Virginia Transportation Electrification Stakeholder Process Report

PROCESS SUMMARY AND POLICY PROPOSALS

The stakeholder engagement process described in this report was convened by the Virginia State Corporation Commission, facilitated by Great Plains Institute, with modeling & analysis performed by ERM Group Inc.

FEBRUARY 2022

About this Report

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Usage of this Report

This document summarizes the process, policy proposals, modeling, and analysis of the Virginia Transportation Electrification Stakeholder Process. The viewpoints stated in this document represent the collective thinking of the participants. No view should be attributed to any specific individual or organization.

Acknowledgments

The Great Plains Institute (GPI) and ERM Group Inc. (ERM) would like to thank the Virginia State Corporation Commission (SCC) for the opportunity to convene this process and conduct modeling in support of it. GPI and ERM would also like to thank the participants and guest speakers for their significant time commitment and thoughtful engagement throughout this process.

About the Facilitator and Modeling Partner

Great Plains Institute: A nonpartisan, nonprofit organization, GPI is transforming the energy system to benefit the economy and environment. Working across the US, we combine a unique consensus-building approach, expert knowledge, research and analysis, and local action to find and implement lasting solutions. Our work strengthens communities and provides greater economic opportunity through creation of higher paying jobs, expansion of the nation's industrial base, and greater domestic energy independence while eliminating carbon emissions. Learn more at www.betterenergy.org.

ERM Group Inc.: ERM partners with the world's leading organizations, creating innovative solutions to sustainability challenges and unlocking commercial opportunities that meet the needs of today while preserving opportunity for future generations. Our diverse team of world-class experts supports clients across the breadth of their organizations to operationalize sustainability, underpinned by our deep technical expertise in addressing their environmental, health, safety, risk and social issues.

Questions About This Report

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I. Report Overview and Process Take-Aways

This report summarizes the results of a stakeholder engagement process that was convened to develop policy proposals for accelerating transportation electrification in the Commonwealth of Virginia, with a particular focus on public electric utility programs.

The Virginia State Corporation Commission (SCC) convened the process in response to House Bill 2282 of the Virginia General Assembly. It was facilitated by the Great Plains Institute (GPI), with modeling and analytical support from ERM Group.

Over the course of five meetings, a group of approximately 85 stakeholders met to hear presentations, develop scenario modeling, and engage in facilitated conversations to work through a series of topics and considerations with respect to electrifying transportation in the Commonwealth. Ultimately, the group developed six policy proposals for consideration by the SCC and the General Assembly, including requiring utilities to submit transportation electrification plans and anonymized data filings, providing guidance on time-varying rate designs, pursuing and coordinating federal funding for transportation electrification, launching a separate process focused specifically on solutions for medium- and heavy-duty vehicles, and ensuring the SCC has the authority it needs to comply with House Bill 2282. These proposals are listed in greater detail in the report that follows. While the group did not drive to consensus, there was general support for the resulting policy proposals in the final meeting.

The process also generated several take-aways that may be of interest to the SCC and the General Assembly, including the following:

- **Electric system costs**: The modeling conducted as part of this process found that total utility revenue associated with electric vehicles is likely to exceed the total cost of increased generation and infrastructure needed to serve those electric vehicles due to more efficient use of the grid, even in a scenario where all vehicles in Virginia are electric by 2045.[1]
- **Electric vehicle owner costs:** The modeling also found that the lifetime cost of owning an electric vehicle is cheaper than owning a combustion vehicle, considering the cost of the vehicle, fuel (gas or electricity), maintenance, and the cost of a charger for electric vehicles.
- **Investments to support electrification:** Significant investments in charging and electric system infrastructure would be required to reach high levels of electric vehicle adoption in Virginia. In a scenario where all vehicles in Virginia become electric, annual charging infrastructure investments would be more than $900 million by 2050.

[1] In assessing utility costs, the model considered the increased electricity sales attributable to electric vehicles, the generation and transmission costs of that additional electricity, and the costs of building additional transmission and distribution infrastructure to accommodate increases in peak demand caused by electric vehicles. However, the model did not seek to identify specific generation resources that would need to be built nor how transportation electrification might impact hourly PJM energy prices.

- **Societal benefits:** Widespread electric vehicle adoption would provide air quality, climate, and electric utility rate benefits to everyone in Virginia and would decrease the cost of vehicle ownership for electric vehicle owners. For example, under a 100% penetration scenario annual societal benefits would reach $7.1 billion.
- **Strategies for utilities to advance transportation electrification:** While electric utilities don’t have direct control over vehicle sales, the stakeholders in this process identified many things that they can do to help advance transportation electrification in their service territories, including providing rebates and incentives for chargers and wiring needed to support electric vehicles, rate designs that encourage charging at times that won’t contribute to electric system peak and that will utilize renewable energy, and customer education and outreach to increase familiarity with electrified transportation technologies, among many other tools and strategies described in this report.
- **Benefits of managed charging:** Successfully managing electric vehicle charging through utility programs and rate designs would increase the societal benefits of electric vehicle adoption and minimize the overall impact on the electric system. In a scenario where all vehicles in Virginia become electric, unmanaged charging would result in $690 million of foregone benefits per year by 2050.
- **Strategies for utilities to enhance equity:** In addition, stakeholders identified a number of ways that electric utilities can improve equitable access to electrified transportation, including in the design of rebate programs and rate designs, through partnerships with local transit authorities, and through direct engagement with local communities.

The report that follows covers these items in greater detail, with attention to many considerations for the resulting policy proposals. The following list provides a summary of each major section of the report:

- **Executive Summary and Introduction:** This section introduces transportation electrification at a high level, summarizes House Bill 2282, and summarizes the process and resulting policy proposals.
- **Engagement Process**: This section describes the process and participating organizations, results of an initial participant survey, a list of desired outcomes for transportation electrification that were developed by the stakeholder group, an introduction to the scenario modeling that informed the group’s thinking, and a list of presentations and discussions that occurred at each meeting.
- **Discussion Topics:** This section summarizes the group’s discussions across the five meetings, organized by each major topic that House Bill 2282 asked the SCC to evaluate in developing its policy proposals. Each subsection describes a list of strategies that utilities can deploy to advance transportation electrification, stakeholder commentary on those strategies, additional considerations beyond utility programs, and strategies focused specifically on promoting equity.
- **Scenario Modeling:** This section describes the inputs and results of the scenario modeling that ERM Group conducted at the direction of the stakeholder group. It covers

three very different transportation electrification scenarios and the impacts that each would have on consumers, the grid, and utilities.

- **Policy Proposals:** This section describes the six policy proposals developed by the stakeholder group for consideration by the SCC and the General Assembly.
- **Conclusion:** This section summarizes key points of the process and the resulting policy proposals.

II. Introduction and Executive Summary

Introduction

Across the United States, electrified transportation is increasingly being looked at to reduce greenhouse gas emissions and reduce overall costs for consumers. Electrifying transportation brings with it the challenge of merging two sectors that have traditionally been distinct from one another—transportation, which is regulated through federal, state, and local governments; and the electric sector, which is regulated federally at the wholesale level, as well as by state utility regulatory commissions at the wholesale and distribution levels. Merging these sectors raises new questions about how electric utility investments and programs that support transportation electrification should be regulated.

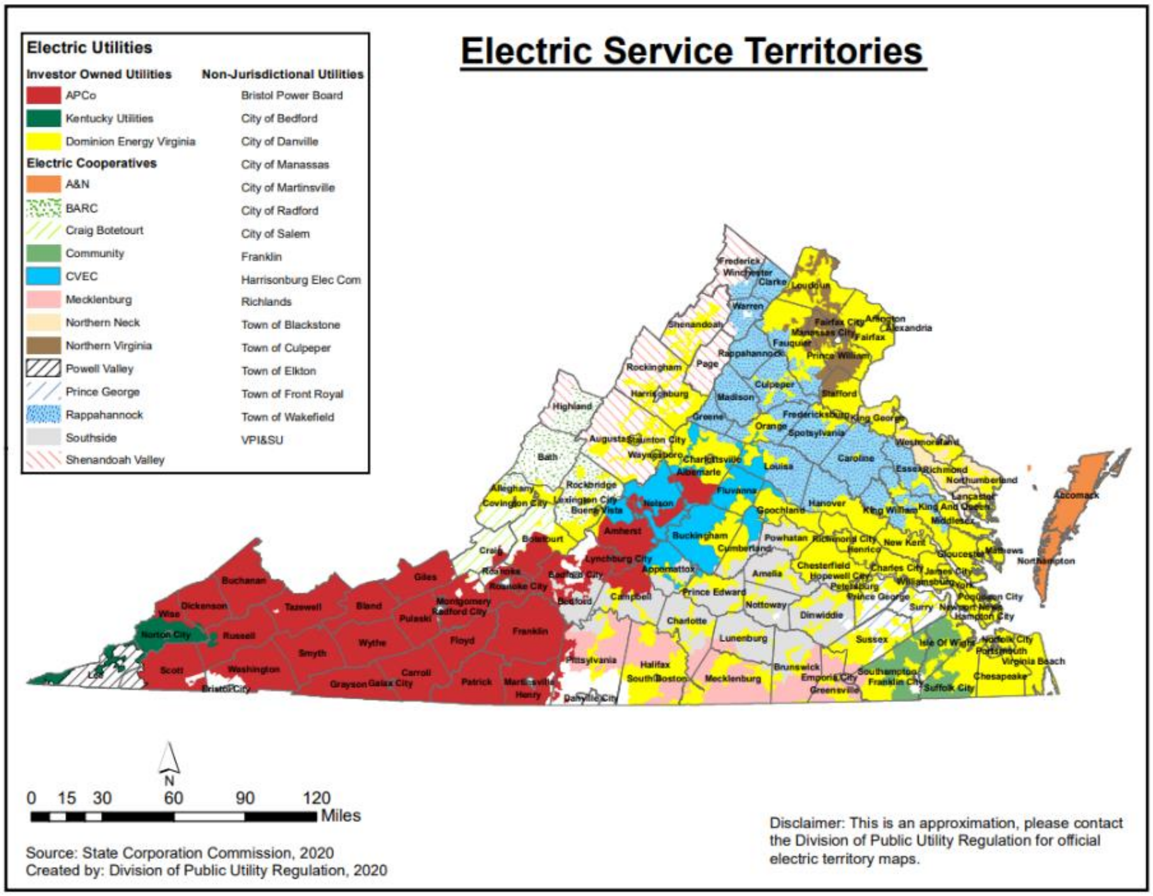
As more electric vehicles and associated charging infrastructure are deployed, electric utilities and their regulators are seeing both opportunities and challenges. On the one hand, electric vehicles could potentially put downward pressure on electricity rates by allowing utilities to sell more units of electricity to cover the fixed costs of utility infrastructure, ultimately making electricity more affordable for all customers. On the other hand, supplying the additional electricity needed to support electric vehicles could require utilities to invest in infrastructure upgrades, putting upward pressure on electricity rates and potentially making electricity more expensive for all customers. Notably, the modeling conducted during this process found that the total utility revenue associated with electric vehicles is likely to exceed the total cost of increased generation and infrastructure needed to serve those electric vehicles. If these savings were to flow to utility customers, high levels of electric vehicle saturation may put downward pressure on rates.

In addition, many utilities are now offering programs to educate their customers on electric vehicles and reduce the costs of purchasing and owning an electric vehicle. When deciding whether to approve these programs, regulators may consider many things. Considerations may include the impact on rates, consumer choice, equity, the role of the utility versus private companies, and accessibility to transportation services.

Notably, the size, type, and characteristics of the utility that serves a particular area can be important for determining which transportation electrification offerings are reasonable and in the public interest. In Virginia, retail electricity is provided by three investor-owned utilities, 13 cooperative utilities, and 16 non-jurisdictional (mostly municipally governed) utilities. Of these utilities, the SCC regulates the investor-owned utilities and 12 of the cooperative utilities.[2] The approximate utility service territories are illustrated in figure 1 below.

[2] Twelve of Virginia's electric cooperatives are regulated as to rates and to service by the SCC; one is regulated as to rates by the Tennessee Valley Authority, and as to service by the SCC.

Figure 1: Virginia Electric Utility Service Territories



Source: Reprinted with permission from the Virginia State Corporation Commission, Division of Public Utility Regulation, 2020.

House Bill 2282

In the spring of 2021, the Virginia General Assembly passed, and Governor Northam signed into law, House Bill 2282[3] (HB 2282), which directed the Virginia State Corporation Commission (SCC) to submit a report to the General Assembly no later than May 1, 2022, recommending policy proposals that could govern public electric utility programs to accelerate widespread transportation electrification in the Commonwealth. HB 2282 also required that the SCC evaluate the following in developing its policy proposals:

1. Areas where utility or other public investment may best complement private efforts to effectively deploy charging infrastructure, with a particular focus on low-income, minority, and rural communities.

[3] H.B. 2282, 161st General Assembly, Reg. Sess. (Va. 2021).

2. How smart growth policies can complement and enhance the Commonwealth's transportation electrification goals.
3. How utility programs, investments, or incentives to customers or third parties to facilitate the deployment of charging infrastructure and related upgrades can support or enhance:
    a. statewide transportation electrification, including electrification of public transit;
    b. the electrification of medium-duty and heavy-duty vehicles, school buses, vehicles at ports and airports, personal vehicles, and vehicle fleets;
    c. increased access to electric transportation and improved air quality in low-income and medium-income communities;
    d. achievement of the energy storage targets established in subsection E of § 56-585.5 of the Code of Virginia;
    e. improvements to the distribution grid or to specific sites necessary to accommodate charging infrastructure; and
    f. customer education and outreach programs that increase awareness of such programs and the benefits of transportation electrification.

HB 2282 further required that the SCC's report address whether and how transportation electrification can deliver the following benefits under current law, or include recommendations for how policy would need to change to bring about these benefits:

- reduce total ratepayer rates and costs;
- assist in grid management and more efficient use of the grid in a manner that does not increase peak demand through time-of-use rates, managed charging programs, vehicle-to-grid programs, or other alternative rate designs;
- utilize increased generation from renewable energy resources; and
- reduce fueling costs for vehicles.

Finally, the bill required the SCC to retain a third-party facilitator to facilitate a public engagement process to guide the development of policy proposals. The SCC subsequently issued a request for proposals and hired the Great Plains Institute (GPI) to convene a stakeholder engagement process and GPI's partner ERM Group Inc. to conduct modeling supporting the process.

Process Participants

GPI convened stakeholders for a series of five meetings from October through December 2021 to solicit input that could inform the SCC's report to the General Assembly. Each meeting agenda included a mix of expert presentations to build the group's understanding of the issues, panel discussions to understand different perspectives on those issues, and whole group discussions to develop policy proposals.

Over 60 different organizations participated in the meetings, including investor-owned and cooperative electric utilities, clean energy advocates, consumer advocates, environmental advocates, business and economic development advocates, auto manufacturers, electric vehicle service providers, state government agencies, local governments, and others.

Initial Survey

To kick off the stakeholder engagement process, GPI issued a survey to all participants to identify their level of transportation electrification literacy and expertise, their initial opinions on transportation electrification benefits and concerns, and their desired outcomes.[4]

The survey showed that participants collectively had broad expertise on utility regulation and transportation electrification issues. Areas of expertise included electric vehicle technologies, policy design, utility rate design, renewable energy, energy storage, and specific transportation sectors.

It also showed general agreement among stakeholders that transportation electrification can bring about most of the desired benefits stated in HB 2282, including assisting in grid management and more efficient grid use, utilizing increased generation from renewable energy resources, and reducing fueling costs for vehicles. Stakeholders were less certain that transportation electrification could reduce total ratepayer electric rates and costs.

Stakeholders cited many additional benefits from transportation electrification: reducing emissions of both greenhouse gases and local air pollutants, improving public health, creating jobs and economic development opportunities, promoting greater social equity, reducing dependence on foreign energy sources, reducing noise pollution, and fostering the development of emerging technologies like energy storage.

Survey respondents also cited several concerns about increased transportation electrification: equitable distribution of and access to electric vehicle infrastructure, interoperability of electric vehicle charging stations, appropriate subsidization, cost impacts overall and to poor and rural individuals, grid constraints, vehicle availability, charging station availability, customer friendliness of new technologies and programs, and waste streams associated with discarded batteries. In addition, multiple respondents said their concern was that transportation electrification is not happening fast enough.

These benefits and concerns were discussed in the first two meetings and incorporated into a list of desired outcomes of transportation electrification policies included in the full report.

Scenario Modeling

To inform stakeholder discussions, ERM Group conducted modeling that assessed the high-level impacts of three primary statewide electric vehicle deployment scenarios:

- 25 percent electric vehicle saturation by 2045
- 50 percent electric vehicle saturation by 2045

[4] A summary of the full survey results can be found in the appendix of this report. Importantly, the survey results only provide context for stakeholder perspectives before the meetings took place. All the issues covered by the survey were also addressed in the meetings themselves, so stakeholder opinions may have changed after the meeting presentations and discussions.

- 100 percent electric vehicle saturation by 2045

The goal of conducting this modeling was not to predict the future with respect to transportation electrification in Virginia or determine what policies would be needed to advance transportation electrification. Rather, the goal was to develop a handful of very different scenarios for how the future could unfold, assess the impacts of those scenarios, and use those scenarios and impacts as a tool to inform the group's development of policy proposals.

The model compared the electric vehicle deployment scenarios with a reference case where deployment remains at today's level. All modeled scenarios showed that by 2050, they would result in lower overall costs to electric vehicle owners and all electric utility customers (even those that do not own an electric vehicle) while also improving air quality and reducing greenhouse gas emissions.[5]

The full modeling results are described in greater detail in the report and cover the inputs and assumptions used, as well as the impacts of each scenario on electric utilities, all utility customers, vehicles owners, greenhouse gas emissions, air quality, and society.

Policy Proposals

Informed by the modeling results and presentations and panel discussions from experts both within and outside the stakeholder group, participants discussed many different strategies for ensuring that transportation electrification in the Commonwealth can bring about the desired outcomes stated in HB 2282. Ultimately, the group refined a set of six policy proposals that could govern public electric utility programs to accelerate widespread transportation electrification in the Commonwealth. A brief description of each proposal is listed below; the full details of each proposal are described in the full report:

1. The SCC or the Virginia General Assembly could require regulated electric utilities to submit transportation electrification plans to the Commission on a regularly occurring cadence. These plans would detail several items, including transportation electrification forecasts, potential impacts, and planned utility offerings. This would allow the Commission and stakeholders to iteratively evaluate and provide feedback to electric utilities with regard to their transportation electrification planning and programs.
2. As a complement to transportation electrification plans, the SCC or the Virginia General Assembly could require utilities to regularly file anonymized transportation electrification data, which would provide transparency and encourage innovation. The required data could include information such as the number of electric vehicles enrolled in a utility's managed charging programs and the impacts of those vehicles on system peak electric load. To initiate this process, the SCC could hold a workshop to determine what

[5] In assessing utility costs, the model considered the increased electricity sales attributable to electric vehicles, the generation and transmission costs of that additional electricity, and the costs of building additional transmission and distribution infrastructure to accommodate increases in peak demand caused by electric vehicles. However, the model did not seek to identify specific generation resources that would need to be built nor how transportation electrification might impact hourly PJM energy prices.

information would be most useful and what it would take to access and collect that information.

3. To assist utilities and acknowledge the importance of managing when electric vehicles charge, the SCC could develop guidance on time-varying rate designs and managed charging offerings for utilities to utilize when designing such offerings.
4. The state should pursue federal funding to support transportation electrification in the Commonwealth and form a joint interagency team to ensure federal dollars are efficiently administered and implemented throughout the state.
5. The SCC or the Virginia General Assembly should implement an additional stakeholder engagement process focused on medium- and heavy-duty electric vehicles, given that the technology is more nascent and there are unique challenges and opportunities for this sector.
6. The General Assembly should give the SCC the authority it needs, with respect to Dominion Energy and Appalachian Power, to make sure that as transportation electrifies, rates accurately reflect total costs and total sales.

In conclusion, this stakeholder engagement process found that transportation electrification can potentially bring about the desired benefits listed in HB 2282, but doing so will require the SCC and/or the Virginia General Assembly to put policies in place that can ensure electrified transportation is deployed thoughtfully and with attention to the potential impacts to all Virginians.

III. Engagement Process

At the direction of the State Corporation Commission (SCC), the Great Plains Institute (GPI) convened stakeholders for a series of five virtual meetings from October through December 2021 to solicit input that could inform the SCC's report to the Virginia General Assembly. The meetings and the overall process were designed to accomplish the following high-level objectives, in addition to addressing the requirements of HB 2282:

1. Build a shared understanding among participants of the current state, challenges, and opportunities around the future growth of transportation electrification in Virginia.
2. Develop policy proposals that could govern public electric utility programs to accelerate widespread transportation electrification in Virginia.
3. Identify areas of agreement and disagreement, as well as key questions, among the stakeholder group.
4. Foster a culture of trust, honesty, and collaboration among stakeholders to support productive dialogue on transportation electrification, both during this process and afterward.

To accomplish these goals and cover the breadth of topics listed in HB 2282, GPI identified a high-level topical focus for each meeting. Each meeting agenda included a mix of expert presentations to build the group's understanding of the issues, panel discussions to understand different perspectives on those issues, and whole group discussions to develop policy proposals. The meetings also offered an opportunity for stakeholders to provide input on the scenario modeling inputs and understand the modeling results to inform their thinking. The content covered in each meeting is described in more detail below.

PARTICIPATING ORGANIZATIONS

To recruit participants, GPI and the SCC conducted outreach to stakeholders that had been involved in previous SCC dockets related to transportation electrification, as well as to additional parties whose perspectives seemed important to discussions of transportation electrification. All interested individuals and parties were welcome to attend the meetings. The following organizations participated in at least one of the five meetings. A complete list of meeting attendees is included in the appendix of this report.

- A&N Electric Cooperative
- The Ad Hoc Group, Inc
- Advance Energy Economy
- Alexandria Transit Company
- Alliance for Automotive Innovation
- Alliance for Transportation Electrification
- AMPLY Power
- Appalachian Power /American Electric Power
- BARC Electric Cooperative
- Central Virginia Electric Cooperative
- Ceres, Inc.
- ChargePoint
- The Climate Collaborative

- City of Alexandria, Office of Energy Management
- City of Salem
- Clean Virginia
- Craig-Botetourt Rural Electric Cooperative
- Dominion Energy
- Earthjustice
- Electrification Coalition
- Energetics
- Energy Efficient Transportation
- EVgo
- Faith Alliance for Climate Solutions
- FreeWire Technologies
- Generation180
- Gentry Locke
- Greenlots
- LG&E and KU Energy, LLC
- Macaulay & Jamerson, PC
- McGuire Woods, LLP
- The Nature Conservancy
- Natural Resources Defense Council
- Northern Neck Electric Cooperative
- Northern Virginia Electric Cooperative
- Old Dominion Electric Cooperative
- Proterra
- Rappahannock Electric Cooperative
- Shenandoah Valley Electric Cooperative
- Sierra Club
- Southeast Sustainability Directors Network
- Southern Environmental Law Center
- Spilman Thomas & Battle, PLLC
- Sunrun
- Tesla
- Toyota Motor North America
- Uber Technologies
- University of Virginia School of Law
- Vectre Corporation
- VEIC
- Virginia Association of Counties
- Virginia Automobile Dealers Association
- Virginia Clean Cities
- Virginia Department of Energy
- Virginia Department of Environmental Quality
- Virginia Department of Transportation
- Virginia Poverty Law Center
- Virginia Truck Association
- Virginia, Maryland, and Delaware Association of Electric Cooperatives
- Volkswagen
- Volvo
- WeaveGrid

INITIAL PARTICIPANT SURVEY

To kick off the stakeholder engagement process, GPI issued a survey to all participants to identify the following:

- Their current level of transportation electrification literacy and relevant areas of expertise
- Their initial opinion on whether transportation electrification could bring about the desired benefits stated in HB 2282
- Additional benefits they felt were important but not listed in HB 2282
- Desired outcomes for the process
- General questions, concerns, and topics of interest to inform the process
- Opinions on scenario modeling inputs

The survey showed that participants collectively had broad expertise on issues relevant to utility regulation and transportation electrification, including electric vehicle technologies, policy design, utility rate design, renewable energy and energy storage, and knowledge on specific transportation sectors.

It also showed general agreement among stakeholders that transportation electrification can bring about most of the desired benefits stated in HB 2282, including assisting in grid management and more efficient use of the grid, utilizing increased generation from renewable energy resources, and reducing fueling costs for vehicles. There was more uncertainty among stakeholders that transportation electrification could reduce total ratepayer electric rates and costs.

Stakeholders cited many additional benefits that transportation electrification can bring about, including reducing emissions of both greenhouse gases and local air pollutants, improving public health, creating jobs and economic development opportunities, promoting greater social equity, reduced dependence on foreign energy sources, reduced noise pollution, and fostering the development of emerging technologies like energy storage.

