q. What is the purpose of your testimony?

A. My testimony discusses key components of rate design and rate design principles, impacts of rate design on adoption of EVs, and addresses the rate design proposals of Liberty, Unitil, and Eversource as submitted in docket number DE 20-170. In particular, my testimony responds to Liberty and Unitil's EV rate design proposals for EV charging, and responds to Eversource's proposed time-of-use rate and managed charging proposal. I recommend the following:

1. The Commission reject Liberty's demand charge proposal and implement a 10-year demand charge holiday for EV rate designs or until DC Fast Charger (DCFC) utilization factors reach 30%;
2. The Commission reject Unitil's demand charge proposal and implement a 10-year demand charge holiday for EV rate designs or until DCFC utilization factors reach 30%;
3. The Commission accept Unitil's time of use rate design proposal, except for DCFC;
4. The Commission reject Eversource's managed charging proposal;
5. The Commission adopt Eversource's time-of-use proposal, with revisions as provided herein;
6. The Commission should require the utilities to collect information regarding EV adoption and usage rates to help inform the pace of evolution for rate design for

EVs until such time as utilization rates for DCFCs reach a level at which demand charges can be recovered across more usage;

7. The Commission should require the utilities to make available public hosting capacity maps to help identify optimal locations for the citing of EV charging infrastructure, including DCFCs; and,
8. At a minimum, the Commission should consider developing state-wide EV rate design policy and implementations, including prohibiting demand charges for EV charging, regardless of charging level, for a period of at least 10 years to minimize the potential for rate shock at site host locations, and to provide certainty to the emerging EV marketplace in New Hampshire.

III. ELECTRIC VEHICLE POLICY

Q. How should the Commission address EV policy?

A. A good first step in this effort is to focus on the rate design, as the Commission has done in this proceeding. However, with the current levels of EV adoption across New Hampshire, the Commission should consider taking additional actions that will do much to support the growth of EVs in New Hampshire. For example, at this early stage of adoption, making a statement that adoption of EVs is a priority of the Commission would show that the Commission is ready and willing to take necessary steps to support the EV market in New Hampshire.

Q. What are some benefits of making EV adoption a policy priority?

A. By making EV adoption a priority, the Commission can ensure that EV adoption and growth is considered across Commission actions. Additionally, making such a statement would allow further discussion and action on identifying opportunities to leverage EVs on the electric system and creating a more efficient distribution system. With appropriate price signals, fleets could be charged during off-peak hours and not negatively impact afternoon peak hours; this type of managed charging would reduce operational costs while also increasing utility sales. Enhancing the efficiency of the distribution system means not only shifting charging times to off-peak periods, but also, during times of low wholesale prices, EV charging infrastructure could be used to charge during times of excess electricity.

Finally, adoption of EVs provides a benefit to New Hampshire's customers and residents by electrifying transportation, be it single-vehicle EVs, a town's transit system, or electric school buses. The costs of operating EVs are lower than internal combustion engines, and EVs do not emit emissions, creating cleaner air for all who live and visit New Hampshire.

Q. What is the status of electric vehicle adoption in New Hampshire?

A. At this time, low. Each of the three utilities has submitted estimates of EV adoption across their service territories, but they are estimates. For example, Unitil's EV forecasts are based on model developed by the Edison Electric Institute, then scaled to their New Hampshire territory.[4] In response to Department of Energy Data Request DOE 2-1 and 2-2, in response to a question about estimating kW and kWh for 2021-2031, Liberty stated

[4] Unitil CVS-3.

"The Company does not have an estimate of kW or kWh for EV charging in its territory."[5] In response to discovery from CENH/CLF, Liberty cited to its 2021 Least-Cost Integrated Resource Plan for its EV forecast, but there Liberty has merged both solar PV peak contributions with EV peak charging.[6] Eversource states they do a yearly evaluation that looks at a number of factors, such as impacts of local, state, and federal policies.[7]

Nevertheless, even though expanded EV production targets have been announced by the major EV producers and EVs will make up an increasing amount of the transportation sector in New Hampshire in the coming decade, all three utilities estimate a rather low projection of EV deployment in New Hampshire, which provides the Commission with a significant opportunity to enact policies that support EV adoption at this early stage and that will help grow the EV market in New Hampshire. Ensuring that there are no unnecessary barriers to EV adoption at this stage will help the EV market mature, support EV adoption, and allow New Hampshire residents to benefit from the savings and environmental benefits that electrification of transportation promises. Providing policy support to help this transition, such as avoiding demand charges, can go a long way to make EV adoption a priority for the state.

Q. Can you explain the benefit of acting while adoption rates are low?

A. Yes. Even with their estimates, each of the utilities have proposed rates that will have minimal impact on their revenue requirement or rely on substantial cross-class subsidies.

[5] Liberty Response to DOE 2-1.
[6] Liberty Response to CLF & CENH 2-13.
[7] Eversource Response to CLF & CENH 2-003, Attachment 1.

Simply put, at low adoption levels, the costs to customers are relatively low. As such, any potential subsidization from other customer classes is likely to be minimal; even then, with EV adoption a priority for the state, and the Commission, it would be reasonable to allow for customers to bear some of the uncollected costs from these rates to support such a policy priority as supporting EV development in New Hampshire. Not collecting demand charges should not have a substantial impact either to the site host or to customers since the low utilization rates of EV charging infrastructure means substantial costs are not being incurred. Furthermore, for Liberty and Unitil, these rates are optional—customers can choose to remain on their otherwise applicable general service tariff. For Eversource, the proposal in this docket is only for its residential class, whose customers can also choose to stay on their otherwise applicable tariff and roll in any consumption due to charging at their home to that rate.

Q. What types of actions should the Commission consider to support EV adoption?

A. First, it is important that the Commission use this time to support EV adoption across the state. This would include development of time of use rates, identification of locations for the siting of DCFCs that will not have significant impacts on the electric system, and ensuring that distribution utilities do not leverage their own market power to interfere with a competitive marketplace. For example, encouraging the utilities to develop and make public EV hosting capacity maps would go a long way to minimizing customer and system costs while maximizing efficiency and leveraging available locations to locate DCFCs.

Second, by proactively stating that EV adoption is a priority for the Commission, it can recognize that EV adoption and deployment is at a nascent stage, so its policies and principles can reflect that determination.

