Direct Testimony and Schedule
Nancy E. Ryan

Before the Minnesota Public Utilities Commission
State of Minnesota

In the Matter of the Application of Northern States Power Company
for Authority to Increase Rates for Electric Service in Minnesota

Docket No. E002/GR-19-564
Exhibit___(NER-1)

Performance Based Ratemaking

November 1, 2019

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Schedule

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, OCCUPATION AND JOB RESPONSIBILITIES.

A. My name is Nancy E. Ryan. I am a partner at Energy and Environmental Economics, Inc. (E3). My business address is 44 Montgomery Street, San Francisco, California.

Q. PLEASE SUMMARIZE YOUR QUALIFICATIONS AND EXPERIENCE.

A. I am a nationally recognized expert in energy economics and public policy. I focus primarily on transforming the energy sector through innovative approaches that balance reliability, decarbonization, and affordability. I am a principal at E3, where I advise clients on regulatory and business strategies, leveraging my deep experience in GHG mitigation policy, electricity regulation, renewable energy, and transportation electrification.

Prior to working at E3, I worked at the California Public Utilities Commission (CPUC) as a Commissioner, Deputy Executive Director for Policy and External Relations, and Chief of Staff and Chief Energy Advisor to former CPUC President, Michael R. Peevey. During my time at the CPUC, I guided the development of California's bellwether policies in renewable energy, energy storage, electric transportation, and long-term resource planning. I also worked closely with senior officials from the California Air Resources Board, the California Energy Commission, the California ISO, and the Governor's Office to formulate strategies to achieve California's ambitious greenhouse gas reduction targets and develop regulations implementing California's cap and trade program from the electric sector. In 2010, Governor Arnold Schwarzenegger appointed me to the Economic and Allocation Advisory

Committee, which was a blue-ribbon panel of economists that provided analysis and recommendations on design of the cap and trade program. I hold a Ph.D. in Economics from the University of California, Berkeley, where I taught courses in applied economics from 1996 to 2007 as a visiting professor in the Goldman School of Public Policy. Exhibit___(NER-1), Schedule 1 summarizes my qualifications.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My testimony proposes three new Performance Incentive Mechanisms (PIMs) related to greenhouse gas (GHG) mitigation measures that I recommend be implemented in Xcel Energy's proposed multi-year rate plan (MYRP) for 2020-2022. I present the rationale for GHG-related PIMs generally and describe why each of the proposed PIMs is needed. I explain how the proposed PIMs fill gaps in the existing regulatory framework by providing targeted incentives to encourage Xcel Energy to take necessary near-term steps that will lay the foundation for long-term, deep GHG reductions in the electricity and transportation. I also survey how other leading utility regulators around the United States have used PIMs to encourage utility actions to achieve their state's decarbonization objectives. I recommend metrics, benchmarks and measurement approaches for each PIM and propose how to structure the reward mechanism.

Q. BRIEFLY DESCRIBE THE GHG PIMS YOU PROPOSE IN YOUR TESTIMONY.

A. I am recommending PIMs in two areas in which Xcel Energy can take meaningful, concrete steps in the near term to hasten cost-effective GHG mitigation in Minnesota. First, I recommend an electricity portfolio PIM be set based on the percentage reduction in total GHGs achieved, relative to a

baseline year. The purpose of this PIM is to reward Xcel Energy for ongoing progress in reducing the GHG emissions of its portfolio more rapidly than currently required. Second, I recommend a two-part electric vehicle (EV) PIM that would be based upon:

1. the percentage of EVs in Xcel Energy territory on managed charging programs, and
2. the percentage of managed charging customers' EV charging load occurring during off-peak hours.

The purpose of the EV PIMs is to reward Xcel Energy for successfully encouraging EV owners to adopt charging behavior that lowers the cost of serving this load.

Q. WHY ARE YOU RECOMMENDING GHG PIMS FOR XCEL ENERGY AT THIS TIME?

A. Minnesota is behind in meeting its statutory GHG mitigation targets. In its 2019 report to the Legislature, the Minnesota Pollution Control Agency (MPCA) stated, "Minnesota has been and will remain a leader in GHG emission trends, but without continued support and additional effort, we are not likely to achieve the goals of the Next Generation Energy Act."[1] While emissions from electricity generation fell nearly 30 percent from 2005 to 2015, transportation sector emissions declined by only 8 percent. Noting that transportation has become the state's largest source of GHG emissions, the

[1] Minnesota Air Pollution Control Agency, Greenhouse Gas Emissions in Minnesota: 1990-2016, Biennial Report to the Legislature, January 2019, p. 15.

MPCA observed that it "will require ongoing, focused effort to reduce emissions to the levels necessary to meet statutory goals."[2]

Xcel Energy is well positioned to contribute to GHG reductions in both the electricity and the transportation sectors, but it lacks incentives to do so. GHG-related PIMs would fill holes in Minnesota's current regulatory framework by rewarding specific actions by Xcel Energy that will further GHG mitigation in both sectors, as the utility continues to provide safe, reliable and affordable service. The phased approach to GHG PIMs that I describe in my testimony will incentivize steady progress and attention to the most impactful initiatives.

Xcel Energy has committed to decarbonize its energy supply faster than state law requires. Sustained, early action by Xcel Energy will help put Minnesota on the long-term pathway to deep decarbonization of the entire economy. An electricity portfolio carbon emissions PIM will reward Xcel Energy for following through on its voluntary commitment. The goals that Xcel Energy has embraced are consistent with the GHG reductions that Minnesota must eventually achieve. They are also very ambitious, and meeting them will require sustained, focused effort.

Xcel Energy is already taking steps to make EVs a beneficial load in the long term. Transportation electrification (TE) is still at a very early stage in Minnesota, with only about 10,000 EVs currently registered in the state. Increased EV adoption will have only a small impact on overall GHG

[2] Ibid. p. 7.

emissions during the pendency of this MYRP, but Xcel Energy can exercise an outsize influence on conditioning customer expectations about when and how to charge EVs. Xcel Energy is currently implementing a portfolio of TE programs that focuses on increasing access to EV charging infrastructure and providing EV owners with cost-effective solutions to access its managed charging rates (Time of Use or TOU). By successfully implementing these programs, Xcel Energy will begin shaping charging norms and consumer behavior while the market for EVs is still in its formative stages. Further, these PIMs provide an incentive for Xcel Energy to experiment with additional managed charging approaches that may augment or improve upon currently-approved measures to induce customers to enroll in managed charging and charge off-peak.

Q. HOW DO YOUR RECOMMENDATIONS FURTHER THE OBJECTIVES OF THE MINNESOTA PUBLIC UTILITIES COMMISSION'S (COMMISSION) ONGOING PERFORMANCE BASED RATEMAKING DOCKET?

A. The Company's proposed MYRP provides the setting to begin implementing the PBR concepts for GHG that are now in final stages of development in Docket No. E002/CI-17-401 (Docket 17-401) in areas where there is generally strong stakeholder support.

Q. HOW IS THE REMAINDER OF YOUR TESTIMONY ORGANIZED?

A The remainder of my testimony is organized as follows:

- *Section II:* Need For New Carbon Reduction PIMs;
- *Section III:* Recommended Carbon Reduction PIMs for Xcel Energy;
- *Section IV:* Conclusion.