Survey respondents also cited several concerns about increased transportation electrification, including equitable distribution of and access to electric vehicle infrastructure, interoperability of electric vehicle charging stations, appropriate subsidization, cost impacts overall and to poor and rural individuals, grid constraints, vehicle availability, charging station availability, customer friendliness of new technologies and programs, and waste streams associated with discarded batteries. In addition, multiple respondents said their concern was that transportation electrification is not happening fast enough.

These benefits and concerns were discussed in the first two meetings and incorporated in the desired outcomes of transportation electrification policies described below.

A summary of the full survey results can be found in the appendix of this report. Importantly, the survey results only provide context for stakeholder perspectives before the meetings took place. All the issues covered by the survey were also addressed in the meetings themselves, so stakeholder opinions may have changed after the meeting presentations and discussions.

DESIRED OUTCOMES OF TRANSPORTATION ELECTRIFICATION POLICIES

While HB 2282 laid out a set of desired outcomes for transportation electrification in the Commonwealth, GPI facilitators felt it was important to ask whether there were additional desired outcomes that participating stakeholders felt should be considered in developing policy proposals. The group subsequently discussed, refined, and agreed to the following desired outcomes for transportation electrification policies and criteria for robust policy development. These were drafted based on HB 2282, input from the initial survey, and discussion in the first two meetings. The desired outcomes are split into two categories:

- **Desired outcomes over time**: These are intended to declare what transportation electrification policies in the Commonwealth should aspire to deliver, uphold, or maintain. Importantly, the group acknowledged that not every transportation electrification policy, program, or investment would need to achieve all these desired outcomes; rather, these provide a vision for what a portfolio of policies, programs, and investments should seek to accomplish over time.
- **Criteria for robust policy development**: These are intended to serve as a checklist for ensuring that the policies developed achieve the desired outcomes, are thoughtful, and can be implemented.

These outcomes are intended to be taken as a package, such that stakeholders agreed to the full set but may not have supported individual outcomes on their own. These are numbered for reference purposes only; the numbers do not reflect a ranking or prioritization.

<u>Desired Outcomes Over Time for Transportation Electrification Policies:</u>

1. **Empower customers through education and outreach:** Support informed decision-making among utility customers by providing adequate education and outreach.
2. **Ensure access and equity:** Increase access to electrified transportation in an equitable manner, such that the benefits of electrified transportation are accessible to all Virginians, accruing first to disadvantaged and rural communities, and that the costs are not borne disproportionately by disadvantaged and rural communities.
3. **Support, complement, or leverage public and private resources:** Support private investment and encourage technology and market innovation in deploying electrified transportation. Utilize utility investment and public funding, such as state or federal subsidies, to complement private investment and fill in gaps, such as in disadvantaged and rural communities.
4. **Encourage efficient use and preparation of the power grid:** Ensure that transportation electrification is implemented in a way that supports efficient use of the grid and minimizes increases to peak demand to the greatest extent reasonably possible. Also ensure the power grid is prepared to handle the scale and scope of the transition to transportation electrification and consider how transportation electrification may create grid benefits.

5. **Reduce greenhouse gas emissions and improve air quality:** Ensure that transportation electrification is implemented in a way that reduces greenhouse gas emissions, consistent with the Virginia Clean Economy Act[6] and other laws requiring net-zero greenhouse gas emissions economywide by 2045, and improves air quality, including and prioritizing low-income and medium-income communities.
6. **Foster workforce and economic development opportunities:** Ensure that transportation electrification is implemented in a way that fosters workforce and economic development opportunities, including as a result of new generation built to serve electrified transportation loads.
7. **Reduce costs for all customers:** Ensure that transportation electrification is done as cost-effectively as possible to maximize utility customer benefits, including implementing policies that can put downward pressure on electricity rates for all customers and reduce consumers' total costs (energy and transportation). Costs should consider externalities where applicable, including the social cost of carbon and lifecycle cost savings of electric vehicles.

Criteria for Robust Policy Development:

8. Ensure that state agencies have the authority and tools needed to be able to implement the policy proposals.
9. Ensure that policy proposals are grounded in information and analysis that all parties find credible and transparent.
10. Assess how policies and programs would integrate and work together with existing policies and programs and those currently being developed.
11. Tailor policies and programs appropriately to specific use cases, vehicle types, applications, and customer segments.

SCENARIO MODELING

As part of its request for proposals for a third-party facilitator, the SCC also requested assistance modeling the impacts of varying levels of electric vehicle deployment in Virginia. GPI's partner, ERM Group Inc. (ERM), worked with stakeholders to conduct this modeling to inform the group's discussions and development of policy proposals.

The modeling, which is described in greater detail later in this report, was developed to assess the high-level impacts of three statewide electric vehicle deployment scenarios that were proposed by the SCC and refined in response to stakeholder feedback:

- 25 percent electric vehicle saturation by 2045
- 50 percent electric vehicle saturation by 2045
- 100 percent electric vehicle saturation by 2045

[6] Virginia Clean Economy Act, H.B. 1156/S.B. 81, 161st General Assembly, Reg. Sess. (Va. 2020).

ERM presented an initial set of inputs and assumptions to the stakeholder group for feedback in the second meeting to establish the modeling inputs and assumptions. These inputs and assumptions were presented in three categories:

1. **Default:** common assumptions used for analyses of transportation electrification and unlikely to require modification.
2. **Standard:** Assumptions that may vary by state or analysis but have fairly standard and well-accepted sources. Changes to these would likely have minor or negligible impacts on modeling results.
3. **Discussion:** Assumptions that have a wider range of possible inputs. Changes to these may have more significant impacts on modeling results.

Facilitators from ERM and GPI asked stakeholders to review the standard assumptions but focus their attention in the meetings on the discussion assumptions. Staff from ERM adjusted the modeling inputs and assumptions in response to stakeholder feedback to ensure that participants could find the modeling results credible.

It is critical that anybody reading this report understands that scenario modeling looking decades into the future is inherently limited. The goal of conducting this modeling was not to predict the future with respect to transportation electrification in Virginia or determine what policies would be needed to advance transportation electrification. Rather, the goal was to develop a handful of very different scenarios for how the future could unfold, assess the impacts of those scenarios, and use those scenarios and impacts as a tool to inform the group's development of policy proposals. The modeling inputs and results are described in greater detail in the modeling section of this report.

MEETINGS

GPI convened stakeholders for five bi-weekly meetings from October 2021 through December 2021. Each meeting included participation from the stakeholders, facilitators from GPI, staff from the SCC, and external experts (regional and national) as noted below. All meetings were six hours long (including break time) and held virtually due to the COVID-19 pandemic. A brief list of the topics covered at each meeting and guest presenters is provided below.

Meeting 1: October 21, 2021: Process Overview, Level-Setting, and Challenges & Opportunities

Prior to this meeting, stakeholders were sent a set of background resources and reports on transportation electrification in Virginia and a survey to identify key challenges and opportunities that should be addressed as part of this process. Stakeholders were also sent a draft set of desired outcomes for transportation electrification policies based on HB 2282 and the survey results.

- The SCC introduced the facilitation team.
- David Essah of the SCC and Doug Scott of GPI provided an overview of the purpose and plan for this stakeholder engagement process.

- Stakeholders reviewed, discussed, and revised the draft set of desired outcomes for transportation electrification policies.
- Stakeholders heard level-setting presentations on the current state, challenges, and opportunities of transportation electrification:
    - National-level presentation by Grace Van Horn, ERM
    - State-level presentation by Catherine McGhee, Virginia Department of Transportation
- GPI facilitated a deeper dive into the current state, challenges, and opportunities in Virginia, featuring panel presentations and full group discussion.
    - Panelists:
        - Kate Staples, Dominion Energy
        - Daniel Francis, American Electric Power
        - Will Cleveland, Southern Environmental Law Center
        - Carine Dumit, EVgo

Meeting 2: November 4, 2021: Shifting/Shaping Electrified Transportation Loads

Prior to this meeting, stakeholders were sent a survey to solicit ideas for policy proposals to shift and shape electrified transportation loads. These ideas were incorporated into the group discussion during the meeting. Stakeholders were also sent a slide deck of the modeling assumptions, revised desired outcomes, and the draft plan for the topics to be discussed in meetings two through five.

- Stakeholders reviewed, discussed, and refined the desired outcomes for transportation electrification policies.
- Stakeholders discussed inputs and assumptions for the scenario modeling (presentation by Grace Van Horn and Ellen Robo, ERM). Stakeholders were invited to provide additional feedback via email through November 9.
- Phil Jones of the Alliance for Transportation Electrification presented on utility program design tools to shift and shape electrified transportation loads.
- GPI presented a menu of policy options for consideration (based on survey feedback and additional research done by GPI).
- Stakeholders discussed what policies are needed to shift and shape transportation electrification loads to reduce costs and/or emissions. GPI facilitated the discussion and provided the following questions and prompts to the group:
    - What are utilities already doing well, and what policies are needed to help fill the gaps?
    - Consider policies for all electrified transportation loads. For example, what rate designs are appropriate for public fast charging?

  - What policies are needed to expand access to electrified transportation for low-income communities and communities of color?
  - How would energy storage influence load shifting/shaping offerings?

Meeting 3: November 18, 2021: Deploying Charging Infrastructure

Prior to this meeting, stakeholders were sent a survey to solicit ideas for policy proposals to advance the deployment of charging infrastructure. These ideas were incorporated into the group discussion during the meeting. Stakeholders were also asked to review the policy options matrix from the second meeting and provide feedback.

- Ellen Robo of ERM Group provided an update on the scenario modeling.
- Stakeholders finalized the desired outcomes for transportation electrification policies.
- Stakeholders reviewed the policy options discussed during the second meeting and flagged any additions based on feedback provided by stakeholders.
- Nicole Lepre of Atlas Public Policy presented on investor-owned utility electric vehicle programs.
- GPI facilitated the following two panel discussions on policy proposals to support the deployment of charging infrastructure:
  - Panel 1: Charging Providers
    - Tom Ashley, Greenlots
    - Carine Dumit, EVGo
    - Kevin Miller, ChargePoint
    - Alleyn Harned, Virginia Clean Cities
  - Panel 2: Utilities
    - Kate Staples, Dominion Energy
    - Daniel Francis, American Electric Power
    - Cassandra Frysinger, Shenandoah Valley Electric Cooperative
    - Ben Hoyne, Virginia Poverty Law Center
  - Questions for both panels:
    - What are utilities doing well? What aren’t they doing well?
    - What policies are needed to deploy charging infrastructure more broadly in Virginia?
    - How can these policies accommodate and support successful third-party charging vendor business models?
    - How should the build-out of charging infrastructure, including both urban and rural areas, be funded and paid for?

        - What policies are needed to foster equitable access to the economic development and workforce opportunities resulting from the build-out of electrified transportation infrastructure (and how much should the public spend and in which areas)?

- GPI presented a menu of policy options for consideration (based on survey feedback and additional research done by GPI).
- Stakeholders discussed policy proposals to support the deployment of charging infrastructure.

Meeting 4: December 2, 2021: Going Beyond Personal Vehicles

Prior to this meeting, stakeholders were sent a survey to solicit ideas for policy proposals to advance transportation electrification beyond personal vehicles, including medium- and heavy-duty vehicles, buses (transit and school), and electric vehicle car sharing. These ideas were incorporated into the group discussion during the meeting.

- Ellen Robo and Grace Van Horn of ERM Group presented the scenario modeling results. Stakeholders asked clarifying questions during the meeting and sent GPI additional feedback via email.
- Rayla Bellis of Smart Growth America presented on how smart growth policies can complement and enhance the Commonwealth’s transportation electrification goals.
- GPI facilitated the following panel discussion on policy proposals to support deployment beyond personal vehicles, including medium- and heavy-duty vehicles, buses (transit and school), and electric vehicle car sharing:
    - Panelists:
        - Jessie Lund, Rocky Mountain Institute
        - Joseph Welborn, Fairfax County Schools
        - Praveen Kathpal, Motor
        - Raymond Mui, Alexandria Transit Company
    - Questions posed to panelists:
        - What are the top 1-2 utility policies that we need to support?
            - Medium- and heavy-duty electric vehicles?
            - Electric buses (transit and school)?
            - Electric vehicle car sharing?
        - What are utilities doing well to support transportation electrification beyond personal vehicles?
        - What additional support is needed from utilities to support transportation electrification beyond personal vehicles?

- GPI presented a menu of policy options for consideration (based on survey feedback and additional research done by GPI).
- Stakeholders discussed the policies needed to support electrification of medium- and heavy-duty vehicles, buses (transit and school), and electric vehicle car sharing.

Meeting 5: December 16, 2021: Review and Refine Draft Policy Proposals

Prior to this meeting, stakeholders were sent a list of draft policy proposals developed by GPI based on the meeting discussions to date and HB 2282. They were asked to note their level of support for each recommendation and provide feedback via a survey.

- Ellen Robo of ERM Group presented a brief update on the scenario modeling results after incorporating feedback from the fourth meeting.
- GPI facilitated a panel discussion among utility representatives on the upstream impacts of transportation electrification. Panelists included:
    - Kate Staples, Dominion Energy
    - Carlos Casablanca and Chad Burnett, American Electric Power/Appalachian Power
    - Sam Brumberg, Virginia, Maryland, and Delaware Associations of Electric Cooperatives
    - Kirk Johnson, Old Dominion Electric Cooperative
- Stakeholders reviewed and refined the draft policy proposals, as well as additional suggested proposals stakeholders had submitted through the pre-meeting survey.

IV. Discussion Topics

HB 2282 asked the SCC to specifically evaluate the following three issue areas in developing its policy recommendations:

1. Areas where utility or other public investment may best complement private efforts to effectively deploy charging infrastructure, with a particular focus on low-income, minority, and rural communities.
2. How smart growth policies can complement and enhance the Commonwealth's transportation electrification goals.
3. How utility programs, investments, or incentives to customers or third parties to facilitate the deployment of charging infrastructure and related upgrades can support or enhance:
    a. statewide transportation electrification, including electrification of public transit;
    b. the electrification of medium- and heavy-duty vehicles, school buses, vehicles at ports and airports, personal vehicles, and vehicle fleets;
    c. increased access to electric transportation and improved air quality in low-income and medium-income communities;
    d. achievement of the energy storage targets established in subsection E of § 56-585.5 of the Code of Virginia;
    e. improvements to the distribution grid or to specific sites necessary to accommodate charging infrastructure; and
    f. customer education and outreach programs that increase awareness of such programs and the benefits of transportation electrification.

HB 2282 further required that the SCC's report address whether and how transportation electrification can deliver the following benefits under current law, or include recommendations for how policy would need to change to bring about these benefits:

- reduce total ratepayer rates and costs;
- assist in grid management and more efficient use of the grid in a manner that does not increase peak demand through time-of-use rates, managed charging programs, vehicle-to-grid programs, or other alternative rate designs;
- utilize increased generation from renewable energy resources; and
- reduce fueling costs for vehicles.

Below, we describe what the stakeholder group discussed with respect to each of these issue areas, including possible utility programs and investments that could be implemented and specific considerations that stakeholders raised concerning those programs and investments. We have also listed a set of equity-specific options and considerations under each issue area separately. These discussions ultimately informed the policy proposals listed later in this report.

COMPLEMENTING PRIVATE EFFORTS TO DEPLOY CHARGING INFRASTRUCTURE

One of the items HB 2282 directed the SCC to evaluate was "areas where utility or other public investment may best complement private efforts to effectively deploy charging infrastructure, with particular focus on low-income, minority, and rural communities."

Unlike their gasoline counterparts, electric vehicles can be charged at home, work, public places, and highway stops. Increased deployment of charging infrastructure at these locations makes driving electric vehicles more convenient and encourages more adoption of these vehicles.

Utilities play a central role in building a flourishing ecosystem where a combination of stakeholders like retailers, charging service providers, workplaces, and local governments build out electric vehicle charging infrastructure. Utility support in the form of rate design, advising and consultation services, and grid upgrades helps private charging service providers, fleet owners, and citizens purchase electric vehicles and install electric vehicle chargers.

Utilities will continue to play an important role in enabling the competitive landscape for electric vehicle charging as they forecast and cater to additional grid load that may come with electric vehicles. Throughout this process, stakeholders offered the following recommendations and additional considerations that can help utilities in Virginia complement private sector efforts to deploy charging infrastructure.

Utility Programs

There are several ways that utilities and other public investments can support private efforts in deploying charging infrastructure. Below, we describe several possible strategies to accomplish this along with specific considerations raised by stakeholders where applicable. These program proposals may not be appropriate for all utilities considering the fact that utilities need reasonable and timely cost recovery for investments. Regulators may look at the size, type, and characteristics of the utility that serves a particular area and determine which transportation electrification offerings are reasonable and in the public interest.

a. **Rebates and incentives for chargers**: Utilities can encourage customers to enroll in managed charging programs by subsidizing the cost of chargers. Some utilities offer rebates on the purchase and installation of select smart chargers. Smart chargers allow customers to monitor and control the duration and speed of charging. Some utilities also offer monthly rebates to customers that enroll in smart charging programs.

   Stakeholders recommended that rebate programs should be paired with educational tools and resources that help customers understand their energy requirements. In addition, some customers may prefer turn-key solutions for their electric vehicle charging needs. In this situation, third-party providers or utilities can provide the infrastructure for a monthly fee instead of financing the infrastructure for customers. In developing its plans and programs, the utility should put consumers and ratepayers, both electric vehicle owners and non-participants, at the forefront of planning and program design. The consumer or host site should be able to learn about utility programs easily. Also, the charging experience, whether it be at home, the workplace, or a public space, should be as seamless and convenient as possible.

Stakeholders also suggested that smart chargers be used to encourage off-peak charging through price signals. Utilities can encourage cheaper off-peak charging by enrolling customers who receive rebates on smart chargers into time-varying rate schedules (discussed in greater detail below under grid benefits).

b. **Incentives and rebates for direct current fast chargers:** Utilities can provide upfront or annual rebates for direct current fast charger owners to reduce the cost of ownership until electric vehicle deployment increases to a point where usage can cover the cost of ownership.

   Stakeholders acknowledged that electric cooperatives have limited budgets and may not be in a position to provide rebates or incentives. However, cooperatives can assist with planning, even if other stakeholders make the investments in direct current fast chargers and other infrastructure associated with electric vehicle charging.

c. **Make-ready infrastructure:** Utilities can lower customer costs to install electric vehicle chargers by covering some of the behind-the-meter infrastructure costs associated with installing chargers (e.g., the trenching and construction work needed to install the meter). These may be gaps that federal and state incentives for charging infrastructure will not cover.

d. **Install and maintain electric vehicle chargers at public places and multi-unit dwellings:** Utilities can increase electric vehicle charging infrastructure by investing in deploying Level 2 and direct current fast chargers at public places as well as multi-unit dwellings in their service area. These investments should target populations that cannot otherwise access adequate charging infrastructure.

e. **Demand charges:** Favorable rate structures can reduce operating and maintenance costs for fleets with electric vehicles. Temporarily eliminating or mitigating demand charges may encourage the adoption of electric vehicles as well as associated charging infrastructure, especially direct current fast chargers, while maintaining cost of service principles. Utilities may be particularly well-suited to offer customer rate analysis and help establish a rate that works for their customers while also balancing power quality.

   Stakeholders strongly encouraged utilities to establish contracts with non-jurisdictional entities (e.g., schools) and develop custom programs and rates.

Additional Considerations

Throughout the meetings, stakeholders raised the following issues that should be considered when planning charging infrastructure investments:

a. **Acknowledge varying vehicle needs**: Private light-duty electric vehicles and medium- and heavy-duty fleet electric vehicles will have varying charging needs. Utilities should recognize the different nature of these vehicles and identify approaches and policies to cater to each group of vehicles.

b. **Acknowledge varying needs across geographies:** Different geographies will also require different approaches (e.g., southwestern Virginia will have different charging needs compared to Northern Virginia). Different parts of the state may have different timelines for electric vehicle adoption.

c. **Utility investments should be future-proofed:** The current grid can support electric vehicles. However, utilities should plan to upgrade the grid and pursue grid modernization strategies, including non-wires alternatives, to meet the increased demand from widespread electric vehicle adoption in the future.

d. **Establish electric vehicle charging infrastructure goals for service territories:** In addition to the electric vehicle adoption goals set by HB 2282, Virginia should establish goals for infrastructure investments by electric utility service territory to guide funding.

e. **Utilize federal funding for rebates and charging infrastructure**: Federal funding should be utilized to support investments in charging infrastructure, especially in areas that have limited scope for private investments.

f. **Consider operating and maintenance costs in planning processes:** When planning for transportation electrification, plans should include operating and maintaining electric vehicle charging infrastructure. Deployment should not only focus on installing equipment. In locations where there is a need but no business case for supporting electric vehicle chargers, the chargers should be viewed as a public good and should be supported accordingly. In addition, this should be a consideration for infrastructure deployment, specifically in rural Virginia, where the utilization rates for the chargers are lower than urban Virginia.

g. **Energy storage:** Consider the integration of battery storage at public direct current fast charging stations and fleet applications to minimize make-ready and grid infrastructure costs as well as the load on the grid. Consider the use of energy storage as a technology solution for off-peak charging and demand charge management.

h. **Education and outreach:** Charging infrastructure deployment may be slowed down by negative perceptions about electric vehicles and charging infrastructure. Utilities and third parties should proactively build acceptance of, comfort with, and demand for these services by carrying out education campaigns about rebate offerings and the existing charging infrastructure market.

Equity Considerations

Transportation electrification and the deployment of associated charging infrastructure provide the opportunity to improve air quality and bring economic opportunities to disadvantaged communities. Stakeholders suggested the following considerations for utilities to make electric vehicle charging infrastructure deployment more equitable. These considerations will need supportive policy, utility investment, and partnerships with the private market:

a. **Equity provisions in transportation electrification plans**: If utilities are required to draft transportation electrification plans (one of the policy proposals coming out of this process), disadvantaged communities should be kept at the forefront of these investments. This includes special provisions for the following:

    i. **Older homes:** It might be a significant cost for some homeowners to upgrade their wiring to accommodate chargers. Utilities should explore supporting upgrades for older homes in concert with other housing programs that provide this support.

    ii. **Electric vehicle charging rebates for income-qualified customers:** Income-qualified customers often live in communities where transportation-related air pollution is a significant health risk. These customers would benefit the most from the improved air quality and fuel-cost savings associated with electric vehicles. However, they might not be able to afford to switch to electric vehicles because of the costs of charging infrastructure. As utilities design electric vehicle charger rebate programs, they should provide additional support to income-qualified customers.

    iii. **Engagement with communities:** Utilities, and other actors involved in electric vehicle charging infrastructure build-out, should engage communities before installing any infrastructure. This can help utilities determine the locations where chargers are needed, the types of chargers needed, and the business models most suitable to keep the chargers running. In addition, some communities may be better suited for electric ridesharing services rather than personal electric vehicles. Community engagement efforts should first seek to identify community needs and desired outcomes before offering solutions.

b. **Utility ownership of charging infrastructure at multi-unit dwellings:** Utilities can provide turn-key services to electric vehicle drivers at multi-unit dwellings, including installing and maintaining charging infrastructure at these buildings.

c. **Education and outreach:** Charging infrastructure deployment may be slowed down by negative perceptions about electric vehicles and charging infrastructure in disadvantaged communities, where people might view these technologies as luxury products for wealthy people. Utilities should work with trusted organizations in the communities to address misconceptions about electric vehicles and charging infrastructure deployment by carrying out educational events.

d. **Eliminating or mitigating demand charges:** Stakeholders discussed that eliminating or mitigating demand charges on a temporary basis, without overburdening the grid or inappropriately spreading costs to other ratepayers, will decrease operating costs of direct current fast charging, which would improve the business case for those stations. Doing so might increase the amount of public charging stations, making them more accessible if added in disadvantaged communities. Increasing accessibility for disadvantaged communities makes electric vehicle ownership easier for people who do not live in a single-family home where they can reliably charge their vehicle at night. The group recognized that time-variable rates may be an appropriate substitute if demand charges were eliminated. The group also recognized that the elimination of demand charges may not be appropriate for all utilities.

e. **Pairing electric vehicle chargers with energy storage:** Energy storage options help open up more locations. On-site energy storage allows chargers to be placed in remote areas where the cost of grid upgrades would be prohibitively expensive. Pairing energy storage technologies with direct current fast charging also presents an opportunity to help minimize demand charges and therefore help to manage operational costs.

SMART GROWTH POLICIES

HB 2282 also directed the SCC to evaluate “how smart growth policies can complement and enhance the Commonwealth’s transportation electrification goals.”

In meeting four, Rayla Bellis from Smart Growth America presented an analysis of the different variables beyond transportation electrification that can affect the greenhouse gas emissions associated with the transportation sector, which now accounts for 29 percent of the country’s greenhouse gas emissions.

While the vehicles on US roads became 18 percent more efficient from 1990 to 2017, the total emissions from the transportation sector still rose by 22 percent. This was due to a 50 percent increase in driving over the same period.