Lastly, the Commission can adopt forecasting and reporting metrics regarding EV adoption so that the utilities, the Commission, and the public can project an adoption rate over time. This forecast is important as it can be used by utilities and the Commission to identify when certain policies can sunset and new policies adopted.

Q. Can you describe the different types of EV use cases?

A. Yes. I identify six basic use cases for EV adoption.

- Residential Level 1, 110 volt charging
- Residential Level 2, 220 volt charging
- Commercial/Public Level 2, 220 volt charging
- Commercial/Public Level 3, DCFC
- Commercial Fleet, Level 2, 220 volt charging, and
- Transit, DCFC

Each of these use cases comes with different technology options, rate design options, impact on utility systems, and pace of adoption. As such, questions remain regarding which rate to apply to which use case. Different rate designs can also apply to these different use cases. For example, for residential customers, a utility could offer a whole home rate, where the energy used to charge an EV is rolled into the total consumption of the premise, or an EV-only tariff, where the energy used to charge the EV is measured

separately from the home and billed at a different rate. However, the impacts of each use case can be very different.

Q. Please explain.

A. A cluster of residential Level 2 charging will have a different impact on utility operations and cost recovery than public DCFC, which will have a different impact from transit and fleet charging use cases. Residential customers are served by one size of transformer, typically, so changing the size of the residential transformer may be needed to address increased demand from EV charging. Of course, a residential transformer may also need to be upgraded in response to any number of new residential investments like installing a hot tub or a pool, adding a new refrigerator and freezer, or building an addition. None of those investments require the homeowner to notify the utility, and any costs incurred by the utility in response to those types of customer actions are recovered through rate base.

On the other hand, DCFC, which could draw up to 1 MW of demand per DCFC in the future, can only be located in certain areas across the distribution and transmission system and where there is available capacity to add such demand. Being able to identify those locations will help customers and developers install DCFC in locations that will not exacerbate potential constraints or overwhelm the location, and will minimize project development costs for charger installers and site hosts. In this case, having access to a utility's hosting capacity map would be useful to identify those locations with available capacity to cite a DCFC. Both Eversource and Unitil currently provide hosting capacity information for its Massachusetts service territories; while hosting capacity does not guarantee interconnection, identifying areas of available capacity that can be provided by

a hosting capacity map, that is updated regularly, can guide deployment of EV infrastructure, notably DCFC, to areas that will not negatively impact utility reliability or service, which will be a benefit to customers and the utility.

In addition to the impacts that this equipment can have on a system, these policies will also have an effect on adoption. If the tariffs include burdensome requirements or otherwise act as a barrier to adoption, then there will be a delay in customers installing charging equipment and purchasing EVs. This may also negatively impact the ability of New Hampshire to attract tourists who may prioritize locations with available charging infrastructure and policies to support development of EV charging infrastructure. This means understanding not only how adoption of EVs will impact the electric system and being able to forecast the adoption rate of EVs, but also how the technology can be used to respond to prices or other programs and services.

Q. How does EV policy impact the Electric Vehicle Supply Equipment (EVSE)?

A. The EVSE is likely the main point of engagement between the customer and the grid, so the EVSE will need to be able to communicate information to the customer about the cost to charge, length of time to charge, and, potentially, other signals to better manage the charging of the vehicle. However, for DCFC, it is unlikely that usage will be elastic as the role of the DCFC is different than a Level 2 charger. Notably, the use of a DCFC means that the customer needs a fast charge in order to get home or continue on their trip; in other words, the DCFC most needs to provide customers with a charge in under 20 minutes. A Level 2 charger, on the other hand, will take several hours to completely charge a customer's battery. In this case, demand is more elastic and can be responsive to price or

grid signal needs or managed by a third party. Level 2 EVSEs for fleets or public or workplace charging where a customer may be connected to the equipment for several hours would likely fit into this category. As such, understanding how rate design impacts adoption and utilization of the type of charger being installed and the application is important. A time of use rate may be the most optimal way for a utility to recover its costs and send a price signal that reflects the marginal cost to serve at that location, while not focusing on the demand, which is ill-suited for low-utilization DCFC at this time.[8] However, due to its demand being inelastic, and with few DCFCs currently in New Hampshire, it may not be appropriate for DCFCs to be on a time of use rate.

IV. RATE DESIGN

Q. Please describe the set of principles that cover rate design.

A. It is important to ensure that any rate design offerings are done in accordance with a set of goals and principles. Generally speaking, commissions around the country tend to rely upon the rate design principles first detailed by Professor Bonbright in 1961.[9] These principles are fairly broad and require the regulator to make some tradeoffs. For example, one principle addresses rate stability but another addresses cost causation, that is, the person who caused the cost should pay for it. Clearly, the principles may conflict, which is why it is important to balance the principles.

[8] "EVGo Fleet and Tariff Analysis: Phase 1 California," Rocky Mountain Institute at 21 (April 2017), (RMI Report), https://rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf.

[9] James C. Bonbright, "Principles of Public Utility Rates" (New York: Columbia University Press, 1961). *See also*, "Distributed Energy Resources Rate Design and Compensation: A Manual Prepared by the NARUC Staff Subcommittee on Rate Design," NARUC at 20-21 (November 2016), (NARUC Manual), https://pubs.naruc.org/pub/19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0.

While cost causation is an important component of rate design, it is not the only one, and is often balanced against other principles such as fairness and equity. For example, with average cost ratemaking, one customer class, say the residential class, will pay the same for electricity regardless of the actual cost to serve each individual customer. In this case, this leads to intraclass subsidies to ensure certain public goals—affordability and accessibility. For EV rate design, other public purposes are also important, in addition to cost causation.

Similarly, rigidly applying the cost causation principle to EV rate design may not strike the right balance between conflicting regulatory principles. In order to achieve public policy priority of increased EV adoption, the Commission should consider other rate-making principles, such as "diffusion of benefits." That is to say, increased EV adoption will benefit the community as a whole, and as such at this early phase in the adoption of EVs, charging infrastructure need not be held strictly to cost causation.