II. NEED FOR NEW CARBON REDUCTION PIMS

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I provide background on Minnesota's ongoing proceeding to consider performance metrics and potentially PIMs for Xcel Energy, and explain why carbon reduction PIMs are needed during the 2020-22 MYRP. I also provide background on the design and role of PIMs, and I discuss how regulators in other jurisdiction have implemented PIMs for carbon reduction.

Q. WHAT IS A PIM?

A. A Performance Incentive Mechanism, or PIM, is a method of encouraging the utility to commit to a goal in a specific area that it is not naturally incentivized to do via the existing regulatory framework. The PIM does so by identifying a metric or a quantifiable target, defining the method of measurement, and specifying a reward, penalty, or both. PIMs are very useful when the incentive for a utility is weak, but the performance area is important or time-sensitive.

Q. ARE PIMS CURRENTLY UNDER CONSIDERATION BY THE MINNESOTA PUBLIC UTILITIES COMMISSION?

A. Yes. Following Xcel Energy's November 2015 general rate case filing the Commission opened an Investigation to Identify and Develop Performance Metrics, and Potentially, Incentives for Xcel Energy's Electric Utility Operations, Docket No. E002/CI-17-401. In addressing Xcel Energy's general rate case filing, the Commission noted that "[p]erformance metrics are an important tool to preserve service quality and align utility incentives with ratepayer interests" but found that the record was insufficient to "determine

the adequacy of Xcel's proposed performance metrics." The Commission opened the current investigation as "the best venue for determining what combination of metrics and incentives, in addition to those already in Xcel's QSP Tariff, would appropriately align utility and ratepayer interests."[3]

Q. WHAT IS THE STATUS OF THE CURRENT METRICS AND PIMS INVESTIGATION?

A. The investigation was divided into two phases. The first phase focused on collecting stakeholder input to establish goals, metrics, and measurement methodologies. On January 8, 2019, the Commission issued an Order in the proceeding that established a Performance Incentive Mechanism (PIM) process and set out Goals, Outcomes, and Metric Design Principles. Following additional stakeholder input, the Commission issued its most recent Order on September 18, 2019 establishing performance metrics in the general outcome categories established in the January 2019 Order: affordability, reliability, customer service quality, environmental performance, and cost-effective alignment of generation and load. Xcel Energy is now working with stakeholders to develop and file a proposed methodology and timeline for calculating, verifying, and reporting each of the metrics no later than October 31, 2019.

The second phase will focus on how the performance measurements and standards developed in the first phase may be used by the Commission, including possible standards or performance targets and the potential for using financial incentives to drive Xcel Energy's performance.

[3] FINDINGS OF FACT, CONCLUSIONS, AND ORDER. Docket No. E002/GR-15-826, June 12, 2017, p. 23.

Q. DOES XCEL ENERGY'S PROPOSED MULTI-YEAR RATE PLAN INCLUDE PIMS?

A. Yes. The MYRP proposes decarbonization PIMs aligned to the Environmental Performance category identified by the Commission in their September 2019 Order in Docket 17-401. The PIMs focus on reducing carbon emissions in the electricity sector and effective electrification of the transportation sector.

Q. WHY SHOULD THE COMMISSION IMPLEMENT NEW CARBON REDUCTION PIMS FOR XCEL ENERGY?

A. Xcel Energy has announced an ambitious carbon reduction vision that goes beyond Minnesota's current Renewable Energy Standard (RES) and implies steeper long-term cuts in power sector GHG emissions than required by Minnesota's statutory goals for economy-wide GHG reduction. The utility has pledged to reduce its electricity portfolio GHG emissions to 80 percent below 2005 levels by 2030, and to provide 100 percent carbon-free electricity to its customers by 2050. Minnesota law requires an economy-wide reduction in GHGs to 80 percent below 2005 levels by 2050.

The electric sector is the fulcrum of economy-wide decarbonization. In its analysis on behalf of Xcel Energy for its 2020-2034 Upper Midwest Integrated Resource Plan (IRP), E3 modeled several economy-wide decarbonization scenarios that meet the Minnesota economy-wide target.[4] This analysis shows that deep GHG reductions are required across the economy, and that the electricity sector can help enable carbon reduction in other sectors through

[4] Appendix P3, Docket No. E002/RP-19-368, July 1, 2019.

supporting deployment of electric vehicles and other forms of beneficial electrification (such as building and industrial electrification).

Xcel Energy's financial incentives need to be better aligned with achieving these important GHG mitigation objectives. The proposed carbon reduction PIMs are designed to give Xcel Energy direct incentives to complete concrete, near-term steps to go beyond existing requirements.

Q. PLEASE DESCRIBE WHAT XCEL ENERGY IS CURRENTLY DOING OR HAS COMMITTED TO DO TO HELP MEET OR EXCEED MINNESOTA'S CLEAN ENERGY GOALS.

A. Xcel Energy is already working to decarbonize generation faster than state law requires. In 2007, Minnesota Governor Tim Pawlenty signed the Next Generation Energy Act (NGEA), which set greenhouse gas emission reduction targets relative to 2005 levels: 15 percent reduction by 2015, 30 percent reduction by 2025, and 80 percent reduction by 2050. Minnesota's RES mandates that by 2020 at least 31.5 percent of Xcel Energy's total retail electricity sales must be from renewable energy technologies, 1.5 percent of which must come from solar energy.

Xcel Energy has set its sights higher than Minnesota's statutes, and plans to exceed the greenhouse gas emission reductions implied by NGEA and renewable energy targets required by Minnesota's RES. The Company's 2020-2034 IRP submitted to the Commission on July 1, 2019 in Docket No. E002/RP-19-368 lays out an ambitious vision for continuing its clean energy transition with plans to:

i) Retire its final remaining coal units, Sherco 3 and Allen S. King, by 2030,

ii) Add a new combined cycle plant at the site of the existing Sherco coal facility,

iii) Extend operations at the Monticello nuclear plant, whose license expires in 2030, through 2040,

iv) Add 4,000 megawatts (MW) of new renewable resources by 2035,

v) Add new energy efficiency and demand response resources to build out a larger demand-side management (DSM) portfolio building up to an average of 2.9 percent of sales by 2034,

vi) Add 1,700 MW of firm load-supporting resources by 2034 in order to ensure reliability while supporting cost-effective integration of renewable resources.

Q. PLEASE DESCRIBE WHAT XCEL ENERGY IS CURRENTLY DOING OR HAS COMMITTED TO DO TO HELP MEET OR EXCEED MINNESOTA'S GHG MITIGATION GOALS IN THE TRANSPORTATION SECTOR.

A. Xcel Energy is taking numerous steps to plan for the arrival of EVs in Minnesota and encourage their cost-effective integration into the grid. Pursuant to the Commission's February 1, 2019 Order in E999/CI-17-879,[5] Xcel Energy submitted a Transportation Electrification Plan (TEP)[6] to the Commission on June 28, 2019. The TEP details the utility's near-term plans to support and enable EV adoption by its residential and commercial customers. The TEP was developed through a stakeholder process and seeks to address three key barriers to EV adoption: (1) lack of information and

[5] ORDER MAKING FINDING AND REQUIRING FILINGS, Docket No. E999/CI-17-879, February 1, 2019.
[6] Transportation Electrification Plan, Docket No. E999/CI-17-879, June 28, 2019.

awareness, (2) upfront costs, and (3) insufficient incentives to charge when energy costs are lowest. It encompasses new initiatives to support home, fleet and public/fast charging as well as pre-existing EV rates and pilots.