The negative effects of increased vehicle miles traveled go beyond the tailpipe emissions associated with the vehicles. For example, more pavement and concrete production accommodate increased vehicle miles traveled, which contributes to urban heat islands, requiring more air conditioning. The particulate matter from tires and breaks, which has negative health effects on the people who inhale it, is also linked directly to vehicle miles traveled, regardless of vehicle efficiency. Furthermore, the vehicle manufacturing process, even for zero-emission vehicles, is an energy-intensive process and contributes significantly to greenhouse gas emissions. Finally, the loss of land due to parking construction and urban sprawl also have negative environmental effects, which include but are not limited to increased greenhouse gas emissions.

Smart Growth America’s analysis showed the following:

- If vehicle miles traveled increase 25-30 percent by midcentury, 73-79 percent electrification would be required to meet the US climate goals of an 80 percent reduction in transportation emissions by 2050.
- If vehicle miles traveled dropped to 1991 levels by 2050, only 45 percent of the passenger vehicle fleet would have to electrify to meet the goal to reduce transportation-related greenhouse gas emissions by 80 percent.[7]

[7] Abdullah F Alarfaj, W Michael Griffin, and Constantine Samaras, “Decarbonizing US passenger vehicle transport under electrification and automation uncertainty has a travel budget,” *Environmental Research Letters* 15, no. 9 (September 7, 2020): 0940c2, https://doi.org/10.1088/1748-9326/ab7c89.

Smart growth policies include urban planning and zoning laws that encourage higher population densities and more affordable housing in areas where residents can use alternatives to private vehicles to make trips.

Bellis' presentation indicated that the COVID-19 pandemic significantly reduced vehicle miles traveled in the short term, but that current data shows that the vehicle miles traveled, from passenger vehicles and transit ridership, are close to pre-pandemic levels. This is because remote work is only possible for a small subset of the population. Most workers still commute to work.

Following the presentation, stakeholders discussed the impacts of ridesharing on total vehicle miles traveled. While ridesharing has the potential to reduce vehicle miles traveled as a first- and last-mile connector to public transit, ridesharing generally contributes to increased vehicle miles traveled because of the empty miles that drivers travel between passenger rides.

Virginia's SMART SCALE is a method of scoring planned projects that use state funds.[8] The scoring methodology prioritizes projects that, among other factors, utilize land efficiently and mitigate congestion on the Commonwealth's roads.

Virginia can complement the electric vehicle adoption goals set by HB 2282 through a comprehensive approach of smart growth policies that reduce vehicle miles traveled in the Commonwealth. Tools like the SMART SCALE can be expanded to institute vehicle mile and greenhouse gas emission reduction as goals for the state's transportation systems. This will incentivize agencies to prioritize electrified public transit and safer active transportation options like bikeways and sidewalks for Virginians.

Finally, stakeholders suggested that the Commonwealth should ensure that transportation electrification complements vehicle miles traveled reduction. To assist in this effort, utilities and other entities should be mindful to only put chargers on curbs as a last resort. Curbside chargers can impede bike lane development, add more obstacles for pedestrians, and signal the dominance of single-occupant vehicles.

SUPPORTING OR ENHANCING DESIRED OUTCOMES

Another item HB 2282 directed the SCC to evaluate was "how utility programs, investments, or incentives to customers or third parties to facilitate the deployment of charging infrastructure and related upgrades can support or enhance (i) statewide transportation electrification, including electrification of public transit; (ii) the electrification of medium-duty and heavy-duty vehicles, school buses, vehicles at ports and airports, personal vehicles, and vehicle fleets; (iii) increased access to electric transportation and improved air quality in low-income and medium-income communities; (iv) achievement of the energy storage targets established in subsection E of § 56-585.5 of the Code of Virginia; (v) improvements to the distribution grid or to specific sites necessary to accommodate charging infrastructure; and (vi) customer education and outreach

[8] "Smart Scale: Funding the Right Transportation Projects," SMART SCALE: Funding the Right Transportation Projects in Virginia, accessed December 24, 2021, https://smartscale.org/

programs that increase awareness of such programs and the benefits of transportation electrification."

Achieving the transportation electrification goals set by HB 2282 means extending transportation electrification beyond passenger vehicles. This will require a concerted effort from different stakeholders in the ecosystem, including fleet operators, charging service providers, local governments, and utilities.

The number of passenger electric vehicles on Virginia's roads has steadily climbed to 20,000 over the past year and is forecasted to continue growing, thanks to progressive legislation like the Clean Cars Virginia bill.[9] Transit operators like the Alexandria Transit Company are also incorporating electric transit buses in their fleets as the total cost of ownership for electric fleets falls below their internal combustion engine counterparts, thanks to utility support in the form of customized rate design and fleet advisory services.

Dominion Energy, Virginia's leading energy provider, introduced one of the country's largest electric school bus charging initiatives in 2020.[10] School bus electrification pilot programs like the one Dominion Energy initiated allow utilities, a leading partner in transportation electrification, to explore the viability of using electric vehicles as storage units to achieve the energy storage targets established in subsection E of § 56-585.5 of the Code of Virginia. Electric vehicles can potentially be used as strategic grid assets to offer support during peak times or other times when the support is needed.

Stakeholders offered recommendations and additional considerations that can help utilities in Virginia reach potential electric vehicle owners and operators. This effort includes developing attractive utility offerings specific to each type of customer, providing consultation services to the customers, and executing widespread education and outreach efforts to inform utility customers of the potential benefits of transportation electrification.

Utility Programs

There are several utility programs, investments, or incentives that can support the various items presented in HB 2282:

a. **Electric vehicle rebates and loans:** Utilities can encourage electric vehicle adoption by offering financial incentives to their customers that lower their purchase price.

   While stakeholders generally supported rebates and financial incentives for electric vehicle charging infrastructure, some participants insisted that the utilities should not play a role in incenting the purchase of the vehicles and should rather be encouraged to

[9] "Electric Vehicle Registrations by State," Alternative Fuels Data Center: Maps and Data - Electric Vehicle Registrations by State, US Department of Energy, accessed December 24, 2021, https://afdc.energy.gov/data/10962.

[10] Robert Walton, "Dominion Launches Electric School Bus Initiative, Aims for 100% Electric Fleet in Virginia Territory by 2030," *Utility Dive*, August 30, 2019, https://www.utilitydive.com/news/dominion-launches-electric-school-bus-initiative-aims-for-100-electric-fl/562021/.

connect their customers to the local, state, and federal vehicle purchase rebates for which their customers are eligible.

b. **On-bill financing:** Utilities already provide on-bill financing for heating, ventilation, and air conditioning, washers and dryers, and thermostats, etc. On-bill financing can be extended to electric vehicles. School districts can benefit from pay-as-you-save programs, which will allow them to pay lower upfront costs and save on operations and maintenance costs.

   Utilities (especially cooperatives) may require legislation to expand on-bill financing to electric vehicles and charging infrastructure.

c. **Group buys:** Group buy programs pool the purchasing power of utility customers to entice dealers and auto manufacturers to offer discounts on electric vehicles. Utilities could initiate group buy programs by establishing partnerships with auto dealers and auto manufacturers. This would allow customers to get discounts on electric vehicles sold by participating auto dealers and auto manufacturers.

d. **Ride-share electrification:** By partnering with ride-share companies, utilities can encourage ride-share drivers to switch to electric vehicles and ensure better utilization for their chargers by entering into agreements to provide them with electric vehicle charging infrastructure.

e. **School bus electrification:** School buses lend themselves well to electrification. Their duty cycles are usually easily met by electric powertrains. They provide significant health benefits to the students and communities where the buses operate. Utilities can help school districts purchase electric school buses and charging infrastructure through grants and other financial incentives.

   Utilities can also use school buses as energy storage for the grid. The impact of electric school buses on the electric grid can be tested by enrolling the school buses in vehicle-to-grid programs.

f. **Fleet advisory services:** Utilities can help fleets adopt electric vehicles by providing advisory services, which could include providing funding for fleet electrification studies to be conducted by professional third-party service providers. While fleets know their transportation needs, utilities and affiliated fleet advisors are best equipped to calculate the energy needs and costs associated with electrification. Utilities can play a significant role in advising fleets on their electrification options and help disseminate information on the advantages of different available rates and load management programs.

   Some stakeholders suggested that state agencies should be tasked with advising fleets that want to electrify, such as active fleet and constituent response programs at Virginia Department of Energy. However, most stakeholders were in favor of utilities also carrying out this function as they thought utilities are likely to have a better understanding of potential grid impacts and tariffs.

g. **Education and outreach programs:** Electric vehicles are a new technology, and many people and organizations are unaware of the capabilities of the current generation of electric vehicles. Utilities can increase electric vehicle awareness for their customers by conducting education and outreach programs. Utilities can adopt various marketing and outreach strategies to educate on the value and importance of electric vehicles, including hosting ride and drive events, social media outreach, and education via bill inserts.

h. **Grid planning:** Utilities are a central point where all information about potential grid impacts should come. The utilities then consider the expected load when investing in the grid. Stakeholders agreed that early conversations with utilities are critical, especially for larger fleets that plan on electrifying.

   Stakeholders also noted that many federal fleet vehicles, a significant number of which operate in Virginia, will electrify to meet the targets set by the federal government. Utilities will need to incorporate that in grid planning.

Additional Considerations

Throughout the meetings, stakeholders raised the following issues that should be considered when planning for increasing electric vehicle uptake:

a. **Research on vehicle-to-grid program acceptance:** Research is needed to determine if vehicle-to-grid programs will be successful with residential customers. The psychological barrier of taking fuel from end-users may inhibit the success of these programs. Utilities can determine the feasibility of these programs by doing the following:
   i. Conducting vehicle-to-grid programs with medium- and heavy-duty vehicles first. This will help identify the potential for using electric vehicles as utility energy storage resources and also gain an understanding of fleet perspectives.
   ii. Piloting managed charging programs with residential customers. This will help establish if residential customer behavior is flexible enough to engage in vehicle-to-grid programs in the future.
b. **Grid load distribution:** As more medium- and heavy-duty fleets electrify, some parts of the grid will face greater loads (e.g., warehouse districts where fleet depots are situated). Utilities should communicate with these fleets ahead of time and try to forecast the load distribution, make appropriate upgrades, and consider on-site integration of energy storage or distributed generation to help manage these loads.
c. **Education and outreach:** Utility plans should discuss, and utility rate and program filings should include, a reasonable budget for education and outreach activities, both for general awareness and to support specific programs. The Commission should allow recovery of such costs in rates.

Equity Considerations

HB 2282 also directed the SCC to evaluate how programs to increase electric vehicle uptake can increase access to electric transportation and improved air quality in low-income and medium-income communities. Equitably distributing the environmental, economic, and health benefits associated with transportation electrification requires proactive policies that incorporate the needs of disadvantaged communities in the planning stages. Stakeholders suggested the following considerations for utilities to make electric vehicles accessible to disadvantaged communities.

a. **Include equity provisions in transportation electrification plans**: As utilities draft transportation electrification plans, disadvantaged communities should be kept at the forefront of these investments. These plans should provide special provisions for income-qualified customers and high-emission communities. These include the following:
    i. Higher rebates and grants on the purchase and lease of new and used electric vehicles for income-qualified customers
    ii. Higher rebates and grants on the purchase and lease of new and used fleet electric vehicles for businesses that operate in disadvantaged communities
    iii. Special financial incentives for ride-share drivers to purchase and lease electric vehicles
b. **Expand access to electric transit options:** Utilities can work with local transit authorities to provide infrastructure support that enables transit authorities to run buses in low-income and high-emissions neighborhoods.
c. **Prioritize disadvantaged communities in pilot programs:** Utilities can ensure that a high percentage of pilot fleet electrification (especially school bus electrification) programs are conducted in disadvantaged communities.
d. **Engage and involve communities in transportation electrification plans:** Utilities can work with local communities to ensure that the programs are tailored to meet community needs.

PROVIDING CONSUMER AND GRID BENEFITS

Lastly, HB 2282 directed the SCC's report to address "whether and how transportation electrification can, under current law:

a. Reduce total ratepayer rates and costs;
b. Assist in grid management and more efficient use of the grid, in a manner that does not increase peak demand, through time-of-use rates, managed charging programs, vehicle-to-grid programs, or alternative rate designs;
c. Utilize increased generation from renewable energy resources; and
d. Reduce fueling costs for vehicles."

The legislation also mentioned that if the stakeholder process concluded that "transportation electrification cannot currently deliver these benefits, then the report shall include recommendations on how public policy can change in order to do so."

In meeting two, Philip Jones from the Alliance for Transportation Electrification presented different utility program design tools that have the potential to shift and shape electrified transportation loads. Stakeholders discussed the potential costs and benefits of transportation electrification.

Utilities have the opportunity to gather stakeholder input and develop inclusive transportation electrification plans. Well-designed transportation electrification plans can help maximize the benefits of transportation electrification by spreading the additional load on the grid and moving the bulk of it to off-peak hours or hours when there is high renewable energy generation. This can be made possible by applying a portfolio approach by combining utility make-ready investments or rebates, third-party ownership of charging stations, vehicle-to-grid programs, rate-design programs, and innovative technology approaches, including integrating energy storage. Stakeholders suggested that the SCC can lay out roles and responsibilities for utilities to follow as part of their transportation electrification plans.

Jones shared that over 80 percent of light-duty electric vehicle charging in the US takes place at home. This means achieving the objectives of reducing rates, peak loads, and fueling costs for vehicles requires addressing residential rate design.

Stakeholders discussed using residential rate design along with other measures like managed charging programs and distributed energy generation and energy storage options to reduce peak load on the grid. Shifting load to off-peak not only allows utilities to minimize the use of expensive electricity generation methods to meet peak demand but also helps better utilization of the grid during off-peak hours. The lower costs can then be passed on to consumers in the form of lower rates.

While less than 20 percent of light-duty electric vehicle charging in the US takes place through public direct current fast chargers, these chargers can have a significant impact on peak load because they require more power to deliver energy quickly. Utilities often charge operators of direct current fast chargers with demand charges to manage the increased load they demand from the grid.

Demand charges are a significant barrier to fleet electrification and potentially for non-home charging locations. Stakeholders discussed the possibility of reducing and waiving demand charges without overburdening the grid or inappropriately spreading costs to other ratepayers. Transitional relief programs offer a path to profitability for fleets by altering the demand charge component of rate structures on a temporary basis. Technology solutions, such as energy storage, provide another option to manage demand charges by reducing the peak demand of electric vehicle fleet charging.

Utility Programs

Utilities can implement transportation electrification programs in a way that shifts and shapes load to reduce costs and emissions as described below:

a. **Time-varying rates:** Time-varying rates focus on altering customer charging behavior by incentivizing customers to charge during hours that are less expensive, less carbon-intensive, or both. The time periods for time-varying rate designs can take both cost and emissions into account and can put downward pressure on rates for all ratepayers. Utilities can encourage customers to enroll in these programs by offering rebates for chargers.

   Stakeholders suggested that time-varying rate programs might be easier to introduce as default offerings.

When incorporating emissions in rate design, stakeholders felt that utilities should consider times of renewable saturation. For example, utilities should offer lower rates during times with more renewable energy production, which would lower the emissions profile for electric vehicles in Virginia. When designing these rates, utilities should also consider how times of renewable energy saturation may change in the future.

Educating consumers about the use of time-varying rates is very important. Customer education (especially for new electric vehicle drivers) can help make these programs successful. Utilities may need to develop a budget for education and outreach about the incentives being offered to customers for participation in managed and time-varying charging programs.

b. **Managed charging programs:** Managed charging relies on communication from a utility to a vehicle or charger to control charging in real time. The communication signals used in managed charging can adjust the time, rate of charge (both load curtailment and load increase) relative to a baseline, or both.

   Stakeholders agreed that managed charging should be kept optional and that programs should be designed to give maximum flexibility to customers. For example, customers should have the option to opt out of demand control events without paying penalties. Additionally, stakeholders flagged several concerns regarding managed charging programs:

   i. **Broadband limitation:** Limitations in broadband service might make it challenging to implement direct load control in rural areas or make it prohibitively expensive.

   ii. **Managed charging at workplaces:** Stakeholders suggested that employee buy-in is needed before implementing such programs. Employees may object to having their charging speeds reduced during demand response events. Some employees may worry that participating in managed charging programs may affect their plans if they expect a full battery at the end of each workday.

   iii. **Future-proofing investments:** Stakeholders acknowledged that implementing managed charging programs would require investments in smart chargers. They recommended that utilities ensure that the chargers they install can handle increased loads and software updates in the future. While some investor-owned utilities in Virginia have programs and tools that allow them to carry out direct load control management successfully, others have yet to invest in such programs and tools.

c. **Vehicle-to-grid technology:** Allows utilities and customers to use distributed electric vehicle batteries to store excess generation and tap into unused energy when needed. This technology could assist the electric grid in a variety of ways, including regulating renewable energy fluctuations, peak power shaving, and providing an emergency backup power source. Through financial incentives, utilities can encourage customers to make their vehicle available for vehicle-to-grid programs.

Stakeholders noted that while some electric vehicles are capable of exporting power, utility programs should acknowledge that there is a difference between exporting to the grid and exporting to local work sites.

Functional vehicle-to-grid programs may require investment in control and communication infrastructure by the utilities. One stakeholder expressed a preference for these programs to be offered as optional to consumers.

Stakeholders recommended that utilities initiate vehicle-to-grid programs with medium- and heavy-duty electric fleets. These fleets are suitable for vehicle-to-grid applications for two reasons:

i. They usually have fixed routes, making it easy to determine how much power they can afford to transfer to the grid without impacting their duty cycles.

ii. The vehicles are parked at central locations, offering utilities a predictable power source at one location.

Lastly, stakeholders noted that utilities might need legislative and regulatory support to expand vehicle-to-grid programs significantly.

d. **Battery storage at charging stations:** Lithium-ion batteries (sometimes re-used electric vehicle batteries) integrated into or paired with charging stations can charge during off-peak hours, providing load shifting and peak power shaving capabilities. Such capabilities can also mitigate demand charges and respond to time-of-use or other peak pricing mechanisms. These configurations can reduce energy costs without jeopardizing service or costs to customers who cannot shift their charging time.

   Stakeholders noted that incorporating battery and solar at charging stations may require regulatory and legislative support.

e. **Solar at charging stations:** Solar power at electric vehicle charging stations complements battery storage. Even if solar power does not cover the overall charging needs, it can lower the input from the grid enough to avoid demand charges. When used in conjunction with battery storage at charging stations, solar power can help flatten the load on the grid.

Additional Considerations

As utilities adopt the programs mentioned above, they should consider the following:

a. **Demand charges:** While some stakeholders supported subsidizing the demand charges for direct current fast chargers, others were not in favor of distributing the power grid's added peak costs associated with fast chargers to households that are already highly energy burdened.

b. **Access to anonymized data for stakeholders to conduct analyses:** The stakeholders noted that while utilities are well-positioned to gather and use data to manage load, they should be more transparent with data and allow researchers access to the data. The stakeholders recommended that utilities apply Data Access Stakeholder Group Principles[11] to move the conversation on data access.

Equity Considerations

The stakeholders suggested the following considerations for utilities to maximize benefits to disadvantaged communities as the utilities shape and shift transportation electrification loads on the grid.

a. **Subsidized rates:** Stakeholders recommended that utilities develop specialized rate programs for low-income communities where they are given subsidized rates for charging electric vehicles at all times of the day. These communities should also receive equipment at subsidized rates.

b. **Rebates for smart chargers:** Stakeholders recommended that low-income communities should be given extra rebates to purchase and install smart chargers that can be used to manage load either directly or through time-varying rates.

[11] *HB 2332 Data Access and Privacy*, State Corporation Commission, April 3, 2020, https://www.scc.virginia.gov/getattachment/95eb387b-6749-4f7c-905b-66afaa2895c7/H2332DataAccess.pdf.

V. Scenario Modeling

To inform stakeholder discussions during this process, GPI retained M.J. Bradley & Associates, an ERM Group company (ERM), to model four scenarios identified by the State Corporation Commission (SCC) reflecting different levels of electric vehicle saturation. This modeling can help evaluate the costs and benefits of increased adoption of electric light-duty vehicles (LDVs) and electric medium- and heavy-duty vehicles (MHDVs) across the Commonwealth.

ERM has more than two decades' experience in the transportation sector. The modeling framework used in this analysis has been developed and refined over the past five-plus years. ERM has conducted studies on the impacts of electric vehicle saturation in more than 10 states for a range of clients, including nonprofits, utilities, and state governments.

The modeling framework incorporates a range of inputs. Inputs include emission factors, vehicle and maintenance costs, projected electricity prices, current state vehicle population, state generation mix, and electric vehicle charging cost and use data. The study estimates the impacts of electric vehicles on fuel use and emissions, air quality and health, utilities, and electric vehicle owners. It also conducts an economic analysis and a gap analysis on needed electric vehicle charging infrastructure. All these components are monetized to understand the net societal benefit of electric vehicle adoption in Virginia.

INPUTS AND ASSUMPTIONS

Modeling Scenarios

The basis for the modeling scenarios was identified by the SCC at the onset of the stakeholder engagement—scenarios that reached 25 percent (Scenario A), 50 percent (Scenario B), and 100 percent (Scenario C) of in-use electric vehicles, as well as a scenario that complied with the adoption of Section 177 of the federal Clean Air Act (Scenario D).

Due to stakeholder feedback and to be in line with the Virginia Clean Economy Act, the target year for Scenarios A-C was set at 2045 and allowed to evolve through the end of 2050. To reach these in-use targets, sales percentages for electric vehicles sold in Virginia were calculated. Stakeholders provided input on the shape of the sales trajectories, and the group agreed upon an S-curve (i.e., sigmoid function) as the best shape to represent the technology adoption.

Table 1. Description of scenarios

Scenario	Description
Scenario A	25% electric vehicle saturation by 2045
Scenario B	50% electric vehicle saturation by 2045
Scenario C	100% electric vehicle saturation by 2045
Scenario D	Adoption of Section 177 of the federal Clean Air Act

Sources: SCC with ERM and stakeholder input.

The analysis used the same electric vehicle sales trajectories for all LDV and MHDV classes. Given the longer expected lifetime of MHDVs, there is a small lag in adoption relative to LDVs with the same sales trajectories. To keep MHDV sales from outpacing LDV sales, MHDV in-use saturation does not reach the target percentage by 2045. However, since MHDVs account for such a small percent of total on-road vehicles, the entire Virginia fleet reaches the targets by 2045. MHDVs reach the target percentages by 2050.

Scenario D models what would happen if Virginia adopted California's low-emission vehicle (LEV) and zero-emission vehicle (ZEV) standards pursuant to § 177 of the federal Clean Air Act (42 U.S.C. § 7507). Given that the LEV and ZEV standards only apply to LDVs, no change in MHDVs was considered for this scenario. The model used several assumptions to convert from ZEV program requirements, which are based on credits, to ZEV sales and penetrations. Assumptions included around three credits per vehicle, no use of banking or extra credit provisions, and the adoption of the proposed Advanced Clean Cars II rule.[12]

Electricity Generation Mix

In the modeling framework, the electricity generation mix and its evolution between 2021 and 2050 contribute to the reduction in emissions associated with electric vehicle adoption. Emissions in the framework include greenhouse gases, nitrogen oxides, and particulate matter. If a generation portfolio is assumed to be a large emitter, replacing a conventional vehicle with an electric vehicle would have a limited impact on the overall state emissions. If generation is predominantly from zero-carbon sources, the impact of each electric vehicle will be greater.

The modeling used the current Virginia generation mix as the starting point. The two main sources used to project the changes in the mix were the Virginia Clean Economy Act and the 2021 US Energy Information Administration's *Annual Energy Outlook 2021* PJM-Dominion and

[12] California Air Resources Board, *Zero-Emission Vehicle Standards for 2026 and Subsequent Model Year Passenger Cars and Light-Duty Trucks*, California Code of Regulations, Section 1962.4 Draft (December 2021) https://ww2.arb.ca.gov/sites/default/files/2021-12/draft%20zero%20emission%20vehicle%20regulation%201962.4%20posted.pdf.