As I discussed above, making EV adoption a policy priority for New Hampshire would mean that the Commission can balance the rate design principles in ways that better align with the societal and policy goals. In essence, with EV adoption as a goal of the state, other rate design principles, like supporting public policy or conservation, may be weighted more favorably than other principles, like cost causation, in order to support the policy goal. So, the Commission can decide that for some period of time, developing rates that will promote EV adoption should be prioritized over other rate design principles. This also applies to goals for revenue neutrality in rates—that is, that rates should recover the costs and not be recovered by other rate classes. Much like how residential rates subsidize those customers

with higher costs to serve (*i.e.*, rural customers), and lower cost to service customers (*i.e.*, city customers) pay more than their cost to service; this cross-subsidy is done on purpose in order to promote equity, affordability, and access to electricity.[10]

Cost causation is an important principle that commissions, including this Commission, point to regarding the development of any particular rate or program. However, it is important to note that while cost causation is an important principle, it is often relegated below other principles as a commission sees fit, such as for residential rates. In the development of appropriate rates, a commission may request or require the utility to submit a class cost of service study, which attempts to identify which customer class is responsible for some percentage of a utility's revenue requirement. The ultimate determination of that responsibility is litigated before state commissions, so any rate that is ultimately adopted by a commission includes a balancing and weighting of principles by the commission itself. This also is apparent when looking at the rates inside each class. For the residential class, all customers inside the class usually pay the same price for electricity, regardless of the actual costs to serve. So, a residential customer who lives in an apartment, or lives in a house in the suburbs, or lives in a rural area will all pay the same price for electricity. In this instance, the regulator has decided that affordability or equity is more important that strictly sticking to cost causation as the main principle. To be sure, some states may have variations to this model; for example, in Xcel Energy's territory in Minnesota, customers who live in areas with undergrounded distribution lines pay a higher customer charge.[11]

[10] NARUC Manual at 107-108.

[11] Northern States Power Company, Residential Service, Rate Code A03, Section No. 5, 31st Revised Sheet No. 1, https://www.xcelenergy.com/staticfiles/xe-responsive/Archive/Me_Section_5.pdf.

Q. Can you describe the role and purpose of time of use rates?

A. Time of use rates are a rate that endeavors to provide a price signal that is more aligned with the costs to serve a customer at that time. So, during higher cost hours, such as a hot summer afternoon, the cost of electricity is likely to be higher as demand increases; a time of use rate would have an afternoon price that reflected these higher prices and when prices are low, typically in overnight hours, the price would be low to reflect these costs. Time of use rates can be used to encourage customers to shift consumption to lower cost hours, which would make the system more efficient and increase load factors. The rates and schedules for a time of use tariff are pre-determined and approved by the regulator.[12]

Time of use rates are typically implemented by a jurisdiction to provide a price signal to customers to shift consumption away from peak periods and into lower cost periods. It is possible that a time of use rate is all that is needed for integration of EV charging into the utility systems as the site host (or its charging manager or aggregator) can then optimize the operations of the EVSEs with the price signal. A customer could then set its vehicles' telematics system or the EVSE to charge below a certain price or set a time for when the vehicle needs to be at a certain charging level and allow the car or EVSE to manage the charging rate.

Q. Please provide your perspective on Unitil's time of use proposal.

A. Unitil's time of use rate is a three-part rate, with off-peak, mid-peak, and on-peak time periods. The on-peak time period is from 3:00 PM to 8:00 PM, Monday through Friday,

[12] NARUC Manual at 26.

except holidays, while the off-peak period is from 8:00 PM through 6:00 AM, Monday through Friday and all-day weekends and holidays. These time periods apply to each of the proposed EV rate design tariffs.

I think it is still important for the rate design to provide customers with a price signal to encourage charging in lower cost hours, or, if charging occurs during peak hours, that the utility be allowed to recover its marginal costs via the volumetric rate (as opposed to through a demand charge, as discussed later). I do think, on the other hand, the Commission may want to consider how the various use cases I identified above may respond to a time of use rate and it may be appropriate to develop use case specific rate designs with different attributes and prices. For example, for DCFCs, which are less elastic than other use cases, an alternative to a time of use rate may be more appropriate. As a public policy priority, the Commission should consider DCFCs differently than the other use cases that make use of Level 2 charging infrastructure. DCFCs provide an important piece of the EV adoption puzzle and rate designs that make the installation of DCFCs harder will delay adoption of EVs. I recommend that Unitil's rate design not apply to DCFCs until higher utilization rates are realized by these locations, consistent with the discussion on demand charges.

Q. To what extent do demand charges impact rate design principles?

A. Demand charges can play a significant role in delaying EV infrastructure roll-out especially at low utilization rates, as New Hampshire is currently experiencing. EV charging can result in substantial demand when the EVSE is in use, which can trigger high demand charges. However, if a public charger is used only occasionally it will not generate enough

volumetric sales to pay for the high demand charge. As such, demand charges can be crippling to the economics of public EV charging.

Both Unitil and Liberty propose a non-coincident peak demand charge for commercial and industrial customers - in other words, the demand charge is based upon the individual customer's peak regardless of when it occurred, rather than the greatest amount of demand during the system peak - but with slight differences. Liberty's proposal is a fixed non-coincident peak demand charge that applies to the highest kW usage in a given month while Unitil proposes to introduce a non-coincident peak demand charge over four years. Arguably, this is to recover the distribution costs associated with serving that location regardless of when that customer's peak occurs. In an effort to align its rate design with the principle of cost causation, Liberty and Unitil apply a demand charge to its commercial and industrial tariffs; however, demand charges do not promote EV adoption.[13]

From a rate design perspective, demand charges create three main problems:

1) At low utilization rates, a location charged a demand charge for EV charging, especially for DCFC, may see their bill rise substantially. In an analysis done by RMI for EVGo looking at their locations in California, RMI determined that in some locations site hosts could incur a bill up to $3,114 a month with 94% of that bill due to demand charges.[14] As further detailed by RMI, under the different proposals by the California utilities, those rate designs that included demand charges would continue to be a significant component of the site hosts' bills. Even at 15%

[13] RMI Report at 20-21.
[14] RMI Report at 16-17.

utilization, RMI estimates that locations could see 70% to 88% of their bill be attributable to the demand charge.[15]

What this research shows is that as utilization rates go up, the impacts of the demand charge are reduced, but that even at 15% utilization, it remains a substantial part of the bill for that location.