Xcel Energy already has several programs in place that are specifically dedicated to encouraging beneficial electrification within the transportation sector by contributing to the upfront costs of charging infrastructure and transitioning towards more appropriate EV rates.

i) Xcel Energy is taking the following steps to support transportation electrification:

- In 2015, the Commission approved Xcel Energy's Residential Electric Vehicle Service tariff, Docket No. E002/M-15-111, which offers discounted rates during off-peak hours on an opt-in basis (June 22, 2015). This rate requires a second meter to monitor EV energy use separately from the rest of the customer's home.
- In 2018, the Commission approved Xcel Energy's Residential EV Service Pilot, Docket No. E002/M-17-817, which allowed up to 100 customers to enroll in the EV Service tariff without incurring the expense of a separate service line or meter (May 9, 2018). Instead, Xcel Energy is using the load-monitoring capability embedded in the charger to gather data on energy usage for EV charging and communicates it to the Company via the customer's home WiFi network. Due to the success of this pilot, Xcel Energy has requested Commission approval to offer the program to all of its EV-owning customers (August 30, 2019).
- The Commission voted to approve Xcel Energy's Fleet EV Service, Docket No. E002/M-18-643, which allows the Company to build

"make ready" infrastructure to partially defray the cost to hosts and fleet owners of deploying public and fleet EV chargers (July 17, 2019). Currently, Xcel Energy is working with three fleet customers including Metro Transit, the Minnesota Department of Administration, and the City of Minneapolis.

- The Commission also approved Xcel Energy's Public Charging Pilots, Docket No. E002/M-18-643, under which the Company would install, own, and maintain EV infrastructure for developers of public charging stations, but would not own or maintain the charging equipment itself (July 17, 2019). As a condition of participating, site hosts are to pass along TOU differentials to their customers; however, they may opt out at their discretion.
- In June of 2019, the Commission voted to approve Xcel Energy's Residential EV Subscription Service Pilot, Docket No. E-002/M-19-186, which is similar to the Residential EV Service Pilot introduced a year earlier, but incorporates a monthly subscription fee for EV Charging service during off-peak hours, with the intention to make the cost of charging an EV easier to understand (October 7, 2019).
- In June of 2019, the Minnesota Department of Commerce (Department) denied Xcel Energy's proposal to add to its Conservation Improvement Program (CIP) portfolio a residential managed charging program called "Charging Perks." The program aimed to capture both energy and demand savings via efficient and controllable charging stations and would have rewarded participants with quarterly incentive payments. While acknowledging the "importance of EV's [and] … optimal EV charging," the

Department concluded that it could not approve the program within the CIP framework.[7]

Q. ARE MINNESOTA'S CURRENT POLICIES SUFFICIENT TO REACH THE STATE'S LONG-TERM GHG MITIGATION GOALS?

A. No. Minnesota did not achieve the 2015 reduction goal of a 15 percent economy-wide reduction in GHG emissions below 2005 levels.[8] E3's "Minnesota Decarbonization Scenarios" study included with the Company's July 1, 2019 IRP filing shows that Minnesota is not on track to meet the 2025 goal of a 30 percent reduction in GHGs below 2005 levels, nor the 2050 goal of an 80 percent reduction in GHGs, under current policies. Current policies are modeled in the Reference scenario. If it is to reach its goal of reducing statewide GHG emissions by 80 percent below the 2005 level by 2050, Minnesota will eventually have to achieve much greater levels of energy efficiency and conservation across all sectors, decarbonization of transportation, buildings, and industry, as well as a low- or zero-carbon electricity supply.

Table 1 below shows the GHG reductions needed relative to 2005 emissions for each sector in two scenarios that both achieve the 2050 decarbonization target. Translating into more concrete terms, meeting these goals in the High Electrification scenario entails 50 percent Zero Emission Vehicles (ZEV) sales by 2030 and 100 percent by 2050, 50 percent electric heat pump sales by 2030 and 100 percent by 2050, a 5 percent reduction in key demands associated

[7] Decision, Docket No. E,G002/CIP-16-115, June 12, 2019, p. 11.
[8] See https://www.pca.state.mn.us/air/greenhouse-gas-emissions-data. The Minnesota Pollution Control Agency estimates that Minnesota achieved an economy-wide GHG reduction of about 12 percent from 2005 to 2016.

with smart appliances and conservation by 2030, and 100 percent market share for high-efficiency appliances by 2030. Lower levels of electrification are assumed in the High Biofuels scenario. The study concludes that electrification and zero-carbon electricity are necessary, but not enough, to reach statewide climate goals. The study notes that significant action is needed in every sector to decarbonize the state of Minnesota, as illustrated in Table 1 below.

Table 1

2050 GHG Reductions in Mitigation Scenarios Relative to 2005 Emissions by Sector

	High Electrification Scenario	High Biofuels Scenario
Buildings	-74%	-14%
Transportation	-87%	-98%
Electricity Generation	-91%	-94%
Other	-64%	-69%
Total	-80%	-80%

Q. CAN EARLY ACTION BY XCEL ENERGY HELP MINNESOTA REACH ITS GHG MITIGATION GOALS ON TIME AND IN A COST-EFFECTIVE MANNER?

A. Yes. Realizing such long-term transformations in a cost-effective manner requires early, sustained and coordinated action by many parties, including electric utilities. Decarbonizing the transportation and building sectors depends on successful commercialization of new technologies such as EVs and heat-pump water heater and HVAC units, as well as sweeping

transformation of the markets for vehicles and appliances; although both are already underway, they will take time—a decade or more.

Taking advantage of opportunities afforded by new construction and the natural turnover of the vehicle, building and appliance stock helps lower the overall cost of the transition, but takes both time and ongoing attention; missed opportunities can result in costly early retirement or lengthy delays in deployment of low/no carbon technologies. Timely collaboration between utilities, automakers and vehicle dealers, appliance manufacturers and contractors can hasten these transformations and lower their cost.

Finally, activating the latent flexibility in EV charging loads can lower the overall cost of decarbonizing the economy by increasing grid utilization and providing a relatively inexpensive resource to enable integration of intermittent renewable resources. On average, personal vehicles are parked about 95 per cent of the time. To the extent that EVs have access to charging while they are parked, there is considerable flexibility in when and how fast they charge. For example, an EV may remain plugged in overnight at home or throughout the workday at its owner's place of employment. TOU rates and other managed charging approaches can shift EV charging to hours when the distribution grid is relatively uncongested, avoiding or deferring the need for grid upgrades and spreading fixed costs over more kWh. Load shifting strategies may also concentrate EV charging in hours when zero marginal cost renewable power is most abundant and may even help reduce renewable curtailment. As the customer has already paid for the battery as part of the initial purchase cost of the vehicle, EV batteries may provide flexibility services at lower cost than dedicated stationary batteries and/or peaker plants.

Proving out this capability and understanding the conditions under which managed EV charging can provide cost-effective flexibility services should be a priority for Xcel Energy in this early, formative stage of EV deployment.