PJM-West regional electricity projections.[13] The Virginia Clean Economy Act implements an aggressive Renewable Portfolio Standard that requires 100 percent of electricity sold in Virginia by 2050 to have a renewable energy certificate. However, the Virginia Clean Economy Act allows electricity suppliers to procure 25 percent of renewable energy certificates outside of Virginia if they are within the PJM electricity market. In addition to the Renewable Portfolio Standard, the Virginia Clean Economy Act mandates the closure of most carbon-emitting generating units by the end of 2045.[14]

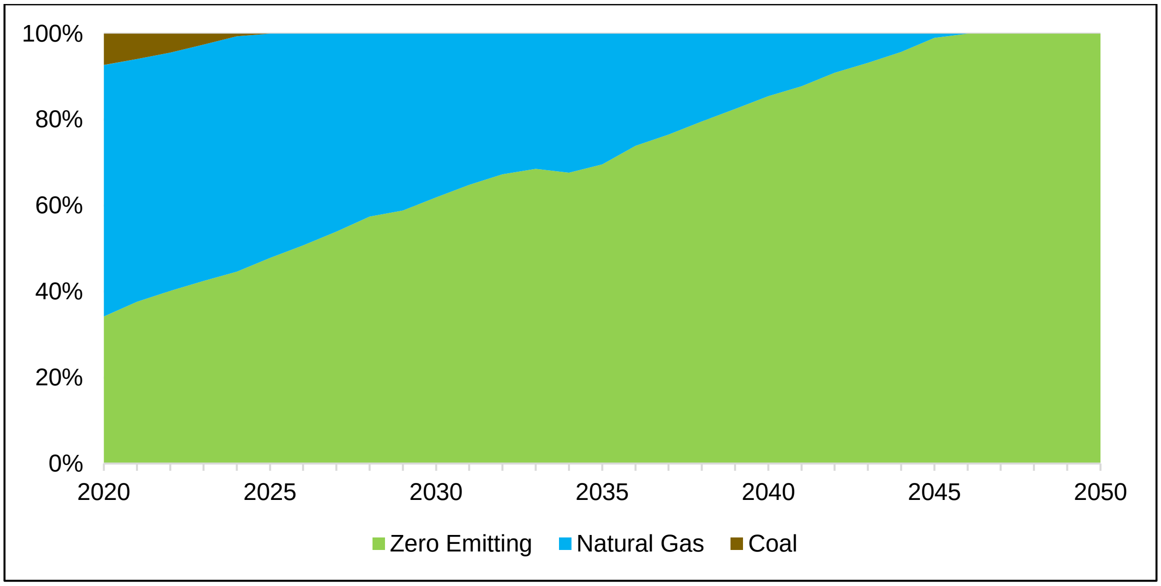
In considering the influence of renewable energy certificates purchased out of state, the local and global emissions impacts need to be weighed. For nitrogen oxides and particulate matter, if cleaner electricity is produced out of state, Virginians will not experience improved air quality. On the other hand, reductions in greenhouse gases produced by the out-of-state renewable energy certificates would be felt by Virginians.

Stakeholders, including utility representatives, provided robust feedback on the proposed generation mix. Factors raised included out-of-state renewable energy certificate procurement plans and differing requirements for cooperative utilities compared to investor-owned utilities. Ultimately, stakeholders decided that the proposed generation mix was an appropriate assumption given the balance of these factors. Figure 1 shows the final generation mix agreed upon by the stakeholders and implemented in the model.

[13] US Energy Information Administration (EIA), *Assumptions to the Annual Energy Outlook 2021: Electricity Market Module*, PJM-Dominion and PJM-West regional electricity projections (Washington, DC: US EIA, February 2021), https://www.eia.gov/outlooks/aeo/assumptions/pdf/electricity.pdf. The *Annual Energy Outlook 2021* PJM-D and PJM-W projections are generated by EIA's Office of Energy Analysis National Energy Modeling System (NEMS). NEMS incorporates current legislation and regulations to optimize for the most economical way to supply electricity within environmental and operational constraints.

[14] Virginia Clean Economy Act, H.B. 1156/S.B. 81.

Figure 1. Modeled Virginia electricity generation mix



Sources: ERM analysis based on data from “Annual Energy Outlook 2021,” Reference Case Projections Tables, US Energy Information Administration (EIA), tables 54.11, 54.13, and 54.16, https://www.eia.gov/outlooks/aeo/tables_ref.php; Galen L. Barbose, *U.S. Renewables Portfolio Standards 2021 Status Update: Early Release* (Lawrence Berkeley National Laboratory, February 2021), https://emp.lbl.gov/publications/us-renewables-portfolio-standards-3; Virginia Clean Economy Act, H.B. 1156/S.B. 81.

While this represents a reasonable projection of the Virginia generation mix, factors including changes in policy, technology jumps, and other market factors will impact the evolution of the generation mix.

Managed Charging

The model allows for managing two types of LDV charging: at-home evening charging and daytime workplace charging. The inputs for the LDV managed charging include the percent of participating vehicles, the timeframe for limiting charging, and the timeframe in which charging is shifted. Given the focus of electric vehicle impacts on utilities, it is central to understand the effect of managed charging on the overall grid.

The model also considers charging for MHDVs. It assumes that much of the management of charging for MHDVs is conducted by fleet owners incentivized by keeping demand charges low.

Home Charging

For many grids, including the summer grid in Virginia, the peak in electricity demand corresponds with when people traditionally arrive home from work in the early evening hours. If all electric vehicle owners began charging their vehicles when they arrived home, the peak in electric vehicle charging load would correspond with the baseline system peak. This could substantially increase the required peak capacity in the electric grid, necessitate additional investment to address these system needs, and make the grid less efficient. However, if the period of charging shifts to off-peak hours, such as nighttime hours, when baseline system demand is lower, electric vehicles have the potential to make the electric grid more efficient.

These scenarios assume that, for electric vehicles arriving home between 3:00 p.m. and 10:00 p.m., home managed charging offerings cause 90 percent of those vehicles to charge between 11:00 p.m. and 5:00 a.m.,[15] rather than beginning charging immediately upon arrival at home. A sensitivity was also run removing managed charging to isolate total impact.

This level of managed home charging was selected with stakeholder input and to maximize the modeled results within a realistic potential future. In other words, the modeling uses, as an assumption, the upper end of the reasonable range of electric vehicle engagement in managed charging schemes, to identify the impact of managed charging and therefore inform possible policy considerations.

Workplace Charging

The modeling assumes that a portion of public workplace charging is managed. For electric vehicles using workplace chargers without managed charging, similar to home charging, a spike in demand would be expected at the beginning of the workday. The model assumes that, for electric vehicles arriving at workplaces between 6:00 a.m. and 10:00 a.m and charging using workplace Level 2 chargers, workplace managed charging offerings cause 25 percent of those vehicles to charge between 10:00 a.m. and 3:00 p.m.

This percentage is significantly lower than that applied to home charging due to the complexity of managing public charging.

Medium- and Heavy-Duty Vehicle Charging

For MHDVs, managed charging looks quite different from managed LDV charging since most MHDVs are assumed to charge overnight at their fleet depot. Also, MHDVs are typically used for local or regional operations in which they begin and end the day at the same location. Since most vehicles are assumed to charge overnight, they are already charging during off-peak hours.

Combination trucks (i.e., a subset of Class 7 and 8 trucks) are treated slightly differently than the rest of MHDVs. Approximately 30 percent of these vehicles are used for local/regional hauling and can use overnight depot charging. The remainder are used primarily for long-haul freight operations, which do not return to the same location every night and can travel 500 miles or more per day. As such, these vehicles will need to use a shared, public network of higher-power chargers (greater than 500 kilowatts per port) and are assumed to plug in as needed to maintain the state of charge.

Managed Charging Over Time

The model does not vary the managed charging scenarios across years and does not allow for changes in the load curve that drives the managed charging scheme. As more renewables are

[15] These hours were selected based on the current Virginia grid. As the grid changes, the optimal hours for managed charging may change as discussed below in section “Managed Charging Over Time.”

added to the Virginia generation mix, patterns of electricity generation and availability may change. A high proportion of solar energy might make shifting vehicle charging to nighttime hours less useful; it may instead make more sense to encourage vehicle charging during early afternoon hours when solar electricity generation is at its highest. Policies and programs need to be responsive to allow managed charging to meet changes in load curve and increase the efficiency of the grid.

RESULTS

Virginia Vehicle Fleet

Virginia's on-road fleet comprises 7.1 million vehicles at the beginning of the modeling period in 2021 and 8.9 million vehicles by midcentury, representing a 26 percent increase. The vast majority of those vehicles—94 percent—are light-duty, and the remaining 6 percent are medium- and heavy-duty.

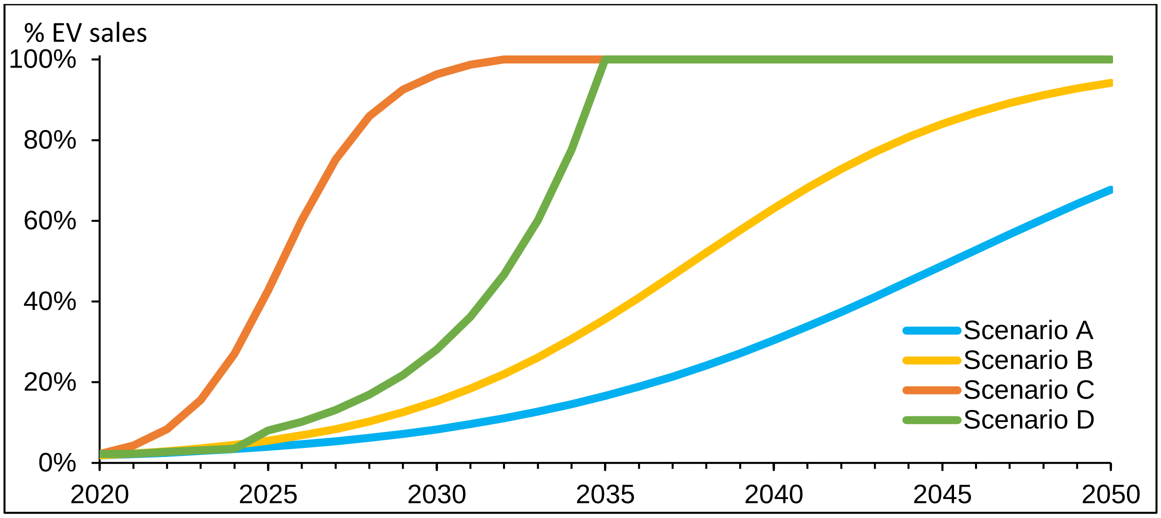
In 2020, of the electric vehicles purchased in Virginia, 22 percent were plug-in hybrid electric vehicles (PHEVs), and 78 percent were battery electric vehicles (BEVs). The majority (over 80 percent) of stakeholders believed that PHEVs would remain very or somewhat important in the future. However, as batteries become cheaper and charging stations become more widespread, the population of electric vehicles is expected to shift to longer ranges and a greater proportion of BEVs.

To balance expected trends and stakeholder feedback in the modeling, BEVs account for 90 percent of electric vehicle sales, and PHEVs account for the other 10 percent by 2050. This modeling assumes Virginia's vehicle fleet will grow. The model uses the 2021 US Energy Information Administration *Annual Energy Outlook* projected rate for the South Atlantic region for each vehicle class.[16]

In all scenarios, electric vehicle sales start at their current state of 2 percent. Figure 2 shows the progression of sales percentages through 2050, while figure 3 shows the on-road electric vehicle share. Under each scenario, sales grow following the curves described above to reach each scenario target in 2045, and then continue growth through 2050.

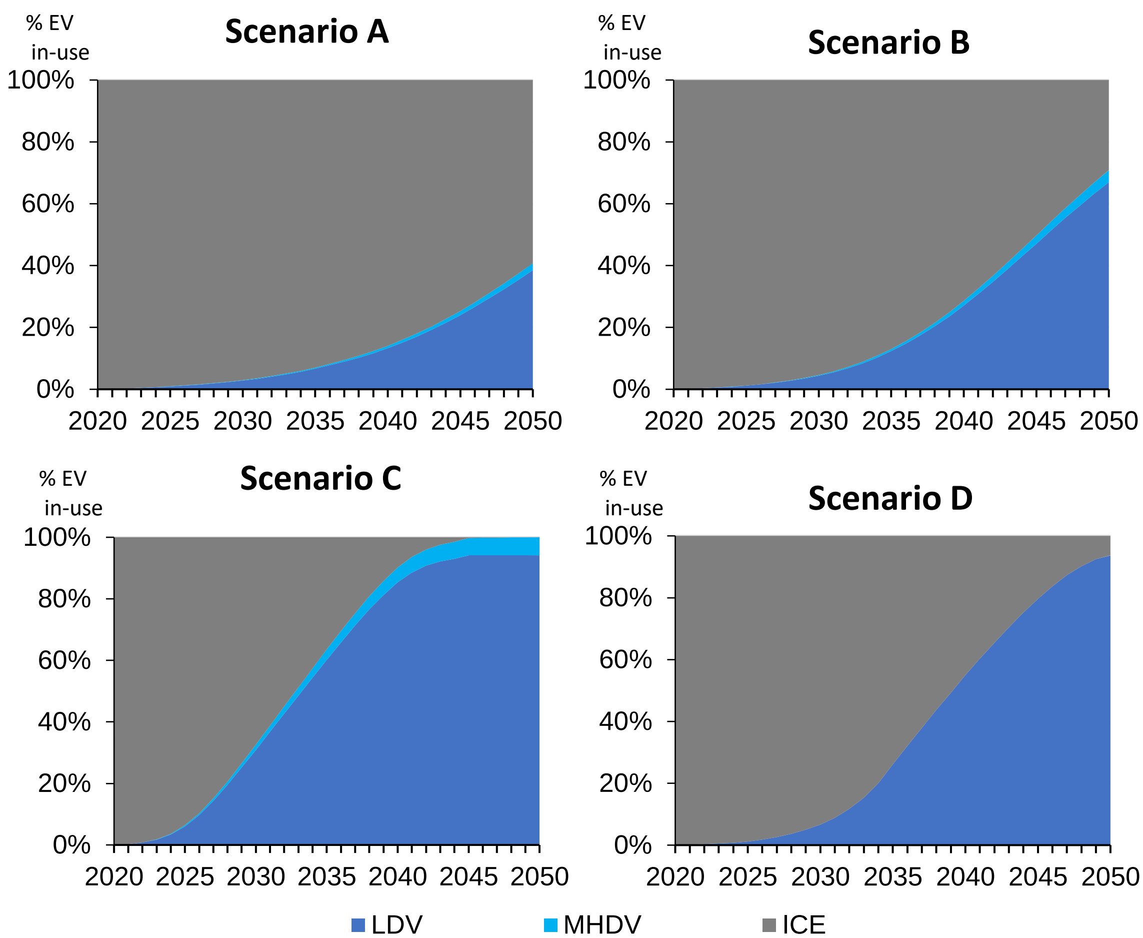
[16] If the fleet growth is different than currently projected, for instance with smart growth strategies that include fewer passenger cars and more transit buses, the size and breakdown of Virginia's fleet would shift and the impact of electric vehicle adoption in the Commonwealth would also change.

Figure 2. Modeled Virginia annual electric vehicle (EV) sales by scenario



Source: ERM analysis as guided by SCC and stakeholders.

Figure 3. Modeled Virginia on-road electric vehicle (EV) saturation



Source: ERM analysis.
Note: ICE stands for internal combustion engine.

Required Charging Infrastructure

Types of Chargers

The model assumes that home chargers will be in the form of Level 1 (standard 120V outlets) and Level 2 (240V). These chargers typically require between 1 and 10 kilowatts per port, depending on the voltage used (Level 1 or 2) and the amperage feeding the charger. Little to no additional equipment or installation beyond the charging cord provided with the vehicle is required for a Level 1 charger.

Level 2 chargers are assumed to be the primary method of charging BEVs due to their higher energy output and, therefore, faster charging speeds. For Level 2 chargers, since the voltage needs to be increased, additional equipment needs to be purchased and installed.

LDVs utilize Level 2 and direct current fast chargers. Direct current fast chargers charge vehicles more quickly (at rates of 50 kilowatts or above) but require more infrastructure investment and maintenance.

For MHDVs, the model includes depot chargers that will require higher power ratings than LDV Level 2 chargers, in the range of 10-50 kilowatts (kW) per port, depending on the vehicle type. Modeled public chargers will range from 150 kW, which supports single-unit freight trucks, to the higher-capacity 500 kW public chargers, which are needed mostly for combination trucks.

Number of Chargers Calculation

The model calculates the number of chargers required by first determining the percentage of electric vehicles charged at homes or depots (as opposed to public chargers) and what charger type they will use. The model assumptions distinguish between single-family homes and multi-unit dwellings, with the model assuming 23 percent of Virginians live in multi-unit dwellings.[17] The model assumes one charger per vehicle charging at home and uses the US Department of Energy's Electric Vehicle Infrastructure Projection Tool Lite charger factors to determine the number of public chargers required.[18] Additional key assumptions are shown below in table 2.

[17] "Census – Table Results," Table C25033, American Community Survey 1-Year Estimates Detailed Tables, US Census Bureau, https://data.census.gov/cedsci/table?q=Table%20C25033&tid=ACSDT1Y2019.C25033."

[18] Eric Wood et al., *National Plug-In Electric Vehicle Infrastructure Analysis* (US Department of Energy Office of Energy Efficiency and Renewable Energy, September 2017), https://www.nrel.gov/docs/fy17osti/69031.pdf.

Table 2. Assumptions regarding location and type of charger utilized by electric vehicle owners

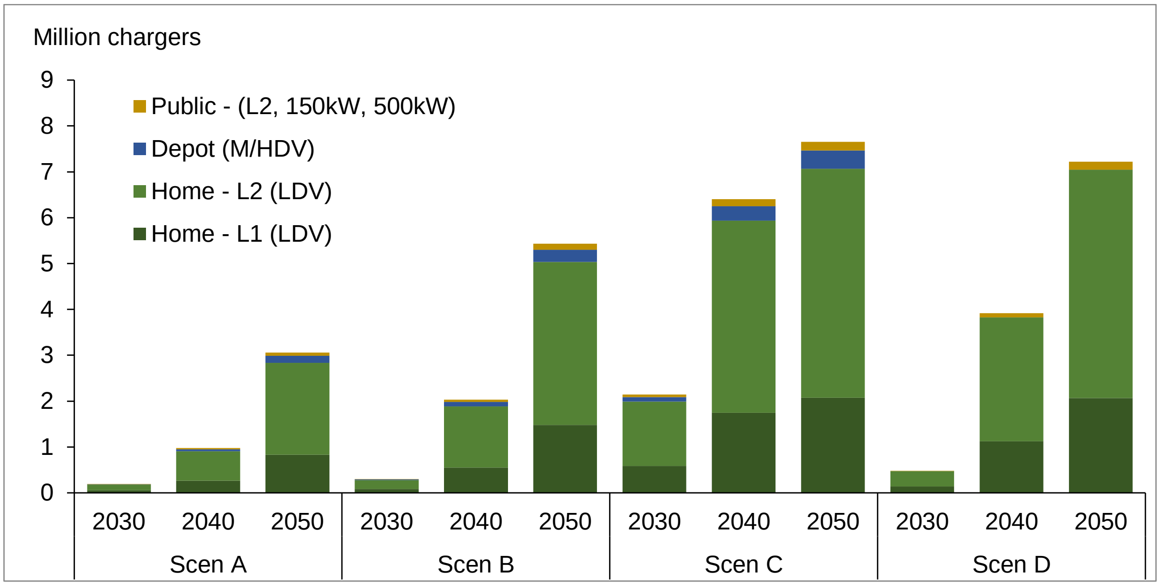
Assumption	BEV Owners	PHEV Owners
Percent of home charging conducted using a Level 1 charger	15%	80%
Percent of home charging conducted using a Level 2 charger	85%	20%
Percent of public charging conducted using a Level 2 charger	40%	100%
Percent of public charging conducted using a direct current fast charger	60%	0%
Percent charging conducted at home (single-family home residents)	90%	90%
Percent charging conducted at home (multi-unit dwelling residents)	60%	25%

Source: ERM analysis.

The model assumes one charger per MHDV that is charged per night in the depot. Since not all MHDVs are assumed to be used every day, this means roughly 0.8 chargers per depot-charging MHDV. The number of public chargers required for MHDVs is calculated assuming between 12 and 22 hours available for vehicles to be charging, with additional assumptions made regarding the length of time it takes the vehicle to charge and the percentage of vehicles by class using public chargers.

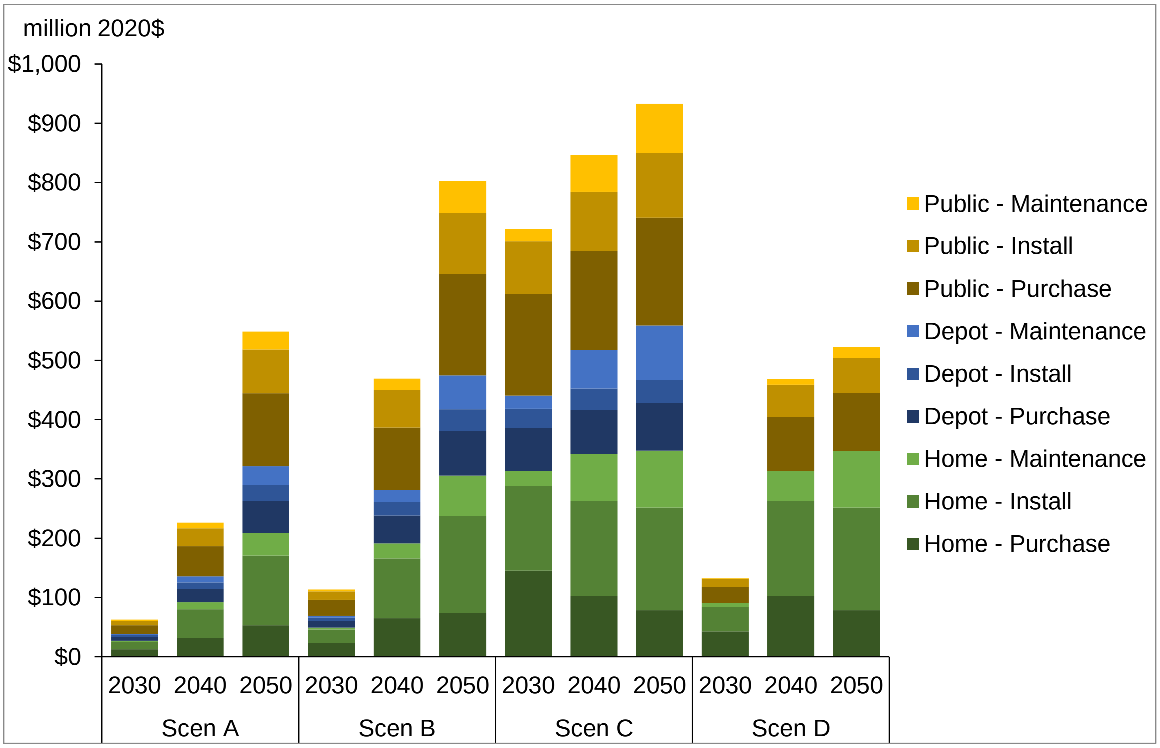
Number and Cost of Chargers

Figure 4. Modeled number of chargers required



Sources: ERM analysis based on data from US Department of Energy's Electric Vehicle Infrastructure Projection Tool Lite (December 2021), https://afdc.energy.gov/evi-pro-lite.

Figure 5. Modeled annual cost of chargers



Sources: ERM analysis based on data from Michael Nicholas, *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas* (The International Council on Clean Transportation, August 2019), https://theicct.org/wp-content/uploads/2021/06/ICCT_EV_Charging_Cost_20190813.pdf.

To transition a major portion of the Virginia fleet to electric vehicles will require a substantial investment in charging infrastructure. In considering charging infrastructure costs, the model includes the cost of charging equipment, installation, and regular maintenance. Soft costs such as lease acquisition and permitting are outside the scope of the modeling. Policies and regulations to make charging equipment easier to install might lower these costs.

As figures 4 and 5 indicate, Virginia's LDV owners will have between 2.8 million and 8.0 million home chargers under Scenarios A-C by midcentury. While Level 1 chargers require little to no additional equipment or installation, using a Level 2 charger at home requires owners to purchase, install, and maintain that charger. By 2050, this investment will reach between $209 and $348 million per year (in 2020 dollars).

For MHDV depot-based chargers, by 2050, the model estimates fleet owners will have purchased and installed between 150,000 and 400,000 depot chargers for a yearly investment of between $112 million and $211 million.

In addition to this private investment across the LDV and MHDV segments, Virginia will require between 80,000 and 190,000 public charging ports, most of which will be Level 2 (~80 percent). However, Virginia will also need higher-speed chargers to support BEV and MHDV charging. As discussed in more detail below, additional utility investment will be required to deploy a large number of chargers successfully.

For Scenarios A-C, most chargers are home chargers (over 90 percent), even though this only accounts for roughly 40 percent of the charger infrastructure costs. The higher speeds required for depot and public chargers necessitate a larger investment in infrastructure. These chargers will also require more maintenance due to their more frequent usage.

For Scenario D, home chargers account for two-thirds of the charger infrastructure investment. Since this scenario does not include electric MHDVs, the remaining third is for public chargers utilized by LDVs.

As of December 2021, there were 984 publicly accessible charging station locations in Virginia, with a total of 2,731 electric vehicle charging ports, including 724 direct current fast charger ports (>50 kW).[19] Half of these direct current fast charger ports are Tesla superchargers that can be used only by Tesla owners. Statewide, there are only 362 direct current fast charger ports fully available to any vehicle.