2) A non-coincident demand charge is not related to system use, so charging a demand charge to a peak that occurs in off-peak hours sends a poor price signal to customers. As the NARUC Manual notes, a non-coincident peak demand charge occurs regardless of when that peak occurs and may act more as a fixed charge than an effort to send a price signal.[16] In other words, a non-coincident peak demand charge is being used to collect the fixed costs of serving that customer rather than sending a price signal around time of use, which would be more of a reflection of system availability. Since a locations peak could occur during the middle of the night when overall system demand is low, this would be a more optimal time to charge, and a time of use rate would encourage charging during these hours; however, a non-coincident peak demand charge would also penalize these locations from doing what the rate design encouraged them to do.

3) A utility may note that a non-coincident demand charge is there to recover the utility's fixed costs to serve. This, however, is focused on short-term marginal costs and ignores long-term marginal costs, where more of the utility's costs are variable.[17] Of course, a

[15] *Id.*
[16] NARUC Manual at 108.
[17] NARUC Manual at 22.

higher fixed charge may also result in a lower volumetric rate, which dilutes the price signal to shift consumption or increase consumption since a customer cannot avoid a fixed charge.[18]

All of this is to say that at low utilization factors, demand charges act as a penalty for installing EV charging infrastructure, especially DCFC, when the state should be trying to encourage deployment of EV charging infrastructure, including DCFC.

Q. How are the utilities in this proceeding addressing the use of demand charges?

A. Each utility understands that demand charges at this time do not support the growth of EV charging infrastructure—and also recognized by the Commission in Order No. 26,394—since both Liberty and Unitil propose reduced demand charges in their applications. Eversource proposes a residential TOU rate and a managed charging program, but not a demand charge, at least in this proceeding. Understanding that demand charges pose a barrier, Liberty's proposal reduces the demand charge by 90% compared to the otherwise applicable General Services rate for a commercial or industrial customer to $1.12/kW, but does not propose a time of use rate.[19] Unitil, which includes a time of use rate, proposes a sliding scale for its demand charge proposal whereby over three years the demand charge would be reduced by 75% to start in year 1 and then each year thereafter, the reduction would be decreased by 25% each year (i.e., in year 2, the demand charge would be reduced

[18] *Id.* at 118.
[19] Liberty Testimony at 4, lines 10-11; Attachment HT/MS-1

by 50% and in year three, the demand charge would be reduced by 25%) until, in year 4, the customer would be charged its full demand charge under its proposed EV rate.[20]

Q. Would these proposals address your concerns about the use of demand charges?

A. No. In both cases, simply reducing the demand charge does not result in an equitable rate nor will it reduce the barrier to installing EV charging infrastructure. Starting with Unitil, its three-year ratchet is entirely arbitrary and not aligned with any forecast or expectation of EV growth in its territory. There is no rush to implement a demand charge at this time especially absent more accurate forecasting based on actual utilization of EV charging infrastructure. Indeed, in its Massachusetts territory, Unitil proposed an EV rate design with a demand charge based on four tranches of load factors (*i.e.*, utilization rates), and would be in place over 10 years.[21] From 0-5% of load factor, the customer would not have a demand charge; from 5-10% load factor, the demand charge would be reduced by 75%; from 10-15% load factor, the demand charge would be reduced by 50%; above 15% load factor, then the full demand charge would apply. However, as noted from the RMI Report, even at 15% utilization, that could still be up to 70% of the bill at a given location. The Massachusetts "demand charge holiday" proposal would be more in line with examples from around the country, notably Southern California Edison Company, which has a $0 demand charge for the first 5 years, ending in 2023, then scaled up over the next 5 years

[20] Unitil Testimony (Carroll, Simpson, and Valianti) at 19, lines 8-9.
[21] Unitil Response to Staff 2-6, Attachment 1.

that was developed for commercial and industrial customers to support the growth of EV and EV charging infrastructure in its service territory.[22]

For Liberty, they took their otherwise applicable tariff, and reset their billing determinants to an equally arbitrary rate. Liberty provided no justification for keeping any demand charge at all, nor for reducing its demand charge by 90%. Furthermore, Liberty does not propose a time of use rate for commercial and industrial customers, which would provide a better price signal than a demand charge. The lack of time of use rate for commercial and industrial customers means that there is no price signal being sent to customers about when to charge.

Having a demand charge tied closer to utilization rates is important because at some point in the future, at a certain utilization factor, it may be appropriate to start implementing demand charges for EV charging infrastructure. This also preserves the business case for installing EV charging infrastructure at low utilization rates and low EV adoption levels, but as more EVs come onto the road, it also ensures that other ratepayers are not unduly paying for the costs of the EV charging infrastructure.

Q. To what should the imposition of a demand charge be tied?

A. Again, at some point in the future, the establishment of a demand charge may be warranted. In a separate study looking at Colorado-specific DCFC rate design options, RMI suggests

[2222] Southern California Edison Schedules TOU-EV-8 and 9, https://library.sce.com/content/dam/sce-doclib/public/regulatory/tariff/electric/schedules/general-service-&-industrial-rates/ELECTRIC_SCHEDULES_TOU-EV-8.pdf; https://library.sce.com/content/dam/sce-doclib/public/regulatory/tariff/electric/schedules/general-service-&-industrial-rates/ELECTRIC_SCHEDULES_TOU-EV-9.pdf.

that 30% utilization factor provides a sufficient amount of usage for the site host to spread the demand charges across.[23] In my opinion, that seems a reasonable threshold for the Commission to set for when full demand charges could be implemented for EV charging infrastructure under an EV-specific rate.

Q. How else can EV rate design be improved in New Hampshire?

A. Another issue with the proposals of the three utilities is that each of the utilities take three different ways to address rate design and EV charging needs. The Commission should consider adopting a statewide approach where all three utilities start at the same place—begin with a time of use rate with no demand charges—then monitor adoption of EVs across the state and the respective service territories so that any modification to the rate design can be done when utilization rates of fast chargers are at a level where a demand charge will not act as a barrier. Treating adoption of EVs as a policy goal of the state means that the Commission should also consider how best to encourage EV adoption. Having consistency in rate design across the state would be one way to support adoption by minimizing differences in charging experiences across the state.

Additionally, the Commission should consider adopting reporting requirements for each utility to collect information about EV adoption, develop forecasts for EVs, and collect utilization rates for DCFC across its service territory. Collecting this information will inform the utilities, the Commission, and stakeholders about trends and can help identify

[23] DCFC Rate Design Study for Colorado Energy Office, Rocky Mountain Institute at 5 (September 2019), https://rmi.org/wp-content/uploads/2019/09/DCFC_Rate_Design_Study.pdf.

when it is time to transition to an alternate rate design, including imposition of demand charges.