Q. WHAT IS THE OVERALL RATIONALE FOR ADOPTING GHG PIMS?

A. Well-designed PIMs can align Xcel Energy's short-term (and long-term) financial incentives with Minnesota's long-term decarbonization goals. The objectives are to incent the timely and cost-effective achievement of desired policy outcomes, to ensure steady progress over time, and to reward outcomes that go significantly beyond what is currently required by law and/or policy, while maintaining reliability and safety for customers.

Q. WHY ARE GHG RELATED PIMS NECESSARY TO AUGMENT MINNESOTA'S CURRENT REGULATORY FRAMEWORK?

A. GHG-related PIMs would fill holes in Minnesota's current regulatory framework because:

i. Minnesota does not currently have a cap and trade program or an alternative policy framework that expressly requires Xcel Energy to reduce carbon.

ii. Absent specific programs and policies (such as energy efficiency mandates), utilities lack direct incentives to support market transformation and GHG savings beyond the electricity sector that are needed to meet the state's long-term climate goals

iii. Cost of service regulation rewards capital intensive approaches, which, notwithstanding the capital budget cap, may not always maximize system efficiency and minimize costs.

iv. Minnesota's current approach to revenue decoupling generally prevents Xcel Energy from realizing additional earnings from successful efforts to promote cleaner electric alternatives to fossil-fueled building equipment. Under decoupling, Xcel Energy can adjust its rates once each year to make up for any deficit or surplus revenues from the revenue baseline. This arrangement is designed to eliminate the disincentive for utilities to promote energy conservation and efficiency, which would otherwise reduce both electricity sales and revenues. However, it also creates a new disincentive to promote electrification, as the utility cannot realize additional revenues from successful efforts to advance adoption of heat pumps. The Commission is taking steps to address this issue for EV charging by exempting this load from decoupling. However, only the portion of this load served that is separately metered can be factored into the analysis. Thus, while the Commission has partially removed the disincentive to promote new EV load, Xcel Energy still lacks an affirmative incentive to actively encourage it.

v. The utility sits at the convergence of (almost) all sectors in the energy economy, so is well positioned to coordinate across sectors in order to lower costs of the overall transition. Incentives need to focus on near-term actions that Xcel Energy can take to step more firmly into this role.

Q. SHOULD MINNESOTA JUST ADOPT A SINGLE GHG METRIC THAT ENCOMPASSES ELECTRICITY GENERATION AND EVS FOR XCEL ENERGY NOW?

A. No. I envision a transition to a GHG metric over time. Electric vehicles are still in the nascent stages of deployment, and there are still a number of

uncertainties and stakeholder questions around how to account for carbon emission savings in the transportation sector. I recommend a phased approach to encourage necessary market transformation in the transportation sector before transitioning to an overall GHG metric.

PIMs based on physical outcomes or technology adoption metrics are more appropriate where market transformation is in the early stages and emissions reductions are hard to measure. At this stage, the objective of PIMs should be to focus utility attention on successfully executing near-term measures that will enable greater, faster and/or more cost-effective GHG reductions in the long run. These should transition to carbon-based PIMs over time as the technology matures, adoption grows, and carbon accounting principles are established.

However, it is appropriate to set a GHG metric now for the Company's electricity portfolio. This is because utility-scale wind and solar generation are already cost-competitive with fossil-fueled resources, and do not require the lengthy market transformation process needed to realize widespread adoption of consumer goods such as EVs.

Q. WHAT SHOULD BE THE FOCUS OF PIMS DURING THE 2020-2022 MYRP?

A. In the near term, PIMs can encourage necessary early steps to create market transformation and realize cost-effective coordination across sectors. Electrification of the transportation sector is at a very early stage in Minnesota, so successful near-term efforts to promote adoption will deliver small GHG reductions and have only a small impact on Xcel Energy's load and emissions. Currently, there are about 10,000 electric vehicles in Minnesota, and Xcel

Energy expects that, within its service territory, there will be approximately 22,000 by 2022. Now is the time to set the stage for Xcel Energy to play a substantive role enabling and promoting beneficial electrification across the economy. This is because:

i) PIMs can encourage electrification-related data collection to enable better carbon accounting of electrified end-uses.

ii) Early success is vital to help advance progress toward longer-term beneficial electrification goals. Here, the utility can play a coordinating role where there are multiple actors and long timescales for market transformation.

iii) It is important to establish appropriate price signals and consumers' willingness to charge EVs in ways that minimize the need for grid upgrades and enable cost-effective integration of renewables.

Q. IS IT REASONABLE TO PROVIDE INCENTIVES FOR XCEL ENERGY TO UNDERTAKE GHG REDUCTION MEASURES WHEN IT HAS ALREADY PUBLICLY COMMITTED TO GO BEYOND STATUTORY TARGETS?

A. Yes. The goals that Xcel Energy has embraced are consistent with the GHG reductions that Minnesota must eventually achieve. They are also very ambitious, and meeting them will require sustained, focused effort. The phased approach to GHG PIMs that I have described will incentivize steady progress and attention to the most impactful initiatives.

Q. HAVE REGULATORS IN OTHER JURISDICTIONS IMPLEMENTED PIMS FOR GHG REDUCTION?

A. Yes. In New York, several utilities – including Central Hudson Gas & Electric Corporation (CHG&E), Con Edison, National Grid, and Orange &

Rockland Utilities – have proposed carbon-based PIMs, three of which have been approved by the Public Service Commission of New York. Some of the utility companies' proposed PIMs for electric vehicles or electric heat pumps, focus on calculating avoided greenhouse gas emissions, using a variety of approaches and formulas. The utilities in New York have requested a range of $0.28 to $38.8 million in incentives, all of which are up-side-only PIMs.

National Grid in Rhode Island has also proposed several carbon reduction PIMs focused on electric vehicles and electric heat pumps. These are still under Rhode Island Public Utilities Commission review.

As other jurisdictions are still in the very early stages of defining implementing carbon-based PIMs, Minnesota is well positioned to act as a leader for defining innovative PIMs that consider the current stage of economy-wide decarbonization across multiple sectors, while properly incentivizing the utility company to accelerate electrification and decarbonization necessary to meet state-wide goals.

III. RECOMMENDED CARBON REDUCTION PIMS FOR XCEL ENERGY

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I provide a detailed description of each of the proposed PIMs and explain how they would be implemented. I also provide a rationale for the proposed approach for each PIM and discuss how it is consistent with the guiding principles specified by the Commission's

September 2019 Order in Docket 17-401 and other criteria presented earlier in my testimony.

Q. DID YOU FOLLOW A COMMON SET OF GUIDING PRINCIPLES IN DEVELOPING THE PROPOSED CARBON REDUCTION PIMS?

A. Yes, beginning with the guiding principles outlined by the Commission in its September 2019 Order in Docket 17-401. The Commission's guidance to Xcel Energy and stakeholders was as follows:

a. Utility performance metrics should be focused on results and outcomes. Metrics should not prescribe detailed or specific tools or tactics. This will provide the utility the opportunity to be flexible and tailored to its unique system and customers' needs.

b. Metrics should not support the deployment of specific technologies such as only one type of electric generation, unless such information is needed for a utility to comply with statutes.

c. Metrics identified to gauge environmental performance should directly measure environmental emissions and impacts.

d. Parties should develop measurement methodologies and future metrics with an eye toward development of a utility performance dashboard.

e. Metrics directed by the Commission at this stage of the process are not to be viewed as the final, exclusive list. As stakeholders work forward through the PIM process, they may propose reshaping or adding to the metrics outlined above.[9]

[9] ORDER ESTABLISHING PERFORMANCE METRICS, Docket No. E002/CI-17-401, September 18, 2019.