Direct current fast charger ports can provide rapid charging of electric vehicles, with some able to replenish 80 percent of a vehicle's battery capacity in under an hour. Given the low level of Virginia's charging infrastructure, the state requires rapid growth and investment to support high levels of electric vehicles. For Scenarios A-C, Virginia will need between 12,200 and 32,000 direct current fast charger ports.

The above cost estimates are based on national averages. However, the oversized California electric vehicle market heavily influences current national averages. Given the nascent charging

[19] "Alternative Fuels Data Center: Alternative Fueling Station Locator," US Department of Energy, accessed on 01/12/2022, https://afdc.energy.gov/stations/#/analyze.

industry in Virginia, the current prices for purchasing and installing infrastructure may be higher than in other parts of the country with more electric vehicle saturation. Therefore, the modeled costs may slightly underestimate total costs in the near term. However, Virginia's purchase and installation costs will likely become closer to the national figures used here as electric vehicle adoption increases in the state.

The modeling does not currently account for costs of home charging beyond electrical panel upgrades and simple installation in a garage or driveway. For parts of Virginia where single-family homes are paired with street parking, installing home chargers could trigger significant increased complexity, such as sidewalk trenching and permitting, leading to higher costs than those modeled here. For Virginians who rent single-family homes, the barrier to install home charger equipment could be even higher. Alternately, electric vehicle owners may choose to utilize public charging rather than installing their own charger. This would increase the required investment in public charging infrastructure.

Electric Utility Impacts

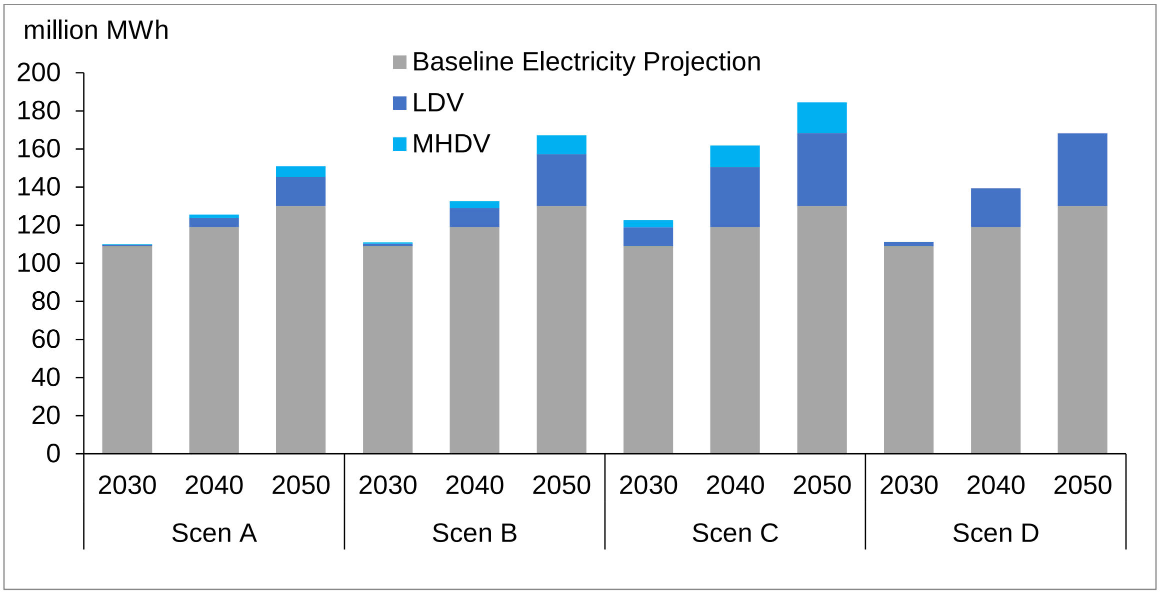
Increased Electricity Usage by Electric Vehicles

As electric vehicle saturation increases in Virginia, electricity sales will also grow. To charge an average electric vehicle passenger car for a full year requires between 4 and 5 megawatt-hours (MWh) of electricity. Given that the average household in Virginia uses 13 MWh a year, charging one electric vehicle would increase a household's electricity usage by roughly a third. Additionally, even though MHDVs only make up 6 percent of the Virginia on-road fleet, they constitute more than a quarter of the total increased electricity demand required by electric vehicles.

Figure 6 shows the additional electricity that electric vehicles in Virginia will require for each of the scenarios. The gray bars show the US Energy Information Administration's *Annual Energy Outlook 2021* reference case projections for the combined commercial and residential electricity sales in Virginia in 2030, 2040, and 2050.[20] The gray bars are intended to serve as approximate baselines upon which the additional electricity projections attributable to the modeled electric vehicle saturation scenarios (blue bars) are added. With significant electric vehicle saturation, the electricity required to charge vehicles will substantially increase electricity sales in Virginia. In 2050, under Scenario C, the additional electricity for charging would cause a 42 percent increase over the baseline.

[20] "Annual Energy Outlook 2021," Reference Case Projections Tables, US EIA, tables 54.11, 54.13, and 54.16, https://www.eia.gov/outlooks/aeo/tables_ref.php.

Figure 6. Electricity usage (baseline plus required for modeled electric vehicle saturation)



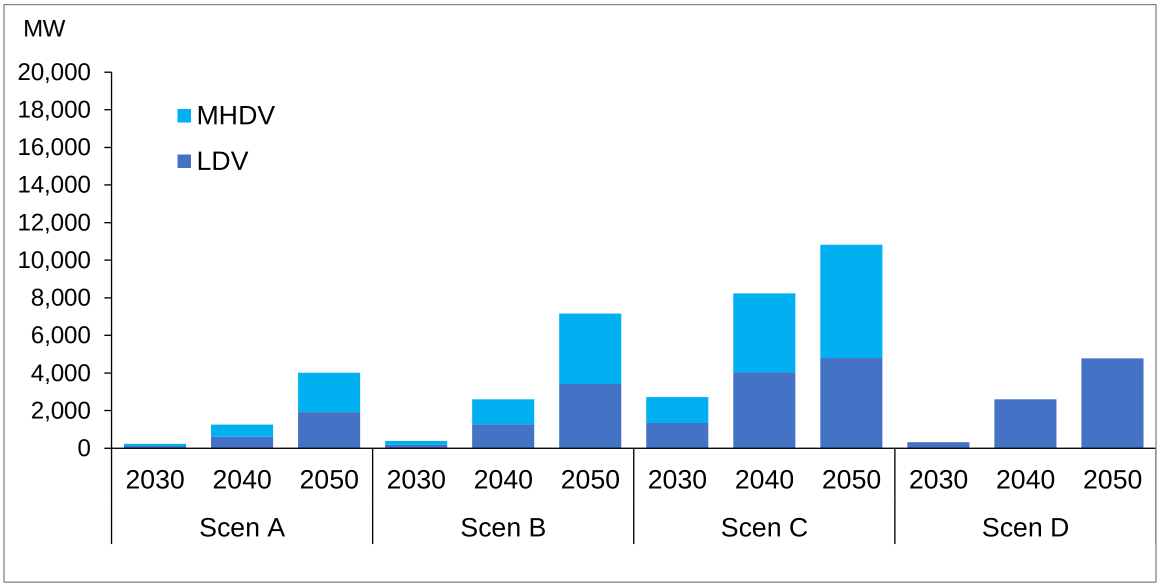
Sources: ERM analysis including data from "Annual Energy Outlook 2021," Reference Case Projections Tables, US EIA, tables 54.11, 54.13, and 54.16, https://www.eia.gov/outlooks/aeo/tables_ref.php.

Changes in Capacity Demand

In addition to increased electricity sales, electric vehicles are modeled to increase the peak electricity demand. The model assumes that the additional transmission and distribution grid capacity needed to support electric vehicle charging is equal to the incremental load incurred by electric vehicles charging between 5:00 p.m. and 9:00 p.m. (i.e., the current peak hours in the Virginia system).[21]

[21] The increased generation capacity needed to support electric vehicle charging (i.e., additional generators to produce needed electricity) was outside the scope of this modeling, though the increase in total generation is modeled.

Figure 7. Incremental transmission and distribution capacity required for electric vehicle charging



Source: ERM analysis.

Figure 7 shows the increased grid capacity the Virginia system will need to add to accommodate the levels of penetration modeled in the scenarios. In 2050, the system will need approximately 4,000 to 11,000 MW of grid capacity. For Scenarios A-C, roughly half of the additional capacity is there to serve MHDVs, even though they account for only around a quarter of electric vehicle electricity usage. This is due to the higher capacity of MHDV chargers—a requirement to recharge these vehicles in a reasonable timeframe during their downtime. This results in a greater contribution to peak capacity needs.

Under the managed charging scenario, the additional load caused by charging electric vehicles is well spread out throughout the day. There is a decrease in the late afternoon and early evening hours and a slight increase in the overnight hours.

Utility Costs

To estimate the net impact of electric vehicle saturation on utility costs, and therefore potential costs to utility customers, the model considers the following:

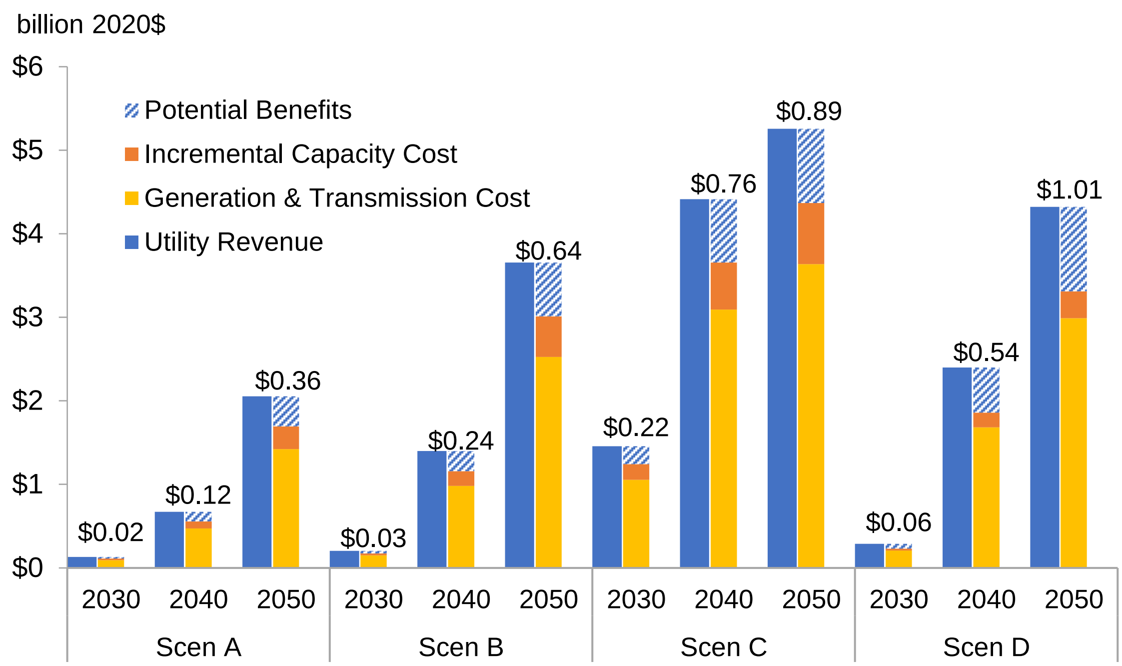
- additional revenue from increased electricity sales
- the cost of generation and transmission of that additional electricity
- the cost of building additional transmission and distribution capacity into the electric system due to the additional load caused by electric vehicles

To calculate the revenue, current residential and commercial electricity rates are adjusted through 2050 based on the US Energy Information Administration's *Annual Energy Outlook 2021* projection for electricity prices for the South Atlantic region.[22]

[22] "Annual Energy Outlook 2021," US EIA, Reference Case Projections Tables, tables 54.11, 54.13, and 54.16.

To calculate the generation and transmission costs, the *Annual Energy Outlook 2021's* regional electricity module assumptions on the portion of rates attributable to generation and transmission are applied to revenue. For the increased capacity cost, commercial demand rates for Virginia are used as a proxy for incremental capacity cost. The demand rates are adjusted in the same manner as the electricity rates.[23]

Figure 8. Statewide utility and customer cost impacts of modeled electric vehicle saturation (managed charging)



Sources: ERM analysis including data from "Annual Energy Outlook 2021," Reference Case Projections Tables, US EIA, tables 54.11, 54.13, and 54.16, https://www.eia.gov/outlooks/aeo/tables_ref.php; Virginia Electric and Power Company, Schedule GS-2 Intermediate General Service (July 2019), https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/virginia/business-rates/schedule-gs2.pdf; Appalachian Power Company, "VA. S.C.C. Tariff No. 26, Schedule Medium General Service," (April 2021), Sheet No. 11-1; and "Annual Electric Power Industry Report, Form EIA-861 detailed data files," US EIA October 2020, https://www.eia.gov/electricity/data/eia861/.

Figure 8 shows modeled annual utility revenue in dark blue. The figure also shows the different elements of incremental annual cost that utilities would incur to purchase and deliver additional electricity to support electric vehicle charging. Yellow represents volumetric generation and

[23] Note that this approach means that overall incremental capacity needs are measured, not feeder-by-feeder needs. This model does not account for locational distribution of electric vehicles which could otherwise increase or decrease costs (e.g., ten electric vehicles on a feeder with excess capacity may not trigger capacity upgrades, while one electric vehicle on an overloaded feeder could require capacity upgrades). However, on a statewide average basis, this approach estimates total needs. Furthermore, this model does not consider non-wires alternatives to distribution capacity upgrades, such as battery storage. These solutions could help to lower long-term costs. Therefore, costs here may be overestimated.

transmission costs,[24] and orange represents the costs required to upgrade or expand distribution system capacity. Capacity upgrade costs are costs incurred by the utility to upgrade their distribution infrastructure to handle the increased peak load from electric vehicle charging. These values are calculated based on currently available information and are likely to change over time.

Impact on Rates and Customer Benefits

The modeling finds that total utility revenue associated with electric vehicles is likely to exceed the total cost of increased generation and infrastructure needed to serve those electric vehicles due to more efficient use of the grid (i.e., utilizing the available capacity during off-peak hours).[25]

If these savings were to flow to utility customers, high levels of electric vehicle saturation may put downward pressure on rates and lead to volumetric ($ per kWh) savings. However, for Virginians who own electric vehicles they charge at home, their electric bill will likely increase due to their higher level of electricity usage. This electricity cost increase is offset by a decrease associated with gas savings, discussed in more depth below.

The other impacts of the Virginia Clean Economy Act on the electric grid, including a transition to a low-carbon generation mix, may have costs associated with them that are not included in this modeling.

Costs and Benefits to Electric Vehicle Owners

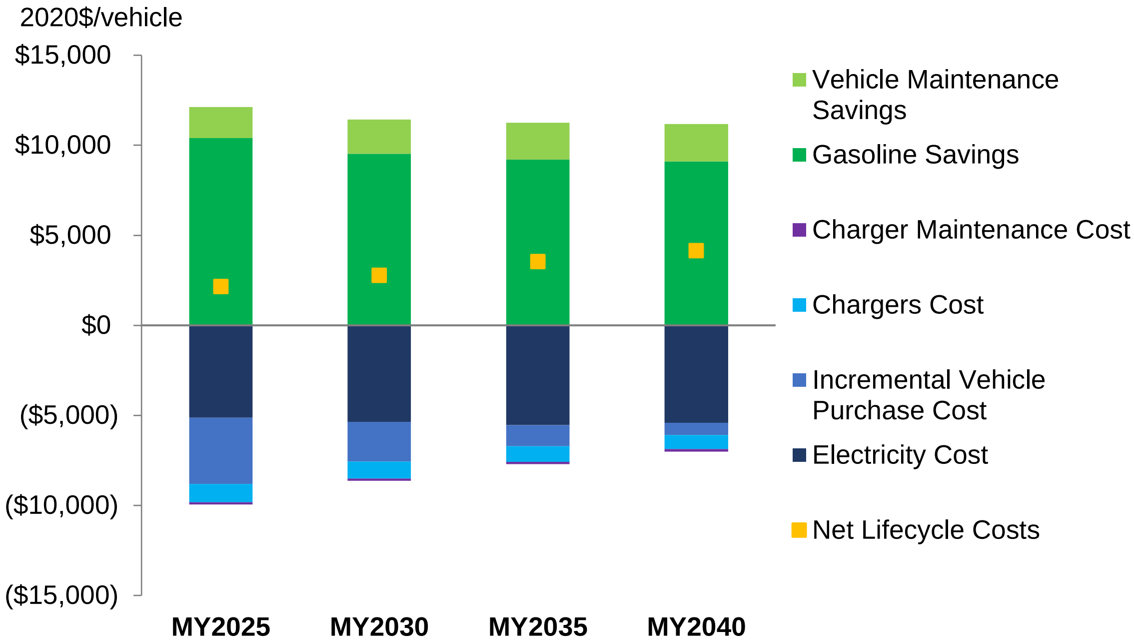
The model estimates the impact of electric vehicle ownership by assessing the differences in fuel, maintenance, charger, and vehicle cost between an electric vehicle and a conventional vehicle. Figures 9 and 10 show the average electric vehicle lifecycle costs for vehicles purchased in model years 2025, 2030, 2035, and 2040. For LDVs, the full lifetime of the vehicle is assumed to be 16 years and for a MHDV, the lifetime is assumed to be 21 years.[26] The fuel and maintenance costs are discounted at 4 percent to calculate their present value.

[24] For simplicity, it is assumed that all electric vehicle owners are part of a utilities' standard service offering (i.e., energy generation plus delivery of the energy is carried out by a single entity).

[25] In assessing utility costs, the model considered the increased electricity sales attributable to electric vehicles, the generation and transmission costs of that additional electricity, and the costs of building additional transmission and distribution infrastructure to accommodate increases in peak demand caused by electric vehicles. However, the model did not seek to identify specific generation resources that would need to be built nor how transportation electrification might impact hourly PJM energy prices.

[26] Analysis using Stacy Davis and Robert Boundy, *Transportation Energy Data Book Edition 39* (Oak Ridge National Laboratory, US Department of Energy, August 2021), tables 4.3-4.7 and 5.1-5.3, https://tedb.ornl.gov/wp-content/uploads/2021/02/TEDB_Ed_39.pdf.

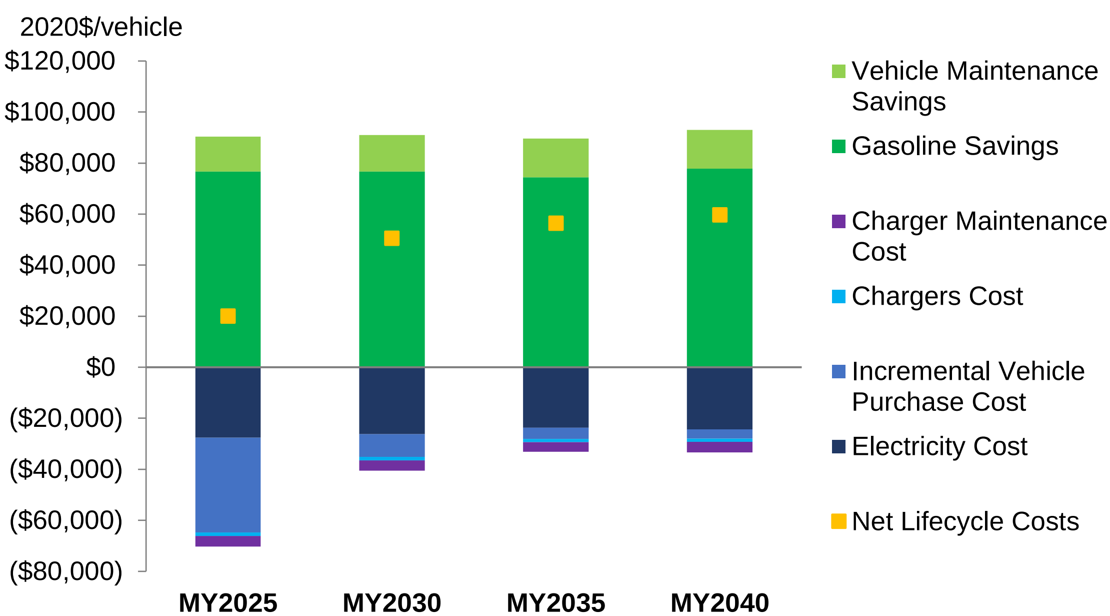
Figure 9. Modeled lifetime incremental costs for light-duty electric vehicles compared with combustion vehicles



Source: ERM modeling results.

Note: MY stands for model year.

Figure 10. Modeled lifetime incremental costs for medium- and heavy-duty electric vehicles compared with combustion vehicles



Source: ERM modeling results.

Vehicle Price

While LDVs are more expensive to purchase than similarly sized gasoline vehicles, they are eligible for various government purchase incentives, including up to a $7,500 federal tax credit. Although incentives are important to spur an early market, electric vehicles are projected to provide a lower total cost of ownership than conventional vehicles in Virginia by 2025, even without government purchase subsidies.

For MHDVs, current vehicle offerings remain low, but many new models are being announced.[27] Given that this market is in its infancy, incremental costs for these vehicles will initially be high. Still, like the light-duty vehicle space, these costs are projected to fall as technology improves and increased demand spreads out costs across the country.

The largest contributor to incremental purchase costs for electric vehicles compared to conventional vehicles is the cost of batteries. The following data points provide recent and projected costs for light-duty offerings:

- Battery costs for plug-in vehicles have fallen from over $1,000/kWh to less than $300/kWh in the last six years.
- Many analysts and auto companies project that battery prices will continue to fall—to below $110/kWh by 2025, and below $75/kWh by 2030. [28]

As battery prices fall, the price of a BEV is expected to fall below that of a gasoline vehicle. While some studies have indicated the purchase price of electric vehicles will match conventional vehicles within the decade, the model uses a more conservative approach:

- LDVs with a range of 200 miles become cheaper than conventional vehicles in 2032.
- BEVs with a 300 mile remain more expensive through the end of the modeling period.

Because PHEVs require both a battery system and a gasoline engine, PHEV prices never fall below conventional vehicles in the model.[29] For MHDVs, total lifetime ownership costs remain higher than conventional vehicles until 2030, when electric vehicles' fuel and maintenance savings outweigh the incremental purchase costs.

This analysis does not consider battery replacement in vehicles. Some practices, such as ultra-fast charging, may impact the battery's useful life. However, battery technology is evolving rapidly, and significant advances have been made in the past few years to improve battery life and charging speed.[30]

[27] Dana Lowell and Alissa Huntington, *Electric Vehicle Market Status-Update* (M.J. Bradley & Associates and Environmental Defense Fund, April 20, 2021), 33, https://mjbradley.com/sites/default/files/EDF_EV_Market_Report_April_2021_Update.pdf.

[28] Lowell and Huntington, Electric Vehicle Market Status-Update, 27.

[29] The analysis assumes that all battery electric vehicles in-use after 2030 will either have 200-mile range or 300-mile range per charge, and that all plug-in hybrid vehicles will either have 25-mile or 50-mile all-electric range.

[30] Sivapriya Mothilal Bhagavathy, Hannah Budnitz, Tim Schwanen, and Malcolm McCulloch, "Impact of Charging Rates on Electric Vehicle Battery Life," *Findings* (March 2021), https://doi.org/10.32866/001c.21459.

Changes in Fuel Use

As discussed previously, increased ownership of electric vehicles will cause an increase in electricity usage for electric vehicle owners who charge at home. An LDV owner will spend an estimated $5,100 more in electricity over the vehicle's lifetime, and an MHDV owner will spend $27,600 more. However, this increase is more than offset by savings from reduced gasoline purchases. Over their lifetimes, an LDV owner will save more than $4,000 in net fuel savings, and an MHDV owner will save more than $50,000 in fuel.

Other Costs and Benefits

Electric vehicles require less vehicle maintenance than traditional gasoline vehicles due to their simpler construction and fewer moving parts. Over the vehicle's lifetime, this translates into $2,000 worth of savings for an LDV and more than $14,000 for an MHDV.

Electric vehicle owners require additional infrastructure to facilitate charging their vehicles, whether they install charging equipment at their homes or depots or use public charging. The cost of all the charging equipment used by LDVs and MHDVs is included in the cost-benefit analysis in figures 9 and 10 above. Even though electric vehicle owners will not personally pay for public charging infrastructure, the cost of charging at a public charger is expected to include a premium in addition to the cost of electricity.