V. PERSPECTIVE ON EVERSOURCE'S TIME OF USE PROPOSAL

Q. What is Eversource's time of use proposal in this docket?

A. Eversource makes two proposals in this docket. It proposes a residential time of use rate, but requests that the Commission reject its time of use proposal and, instead, adopt its EV managed charging proposal. Eversource's position is that it would be too expensive to implement a time of use rate for its territory since it does not have advanced metering infrastructure rolled out. As such, without adequate metering, Eversource would incur significant metering and back-office costs in order to provide interval metering to measure consumption of the EV on the EV time of use rate.

Q. What are your concerns with Eversource's proposal?

A. First, I generally support Eversource's time of use proposal, with one caveat. Eversource proposes an exceptionally long mid-peak price that lasts from 7 AM to 2 PM and 7 PM to 11 PM every weekday and from 7 AM to 11 PM on weekends. While Eversource says these are aligned with marginal costs, as I described above, at low adoption rates, the Commission can certainly create a rate that balances other rate design principles, such as supporting EVs as a matter of policy. While I would generally agree that rates should be based on marginal costs, in this case, it results in a sub-optimal time of use rate proposal especially considering that the Commission should be lowering barriers to EV adoption. I would recommend that the Commission adopt the structure of Eversource's rate design,

but reduce the mid-peak time period to 7 PM to 9 PM on weekdays, and make all weekends and holidays be off-peak. Of note, Unitil's time of use rate is more beneficial to residential customers, with an off-peak rate lasting from 8:00 PM to 6:00 AM weekdays and all weekends and holidays. This is an example of how the lack of consistency between utility proposals could, instead, act as a barrier to EV adoption as a customer who is driving across service territories has to figure out which rate from which utility is more beneficial. If each utility implemented a time of use rate with similar program design, then customer confusion would be reduced, and market entrants could standardize rate information.

Q. What are your other views on Eversource's proposal?

A. While Eversource proposes a time of use rate, it, instead, recommends the Commission not adopt its time of use proposal and adopt its managed charging proposal. I do not support Eversource's proposal to rely upon a managed charging program rather than a time of use rate. A managed charging program should be treated by the Commission more like a competitive service offering rather than as the default option for Eversource's customers. In other words, if the Commission were to approve Eversource's proposal, then Eversource would have a competitive advantage against other providers. The Commission should first and foremost rely on rate design options as the means to promote EV adoption across the state. To the extent the utility and any other providers then want to offer managed charging services on top of that retail rate, then let them compete. However, by limiting customer options only to the utility managed charging program, the Commission loses the rate design option, which may be more than sufficient to integrate EVs, especially for residential customers, and to encourage charging off-peak. Then, if the customer seeks to engage in

a managed charging program or another demand response program, especially after implementation of FERC Order 2222, then the customer can be responsive to a retail rate, but also be part of any other product that directly participates in the wholesale market.

Q. Eversource notes that Automated Meter Reading (AMR) meters are not capable of collecting interval data. Do you agree?

A. No, I do not agree. In response to DOE 4-005, Eversource Witness Moore states that that "The Bridge meter is AMI capable but currently operates in AMR mode. It has the interval data capabilities needed to offer TOU rates but requires an active AMI network and a meter reading and billing system that is capable of processing the interval data.

AMR meters do not have the internal interval data capabilities to allow for creation of a TOU rate."[24]

Fundamentally, an AMR meter can communicate via several channels depending upon the network architecture in place by the utility. In other words, a utility does not need an AMI system for an AMR meter to communicate with the utility more frequently than once a month. Additionally, an AMR meter is perfectly capable of collecting and storing interval data. In fact, this capability has been available in AMR meters for decades. For example, in a presentation prepared by DTE Energy, dated June 29, 2006, it identified "Access to interval meter data (as frequent as every 5 minutes)" as a benefit of an AMR system using a fixed RF AMR system.[25] Now, it may be true that Eversource does not have the

[24] Eversource Response to DOE 4-005.

[25] AMR – Automated Meter Reading Overview, 21st Century Energy Plan Discussion Forum, DTE Energy at 28 (June 29, 2006), http://origin-sl.michigan.gov/documents/mpsc/dteamrjun29_2006_16_578591_7.pdf.

communications capability, but it is also true that an AMR meter can collect interval data and store it and communicate that information back to the utility. Furthermore, Eversource has an existing time of day residential rate design that is presumably metered by some non-AMI metering infrastructure.

I would also suggest that Eversource could use this opportunity to gain greater experience with using the EVSE to gather information about EV usage rather than requiring a separate meter to be installed by the customer.

Q. What is your opinion on Eversource stating it will cost $9 million to offer a time of use rate?

A. It is important to differentiate between two issues- metering and generating a bill. Eversource currently offers an interval meter for customers on their existing time of use rate tariff, but the rate is a 2-part rate (peak and off-peak) whereas the EV rate will have 3 components.[26] While it would be beneficial to have the meter be able to track changes in billing periods, it is not necessary as the billing system could be used to do the math based on the tariff. In other words, the meter would collect the interval usage over the course of the day, then the billing system would multiply the usage for each given hour by the time of use rate for that hour to determine the customer's bill. If Eversource's interval metering solution for its residential time of use rate does not work with the Itron system installed by Eversource, this is not an EV implementation issue, this is an Eversource business issue, and EV customers should not be penalized for Eversource's technological problems.

[26] Joint Testimony of Moore, Rice, and Goldman at 7, lines 14-15.

This also calls into question the interoperability of Eversource's metering solutions if Eversource is installing meters that are not interoperable with other components of its business, including its metering communication infrastructure and its billing system. Backwards compatibility, which is the "ability of new technology operating under a new version of a program to work with an older version of the program without loss of data or communication," is an important component of any company's interoperability plan, so if Eversource has a communications network that is not backwards compatible, then the company should have to pay for this fix, not customers.[27]

VI. RECOMMENDATIONS

Q. Please provide your recommendations for the EV proposals.

A. For Liberty, my recommendations are the following:

1. Reject Liberty's demand charge implementation proposal and require it to modify its demand charge proposal in line with my general recommendations, below, regarding demand charges;
2. Require Liberty to submit a time of use rate for commercial and industrial customers, consistent with the Commission's prior orders, and to provide price signals to customers to help them better manage their EVSEs and costs.