Q. DID YOU DEPART FROM THE COMMISSION'S GUIDING PRINCIPLES FOR CARBON REDUCTION PIMS IN ANY WAY?

A: Yes. As discussed earlier in my testimony, I believe it is premature to directly measure the environmental impacts of EVs during this MYRP. These PIMs are therefore framed in terms of tangible, observable steps Xcel Energy can take in the near term to advance cost-effective electrification.

Q. PLEASE PROVIDE AN OVERVIEW OF THE NEW PIMS THAT YOU RECOMMEND.

A. The new carbon reduction metrics would be:

i. An electricity portfolio carbon emissions PIM, and

ii. Two electric vehicle PIMs.

Q. PLEASE GIVE AN OVERVIEW OF THE ELECTRICITY PORTFOLIO CARBON EMISSIONS PIM.

A. I recommend that the electricity portfolio PIM be set based on the percentage reduction in total GHGs achieved, relative to a baseline year.

Setting a greenhouse gas reduction PIM for the electricity sector is relatively straightforward and has several advantages over technology-specific policies or metrics. Total electricity sector GHG emissions can be measured and tracked, using agreed-upon third-party verified methods through the Climate Registry.

Q. WHY IS AN ELECTRICITY PORTFOLIO CARBON EMISSIONS PIM NECESSARY AT THIS TIME?

A. Xcel Energy has committed to decarbonize its energy supply faster than state law requires. Sustained, early action by Xcel Energy will help put Minnesota on the long-term pathway to deep decarbonization of the entire economy. An

electricity portfolio carbon emissions PIM will reward Xcel Energy for following through on its voluntary commitment.

Q. PLEASE DESCRIBE YOUR RECOMMENDED METRIC AND MEASUREMENT METHOD FOR THE ELECTRICITY PORTFOLIO CARBON EMISSIONS PIM.

A. The method for computing the electricity portfolio carbon emissions PIM is as follows:

i. Metric: The carbon emissions metric would be based on the total GHG emissions associated with serving Xcel Energy's load, including net GHGs from imports and exports. This metric would use the carbon accounting framework established for reporting to the Climate Registry to ensure third-party verification of measurements.

ii. Calculation: The metric is based on percent reduction in Xcel Energy's GHG emissions relative to 2005 emission levels of 28 million short tons. The achieved reductions would be compared to a straight-line projection from 2018 actual emissions to Xcel Energy's 2030 GHG goal of 80 percent below 2005 levels.

iii. Data source(s): Xcel Energy currently publishes annual GHG emissions in an annual report to The Climate Registry, which is verified by an independent third-party verifier. The incentive would be paid out only after this process of reporting and verification completes each year.

Q. PLEASE DESCRIBE HOW YOU PROPOSE THAT THE ELECTRICITY PORTFOLIO CARBON EMISSIONS PIM BE IMPLEMENTED.

A. Below, I describe each element of the proposed PIM:

i. GHG emissions reductions would be benchmarked against 2005 emissions as described above.

ii. I recommend an upside-only incentive in which the value of the incentive increases linearly with increasing GHG reductions, subject to an incentive floor and ceiling. No incentive is earned for emissions reductions that fall more than four percent short of a straight-line projection from 2018 actual emissions to Xcel Energy's 2030 GHG goal announced in December 2018 (80 percent below 2005 levels). A maximum incentive of $10.5 million would be received for emissions reductions that exceed the straight-line projection by more than four percent. Within the region bounded by this floor and ceiling, the incentive would reward $1.3125 million for each percentage point of reductions achieved past the floor. This method of a linear slope with a ceiling and floor provides proper marginal reduction signals around the target range and mutes the effect of year-to-year volatility.[10] Figure 1 below displays the evolution of the incentive region over time, along with the bounding floor and ceiling. An illustration of the incentive structure for 2020, 2021, and 2022 is shown in Figure 2 below.

iii. This PIM would be assessed annually, with the expected lag for third-party verification described above.

[10] See, for example, Lowry and Woolf, "Performance-Based Regulation in a High Distributed Energy Resources Future," Lawrence Berkeley National Laboratory, January 2016; 77 Whited, Woolf and Napoleon, "Utility Performance Incentive Mechanisms: A Handbook for Regulators," Synapse Energy Economics, prepared for the Western Interstate Energy Board, March 2015.

Figure 1

Representation of the Incentive Regions for GHG Reductions

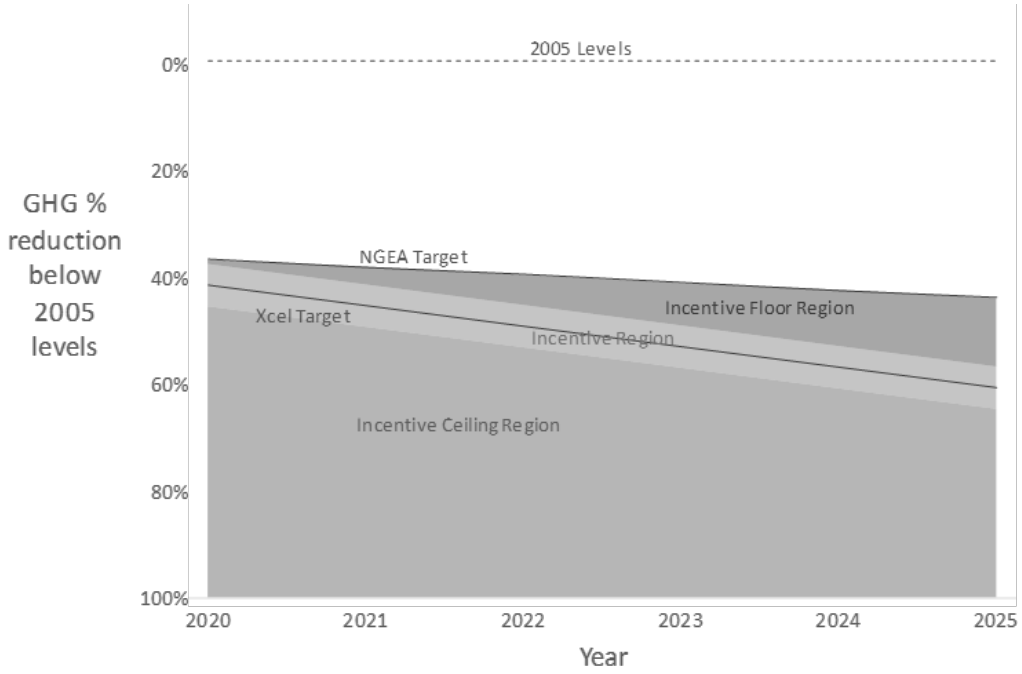
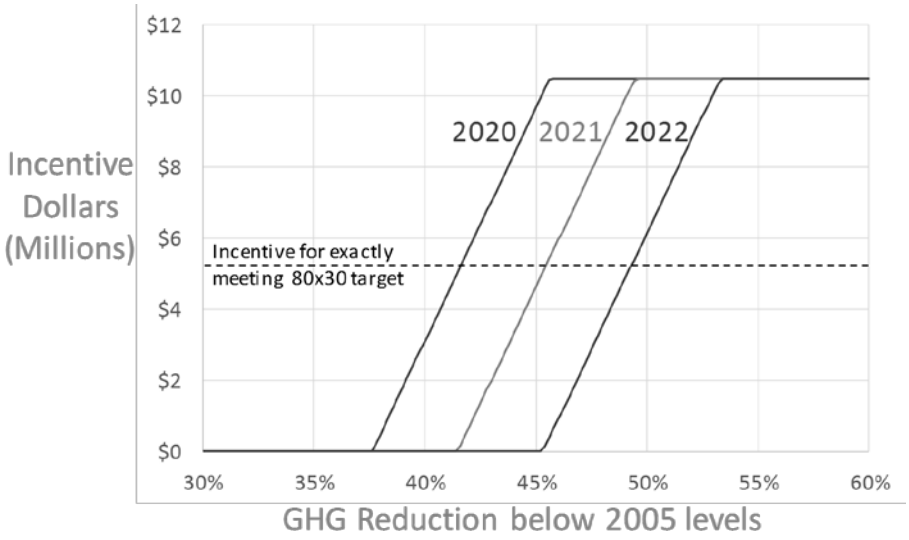


