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October 31, 2019

VIA HAND DELIVERY & ELECTRONIC MAIL

Luly E. Massaro, Commission Clerk
Rhode Island Public Utilities Commission
89 Jefferson Boulevard
Warwick, RI 02888

RE: Docket 4770 – Application of The Narragansett Electric Company d/b/a National Grid for Approval of a Change in Electric and Gas Base Distribution Rates

Dear Ms. Massaro:

On behalf of The Narragansett Electric Company d/b/a National Grid (Company), please find enclosed the Company's Electric Transportation Initiative Rate Year 1 Annual Report, pursuant to the Amended Settlement Agreement in this proceeding, dated August 15, 2018.

Thank you for your consideration of this request.

Respectfully Submitted,

THE NARRAGANSETT ELECTRIC COMPANY d/b/a NATIONAL GRID

By its attorney,

John K. Habib

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Cc: Dkt. 4770 Service List
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National Grid Docket No. 4770 (Rate Application) & Docket No. 4780 (PST)
Combined Service list updated 9/24/2019

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NARRAGANSET ELECTRIC COMPANY
d/b/a NATIONAL GRID
RIPUC DOCKET NO. 4770
CHAPTER 5 – ELECTRIC TRANSPORTATION

ELECTRIC TRANSPORTATION INITIATIVE
RATE YEAR 1 ANNUAL REPORT

October 31, 2019

The Narraganset Electric Company (the Company) entered into an Amended Settlement Agreement dated August 15, 2018 (the ASA). The ASA includes an Electric Transportation Initiative (the ET Initiative)to facilitate the growth of Electric Vehicle (EV) adoption and scaling of the market for EV charging equipment to advance Rhode Island's zero emission vehicles and greenhouse gas emissions policy goals. The ET Initiative includes the following five components "(i) Off-Peak Charging Rebate Pilot, (ii) Charging Station Demonstration Program, (iii) Discount Pilot for Direct Current Fast Charging (DCFC) Station Accounts, (iv) fleet advisory Services, and (v) Electric Transportation Initiative Evaluation." (ASA, Section 17).

Section 17(a)(v) of the ASA states in pertinent part:

". . . . Narragansett Electric will produce and publicly present an Annual Evaluation Report using metrics provided in the original filing with appropriate modifications to be made to reflect the programs as approved in this Settlement Agreement within two months following the end of each Rate Year, describing implementation of the electric transportation initiative, and documenting the information gained through this initiative and any recommendations to enhance the program."

Rate year one commenced as of September 1, 2018 and concluded on August 31, 2019 (RY1). In accordance with the ASA, the Annual Evaluation Report and recommendations to enhance the ET Initiative must be submitted no later than October 31, 2019.

EVALUATION REPORT

The Company engaged Energy & Resource Solutions (ERS) to conduct an independent evaluation of the ET Initiative. The goal of the evaluation is to describe the implementation of the electric transportation initiative and document the information gained through this initiative and any recommendations to enhance the program. For RY 1, the evaluation activities include review of program materials, interviews with program staff, vendors, contractors and analysis of program tracking data and charging data available.

The key findings from Rate Year 1 evaluation report are provided below:

1. Overall, the programs are well-run, engaging multiple facets of the EV market, from direct engagement with EV owners to EVSE vendors and installers, charging station site hosts, and fleet operators responsible for the maintenance and regular upgrades of public and private vehicle fleets. National Grid staff are well-qualified for their roles, and the programs effectively leverage equipment vendors and implementation contractors.
2. The ET Initiative offerings are complementary. There are opportunities for program participants to take advantage of several programs within the initiative offerings.
3. The Off-Peak Charging Rebate Pilot experiment has been well designed and implemented effectively addressing questions raised in other similar studies by using a randomized approach to provide a control group for establishing baseline charging behavior. This design and the metered data being collected will improve the quality of the analysis for Rate Year 2.