Societal Benefits

Air Quality Impacts

An additional benefit of transitioning from conventional vehicles to electric vehicles is improved air quality for all Virginians, which results in improved health. The model takes a lifecycle view of emissions considering the following:

- upstream emissions from petroleum production (well-to-tank)
- tailpipe emissions (tank-to-wheel)
- emissions that will result from the increased electricity generation required to power electric vehicles (well-to-wheel)

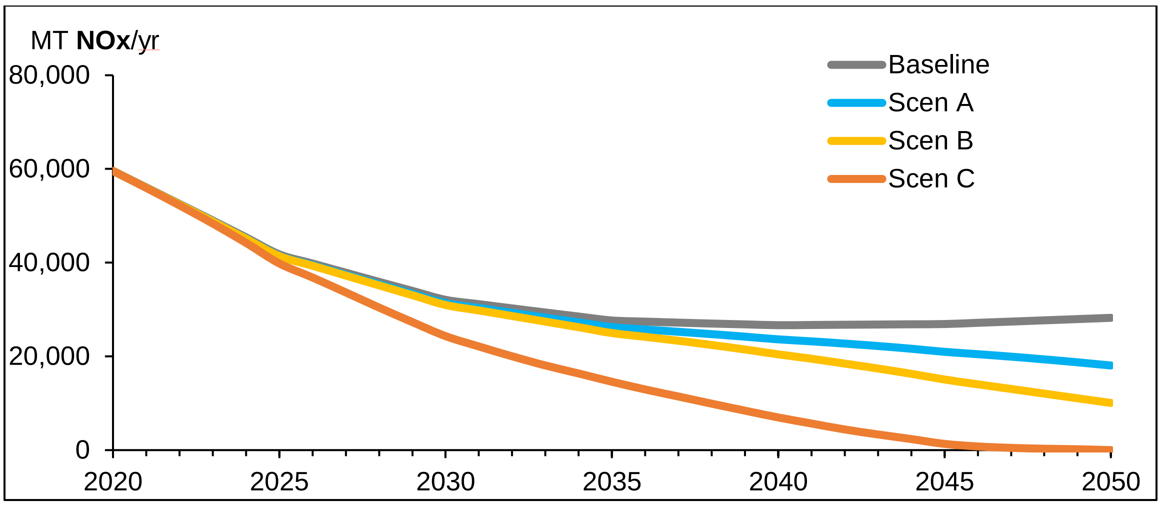
The generation mix discussed above was used to calculate the emissions from the electricity. Estimated emissions from electric vehicle charging along with upstream emissions for gasoline, diesel fuel, and natural gas are based on Argonne National Laboratory's 2020 Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) Model outputs. Tailpipe emissions were calculated using the US Environmental Protection Agency's Motor Vehicle Emission Simulator model.[31]

[31] It should be noted that this model does not consider tire- and brake-wear PM emissions which account for between 10 to 60 percent of all vehicle-related PM emissions depending on the vehicle class. It remains unclear how tire- and brake-wear emissions will differ for electric vehicles compared to petroleum vehicles. Due to regenerative braking in electric vehicles, brake-wear emissions may decrease. On the other hand, due to the heavier weight of electric vehicles, tire-wear emissions may increase. As more electric vehicles are deployed, a better understanding of these emissions will emerge.

The model quantifies the reductions in two criteria pollutants known to have adverse impacts on human health: nitrogen oxides (NOx) and fine particulate matter ($PM_{2.5}$) (identified as PM going forward).

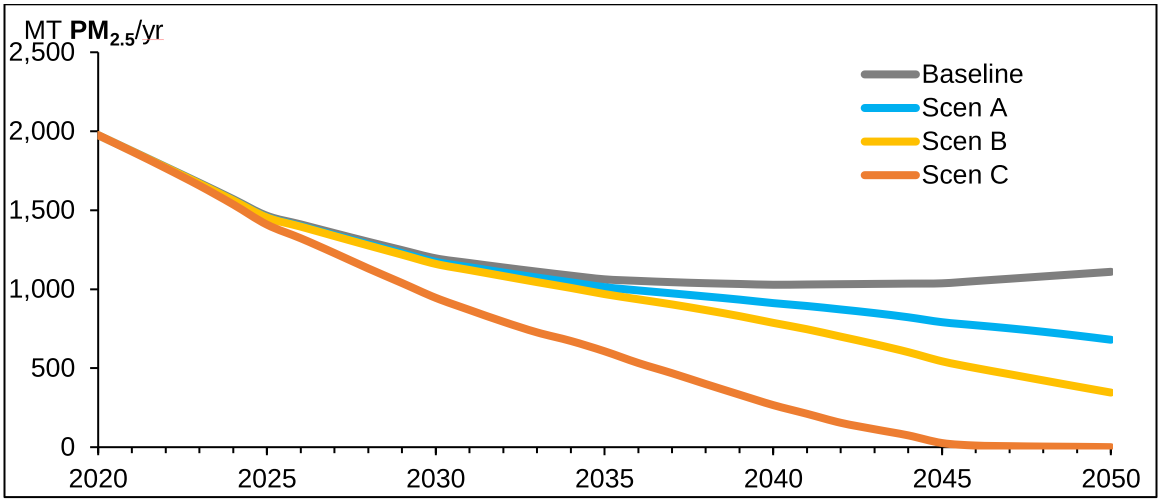
Figures 11 and 12 show estimated annual on-road vehicle related NOx and PM emissions, respectively. The baseline shown is a scenario with no electric vehicles in Virginia. The reductions in PM and NOx under the baseline scenario are caused by improved emissions standards for vehicles. The increase that can be seen in the baseline projection in later years is due to an increase in vehicle miles traveled for Virginia.

Figure 11. Modeled Virginia on-road lifecycle NOx emissions



Sources: ERM analysis including data from “Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) Model,” 2020 release, Argonne National Laboratory, https://greet.es.anl.gov/; “Motor Vehicle Emissions Simulator (MOVES),” MOVES3.0.1, US Environmental Protection Agency, Office of Transportation and Air Quality, March 2021, https://www.epa.gov/moves.

Figure 12. Modeled Virginia on-road lifecycle particulate matter emissions



Sources: ERM analysis including data from "Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) Model," 2020 release, Argonne National Laboratory, https://greet.es.anl.gov/; "Motor Vehicle Emissions Simulator (MOVES)," MOVES3.0.1, US Environmental Protection Agency, Office of Transportation and Air Quality, March 2021, https://www.epa.gov/moves.

The model found the following impacts to nitrogen oxide (NOx) and particulate matter (PM) emissions:

- Compared to the baseline, Scenario A is estimated to decrease NOx by 36 percent and PM by 39 percent in 2050. This represents a cumulative reduction in emissions between 2021 and 2050 of 86,000 MT for NOx and 3,400 MT of PM.
- Under Scenario B, emissions for NOx and PM are estimated to decrease by 64 percent and 69 percent, respectively, representing a cumulative reduction of 164,000 MT of NOx and 6,600 MT of PM by midcentury.
- Finally, for Scenario C, emissions for NOx and PM are expected to fall 100 percent by 2050 with cumulative reductions of 426,000 MT of NOx and 16,000 MT of PM.

By midcentury, all scenarios have an entirely zero-emitting grid. Under Scenario C, Virginia has only electric vehicles on the road.

MHDVs account for most NOx emissions. Scenario D represents the case where LDVs electrify but MHDVs do not. As can be seen in figure 11, NOx emissions under Scenario D are estimated at only 31 percent below the baseline even though by midcentury, all LDVs are electric.

Public Health Benefits

The reduced emissions discussed above could have positive health impacts on Virginia residents due to breathing fewer pollutants. Estimated public health impacts include reductions in premature mortality, fewer hospital admissions, and emergency room visits caused by asthma. There will also be reduced cases of acute bronchitis, exacerbated asthma, and other respiratory symptoms, and fewer restricted activity days and lost workdays.

Cumulative estimated reductions in these health outcomes in Virginia under the modeled scenarios are shown in table 3. These benefits were estimated using the US Environmental

Protection Agency's CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool. The monetized value of cumulative public health benefits between 2021 and 2050 totals $2.0 billion, $3.9 billion, and $9.8 billion for Scenarios A, B, and C, respectively.

Table 3. Modeled cumulative public health benefits (2021 – 2050)

Health Metric	Scenario A	Scenario B	Scenario C
Avoided Premature Deaths	172	330	836
Avoided Hospital Visits[a]	173	332	841
Avoided Minor Cases[b]	105,678	202,128	512,638
Monetized Value (bill 2020$)	$2.0	$3.9	$9.8

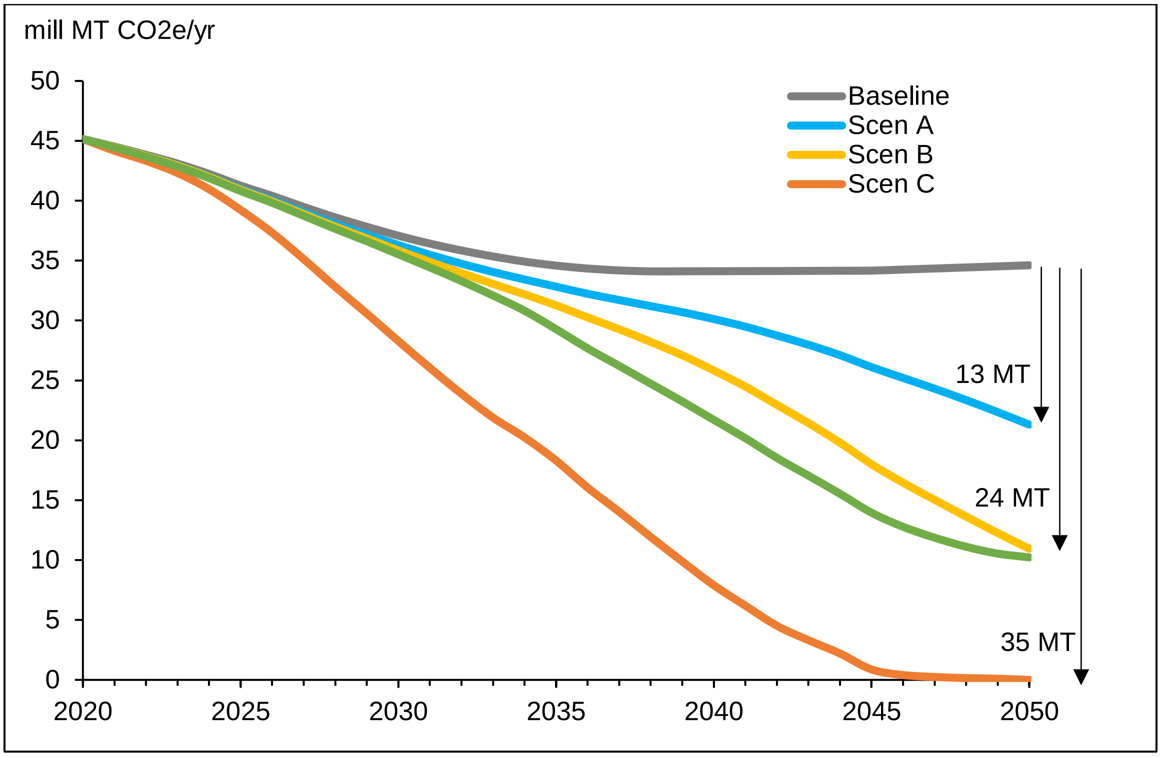
[a] Includes hospital admissions and emergency room visits.

[b] Includes reduced cases of acute bronchitis, exacerbated asthma, and other respiratory symptoms, and reduced restricted activity days and lost workdays.

Sources: ERM analysis including data from US Environmental Protection Agency, "CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA)," accessed November 11, 2021, https://www.epa.gov/cobra.

The projected annual greenhouse gas emissions measured in million metric tons carbon dioxide equivalent (CO_2e million tons) from the Virginia fleet under each electric vehicle penetration scenario are shown in figure 13. The figure also illustrates a baseline trajectory, in which the Virginia fleet does not adopt any electric vehicles and keeps its current mix of gasoline and diesel vehicles. Reductions associated with each electric vehicle scenario are compared against this baseline.

Figure 13. Modeled Virginia on-road lifecycle greenhouse gas emissions



Source: ERM analysis including data from Argonne National Laboratory's Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model and US Environmental Protection Agency's Motor Vehicle Emissions Simulator.

Climate benefits are monetized using the social cost of greenhouse gas values with a 3 percent discount rate reported by the Interagency Working Group on Social Cost of Carbon, Methane, and Nitrous Oxide.[32] This estimate represents the monetary value of the net harm to society associated with the impacts of incremental increases in greenhouse gas emissions in a given year. These impacts include sea level rise in coastal communities such as Virginia Beach, damage inflicted by stronger tropical cyclones and flooding, health and agriculture impacts from extreme summer temperatures, increased environmental migration, and many other consequences of climate change. Table 4 summarizes the modeled monetized social value of cumulative greenhouse gas reductions (2021-2050) that will result from greater electric vehicle use in Virginia.

[32] Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990* (United States Government, February 2021), https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

Table 4. Modeled cumulative greenhouse gas emission reductions and monetized value (2021 – 2050)

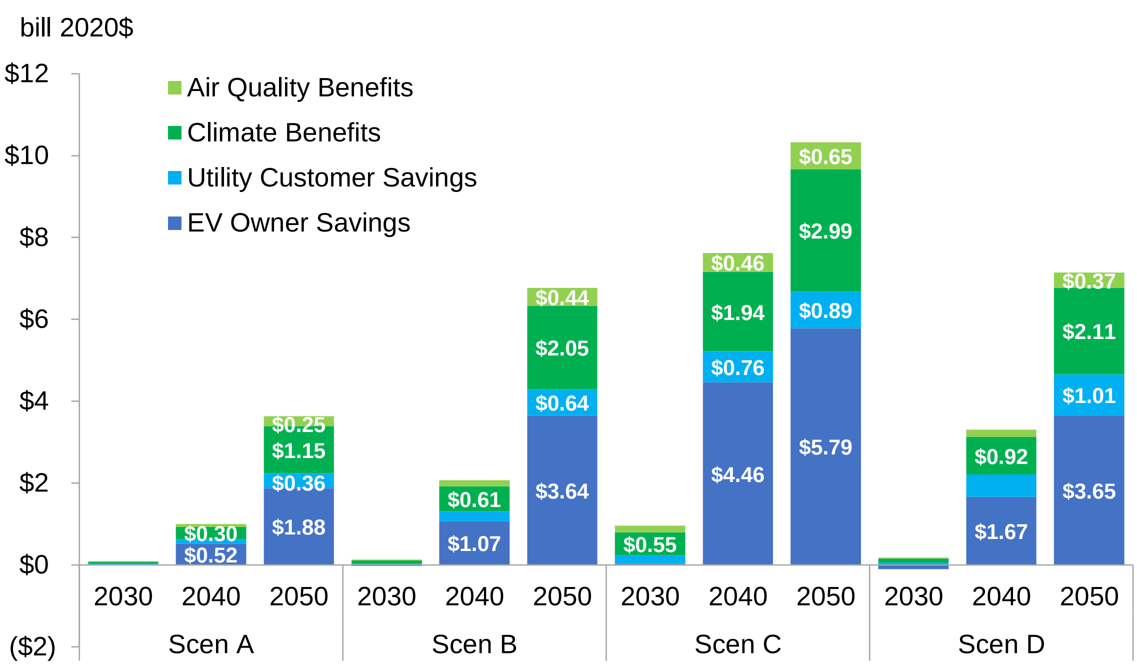
	Scenario A	Scenario B	Scenario C
Cumulative Reductions in 2050 (mill MT CO_2e)*	112	215	537
Monetized Value (bill 2020$)	$8.8	$17.0	$40.7

*Compared against baseline trajectory

Source: ERM analysis including data from Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990* (United States Government, February 2021), https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

Net Societal Benefits

Figure 14. Modeled societal benefits of Virginia electric vehicle adoption



Source: ERM analysis.

Notes: Utility Customer Savings assume that all potential benefits flow to utility customers, not utility shareholders. Air Quality Benefits are Health Benefits resulting from less polluted air, segments without data labels are less than $0.2 billion.

Figure 14 shows the annual total net societal benefits, combining four classes of costs and benefits discussed above: air quality benefits, climate benefits, utility customer savings, and electric vehicle owner savings. Electric vehicle owner savings (~50 percent) and climate benefits (~30 percent) make up most of the societal benefits. Net and cumulative benefits achieve the following:

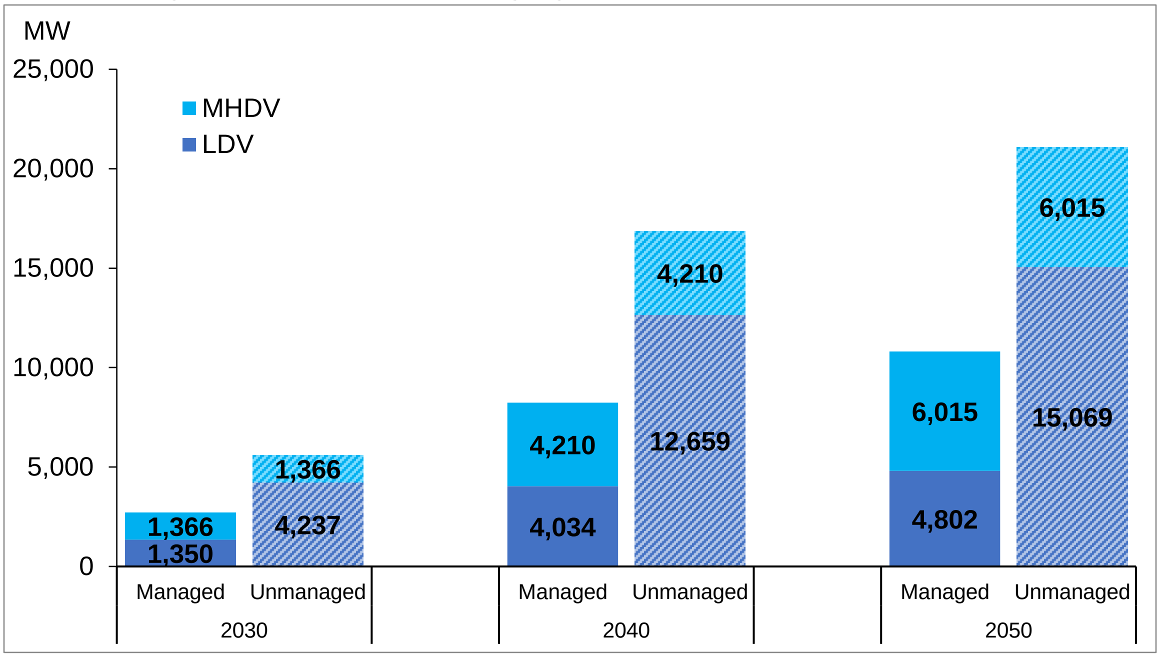
- By 2050, annual net societal benefits will reach $3.6 billion, $6.7 billion, $10.3 billion, and $7.1 billion for Scenarios A to D, respectively.
- The cumulative benefits between 2021 and 2050 amount to $27 billion, $54 billion, $138 billion, and $70 billion for Scenarios A to D, respectively.

Modeled Sensitivities

Unmanaged Charging

Achieving the levels of managed charging modeled in the base scenarios will require significant actions by many stakeholders across the state—action which is not guaranteed. To understand the impact of managing electric vehicle charging on the electric grid capacity requirement, Scenario C was modeled with no managed LDV charging. Figure 15 presents the peak capacity required due to increased electric vehicle charging under the regular Scenario C and unmanaged charging sensitivity. The peak capacity required to meet LDV charging needs more than triples in the unmanaged relative to the managed Scenario C. In 2050, 4,800 MW are required by charging LDVs in the managed case compared with 15,100 MW in the unmanaged case.[33]

Figure 15. Incremental transmission and distribution capacity required under managed vs. unmanaged electric vehicle charging sensitivity



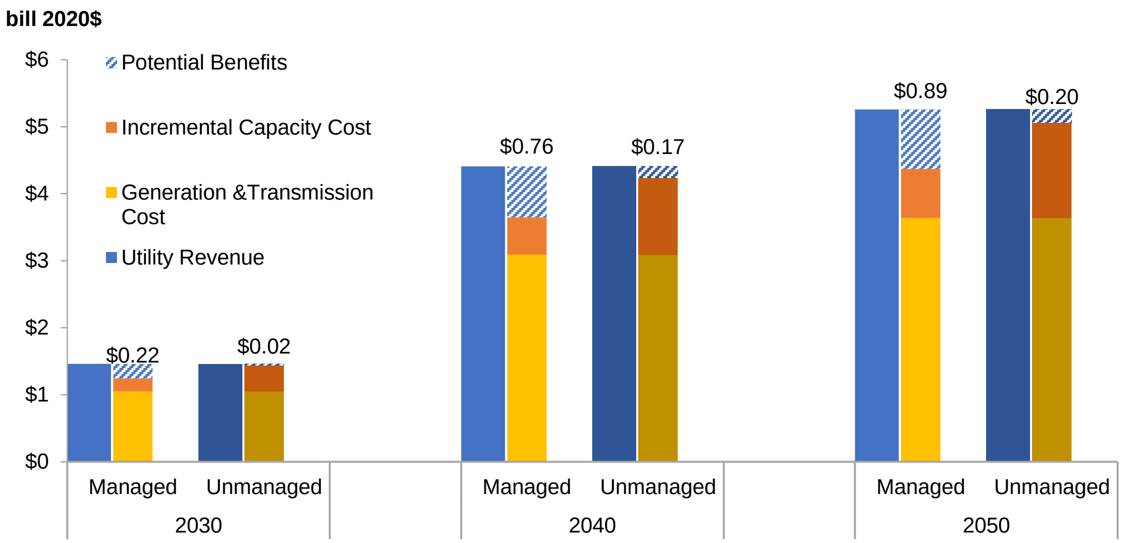
Source: ERM analysis.

The increase in peak demand under the unmanaged scenario results in lower net customer savings, due to the increase in incremental capacity needs. Figure 16 illustrates this outcome. For each year shown, the left-hand set of bars show the utility costs and revenue under the

[33] The MHDV capacity component does not change because the management of charging done by fleet owners is not expected to change.

managed Scenario C, and the right-hand set of bars show the unmanaged case. Revenue and generation and transmission costs remain the same in the managed and unmanaged case, but in the unmanaged scenario, the orange bar representing increased capacity costs is much larger, decreasing customer savings quite significantly. In 2020, under Scenario C, customer savings go from $890 million to $200 million in the managed and unmanaged cases, respectively. Customer rates would therefore be expected to be higher in an unmanaged charging scenario than in a managed charging scenario.

Figure 16. Comparing statewide utility and customer cost impacts under managed vs. unmanaged charging sensitivity



Source: ERM analysis.

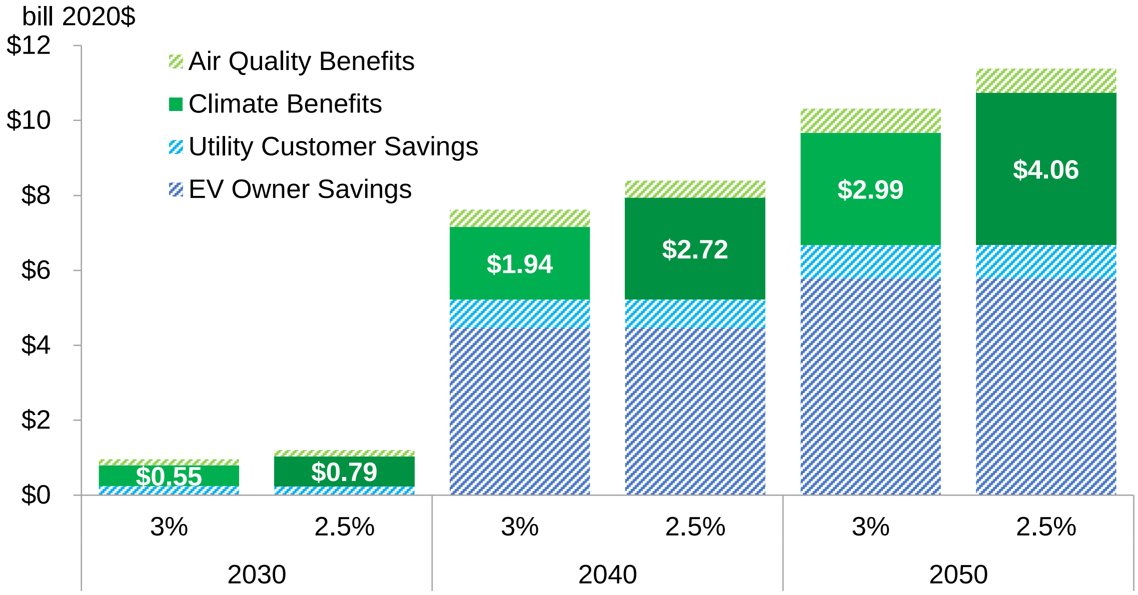
Change in Social Cost of Greenhouse Gases Discount Rate

To assess the monetary value of greenhouse gas emission reductions, a discount rate of the future value of those reductions needs to be assumed. The Interagency Working Group on Social Cost of Carbon, Methane, and Nitrous Oxide reports values with discount rates of 5 percent, 3 percent, 2.5 percent, and the 95th percentile of 3 percent.[34]

While 3 percent is used for most scenarios, stakeholders were interested in seeing the effects of using a lower discount rate. Figure 17 shows Scenario C with 3 percent and 2.5 percent discount rates on greenhouse gas emission reductions. Climate benefits increase by roughly 40 percent when using a 2.5 percent instead of 3 percent discount rate.