For Unitil, my recommendations are the following:

1. Approve Unitil's time of use rate proposal, except for DCFC applications;

[27] "Smart Grid Interoperability: Prompts for State Regulators to Engage Utilities," NARUC at 2 (April 2020), https://pubs.naruc.org/pub/28950636-155D-0A36-313C-73CCEA2D32C1.

2. Reject Unitil's demand charge implementation proposal and require it to modify its demand charge proposal in line with my general recommendations, below, regarding demand charges.

For Eversource:

1. Approve Eversource's time of use rate as modified in my testimony;
2. Reject Eversource's managed charging program;
3. Require Eversource to pay for metering upgrade costs.

More generally, I also recommend that

1. The Commission issue an order stating that no demand charges should be applied to EV charging for at least 10 years or upon DCFC reaching a utilization factor of 30% across their service territories;
2. Utilities should monitor EV adoption rates across their service territories to help inform trends and identify timelines for rate design modifications;
3. Monitor utilization rates of DCFC in their service territories to help inform trends and identify timelines for rate design modifications; and
4. Utilities should make available hosting capacity maps that can help inform developers and customers identify optimal locations for the placing of EV charging infrastructure, especially DCFC.

Q. Do you have any other rate design recommendations?

A. Yes. I think the Commission should consider more specific rate design options by use case. For example, demand charges affect DCFC more than commercial or public Level 2 charging, so utilities could propose a DCFC-specific rate, a fleet-specific rate, or a public charging-specific rate. Since adoption of EVs is still fairly low in New Hampshire, these use case-specific rates may not be needed immediately, but by looking at the different use cases and applications of EVs, their impacts on utility operations will be different, as I explained previously.

Q. Does that complete your testimony?

A. Yes.

CHRISTOPHER R. VILLARREAL

9492 Olympia Drive, Eden Prairie, MN 55347 *(415) 680-4224*
email: chris@pluggedinstrategies.com

EMPLOYMENT

NON-RESIDENT (ENERGY AND ENVIRONMENTAL POLICY) ASSOCIATE FELLOW — SEPTEMBER 2019-CURRENT
R Street Institute — *Washington, D.C.*

- Provide regulatory and policy support on topics including performance-based ratemaking, development of rules for integrated resource planning, distributed energy resources, and market-oriented solutions for customer choice and development of clean energy resources.
- Develop written materials summarizing regulatory actions on topics related to performance-based ratemaking, customer choice, distribution system planning, distributed energy resources, and other topics as needed.
- Participate in state and federal regulatory proceedings and working groups on development of performance-based ratemaking mechanisms, net energy metering, and integrated resource planning, including the review of utility proposals, participating in working groups to review and recommend metrics for performance-based ratemaking frameworks, and providing comments to state regulatory commissions on performance-based ratemaking metrics and frameworks.

PRESIDENT — APRIL 2017-CURRENT
Plugged In Strategies — *Eden Prairie, MN*

- Provide regulatory and policy analysis and consulting services related to evolution of electricity grid, distribution system planning, emerging customer and grid-connected technologies, and regulatory strategies
- Provide facilitation and moderation services for groups, workshops, and working groups
- Provide research and analysis services regarding utility and regulatory matters and structures
- Provide additional expert analysis on matters affecting electricity and regulatory structures, including topics such as data privacy, data access, rate design, interoperability, advanced technologies, performance-based ratemaking, and convergence of technology, industries, and markets.
- Provide expert testimony and presentations before state utility commissions on topics including distribution system planning, distributed energy resources, data privacy and data access, performance-based ratemaking, and grid modernization.
- Prepare training materials on distributed energy resources, interoperability, and grid modernization for international regulatory and policy decision-makers.

DIRECTOR OF POLICY — MAY 2015- APRIL 2017
Minnesota Public Utilities Commission — *Saint Paul, MN*

- Maintained high profile inside and outside the state representing the Commission on electricity matters.
- Assisted Commissioners with policy analysis to support decision-making options.
- Provided policy analysis to support development of record in proceedings.
- Provided subject matter expertise on specific topics, including rate design, energy storage, grid modernization, data privacy, data access, interconnection, and security.
- Organized workshops, including preparing agendas, inviting speakers, and moderating public panels.
- Engaged and interact with several national organizations, including National Association of Regulatory Utility Commissioners, Department of Energy, Federal Energy Regulatory Commission, National Institute of Standards and Technologies, North American Energy Standards Board, and Smart Grid Consumer Collaborative.
- Regularly spoke and participated in panels, conference, webinars, and other international, national, and state conferences on behalf of the Minnesota Public Utilities Commission.
- Engaged and worked with several state-level projects, including e21 Initiative and 2025 Energy Action Plan
- Participated in actions related to Midcontinent Independent System Operator product development, including demand response and energy storage.
- Chaired NARUC Staff Subcommittee on Rate Design, and managed development of Distributed Energy

Resources Rate Design and Compensation manual, which included meeting specific deadlines, organize and manage a group of seven staff from around the country to develop, draft, and finalize manual on time.
- Maintained an awareness and understanding of electricity policy developments across the country, including at national and state level; provide an analysis of these developments for Commissioners.

SENIOR REGULATORY ANALYST — MARCH 2006- APRIL 2015
California Public Utilities Commission — *San Francisco, CA*

Major Accomplishments:
- Staff lead on Commission Smart Grid rulemaking: responsible for coordinating Staff work on rulemaking, working with ALJ and Assigned Commissioner's Office, organizing and facilitating workshops on a number of Smart Grid-related topics, including cybersecurity, privacy, customer data access and other customer issues, and ensuring proceeding met legislatively mandated time-frame.
- Prepared initial Orders Instituting Rulemaking on energy storage, rate design reform, and Smart Grid, and assisted in completion of final Commission decisions on Smart Grid, rate design, customer access to data, and privacy.
- Named as a Top 50 Smart Grid Pioneers for 2013 by Smart Grid Today.