4. Baseline analysis of Off-Peak Charging Rebate Pilot participants suggests that there may be an opportunity to shift load to off-peak periods. The majority of charging sessions and charging activity (kWh) in the baseline period occurred during the latter half of the 1 p.m. to 9 p.m. peak window. The baseline load profile suggests that most EV charging is unmanaged with respect to timing.
5. The Charging Station Demonstration Program has started well, but it will require targeted outreach and attention to meet segment-specific program charging port targets. Some Level 2 segments – such as workplaces, multi-unit dwellings (MUD), and environmental justice communities – are fully, or almost fully, subscribed, while other Level 2 and all DCFC segments will require additional attention in Rate Years 2 and 3 (RY2 and RY3) which National Grid staff are planning for and continue to execute on.
6. Successful deployment of a robust EVSE network will likely require industry maturity to encompass more EVSE providers and installers. Currently there is only one charging station equipment provider with activated stations in the Charging Station Demonstration Program. While there are relatively few EVs registered in Rhode Island, ERS team anticipates that as this market grows, EVSE provider diversity will increase to meet growing demand for public charging infrastructure. In addition, National Grid is accelerating the number of qualified installers through its EV Charging Station Installers (EV CSI) RFI, which is going out to bid shortly.

Based on lessons learned from evaluation activities in Rate Year 1, the ERS team developed the following recommendations:

- Recommendation #1: Continue advocating for flexibility in program design to align program offerings with market intelligence. These are new programs in an immature and fast-changing marketplace where primary participants appear to be early adopters. Flexibility in program design and offerings can increase the overall impact of the ET Initiative. ERS interviews with program staff suggest that National Grid's RY1 proposed program changes, including proposals regarding support for Level 2 charging for electric school buses and Level 1 charging infrastructure development, are consistent with this recommendation for continued flexibility.
- Recommendation #2: Standardize and enhance Rhode Island ET Initiative program tracking methods, with the highest priority being the Charging Station Demonstration Program. National Grid program staff retain program tracking spreadsheets for each of the Rhode Island programs. These spreadsheets track project-specific information and program goals and budgets, and they serve as the system of record for the programs. Strengthening these tracking systems would expand accessibility internally, for others (e.g. evaluators), and would better enable National Grid to expand the Charging Station Demonstration Program in the future.

- Recommendation #3: Increase direct engagement with program participants to explore additional station development opportunities. Several initial participants expressed interest in additional direct engagement with National Grid to learn more about the suite of ET Initiative programs to help identify additional station development prospects within their networks. The programs effectively leverage vendor relationships, and National Grid is actively working to expand the vendor network to support participants' continued expansion of charging infrastructure.

The full report provides detailed results and findings for each of the programs and is attached hereto as Appendix 1. The Company will consider the recommendations from the evaluation report and report out the Company's plan for addressing each of these recommendations at the next meeting of the PST ET Advisory Committee on December 11, 2019.

PST ADVISORY GROUP AND MODIFICATIONS

In accordance with Section 17(e) of the ASA, commencing on October 18, 2018, the Company met on a quarterly basis with the Electric Vehicle PST Advisory Group and monthly with the Division of Public Utilities and Carriers and Rhode Island Office of Energy Resources " to discuss the progress and challenges in the development and implementation of the PST components of the MRP, along with emerging insights and learnings . . . ." The first PST Advisory Group meeting after the end of RY 1 occurred on September 12, 2019 and included a review of lessons from RY1 as well as the Company's recommendations for any modifications to enhance the ET Initiative. The planned modifications represent technology and process enhancements based on the lessons from RY1 and are more fully described herein. In accordance with the ASA

the modifications do not require a transfer of funds between ET Initiative components and therefore the Company is not seeking PUC approval (ASA Section 17 v.e). The Company received no objections from the Advisory Group to the planned modifications described herein.

Overall the Company expects that the ET Initiative will reach the goals established in the ASA and within established budgets. Below is a (i) summary of the status of the program components of the ET Initiative, (ii) the lessons learned from each program and (iii) the planned modifications to individual programs to enhance the overall ET Initiative. In addition, the Company is proposing two additional modifications pursuant to the ASA pertaining to the reevaluation of Company EVSE ownership as well as the CO2: Consumer Electric Vehicles performance incentive mechanism.

OFF PEAK CHARGING REBATE PILOT PROGRAM

The Off-Peak Charging Rebate Pilot Program has been available to customers since June 2019.

Lessons Learned & Modifications

1) During RY1, the Company developed the Off-Peak Charging Rebate Pilot Program including:

    - Outreach to EV drivers through a multi-faceted marketing campaign leveraging digital, email, print, paid search, and paid social media channels
    - Driver enrollment

- Design and implementation of the randomized control experiment.