Figure 2

Relationship Between Incentive Dollars and GHG Reductions



Q. WHY ARE POSITIVE-ONLY DECARBONIZATION PIMS WARRANTED AT THIS STAGE?

A. The decarbonization PIMs are focused on new performance expectations that align utility incentives with state policy objectives as compared to incentive mechanisms that are focused on basic service requirements. Unlike basic service requirements, these expectations require new methods of utility operation, innovation, and new forms of coordination with independent third parties. Positive-only PIMs are useful for activities associated with positive societal value where improved utility performance is clearly aligned with customer value.

Q. IS THE POSITIVE-ONLY RECOMMENDED DECARBONIZATION PIMS APPROACH ALIGNED TO ACTIONS IN OTHER STATE JURISDICTIONS?

A. Yes. New York has the most advanced PIMs across the nation, where the Public Service Commission implemented positive-only incentives, Case No. 17-E-0459, for the initial implementation of decarbonization PIMs across the New York utilities (June 14, 2018). If the positive-only incentives prove to be ineffective, the Public Service Commission still has the option to consider symmetrical or negative incentives in future PIM iterations. The positive-only approach has also been proposed in Rhode Island and appears to be an early theme in proceedings in other jurisdictions where PIMs are being advanced.[11]

Q. PLEASE GIVE AN OVERVIEW OF THE ELECTRIC VEHICLE PIM.

A. I recommend a two-part EV PIM that would be based upon:

[11] Wang, Fei and Crawford, Jonathan., *Regulatory evolution for a decentralized electric grid: State of performance-based ratemaking in the U.S.* Wood Mackenzie Power & Renewables and EnerKnol, June 2019.

1. the percentage of EVs in Xcel Energy territory on managed charging programs, and
2. the percentage of managed charging customers' EV charging load occurring during off-peak hours.

Q. WHY IS AN ELECTRIC VEHICLE PIM NECESSARY AT THIS TIME?

A. Transportation electrification is still at a very early stage in Minnesota, with only about 10,000 EVs currently registered in the state. Increased EV adoption will have only a small impact on overall GHG emissions during the pendency of this MYRP. Xcel Energy is well positioned to take near-term steps that will make EVs a beneficial load in the long term. Xcel Energy is currently implementing a portfolio of TE programs that focuses on increasing access to EV charging infrastructure and providing EV owners with cost-effective solutions to access its managed charging rates (TOU). By successfully implementing these programs, Xcel Energy will begin shaping consumer behavior and charging norms while the market for EVs is still in its formative stages. Further, these PIMs provide an incentive for Xcel Energy to experiment with additional managed charging approaches that may be more effective than currently approved measures or reach more segments of its EV-owning customer base.

Q. PLEASE DESCRIBE YOUR RECOMMENDED METRIC AND MEASUREMENT METHOD FOR THE ELECTRIC VEHICLE PIMS.

A. The method for computing the first EV PIM (managed charging enrollment) is as follows:

i. Metric: Percent of EVs in Xcel Energy's Minnesota service territory participating in managed charging programs or on whole-house TOU rates.

ii. Calculation: The numerator would be composed of customers on EV-specific managed charging programs (including Residential Electric Vehicle Service and Residential Electric Vehicle Pilot Service) and customers on whole-house TOU rates (Residential Time of Day Service and Residential Time of Use Pilot Service), who have self-identified as EV owners/lessors. The denominator would be the number of EVs registered in Xcel Energy's service territory.

iii. Data source(s): The sources for the numerator would be Xcel Energy's customer billing system and the results of customer surveys for customers who opt into managed charging programs. The denominator would be computed using the most reliable source of vehicle registration data from the Commission, the Minnesota Pollution Control Agency, or the Minnesota Department of Transportation (MN DOT).

The method for computing the second EV PIM (off-peak charging) is as follows:

i. Metric: Percentage of managed charging customers' residential EV charging load during off-peak hours.

ii. Calculation: Both the numerator and the denominator are measured as cumulative annual megawatt hours (MWh). The numerator is the total annual energy consumed (MWh) by EVs charging during off-peak hours at the residences of customers enrolled in Xcel Energy's EV TOU rates or other managed charging programs. The denominator is

the total annual energy consumed (MWh) by EVs charging at the residences of customers enrolled in Xcel Energy's EV TOU rates or other managed charging programs. EV charging for customers on whole-house TOU rates cannot be tracked independently using the metering technology currently deployed. This includes customers enrolled in the EV DR program, since interval kilowatt hours (kWh) data is not collected for those customers. If usage data that allows for tracking off-peak EV charging becomes available for these customers, future calculations should include their load as well.

iii. Data source(s): Hourly customer billing data extracted from Xcel Energy's Customer Resource System (CRS).

Q. PLEASE DESCRIBE HOW YOU PROPOSE THAT THE ELECTRIC VEHICLE PIMS BE IMPLEMENTED.

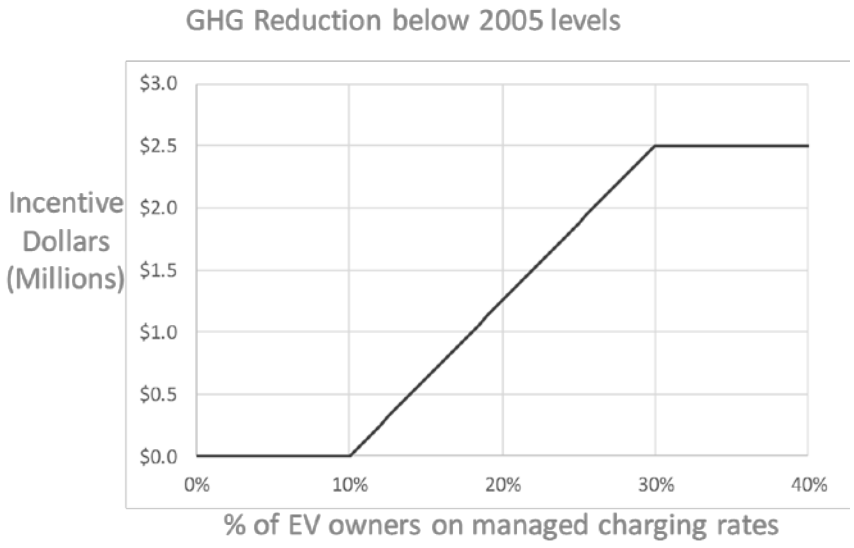
A. Both PIMs would be upside-only and assessed on an annual basis. The rationale for the EV PIMs being upside-only is the same as for the GHG PIM.