- Managed and facilitated Commission workshops on emerging topics, such as privacy, cybersecurity, energy storage, and customer data access.
- Provided lead and support analysis on many electricity issues affecting customers, market participants, and utilities, including dynamic pricing, demand response, energy efficiency, rate design, electric energy storage, direct access and retail/wholesale integration.
- Responsible for monitoring activities, preparing analyses of policies, and preparing and submitting comments related to specific subject areas before FERC, U.S. Congress, California State Legislature, CEC, DOE, NIST, and Office of Science and Technology Policy.
- Participated in standard making process, and prepared and submitted comments to FERC, NIST, and NAESB.
- Chair of NAESB Energy Services Provider Interface Task Force, and a member of NAESB Executive Committee.
- Lead author and contributor on White Papers related to several emerging topics, such as Pre-Pay, cybersecurity, and microgrids.
- Presented at conferences on updates and summaries of Commission position on Smart Grid issues, such as customer education, privacy, cybersecurity, customer access to usage, rate design and tariffs, and general regulatory policy.

PARALEGAL — NOVEMBER 2005-FEBRUARY 2006
Patton Boggs — *Washington, D.C.*

- Performed research at FERC, other Federal agencies, Congressional legislative history, and various state agencies.
- Cite-check, proofread, and shepardize pleadings filed at FERC and various U.S. Courts of Appeals.
- Organized and maintained discovery files.

PARALEGAL — JULY 2004- OCTOBER 2005
McCarthy, Sweeney & Harkaway — *Washington, D.C.*

- Performed research for FERC, other Federal agencies, U.S. Congress, state legislatures and state regulatory agencies.
- Obtained and summarized pleadings filed at FERC and courts for clients and attorneys.
- Performed energy-related research (*e.g.*, monitor Energy news, obtain FERC and U.S. Court cases and opinions) and maintained extensive knowledge of many energy issues (*e.g.*, RTOs, deregulation/competition, and California/Pacific Northwest refund proceedings at FERC and U.S. Courts).
- Prepared testimony and discovery-related materials for hearing before FERC Administrative Law Judge, and provided proofreading, cite-checking, and shepardizing assistance for documents filed at FERC, U.S.

Supreme Court, U.S. Court of Appeals and U.S. District Courts.
- Prepared briefs and appendices, and maintained and organized case files for proceedings before FERC and U.S. Court of Appeals.
- Monitored energy-related legislation and hearings before U.S. Congress and state legislatures, as well as energy-related activities at state PUC levels (*e.g.*, electric competition/deregulation activities).

PARALEGAL — MARCH 2003- JUNE 2004
Duane Morris, LLP — *Washington, D.C.*

- Performed research at FERC and other Federal agencies. Monitored FERC meetings and prepared summaries of meeting for attorneys and clients.
- Obtained and summarized pleadings filed at FERC and courts for clients and attorneys.
- Performed energy-related research (*e.g.*, monitor Energy news, obtain FERC and U.S. Court cases and opinions) and maintained knowledge base on many energy issues (*e.g.*, RTOs, deregulation/competition, and California/Pacific Northwest refund proceedings at FERC and U.S. Courts).
- Prepared testimony and discovery-related materials for hearing before FERC Administrative Law Judge, and provided proofreading, cite-checking, and shepardizing assistance for documents filed at FERC, U.S. Supreme Court, U.S. Court of Appeals, and U.S. District Courts.
- Monitored energy-related legislation and hearings before U.S. Congress and state legislatures, as well as energy-related activities at state PUC levels (*e.g.*, electric competition/deregulation activities).

LEGAL ASSISTANT — APRIL 2001-MARCH 2003
McGuireWoods LLP — *Washington, D.C.*

- Performed research at FERC and other Federal agencies. Monitored FERC meetings and prepared summaries of meeting for attorneys and clients.
- Performed energy-related research (*e.g.*, monitor energy news, obtain FERC and U.S. Court cases and opinions) and responsible for monitoring energy issues for attorneys (*e.g.*, RTOs, deregulation/competition, generation interconnection, and California/Pacific Northwest refund proceedings at FERC and U.S. Courts).
- Prepared testimony and discovery-related materials for hearing before FERC Administrative Law Judge, and provided proofreading, cite-checking, and shepardizing assistance for documents filed at FERC, U.S. Supreme Court, U.S. Court of Appeals for D.C. Circuit and 9th Circuit, and U.S. District Court for D.C.
- Monitored energy-related legislation and hearings before U.S. Congress and state legislatures, as well as energy-related activities at state PUC levels (*e.g.*, electric competition/deregulation activities).

ENERGY SPECIALIST — MARCH 1998- APRIL 2001
Verner, Liipfert, Bernhard, McPherson, & Hand — *Washington, D.C.*

- Performed research at FERC, SEC, Library of Congress, U.S. Congress, NRC, Department of Interior, National Archives, EPA, U.S. Supreme Court, U.S. Court of Appeals for D.C. Circuit, U.S. District Court for D.C., and other state agencies.
- Performed and monitored energy and environmental-related research.
- Made filings at FERC, U.S. Court of Appeals for D.C. Circuit, U.S. District Court for D.C., and SEC.
- Provided proofreading assistance, including cite-checking and shepardizing of documents.
- Attended U.S. Congress hearings on Energy issues and summarized for attorneys.
- Organized and maintained Energy Group library and trade press.
- Supervised Energy Group Summer intern.

EDUCATION

BACHELOR OF ARTS IN HISTORY — 1993-1997
Baylor University — Waco, Texas

ASSOCIATIONS

- Board of Directors, Minnesota Conservative Energy Forum
- Board of Directors, Minnesota Solar Energy Industries Association
- Associate Member, GridWise Architecture Committee
- Planning Commission, City of Eden Prairie, MN (2017-2020)
- Board of Directors, Emeritus, North American Energy Standard Board
- Executive Committee, Emeritus, Retail Markets Quadrant, North American Energy Standards Board
- Board of Directors, Emeritus, Smart Grid Consumer Collaborative
- Chair, Staff Subcommittee on Rate Design, National Association of Regulatory Utility Commissioners (November 2015-April 2017)
- Co-Chair, Business and Policy Domain Expert Working Group, Smart Grid Interoperability Panel (2014-2016)

PUBLICATIONS

- *Investigating Interoperability for Electric Vehicles: A Case Study from Connecticut*, National Association of Regulatory Utility Commissioners, on behalf of the Connecticut Public Utilities Regulatory Authority (October 2021)
  http://www.dpuc.state.ct.us/2nddockcurr.nsf/4b3c728dd1c0d642852586db0069aa70/4bbe0455899099228525876400 5afb5e/$FILE/NARUC%20CT%20Case%20Study%20on%20EV%20Interoperability-submission.pdf