[34] Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document*.

Figure 17. Net benefits under social cost of greenhouse gas discount rate sensitivity (3% and 2.5%)



Source: ERM analysis including data from Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990* (United States Government, February 2021), https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

VI. Policy Proposals

The following section provides a list of possible policy proposals that could govern public electric utility programs to accelerate widespread transportation electrification in Virginia. These proposals reflect stakeholder discussion and input received in addition to background research conducted throughout the stakeholder process.

Each proposal described could be implemented as a stand-alone action or in concert with one or more of the other proposals. Each proposal is written as an action that the State Corporation Commission (SCC) or the Virginia General Assembly could implement, as GPI leaves open to the Commission to determine what is within its authority versus that of the legislature.

The group did not rank or prioritize the proposals; they are numbered for reference purposes only. The proposals are listed below as they were presented in the final stakeholder meeting, with small edits for clarity of language. Additional stakeholder feedback received after the last meeting is listed below after the policy proposals.

POLICY PROPOSALS AT THE CONCLUSION OF THE FINAL MEETING

1. Utility Transportation Electrification Plans

The SCC or the Virginia General Assembly could require regulated utilities to submit transportation electrification plans to the Commission on a regularly occurring cadence (e.g., every three years, with progress reports as warranted by significant updates) detailing the items listed below. This would allow the Commission to iteratively evaluate and provide feedback on transportation electrification forecasts, potential impacts, and expected utility offerings as an ongoing planning tool. It would also allow utilities to provide upfront information on long-term transportation electrification offerings they are contemplating and receive Commission and stakeholder input on those offerings. Importantly, the iterative nature of these plans would help utilities, the Commission, and stakeholders to stay abreast of changes in technology, economics, and policy over time.

Under this proposal, Appalachian Power and Dominion Energy would file individual plans meeting the full list of items described below, while other utilities would be asked to file smaller or aggregated plans. Process-wise, for Appalachian Power and Dominion Energy, the Commission would determine if a utility’s near-term transportation electrification investments and offerings are reasonable and complete. Aggregated cooperative plans submitted under this recommendation would be treated as informational. The first plans would be due at a date specified by the SCC, but no less than one year from the point of a Commission order requiring these plans. Utilities would also be able to submit programs for approval between plans if needed.

Regarding Virginia’s investor-owned utilities, stakeholders felt it was important that the SCC preserve complete authority over the approval of these plans and investments.

The Commission could require utilities to include the following in their transportation electrification plans or explain why the information is not available or applicable:

a. The current state and forecasted near-term future state (e.g., over the next five years) of transportation electrification deployment in their service territory, including for light-duty, medium-duty, and heavy-duty vehicles.
b. Investments and programs they expect to implement in the near term (five years) to accommodate the forecasted transportation electrification by that point in time. In presenting these investments and programs, utilities should include the following:
    i. A description of how the utility worked with customers and stakeholders to design and refine the proposal prior to filing.
    ii. How the proposed investment or program is appropriately tailored to the target use cases, vehicle types, applications, customer segments, and investment levels per customer segment.
    iii. An assessment of the costs and benefits of the proposal, including the expected costs and benefits to participants, non-participant ratepayers, the electrical system, and society. Pilot proposals may not require a full cost-benefit analysis in cases where the pilot is designed to build an understanding of the costs and benefits.
    iv. For pilot proposals, identify what the utility expects to learn from the pilot and include a list of metrics that should be used to evaluate whether the pilot should be expanded to a full program.
c. Investments they would need to implement to help increase the deployment of transportation electrification to one or more specified levels[35] in their service territory, such as the following:
    i. 25 percent electric vehicle saturation by 2045 (50 percent of sales by 2030)
    ii. 50 percent electric vehicle saturation by 2045 (75 percent of sales by 2030)
    iii. 100 percent electric vehicle saturation by 2045 (100 percent of sales by 2030)
d. For items 1-b and 1-c, utilities should address the following, unless the SCC determines that a different state agency or another SCC reporting mechanism is the appropriate way to gather that information:
    i. How those investments and programs, as a package, would impact the following:
        1. Total ratepayer rates and costs

[35] The SCC or the General Assembly could establish a set of targets for these plans. In the absence of such established targets, it may make sense to use the targets included in the modeling scenarios in this report so that the modeling results can inform the plans.

2. Grid management and more efficient use of the grid
3. Utilization of increased generation from renewable energy resources
4. Overall fuel costs for vehicles
5. Access to transportation electrification for low-income and medium-income communities.
6. Achievement of the energy storage targets established in subsection E of statute 56-585.5 of the Code of Virginia
7. Greenhouse gas emissions and air quality, including for low-income and medium-income communities
8. Workforce and economic development opportunities
9. Customer education and awareness of the benefits of transportation electrification

ii. How private (e.g., non-utility) efforts may support those investments and programs.

iii. How smart growth policies can complement or enhance those investments and programs.

iv. How those investments and programs would support low-income, minority, and rural communities.

v. How those investments and programs would integrate and work together with existing and future policies and programs, to meet the needs of various customer segments.

vi. How those investments and programs would enable on-street charging for homeowners and residential renters without dedicated parking and for city streets.

vii. The level of investment for different offerings, differentiated by customer segment.

viii. Whether or not the following specific types of utility transportation electrification investments and programs would be included, and for which customer segments they would be offered:[36]

1. **Distribution investments:** Improvements to the distribution grid that are necessary to accommodate transportation electrification broadly.

[36] There may be additional types of utility transportation electrification investments and programs that are of interest to the Commission and stakeholders. This initial list was developed based on the discussions in this stakeholder engagement process, but should not be seen as limiting what may be included in this list in the future.

2. **Utility investments in charging stations:** Direct utility investment in electric vehicle charging stations, with a focus on underserved markets, including multi-unit dwellings, low-income communities, rural communities, workplaces, heavy-duty vehicle electrification, and highway corridors.
3. **Utility investments in make-ready infrastructure:** Electric grid infrastructure upgrades and improvements on both sides of the meter to ensure that sites are "ready" for the installation of charging stations. Encourage greater attention on investing in infrastructure for multi-unit dwellings, public and workplace charging sites, and for medium- and heavy-duty fleets. Consider the potential of energy storage technologies to optimize these investments.
4. **Utility rebates for charging:** Utility rebates for chargers, which could require subscribing to a time-of-use or off-peak rate.
5. **Utility rebates for vehicles:** Utility rebates to lower the upfront cost of electric vehicle purchases until electric vehicles reach cost parity with conventional vehicles. Higher rebates should be offered to underserved markets, including low-income and rural communities.
6. **Time-of-use or electric vehicle tariffs:** Special tariffs that can support electric vehicle adoption, reduce operating and maintenance costs, and encourage electric vehicle charging during times that maximize grid benefits. Request that utilities provide details on how they will design rate structures and provide customer education to encourage high subscription rates.
7. **Managed charging programs:** Deploying managed charging programs (i.e., direct load control) where it makes geographical sense to do so (e.g., there may be greater barriers in rural areas due to broadband limitations). In designing programs, ensure there is a way for customers to opt out of demand response events.
8. **Commercial tariffs:** Special tariffs for direct current fast chargers that encourage charging station development and utilization while encouraging customer charging during times that maximize grid benefits and reduce operating and maintenance costs.
9. **Public transit electrification:** Investments to support airport, port, and truck stop electrification infrastructure and to help mass transit agencies accelerate bus electrification.
10. **Car-share and ride-share programs:** Charging infrastructure and incentives to support the conversion of car-share and ride-

share vehicles to electric and to educate riders when they are riding in an electric vehicle. Greater focus on providing services in underserved communities (e.g., rural, low-income, environmental justice) should be encouraged.

11. **Research and development:** Examples might include pilot programs to research vehicle-to-grid applications, charging behavior, optimal siting of charging locations, co-location of electric vehicles with distributed energy resources and associated impacts to the distribution grid, etc.
12. **Fleet advisory services:** Assistance provided to fleets to understand fleet needs and develop rates that assist them in their efforts to electrify. Identify charging needs and whether they will require grid upgrades. Partner with the appropriate state agency (e.g., Virginia Department of Energy) to navigate procurement of electric vehicles for the fleet.
13. **Customer education & outreach:** Robust marketing, communication, and outreach efforts to educate customers about electric vehicles, including partner rewards and recognition, ride and drive, workplace "pop-up" events, etc. Build an understanding of perceptions among customers and develop education and outreach programs to overcome skepticism.

2. Anonymized Data Filings

As a complement to transportation electrification plans, the SCC or the Virginia General Assembly could require utilities to regularly (e.g., annually) file anonymized data for stakeholders to conduct analyses, which will provide transparency and encourage innovation. Appalachian Power and Dominion Energy would file individual plans, while other utilities would be asked to file aggregated plans. The required data could include the following, to the extent it is available to the utility. If the data is not available, utilities would be asked to explain why the information is not available and/or what would be needed to collect or access the data. It may also be helpful for the SCC to establish the desired format for filing the data (e.g., in a spreadsheet) and a regular time period for reviewing and updating the list of required information. To initiate this process and inform the SCC's guidance on what to include as far as data content, the SCC could hold a workshop to determine what it would take to access and collect this information.

a. Number of electric vehicles in service territory by type (e.g., light-, medium, or heavy-duty).
b. Number of customers and vehicles on each off-peak, time-varying, or managed charging rate, as well as energy consumed and average hourly load profiles by month.
c. Level of demand in kilowatts from electric vehicles during each hour of the day for each electric vehicle tariff offered by the utility.

d. Consumption of electricity in kilowatts by electric vehicles during each hour of the day for each electric vehicle tariff offered by the utility.
e. Number and capacity of known Level 2 charging stations.
f. Number and capacity of known direct current fast charging stations.
g. System upgrades performed to accommodate electric vehicle charging, total costs paid by utility and customer, and average cost per upgrade.
h. Electric vehicle adoption forecast scenarios (low, likely, high) by sector (residential, medium-duty, and heavy-duty).
i. Electric vehicle load forecast scenarios (low, likely, high) for capacity and energy, by sector (residential, medium-duty, and heavy-duty).

3. Provide Guidance for Utilities in Developing Time-Varying Rate Structures and Managed Charging Offerings

To assist utilities and acknowledge the importance of managing when electric vehicles charge, the SCC could develop guidance on time-varying rate designs and managed charging offerings for utilities to utilize when designing such offerings. For example, for time-varying rates, the guidance could state that utilities should have a minimum number of pricing periods (e.g., three to four), ensure that on-peak to off-peak prices have a reasonable ratio, and ensure that impacts to low-income customers are considered and addressed.

This guidance should…

a. Be as specific as possible
b. Apply to multiple use cases and customer segments (with specific guidance per use case or segment as applicable), including but not limited to personal vehicles, private commercial fleets, delivery fleets, and public sector transit
c. Address demand charge optimization

4. Pursue and Coordinate Federal Funding

The state should pursue federal funding to support transportation electrification in the Commonwealth and form a joint, interagency team to ensure federal dollars are efficiently administered and implemented throughout the state.

5. Focused Process for Medium- and Heavy-Duty

The SCC or the Virginia General Assembly should implement a more detailed stakeholder engagement process (like this one) specifically focusing on medium- and heavy-duty electric vehicles. Not only is the technology much more nascent, but there are challenges from electricity profile, needs from users, rate design, and geography of use. There is more time to get medium- and heavy-duty electric vehicle rollout right, and the stakes of doing so are likely much higher for adoption. This should also include an examination of the energy storage resources that these vehicles can provide and how to value the benefits of those resources to the grid.

6. Ensure SCC Authority to Implement HB 2282

The Virginia General Assembly should give the SCC the authority it needs, with respect to Dominion Energy and Appalachian Power, to make sure that as transportation electrifies, rates accurately reflect total costs and total sales.

ADDITIONAL FEEDBACK RECEIVED AFTER THE FINAL MEETING

Given a relatively short timeline to complete this stakeholder engagement process, the policy proposals listed above were initially drafted and sent to stakeholders in advance of the fifth and final stakeholder meeting. Some edits were made during that meeting while asking for general agreement on those edits from all parties present. However, given the short amount of time that participants had to review the policy proposals and consult their colleagues (for participants in larger organizations), GPI staff asked participants to send additional feedback after the fifth meeting, noting that while there was not time for additional meetings to seek agreement on additional edits, the feedback could still be summarized in the report.

This section of the report is that summary of feedback received after the last meeting. These suggested changes were submitted by individual participants and organizations and have not been reviewed and discussed by the full stakeholder group, but nevertheless may be worth considering.

Feedback on Proposal #1: Utility Transportation Electrification Plans

- **Cost recovery:** Multiple stakeholders suggested that the process for cost recovery of transportation electrification investments be better defined to ensure transparency and set clear expectations for stakeholders. In addition, one participant requested that there be an explicit statement that costs associated with developing transportation electrification plans, including consulting support, will be recoverable. Another stakeholder requested that utilities include in their plans the mechanism through which they would seek cost recovery for transportation electrification investments and programs.
- **Timely approval of transportation electrification plans:** Multiple participants provided feedback on the approval process for transportation electrification plans. One participant requested that there be an explicit statement of the responsibility of the SCC to review and provide timely and substantive guidance to each element of a utility's transportation electrification plan. Another suggested that there be an established time period for review and approval by the SCC, as well as an established process for consideration and criteria for approval.
- **Impact on customer bills:** one stakeholder suggested that utilities should evaluate the impact of transportation electrification investments on customer bills, in addition to rates and costs.
- **Emphasis on vehicle-to-grid potential:** One participant stated that vehicle-to-grid (using electric vehicles to provide grid services) opportunities did not receive sufficient emphasis in the plan requirements. This participant requested that vehicle-to-grid, for

fleets specifically, be listed as one possible type of transportation electrification investment.

- **Inclusion of on-bill financing:** One stakeholder noted that on-bill financing for electric vehicles and charging infrastructure is discussed in the report but not included under the policy proposals. This stakeholder requested that on-bill financing should be included as an element of utility transportation electrification plans while noting that legislation would be required to permit implementation.
- **Unique considerations for cooperative utilities:** One participant noted that cooperative utilities may deserve unique consideration under this proposal given their lack of vertical integration and differences among cooperatives in wholesale suppliers. This participant also noted that cooperative utility plans may need to be made as a group or through the Association of Electric Cooperatives, and that cooperatives that were members of a generation and transmission cooperative may need the support of that organization for certain reporting requirements.
- **Requiring customer education and outreach programs:** While this policy proposal asks utilities to declare whether customer education and outreach programs are (or are not) included in their transportation electrification offerings, one stakeholder requested that this should be required in all utility transportation electrification plans, programs, and rates. In addition, this stakeholder requested that the SCC explicitly consider allowing recovery of associated costs.
- **Inclusion of innovative energy technology approaches:** one participant requested that this policy proposal include innovative technology approaches, such as integrating energy storage with electric vehicle charging infrastructure, as a listed type of investment or program for utility consideration.
- **Inclusion of resiliency for electric vehicle charging:** one stakeholder requested that transportation electrification plans include consideration of offerings to ensure that charging can happen in emergencies and when the grid is not available, such as through (but not prescribed or limited to) backup from storage, solar, management software, or microgrids.
- **Acknowledgment of utility control over electric vehicle deployment:** One participant noted that utility programs cannot ensure certain penetrations on electric vehicles, as the adoption rates are impacted by numerous variables, most of which are outside the purview of utilities. This participant requested that the language be updated to acknowledge that viewpoint.
- **Aligning transportation electrification plans with integrated resource plans:** One participant suggested that, as practical, utility transportation electrification plans should be developed in parallel with the integrated resource planning process to ensure synergies between the two planning efforts.

- **Inclusion of budgets:** one stakeholder requested that in describing their transportation electrification investments and programs, they include the budgets for such investments and programs.
- **Support for environmental justice communities:** one participant asked that transportation electrification plans address how utility investments and programs would support environmental justice communities.
- **Metrics for programs in addition to pilots:** one stakeholder suggested that utilities should propose metrics for the evaluation of programs and pilots (since the policy proposal only lists needing to propose metrics for pilots).
- **Clarification of the complexity of commercial tariffs:** in response to the requirement that utilities state whether or not their transportation electrification plans include commercial tariffs, one participant asked for acknowledgment that it may be difficult to align direct current fast charging behaviors with grid needs and that this should be taken into account in tariff designs.
- **Feedback on items under 1-d (descriptive items for transportation electrification investments and programs):**
    - One participant noted that utilities can provide the SCC with their rate structures but will likely not have direct access to the retail pricing structures at all charging stations within their service territories.
    - One stakeholder recommended that there be subcategories for different vehicle types (e.g., light-duty, medium-duty, heavy-duty), given that the fuel costs of those vehicles would differ significantly.
    - One participant stated that workforce and economic development opportunities seem out of scope for utilities to provide in a transportation electrification plan.
    - One stakeholder recommended deleting the term “on-street” from item 1-d-vi, explaining that charging access for these populations should be a priority, but on-street charging may not be the best solution for all areas of the state to meet this goal.

Feedback on Proposal #2: Anonymized Data Filings

- **Best practice review of similar data filings:** multiple stakeholders recommended that the SCC conduct a best practice review of similar transportation electrification data filings in other jurisdictions to inform the list of information that should be filed.
- **Time to deploy electric vehicle infrastructure:** one participant noted that it would be helpful to track the time it takes to deploy electric vehicle infrastructure, such as direct current fast chargers, to better understand how to improve the speed of deployment.
- **Vehicle registration data from the VA Department of Motor Vehicles:** One stakeholder noted that the Virginia Department of Motor Vehicles (DMV) likely has the most comprehensive database of electric vehicle registrations in Virginia, through which vehicle identification numbers can be decoded and sorted by type of electric vehicle and

anonymized by ZIP+4 information. This stakeholder recommended that the VA DMV explore providing this information to the SCC and utilities at regular intervals, adding that this data can be of significant help to utilities when offering program participation and determining potential impacts on the grid.

- **Support for specific customer types:** one participant asked whether it would be possible to include information to track the number of low- and moderate-income and environmental justice customers supported through utility transportation electrification programs.

Feedback on Proposal #3: Provide Guidance for Utilities in Developing Time-Varying Rate Structures and Managed Charging Offerings

- **Clarifying the process for filing managed charging offerings:** multiple stakeholders requested that the SCC, as part of its guidance, identify the processes by which managed charging offerings can be filed, reviewed, and approved by the SCC (e.g., as individual tariff filings or through utility rate cases).
- **Rate options for medium- and heavy-duty vehicles:** multiple stakeholders proposed that rate options affecting medium- and heavy-duty vehicles be discussed in the proposed stakeholder process for medium- and heavy-duty vehicles.
- **Customer protections:** one participant suggested that the SCC should direct utilities to consult stakeholders in the development of key customer protections within electric vehicle tariff design and deployment.
- **Timeline for developing guidance:** one participant suggested that the SCC should establish a timeline by which it would develop and publish the proposed guidance.
- **Reliance on existing technologies:** One stakeholder recommended that the SCC initially encourage of the use of existing technologies in managing charging, such as the timer settings that are already available within most electric vehicles to schedule charging events in accordance with time-varying rate designs. This stakeholder noted that reliance on new technologies could add cost unnecessarily, and moreover, that as the market progresses new technologies and policy-based solutions will become more cost-effective.
- **Inclusion of storage technologies:** one participant requested that storage technologies be considered in the design of time-varying rate structures and managed charging offerings.

Feedback on Proposal #4: Pursue and Coordinate Federal Funding

- **Local government participation:** one stakeholder suggested that pursuit and coordination of federal funding for transportation electrification, including the formatting of an interagency team, should include participation of local governments.
- **Private sector participation:** similar to local government participation, one participant suggested including participation of the private sector.

- **Engagement with Virginia Clean Cities:** one stakeholder mentioned that the Virginia Clean Cities technology deployment team based at James Madison University works with Virginia Department of Energy and all agencies and tracks and pursues federal funding, which could be a resource in support of this proposal.

Feedback on Proposal #5: Focused Process for Medium- and Heavy-Duty Vehicles

- **Timeline for initiation and completion:** multiple stakeholders recommended that the SCC establish a timeline for initiation and completion of this process, to ensure transparency and set expectations for stakeholders.

Feedback on Proposal #6: Ensure SCC Authority to Implement HB 2282

- **SCC staffing budget:** one stakeholder recommended that, in addition to authority, and in recognition of the expanded administrative tasks outlined in this report, the SCC should evaluate their internal costs to comply with the recommendations and request that the legislature increase the SCC budget accordingly to ensure adequate staff time to develop guidance, review filings, and evaluate program results in a timely manner.

VII. Conclusion

This report summarized the results of a stakeholder engagement process that was convened to develop policy proposals for accelerating transportation electrification in the Commonwealth of Virginia, with a particular focus on public electric utility programs. The Virginia State Corporation Commission (SCC) convened the process in response to House Bill 2282 of the Virginia General Assembly. It was facilitated by the Great Plains Institute (GPI), with modeling and analytical support from ERM Group.

Over the course of five meetings, a group of approximately 85 stakeholders met to hear presentations, develop scenario modeling, and engage in facilitated conversations to work through a series of topics and considerations with respect to electrifying transportation in the Commonwealth.

Stakeholders collectively identified many things that electric utilities can do to help advanced transportation electrification in their service territories, including rebates and incentives for charges and wiring needed to support electric vehicles, rate designs that encourage charging at times that won’t contribute to electric system peak and that will utilize renewable energy, and customer education and outreach to increase familiarity with electrified transportation technologies, among many other tools and strategies described in this report.

Stakeholders also identified a number of ways that electric utilities can improve equitable access to electrified transportation, including in the design of rebate programs and rate designs, through partnerships with local transit authorities, and through direct engagement with local communities.

To inform stakeholder discussions, ERM Group conducted modeling that assessed the high-level impacts of three primary statewide electric vehicle deployment scenarios:

- 25 percent electric vehicle saturation by 2045

- 50 percent electric vehicle saturation by 2045
- 100 percent electric vehicle saturation by 2045

The goal of conducting this modeling was not to predict the future with respect to transportation electrification in Virginia or determine what policies would be needed to advance transportation electrification. Rather, the goal was to develop a handful of very different scenarios for how the future could unfold, assess the impacts of those scenarios, and use those scenarios and impacts as a tool to inform the group's development of policy proposals.

The model compared the electric vehicle deployment scenarios with a reference case where deployment remains at today's level. All modeled scenarios showed that by 2050, they would result in lower overall costs to electric vehicle owners and all electric utility customers (even those that do not own an electric vehicle) while also improving air quality and reducing greenhouse gas emissions.[37]

Informed by the modeling results and presentations and panel discussions from experts both within and outside the stakeholder group, participants developed six policy proposals for consideration by the SCC and the General Assembly, including the following:

1. requiring utilities to submit transportation electrification plans;
2. requiring utilities to submit anonymized data filings;
3. providing guidance on time-varying rate designs;
4. pursuing and coordinating federal funding for transportation electrification;
5. launching a separate process focused specifically on solutions for medium- and heavy-duty vehicles; and
6. ensuring the SCC has the authority it needs to comply with House Bill 2282.

While the group did not drive to consensus, there was general support for the resulting policy proposals in the final meeting.

In conclusion, this stakeholder engagement process found that transportation electrification can potentially bring about the desired benefits listed in HB 2282, but doing so will require the SCC and/or the Virginia General Assembly to put policies in place that can ensure electrified transportation is deployed thoughtfully and with attention to the potential impacts to all Virginians.

[37] In assessing utility costs, the model considered the increased electricity sales attributable to electric vehicles, the generation and transmission costs of that additional electricity, and the costs of building additional transmission and distribution infrastructure to accommodate increases in peak demand caused by electric vehicles. However, the model did not seek to identify specific generation resources that would need to be built nor how transportation electrification might impact hourly PJM energy prices.