The first EV PIM (managed charging enrollment) will be benchmarked against targets that encourage managed charging participation improvement well beyond current levels. The incentive range starts above Xcel Energy's current enrollment level and provides space for dramatic improvement before the incentive ceiling. The wide linear incentive encourages Xcel Energy to make steady progress in enrolling customers in managed charging through continuous improvement in program design and delivery. It is difficult to benchmark Xcel Energy's performance against that of other utilities due to varied incentives to induce customer enrollment, program and tariff designs, and approaches to calculate participation. However, the enrollment levels

seen in the two largest California investor-owned utilities (IOUs) fall between the floor and ceiling of the proposed incentive.[12]

The value of the incentive increases linearly with the percentage of EV owners enrolled in managed charging programs, subject to an incentive floor and ceiling. No incentive is earned if the percentage of EV owners enrolled in managed-charging rates is less than 10 percent. A maximum incentive of $2.5 million would be received if the percentage is more than 30 percent. Within the region bounded by this floor and ceiling, the incentive would reward $125 thousand for each percentage point of improvement above the floor. An illustration of the incentive structure is shown in Figure 3 below.

Figure 3
Relationship Between Incentive Dollars and Managed-Charging Rate Participation



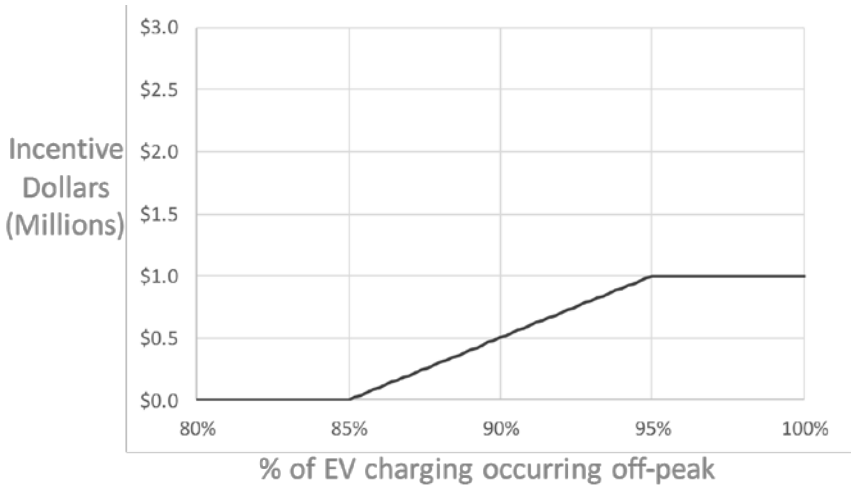
[12] California Energy Commission, Joint IOU Electric Vehicle Load Research - 7th Report, April 2, 2019; California Energy Commission, Joint IOU Electric Vehicle Load Research - 6th Report, December 29, 2017; California Energy Commission, Joint IOU Electric Vehicle Load Research - 5th Report, December 30, 2016; California Energy Commission, Joint IOU Electric Vehicle Load Research - 4th Report, December 24, 2015.

The second EV PIM (off-peak charging) would benchmark the percent of off-peak charging occurring in Xcel Energy's territory against similar results reported by the California IOUs. This metric is easier to benchmark against other utilities since it is meant to encapsulate the effectiveness of managed charging rate design and communication with customers. The higher penetrations of EVs in California make the state a good benchmark for future EV penetrations in Minnesota.

The value of the incentive increases linearly with the percentage of at-home EV charging occurring off-peak, subject to an incentive floor and ceiling. No incentive is earned if less than 85 percent of EV charging occurs off-peak. A maximum incentive of $1.0 million would be received if more than 95 percent of EV charging occurs off-peak. Within the region bounded by this floor and ceiling, the incentive would reward $100,000 for each percentage point of charging load occurring off-peak beyond the floor. For the purposes of the PIM, "Off-peak" would include both off-peak and super off-peak periods for three-part TOU rates. An illustration of the incentive structure is shown in Figure 4 below.

Figure 4

Relationship Between Incentive Dollars and Off-Peak EV Charging



The 85 percent performance target is based on the approximate median performance of the California IOUs from 2014 to 2018.[13] Xcel Energy has achieved high percentages of off-peak EV charging in early pilots (>90 percent). As seen in the more mature California market, this level of success is unlikely to continue as swaths of the population outside of highly engaged early adopters purchase EVs.

The managed charging enrollment incentive is set to have a higher maximum value than the off-peak charging incentive to highlight relative need in the near term. Xcel Energy has historically done well to get customers on managed charging programs to respond to price signals, but the effectiveness of this load shift is limited by the number of customers participating in the rates.

[13] Ibid. 12.

IV. CONCLUSION

Q. PLEASE SUMMARIZE YOUR DIRECT TESTIMONY.

A. I argue that the three carbon-based PIMs should be included in Xcel Energy's proposed multi-year rate plan for 2020-2022 in order to better align the utility's financial incentives with both the state's and the utility's long-term carbon reduction goals. In order to accelerate towards these goals, Xcel Energy must allocate sufficient resources towards carbon-free electricity generation and successfully encourage EV owners to participate in and respond to managed charging programs. Minnesota is well positioned to act as a leader for defining innovative PIMs that consider the current stage of economy-wide decarbonization across multiple sectors, while properly incentivizing the utility company to accelerate electrification and decarbonization necessary to meet state-wide goals.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, it does.

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Partner

Dr. Nancy Ryan is a nationally recognized expert in energy economics and public policy who focuses on transforming the energy sector through innovative approaches that balance reliability, decarbonization, and affordability. Her work advising E3 clients on regulatory and business strategy leverages her deep expertise in GHG mitigation policy, electricity regulation, renewable energy, and transportation electrification along with her unique experience in government, private enterprise, academia, and environmental advocacy. Her multifaceted career has honed her ability to synthesize and translate complex information for clients and stakeholders as they navigate the changes sweeping through the energy and transportation industries.

Dr. Ryan came to E3 in 2013 from the California Public Utilities Commission, where she held several high-level appointed positions including Commissioner, Deputy Executive Director for Policy and External Relations, and Chief of Staff to President Michael R. Peevey. During her CPUC tenure, Dr. Ryan guided development of California's cutting-edge policies in renewable energy, smart grid, energy storage, electric transportation, and long-term planning and procurement. She also worked closely with senior officials from the California Air Resources Board, the California Energy Commission, the California ISO and the Governor's Office to devise strategies to achieve California's ambitious greenhouse gas reduction targets and develop regulations implementing California's cap and trade program for the electric sector. In 2010, Dr. Ryan was appointed by Governor Arnold Schwarzenegger to the Economic and Allocation Advisory Committee, a blue-ribbon panel of economists that provided analysis and recommendations on design of the cap and trade program.