- *AMI in Review: A Lens into an Unfolding Future*, T&D World (March 5, 2021)
  https://www.tdworld.com/smart-utility/metering/article/21157103/ami-in-review-a-lens-into-an-unfolding-future

- *Enabling and Benefiting from Distributed Energy Resources in Texas*, R Street Policy Study No. 211, R Street Institute (November 2020)
  https://www.rstreet.org/wp-content/uploads/2020/11/Final-No-211-DERs.pdf

- *Net Metering and Distributed Energy Resources Policy: R Street Shorts No. 93*, R Street Institute (August 2020)
  https://www.rstreet.org/wp-content/uploads/2020/08/Short-No.-93-Net-Metering.pdf

- *AMI in Review: Informing the Conversation*, U.S. Department of Energy, Advanced Grid Research (July 2020)
  https://smartgrid.gov/files/documents/AMI_Report_7_8_20_final_compressed.pdf

- *Smart Grid Interoperability: Prompts for State Regulators to Engage Utilities*, National Association of Regulatory Utility Commissioners (April 2020).
  https://pubs.naruc.org/pub/28950636-155D-0A36-313C-73CCEA2D32C1

- *Framework and Roadmap for Smart Grid Interoperability Standards Regional Roundtables Summary Report*, NISTIR 8284, National Institute of Standards and Technology, *et al.* (February 2020).
  https://doi.org/10.6028/NIST.IR.8284

- *Distributed Energy Resources Rate Design and Compensation Manual*, National Association of Regulatory Utility Commissioners, Staff Subcommittee on Rate Design (November 10, 2016). http://pubs.naruc.org/pub/19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0

- *Microgrids: A Regulatory Perspective*, California Public Utilities Commission, Policy and Planning Division (April 14, 2014). http://www.cpuc.ca.gov/NR/rdonlyres/01ECA296-5E7F-4C23-8570-1EFF2DC0F278/0/PPDMicrogridPaper414.pdf

- *Utility Investment Valuation Strategies: A Case for Adopting Real Options Valuation*, California Public Utilities Commission, Policy and Planning Division (October 3, 2013). http://www.cpuc.ca.gov/NR/rdonlyres/D5C63A2B-40F2-468D-964A-F265B90346B1/0/Final2RRM.pdf

- *Cybersecurity and the Evolving Role of State Regulation: How it Impacts the California Public Utilities Commission*, California Public Utilities Commission, Grid Planning and Reliability/Policy and Planning Division Policy Paper (September 19, 2012). http://www.cpuc.ca.gov/NR/rdonlyres/D77BA276-E88A-4C82-AFD2-FC3D3C76A9FC/0/TheEvolvingRoleofStateRegulationinCybersecurity9252012FINAL.pdf

- *A Review of Pre-Pay Programs for Electricity Service*, California Public Utilities Commission, Policy and Planning Division Policy Paper (July 26, 2012). http://www.cpuc.ca.gov/NR/rdonlyres/152ED1D4-DD85-4D6F-984B-B84847933A18/0/Prepaypolicypaper0712.pdf

- *Electric Energy Storage: An Assessment of Potential Barriers and Opportunities*, California Public Utilities Commission, Policy and Planning Division (July 9, 2010). http://www.cpuc.ca.gov/NR/rdonlyres/71859AF5-2D26-4262-BF52-62DE85C0E942/0/CPUCStorageWhitePaper7910.pdf

TESTIMONY

- *In the matter of the application of Consumers Energy Company for authority to increase its rates for the generation and distribution*, Direct Testimony of Christopher Villarreal on Behalf of Michigan Environmental Council, Natural Resources Defense Council, and Sierra Club, before the Michigan Public Service Commission, Case No. U-20134 (September 10, 2018) https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t0000002ftVkAAI

- *In the matter of the application of DTE ELECTRIC COMPANY for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority*, Direct Testimony of Christopher Villarreal on Behalf of Michigan Environmental Council, Natural Resources Defense Council, and Sierra Club, before the Michigan Public Service Commission, Case No. U-20162 (November 7, 2018) https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000329ckAAA

- *Application of Duke Energy Carolinas, LLC for Adjustments in Electric Rate Schedules and Tariffs and Request for an Accounting Order*, Direct Testimony of Christopher Villarreal on Behalf of South Carolina Solar Business Alliance, before the Public Service Commission of South Carolina, Docket No. 2018-319-E (February 26, 2019) https://dms.psc.sc.gov/Attachments/Matter/499c7e9c-65b6-4469-afbd-9d7614711b84

- *Application of Duke Energy Progress, LLC for Adjustments in Electric Rate Schedules and Tariffs and Request for an Accounting Order*, Direct Testimony of Christopher Villarreal on Behalf of South Carolina Solar Business Alliance, before the Public Service Commission of South Carolina, Docket No. 2018-318-E (March 1, 2019)
https://dms.psc.sc.gov/Attachments/Matter/ce0917d7-35f2-4bb0-8715-5c2345a5026c

- *In the matter of the Application of Indiana Michigan Power Company for authority to increase its rates for the sale of electric energy and for approval of depreciation rates and other related matters*, Direct Testimony of Christopher Villarreal on Behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, before the Michigan Public Service Commission, Case No. U-20359 (October 17, 2019)
https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t00000077IYRAA2

- *In the matter of the Application of DTE Electric Company for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority*, Direct Testimony of Christopher Villarreal on Behalf of the Environmental Law & Policy Center and the Natural Resources Defense Council, before the Michigan Public Service Commission, Case No. U-20561 (November 6, 2019)
https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t0000007X6ZiAAK

- *In the matter of the Application of Consumers Energy Company for authority to increase its rates for the generation and distribution of electricity and for other relief*, Direct Testimony of Christopher Villarreal on Behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and Citizens Utility Board of Michigan, before the Michigan Public Service Commission, Case No. U-20697 (June 24, 2020).
https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000CIwhzAAD

- *In the matter of the Application of Consumers Energy Company for authority to increase its rates for the generation and distribution of electricity and for other relief*, Direct Testimony of Christopher R. Villarreal on Behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and Citizens Utility Board of Michigan, Case No. U-20963 (June 22, 2021).
https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000Pvx0LAAR