VIII. Appendix

STAKEHOLDER MEETING ATTENDANCE

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Shawn	Hildebrand	A&N Electric Cooperative	X				
Leo	Radkowski	A&N Electric Cooperative	X	X			X
Harrison	Godfrey	Advanced Energy Economy	X	X	X	X	X
Raymond	Mui*	Alexandria Transit Company				X	
Dan	Bowerson	Alliance for Automotive Innovation	X				
Bruce	Edelston	Alliance for Transportation Electrification	X	X	X	X	
Philip B.	Jones	Alliance for Transportation Electrification		X	X		
Adriane	Jaynes	American Electric Power		X	X	X	X
Heidi	Sickler	AMPLY Power		X		X	
Chad	Burnett*	APCo/American Electric Power					X
Will	Castle	APCo/American Electric Power				X	X
Carlos	Casablanca*	APCo/American Electric Power					
Daniel	Francis	APCo/American Electric Power	X		X		
Eleanor	Keeton	APCo/American Electric Power	X	X	X	X	X
Jason	Smith	APCo/American Electric Power	X	X	X	X	X

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Daniel	Zambory	APCo/American Electric Power				X	
Nicole	LePre*	Atlas Public Policy			X		
Meredith	Winkler	BARC Electric Cooperative	X	X	X	X	X
Andrew	Cotter	Central Virginia Electric Cooperative	X		X		
Alli	Gold Roberts	Ceres, Inc.				X	
Mel	Mackin	Ceres, Inc.	X	X	X		
Jared	Ballew	ChargePoint					X
Matt	Deal	ChargePoint	X	X	X		
Jena	Ginsburg	ChargePoint	X	X	X	X	
Emily	Kelly	ChargePoint	X		X		
Kevin	Miller*	ChargePoint	X		X		
Bill	Eger	City of Alexandria, VA, Office of Energy		X		X	X
A.K.	Briele	City of Salem	X		X	X	X
Laura	Gonzalez	Clean Virginia		X	X	X	X
Jeff	Ahearn	Craig-Botetourt Rural Electric Cooperative	X		X	X	
Audrey	Bauhan	Dominion Energy Virginia	X				
Stephenie	Harrington	Dominion Energy Virginia	X				
Alexander	Rendon	Dominion Energy Virginia	X				

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Devin	Sclater	Dominion Energy Virginia	X			X	X
Emma	Crescentini	Dominion Energy Virginia	X	X	X	X	X
Tim	Faherty	Dominion Energy Virginia	X	X			
Nathan	Frost	Dominion Energy Virginia	X	X	X	X	
Glenn	Kelly	Dominion Energy Virginia		X			
Abhijit	Rajan	Dominion Energy Virginia	X	X			X
Rick	Siepka	Dominion Energy Virginia				X	
Kate	Staples	Dominion Energy Virginia	X	X	X	X	X
Robert (Bob)	Trexler	Dominion Energy Virginia	X	X		X	X
Chris	Mertz	Dominion Energy Virginia			X	X	X
Tim	Oberleiton	Earthjustice	X	X			
William	Drier	Electrification Coalition	X				
Julia	Sexton	Electrification Coalition		X			
Anne	Blair	Electrification Coalition	X	X	X	X	X
Tom	Perrot	Energetics	X	X		X	X
Justin	Brightharp	Energy Efficient Transportation, Southeast	X	X	X	X	X
Carine	Dumit	EVgo	X	X	X		
Rebecca	Peters*	Fairfax County Schools				X	

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Joseph	Welborn*	Fairfax County Schools				X	
John	Cartmill	Faith Alliance for Climate Solutions		X	X	X	X
John	Clewett	Faith Alliance for Climate Solutions	X	X	X	X	X
Robert	Jordan	Faith Alliance for Climate Solutions	X	X	X	X	X
Peter	Olmsted	FreeWire Technologies	X	X	X		X
Stuart	Gardner	Generation180	X	X		X	
Blair	St. Ledger-	Generation180	X		X	X	
Patrice	Lewis	Gentry Locke	X				
Abigail	Thompson	Gentry Locke	X	X			
Kory	Trapp	Gentry Locke	X				
Alissa	Bemis^	Great Plains Institute	X	X	X	X	X
Katelyn	Bocklund^	Great Plains Institute	X	X	X	X	X
Trevor	Drake^	Great Plains Institute	X		X	X	X
Doug	Scott^	Great Plains Institute	X	X	X	X	X
Moaz	Uddin^	Great Plains Institute	X	X	X	X	X
Tom	Ashley	Greenlots	X	X	X	X	
Josh	Cohen	Greenlots	X				
Erick	Karlen	Greenlots			X		

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Rick	Lovekamp	LG&E and KU Energy LLC	X	X	X	X	X
Alexander	Macaulay	Macaulay & Jamerson, PC	X	X			
Michele	Satterlund	McGuire Woods LLP	X	X			
Ellen	Robo^	ERM		X	X	X	X
Grace	Van Horn^	ERM	X	X		X	
Praveen	Kathpal	Motor				X	
Kathy	Harris	Natural Resources Defense Council	X		X	X	X
Walton	Shepherd	Natural Resources Defense Council	X	X			
Kyle	Allwine	Northern Neck Electric Cooperative	X	X		X	X
Richard	McLendon	Northern Neck Electric Cooperative	X				
Gilbert (Gil)	Jaramillo	Northern Virginia Electric Cooperative	X	X		X	X
Howard	Spinner	Northern Virginia Electric Cooperative	X				
Kirk	Johnson	Old Dominion Electric Cooperative	X	X	X	X	X
Stephanie	Kane	Old Dominion Electric Cooperative				X	X
Erin	Puryear	Old Dominion Electric Cooperative	X		X	X	X
Lindsay	Battenberg	Proterra	X	X			
Lee	Brock	Rappahannock Electric Cooperative	X		X	X	
Brian	Doherty	Rappahannock Electric Cooperative	X	X	X	X	X

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Jessie	Lund*	Rocky Mountain Institute				X	
Cassandra	Frysinger	Shenandoah Valley Electric Cooperative	X	X	X	X	X
Tom	Handley	Shenandoah Valley Electric Cooperative	X	X	X	X	X
Rayla	Bellis*	Smart Growth America				X	
William	Cleveland	Southern Environmental Law Center	X	X			X
Carrie	Grundmann	Spilman Thomas & Battle, PLLC	X	X	X	X	X
Thad	Culley	Sunrun	X	X		X	X
Bill	Ehrlich	Tesla				X	X
Annie	Gilleo	The Ad Hoc Group, Inc	X	X	X		
Brian	Kooiman	The Ad Hoc Group, Inc	X				X
Caetano	de Campos	The Climate Collaborative	X				
Lena	Lewis	The Nature Conservancy	X	X	X	X	X
Nathaniel	Shoaff	The Sierra Club	X	X	X	X	X
Max	Parness	Toyota Motor North America		X		X	
Molly	Bauch	U.S. House of Representatives	X			X	
Michele	Blackwell	Uber Technologies	X				
Cale	Jaffe	University of Virginia School of Law	X	X	X		
Jessica	Rollinson	University of Virginia School of Law	X		X		

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
David	Skiles	Vectre Corporation	X	X			
David	Gelman	VEIC	X	X	X	X	X
Joe	Lerch	Virginia Association of Counties	X	X	X	X	
Anne	Gambardella	Virginia Automobile Dealers Association	X	X	X	X	X
Alleyn	Harned	Virginia Clean Cities	X	X	X	X	
Bruce	VLK	Virginia Clean Cities	X	X	X	X	X
Robin	Jones	Virginia Department of Energy	X		X		
Erik	Olson	Virginia Department of Energy	X	X	X	X	X
Michael	Dowd	Virginia Department of Environmental Quality	X	X	X		X
Al	Christopher	Virginia Department of Mines Minerals and		X		X	
Catherine	McGhee, P.E.	Virginia Department of Transportation	X				X
Ben	Hoyne	Virginia Poverty Law Center (Hoyne left VPLC in December and asked to be removed from the stakeholder participant list)	X	X	X		
Greg	Abbott*	Virginia State Corporation Commission	X	X	X	X	X
Scott	Armstrong*	Virginia State Corporation Commission		X	X	X	X
William	Chambliss*	Virginia State Corporation Commission	X				
Mike	Cizenski*	Virginia State Corporation Commission	X	X	X	X	X

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Jeff	Dodson*	Virginia State Corporation Commission	X	X	X	X	X
David	Essah*	Virginia State Corporation Commission	X	X	X	X	X
Georgie	Ferrell*	Virginia State Corporation Commission	X	X	X	X	
William	Harrison IV*	Virginia State Corporation Commission	X				
Katya	Kuleshova*	Virginia State Corporation Commission	X	X	X	X	X
Ashley	Macko*	Virginia State Corporation Commission	X	X	X	X	X
Yousuf	Malik*	Virginia State Corporation Commission		X	X	X	X
Kim	Pate*	Virginia State Corporation Commission	X	X	X	X	X
Allison	Samuel*	Virginia State Corporation Commission	X	X	X	X	X
Sean	Welsch*	Virginia State Corporation Commission		X	X	X	X
Dale	Bennett	Virginia Trucking Association	X	X	X		
Sam	Brumberg	Virginia, Maryland, & Delaware Association of	X			X	X
Carol	Davis	VML/VACo APCo Steering Committee	X	X	X	X	X
Nichole	Barranco	Volkswagen	X	X		X	
Aravind	Kailas	Volvo	X				
Mathias	Bell	WeaveGrid				X	X
Caryn	Potter	Southeast Sustainability Directors Network		X	X	X	X

First Name	Last Name	Organization	10/21/21	11/4/21	11/18/21	12/2/21	12/16/21
Dylan	DeBiasi			X			
Sydney	Green		X				
Brian	Kee		X				
Robbie	Wright				X		
mcoleman						X	
		Total Attendance	106	86	77	87	70

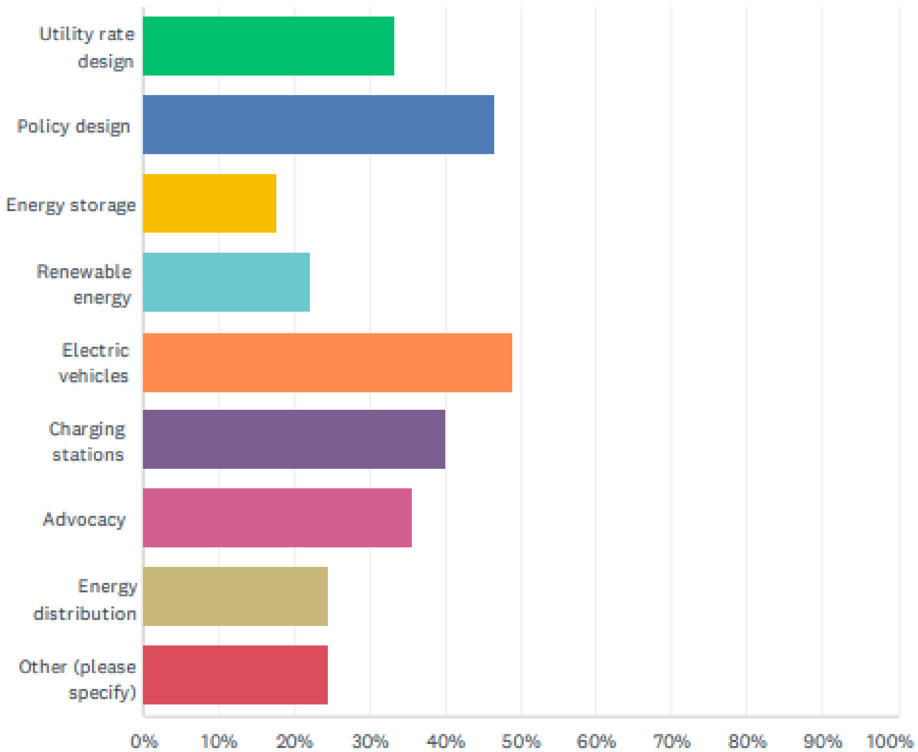
^ = Facilitation and Modeling Staff

* = Participated as presenters/panelists/observers only, which means they provided information to support discussions but were not asked to agree to the final policy proposals.

SUMMARY OF INITIAL SURVEY RESULTS

1. What are your areas of expertise? Check all that apply.

Answered: 45 Skipped: 1



ANSWER CHOICES	RESPONSES	
Utility rate design	33.33%	15
Policy design	46.67%	21
Energy storage	17.78%	8
Renewable energy	22.22%	10
Electric vehicles	48.89%	22
Charging stations	40.00%	18
Advocacy	35.56%	16
Energy distribution	24.44%	11
Other (please specify)	24.44%	11
Total Respondents: 45		

If other, please specify:

- Environmental regulation
- Rebates
- Trucking
- Wholesale power cost; transformers and electrical system infrastructure

- Engineering, operations, leadership
- General technical advisement for the zero-emission industry
- Director of state energy office
- EV charging
- Generation planning

2. How would you rate your transportation electrification literacy?

Literacy Rating	Number of respondents
0-9	1
10-19	1
20-29	1
30-39	1
40-49	2
50-59	6
60-69	4
70-79	12
80-89	8
90-100	10
Total Respondents	46
Average Rating	69

3. To what extent do you agree transportation electrification can bring about the following benefits in Virginia?

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEUTRAL/UNSURE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Reduce total ratepayer rates and costs	2.22% 1	6.67% 3	44.44% 20	20.00% 9	26.67% 12	45
Assist in grid management and more efficient use of the grid, in a manner that does not increase peak demand, through time-of-use rates, managed charging programs, vehicle-to-grid programs, or other alternative rate designs	2.17% 1	4.35% 2	23.91% 11	28.26% 13	41.30% 19	46
Utilize increased generation from renewable energy resources	0.00% 0	8.70% 4	21.74% 10	26.09% 12	43.48% 20	46
Reduce fueling costs for vehicles	0.00% 0	2.17% 1	17.39% 8	19.57% 9	60.87% 28	46

4. Are there additional benefits of transportation electrification in Virginia that you think are important, but are not listed above? If so, what are they?

- Reduced climate and local pollution (smog)
- Positive climate, health, and economic impacts.

- Transportation electrification enhances the ability to integrate additional DERs and other transactional grid services
- Decarbonization of transportation
- EV energy is a leading software platform that manages residential electric vehicle ("EV") charging for utilities and grid operators through direct load control utilizing both vehicle telematic systems and networked Electric Vehicle Supply Equipment. Managed charging software helps bring about the full realization of the benefits of transportation electrification on the residential side, including reliable load shifting, meaningful demand response, renewable generation alignment, and customer savings.
- Reduced carbon footprint of the transportation sector overall 1
- decarbonization, equity
- Carbon reduction, air quality improvements, reduced operations costs for drivers
- If designed well, TE programs can address social equity issues through e.g. pre-owned EV rebate programs and income-qualifying EVSE rebates
- Reduction in GHG emissions.
- Health
- 1. Reduce greenhouse gas emissions from one of the largest contributing sectors (if not the largest) in Virginia, even with current utility fuel mix. 2. Noise pollution benefits. 3. Water quality benefits (leaking automotive fluids are a significant contributor to non-point source pollution. 4. Reduced transportation costs for Virginians (fuel and maintenance savings). 6. Improved air quality and public health outcomes - particularly in non-attainment/heavily urbanized areas.
- Reduce air pollution and greenhouse gas emissions – Address energy and transportation issues related to disadvantaged communities – Add "energy storage technologies" to the second category of benefit related to grid management and efficient use of the grid
- Climate, air quality, and public health
- Reduce maintenance costs.
- (1) Reduction of public health impacts (i.e., reduced air pollution from transportation). (2) Mitigate greenhouse gas emissions/climate pollution. (3) Job creation potential in VA. (4) Social Cost of Carbon benefits. (5) Reduce maintenance costs for vehicle. (6) Helping Commonwealth meet its obligations under Va. Clean Economy Act and be best-positioned under to assist Virginia in RGGI and TCI.
- Reduced air pollution from transportation; mitigate GHG emissions
- Shifting the dependence on fossil fuels for transportation from the individual consumer to the generation-owners; may drive more investment in non-fossil fuel based generation
- Tourism, economic development, beneficial electrification in commercial and industrial settings
- Virginian ratepayers also spend $50 million a day on oil which is a high cost energy expense. Electric fuel at off peak $.01 per kWh wholesale PJM could cost as little as $.10 a gallon in Virginia, a reduction of more than 95% or $45 million a day saved to ratepayers. The social cost of our 50 million metric tons of carbon from gasoline/diesel is $2.5 to $7.5 billion annually, which could be reduced significantly with electrification investments.
- Incentives to motivate consumers to select electric vehicles.
- Less dependence on foreign oil (OPEC).
- reduce carbon emissions from the transportation sector
- Reduce GHG emissions, improve air quality, reduce noise pollution
- Health benefits through reduced pollution
- Environmental benefits
- Air quality improvements, less noise pollution
- Reduced local air pollution, reduced noise pollution

5. What concerns, if any, do you have about increased transportation electrification in Virginia?

- Ensuring rapid electrification, ensuring it occurs equitably
- Inequitable distribution of EV charging infrastructure and EVs being used to justify increased fossil fuel build outs.
- Ensuring equity for vulnerable communities without crossing into gentrification.
- 1.Interoperability of EVSE 2. Inappropriate subsidies 3. Equality and equal access to technology and grid services (including EVSE)
- basic feasibility of electrification on large scale over next 15 years; effect of electrification on transportation costs to poor and rural individuals
- Even with managed charging and off-peak rates, there will still be an overall load increase on the grid and utilities need to be ready for that. Breaking it down to the individual service level, we have found the increased demands from even one Level 2 EV charger can almost double the current kW demand at the typical residence. On a distribution system, this leads to issues because single services were not designed for those kinds of demands.
- Capital investment planning will be challenging and complex
- Vehicle availability, chip shortage issues
- Managed charging programs need to be easy-to-understand and very customer-friendly and accessible if they are to be successful.
- Vehicle Cost, Energy Cost and lack of charging infrastructure
- 1. How to ensure people without dedicated parking at home can access affordable/convenient charging options (multifamily housing, urban areas with on-street parking). 2. Building out a more robust and redundant network of Level 3 charging. 3. Potential for politicization of transportation electrification (red vs. blue; rural vs. urban). 4. Utility takeover/dominance of EV charging infrastructure; extension of monopolistic status that slows clean energy transition and stymies cost-effective market solutions & innovation. 5. Utilities using transportation electrification as an opportunity to push for punitive RACs or other revenue-generation that is disproportionate to their actual expenses. 6. Lack of vision/political will to ensure integration of EV infrastructure with new commercial/residential development - perhaps though legislation or regulatory means (DHCD).
- If not designed and planned in an optimized manner, increased transportation electrification and associated infrastructure may result in less efficient grid management
- That it's not happening fast enough and requires greater scale of ratepayer investment than has been envisioned
- (1)Ensure equitable distribution/access to public charging infrastructure. (2) Ensure protection for ratepayers. I.e., balance costs between shareholders/customers. (3) Ensure that building out of EV infrastructure is paired with transition to zero-carbon generation.
- Utility notification of EV chargers; availability of material to upgrade services for chargers; eventual shifting of peak times; building infrastructure before needed or where not needed
- The existing distribution system infrastructure is not prepared for a large influx of EVs. This is not my take from just my current co-op but from my experience at 3 co-ops I've worked, including BARC Electric
- Equitability and affordable access
- Massive logistics changes needed to achieve savings
- widespread availability of charging
- Waste streams associated with discarded batteries.
- Will our infrastructure be able to handle the additional demand and consumption?
- if not properly planned for, multiple EV charging stations can overload transformers and
- circuits.
- It's not happening quickly enough

- Particularly in agencies that serve the public - reliability of use is critical. Small disruptions in service can result in catastrophic events in communities and for individuals.
- Utilities trying to grab market share
- Impact to electricity distribution systems.
- battery disposal, battery supply shortages, time it will take to get infrastructure in place, infrastructure standardization

6. Which of the following topics are you most interested in discussing with other stakeholders?

ANSWER CHOICES	RESPONSES	
Areas where utility or other public investment may best complement private efforts to effectively deploy charging infrastructure, with particular focus on low-income, minority, and rural communities	64.29%	27
How smart growth policies can complement and enhance the Commonwealth's transportation electrification goals	50.00%	21
How utilities can support or enhance statewide transportation electrification, including electrification of public transit	50.00%	21
How utilities can support or enhance the electrification of medium-duty and heavy-duty vehicles, school buses, vehicles at ports and airports, personal vehicles, and vehicle fleets	59.52%	25
How utilities can support or enhance increased access to electric transportation and improved air quality in low-income and medium-income communities	59.52%	25
How utilities can support or enhance achievement of the energy storage targets established in subsection E of § 56-585.5 of the Code of Virginia	28.57%	12
How utilities can support or enhance improvements to the distribution grid or to specific sites necessary to accommodate charging infrastructure	64.29%	27
How utilities can support or enhance customer education and outreach programs that increase awareness and benefits of transportation electrification	54.76%	23
Total Respondents: 42		

7. What is the most important thing you'd like to see come out of this process?

- Specific EV adoption targets
- Increased deployment of EVSE in rural and LMI communities.
- A "small win" for the Commonwealth in the form of a reasonable platform on which each utility (including munis and coops) can build a transportation electrification offering that works for its customers/members/residents.
- To see that the decarbonization and transportation electrification goals of the administration (the governor and secretary of natural resources) are reflected in the final work product.
- Effective program design is a critical component necessary for utilizing the electric vehicles on the grid. We would like to see discussion and recommendations around the development of these programs.
- What can the Virginia General Assembly and the SCC do to help distribution cooperatives prepare for transportation electrification without adversely impacting the overall membership of the Coop. As not for profit entities, Distribution Coops have a responsibility to provide service to all of their members equitably and while we anticipate a small amount of cross subsidization across the membership during the transportation electrification movement, we do not want this to be burdensome to our LMI membership.
- Improved understanding of the issues and challenges
- Alignment on policy and regulations that clearly support the advancement of TE in Virginia, specifically equitable access to charging infrastructure for all customers
- A TE plan for Virginia

- A clear understanding of and plan to address the grid infrastructure needs to support large scale electrification of the transportation system.
- Support for real pro EV policies
- A practical, realistic approach that minimizes the impact on commercial vehicle owners and their customers.
- A suite of ambitious and actionable strategies that will ensure a swift and equitable transition of the transportation system.
- A well conceived framework designed to support and guide the deployment of EVSE, particularly high-speed fast charging infrastructure. Recommendations on policies, programs and regulations designed to encourage and incentivize cost-effective and shovel-ready EVSE deployments.
- Clear guidance for utilities to develop significant transportation electrification planning and investment
- Not sure Just listening
- Coordinated and action-oriented plan.
- We need to put policies in place that will rapidly accelerate our current pace in transitioning to EVs -- focusing both on private vehicles and government/fleet vehicles.
- A sensible plan with a lot of good data!
- Widespread understanding of the benefits, challenges, and needed infrastructure improvements associated with an influx of EVs into the VA grid
- An equitable regulation of retail and utility charging networks
- Good input and good public analysis from SCC
- It is important to recognize that electric cooperatives are different, often have different needs versus the investor-owned utilities, and are in a different place when it comes to EV adoption, especially for the residential market.
- Support for incentives for consumers to select EV's to prime the market for everything else.
- A comprehensive and global perspective on how EV penetration can be integrated into renewable energy goals.
- Agreement and flexibility from the regulators on rates and compliance reporting.
- I want EV drivers are in involved in the process so that we have some input from those will be directly impacted by recommendations of the group.
- A plan to directly accelerate adoption (as opposed to only indirectly by building more charging)
- Open discussion and education of the realities of electrification and the framework for a plan to support the end-users of the electrification process that can be developed into legislation or a similar path.
- Inclusive, well-designed EV infrastructure policies including EV charging time-of-use rates and consideration of EV charging "make-ready" investments by utilities.
- That the Commission would recognize the importance of transportation electrification to our economy and the environment and puts appropriate safeguards in place to prevent the utilities from having an unfair advantage.
- Viable path forward

8. What do you anticipate for your level of participation?

ANSWER CHOICES	RESPONSES	
I'm ready to hit the ground running! I will actively participate and contribute to conversations.	59.09%	26
I'm more of a fly on the wall. I plan to listen in on conversations and interject as needed.	40.91%	18
TOTAL		44

9. How aggressive do you envision Virginia can be as it relates to managing electric vehicles to charge off-peak?

ANSWER CHOICES	RESPONSES	
Aggressive (more than 80% EVs on off-peak rates)	39.02%	16
Moderately aggressive (50-80% EVs on off-peak rates)	39.02%	16
Moderate (30-50% EVs on off-peak rates)	12.20%	5
Not aggressive (less than 30% EVs on off-peak rates)	9.76%	4
TOTAL		41

10. When you think of Virginia's electric grid, how clean do you envision it being in 2050?

ANSWER CHOICES	RESPONSES	
More than 80% zero-emitting	58.54%	24
60-80% zero-emitting	24.39%	10
Less than 60% zero-emitting	17.07%	7
TOTAL		41

11. Related to light-duty vehicles, what vehicle range would you like to see modeled?

ANSWER CHOICES	RESPONSES	
100-200 miles	12.82%	5
200-300 miles	61.54%	24
More than 300 miles	15.38%	6
Other (please specify)	10.26%	4
TOTAL		39

#	OTHER (PLEASE SPECIFY)	DATE
1	For medium- and heavy-duty CMVs more than 300 miles	10/11/2021 5:24 PM
2	200+ miles	10/10/2021 11:23 PM
3	Real world, 20, 50, 100, 250, 300. Look at va registration database already published and trends	10/7/2021 3:53 PM
4	Unsure - don't know enough about this topic	10/7/2021 8:43 AM

12. How important do you see plug-in hybrid electric vehicles being in the future?

ANSWER CHOICES	RESPONSES	
Very important	17.50%	7
Somewhat important	62.50%	25
Not at all important	20.00%	8
TOTAL		40