General Topic Areas

- Leads E3's work helping utilities, asset owners, and public agencies understand the impacts and implications of public policy, including climate change mitigation measures. Evaluates opportunities, costs, benefits, and risks of different policy scenarios and helps clients develop data-driven business and investment strategies informed by a rich understanding of the policy context.
- Has established E3 as a leading U.S. transportation electrification consultancy, with a focus on illuminating grid impacts and the interactions between a progressively decarbonized grid and increasingly electrified transportation and building sectors. Assists leading utilities in developing electrification strategies, identifying investment opportunities, and understanding cost and rate design impacts. Advises automakers, technology companies, and investors on the competitive landscape, potential revenue streams, and emerging risks. Supports regulators in evaluating costs, benefits, and risks of ratepayer-funded investments in utility transportation electrification programs.

- Educates California stakeholders on the costs, benefits, risks, and policy options related to the expansion of community choice aggregation (CCA). Advises CCAs on rate design, planning, procurement, program development, and regulatory strategy. Counsels utilities on strategy around CCAs and assists investors in evaluating opportunities to serve CCA off-takers.

Sample Engagements

- Analyzed the impacts of light-duty plug-in electric vehicle (PEV) adoption on New York's electric grid on behalf of NYSERDA, finding that PEV adoption benefits all three regions of New York and that utility programs accelerating adoption and implementing managed charging would increase those benefits significantly.
- Developed an industry-leading "Electrification of Transportation Strategic Roadmap" for the Hawaiian Electric companies quantifying expected benefits from EVs between now and 2045: $550 per vehicle to ratepayers, and $1,800 per vehicle to the state's economy. These values increase if more vehicles charge in the middle of the day during an abundance of solar production.
- Directed a detailed analysis of the grid impacts of PEV charging for four California utilities, finding that distribution impacts are modest and managed charging reduces distribution upgrade costs by 60 percent. Unlike energy efficiency and distributed PV, EVs can reduce rates for utility customers while providing net economic, environmental, and societal benefits.
- Supported the California Air Resources Board (CARB) in developing an updated "Scoping Plan" to meet its requirements under AB 32 (the Global Warming Solutions Act of 2006), employing E3's statewide GHG mitigation analysis to evaluate the GHG and cost implications of different 2030 scenarios and translating E3's results for CARB's study of associated structural and job impacts.
- Developed the policy case for Southern California Edison's successful CPUC application to pilot a ratepayer-funded PEV infrastructure program and education effort, showing that increasing PEV adoption by 2030 is essential to achieving California's long-term GHG mitigation goals and that PEV adoption yields net economic and ratepayer benefits.
- Evaluated the feasibility and cost of a range of 2030 California GHG reduction targets on the way to meeting the state's 2050 GHG goal. E3's detailed analysis encompassed the entire California economy and produced GHG emission reductions, fuel use, energy intensity, and costs for each scenario—results that Gov. Brown's office and several state agencies have leveraged to inform ongoing implementation and analysis of the state's climate goals.
- Evaluated the challenges, costs, and potential solutions for achieving a 50% RPS in California by 2030, finding that such a policy was indeed feasible and recommending a range of integration and coordination strategies to lower its cost.

CALIFORNIA PUBLIC UTILITIES COMMISSION San Francisco, CA

Commissioner January 2010 – January 2011

- Reviewed/approved rates and rate-payer financed investments for investor owned electric, water and communications utilities.
- Assigned Commissioner for ongoing proceedings to develop policies for electric vehicles, smart grid, solar power, energy storage, and nuclear energy.

- Spoke frequently to state, national and international audiences on California's clean energy policies.
- Served on CPUC legislative subcommittee, responsible for reviewing and recommending positions on pending legislation affecting industries under CPUC jurisdiction.

Deputy Executive Director for Policy and External Relations January 2011 – March 2013
April 2009 – January 2010

- Responsible for developing policies and overseeing technical analyses for the electric sector, including greenhouse gas emissions reduction, renewable energy, energy storage, electric transportation, smart grid, and long-term procurement planning.
- Liaison to Governor's office, California Legislature, other state energy and environmental agencies, federal authorities, foreign governments and stakeholders.
- Served on Governor's Climate Action Team and Energy Principals' Group, which develop greenhouse gas reduction strategies and coordinate efforts across agencies.
- Delivered frequent speeches and presentations at conferences, testified before the California Legislature, participated in policy roundtables.

Chief of Staff to President Michael R. Peevey June 2007 – March 2009

Directed a team of five advisors supporting President Peevey and provided ongoing direction to several interdisciplinary staff teams responsible for developing the CPUC's energy policies in the context of quasi-judicial regulatory proceedings.

Chief Energy Advisor to President Michael R. Peevey January 2006 – June 2007

- Advised CPUC President on a wide range of economic and environmental policies affecting the electric power industry, with emphasis on policies aimed at reducing greenhouse gas emissions and relating to the industry's wholesale and retail market structure.
- Prepared speeches and presentations for President Peevey.

ENVIRONMENTAL DEFENSE Oakland, CA
Senior Economist and California Deputy Regional Director 2001 – 2005

Provided economic and policy analyses, with focus on environmental impacts of energy use and production. Developed and maintained relationships with public officials, businesses, consumer and taxpayer advocates, unions, and other stakeholders. Served as media spokesperson. Managed multi-disciplinary teams of professional staff and consultants.

GOLDMAN SCHOOL OF PUBLIC POLICY, University of California, Berkeley
Visiting Assistant Professor 1996 – 2007

Taught a graduate course on Cost-Benefit Analysis and undergraduate courses on Cost-Benefit Analysis, Regulatory Policy and Industrial Organization (Economics Department)

INDEPENDENT CONSULTING San Francisco Bay Area, CA
1997 – 2001

Advised and provided economic analysis to environmental organizations and government agencies on electric utility restructuring, FERC relicensing of hydroelectric projects, and environmental restoration and mitigation programs.

QUANTUM CONSULTING Berkeley, CA
Senior Manager 1993 – 1996

Managed all aspects of research projects for major electric utilities and the Electric Power Research Institute. Projects emphasized load research and integrated analysis of conservation programs for the commercial and residential sectors. Developed sample designs and work plans. Devised statistical methods and provided expert review of research findings. Directed activities in multiple locations of interdisciplinary project teams. Prepared client reports and presented research results. Marketed to new and existing clients. Responsible for hiring, training, discipline and performance appraisal of professional staff.

Analyst/Senior Economist 1987 – 1989
Analyzed impacts of demand side management programs and conducted market research for electric utilities and the Electric Power Research Institute. Trained and supervised junior analysts.

FACULTY of COMMERCE and BUSINESS ADMINISTRATION University of British Columbia
Assistant Professor 1991 – 1993

Conducted empirical research on political economy of environmental and public utility regulation in the U.S. and Canada. Taught undergraduate courses in applied economics and statistical analysis.

Education

University of California Berkeley, CA
Ph.D., Economics

Yale University New Haven, CT
B.A., Economics
With Distinction; Magna Cum Laude

Citizenship

United States