The randomized control experiment runs from September through August in RY2. Therefore, the Company expects its RY2 report will include learnings on the effectiveness of price signals to shift driver charging behavior. The Company's learnings and modifications in RY1 focused on increasing the percentage of drivers that installed the monitoring devices in their vehicles in preparation for randomly allocating participating vehicles to the control and treatment groups in RY2.

2) Based on the lessons learned from RY 1, the process change summarized below is being implemented to this program to increase installation of the devices.

Lessons Learned	**Program Change/Clarification**
A percentage of shipped devices were not being installed because of participants' schedules and difficulty with installing the devices	A process was implemented that included: • Reducing the number of days before the participant was contacted by the vendor • National Grid directly emailing participants • National Grid calling participants and offering incentive to install device • Program Manager available by telephone to support installation by participants • Weekly tracking of shipped and installed devices • Installation Concierge Service at the RI ZOO NDEW event

<u>Modification Budget Impacts</u>

Based on RY1 data, the Company does not seek budget modifications at this time

CHARGING STATION DEMONSTRATION PROGRAM

The Charging Station Program has been available to customers and vendors since the beginning of Q4 2019. Per the ASA, the Charging Station Program defines the categories and number of charging stations to be developed as part of this initiative. Within the Charging Station Program, multiple sectors have seen progress and the Company continues to address charging program segments with less activity to date. The Company is projecting a three-year Charging Station Demonstration Program budget of $6.3M, approximately $1.0M below the original budget for the Charging Station Demonstration Program ($7.3M)(See Modifications and Budget Impacts below - Table 1).

Implementing the modifications described below is forecasted to decrease the projected spend by an additional $0.3M (See Table 2), resulting in the three-year budget forecast for the Charging Station Demonstration Program of $6.1M, approximately $1.3M less than the budget contained in the ASA (See Table 2).

The Electrify Rhode Island Electric Vehicle Charging Station Incentive Program (Electrify RI Program) is expected to fund the installation of Level 2 and DCFC charging stations in Rhode Island in Quarter 4, 2019. The Company is projecting that the Electrify Rhode Island Program will reduce, for some segments, the investment made by the Company for infrastructure, charging equipment, and the proposed funding of network and maintenance costs.

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Lessons Learned & Modifications

1) Over 75% of the program's ports are approved or in development:

a) 124 ports of 366 ports (34%) installed or approved

b) *152* ports (42%) in development or identified for future projects (e.g. public transit buses, public transit such as Pawtucket transit hub, government fleet)

c) See below for Level 2 and DCFC for RY1 installed or approved ports and projections for RY2 and 3

Level 2 Segment	Segment Ports	RY1 Installed & Approved	RY2	RY3
Corporate light-duty fleet	24	-	-	24
Government light-duty fleet	24	8	10	6
Public transit stations	60	-	20	40
Environmental Justice	36	20	12	4
MUD	36	10	20	6
Workplaces	140	86	40	14
Total L2 Ports	320	124	102	94

DCFC Segment	Segment Ports	RY1 Installed & Approved	RY2	RY3
Municipal school buses	3	-	-	3
Other heavy-duty (port, airport)	8	-	-	8
Rideshare company hub	5	-	-	5
Public transit buses	10	-	-	10
Public DCFC	20	-	5	15
Total DCFC Ports	46	-	5	41

2) Some charging infrastructure projects may extend beyond August 31, 2021 (e.g. electric bus charging stations). The Company intends to commit the program's funds to these projects with the expectation that the installation and pay out may occur after RY3. To the extent the base distribution rate allowances allocated to the program exceed the actual costs incurred in RY3 due to reasonable delays in program delivery, the Company will defer the difference to a regulatory liability account. The deferral will then be applied to program costs incurred after RY3

3) The modifications to enhance this program are based on lessons learned in RY1 relating to either equipment modifications for certain sectors/sites or process improvements. These modifications are summarized below.

a) Install Level 1 stations at locations with long-dwell times (e.g. commuter parking lots)

The Company's discussion with potential site hosts identified the option of installing Level 1 charging stations at the Pawtucket Transit Hub and Park and Ride locations throughout the State instead of Level 2 or DCFC charging stations, as stipulated in the ASA. The benefits of Level 1 stations include:

- Lower installation and equipment costs for Level 1 stations
- Drivers parking at these locations for longer periods of time can charge their vehicles, leaving the Level 2 stations available for those requiring a faster charge

The Company has not identified which Level 1 stations will be eligible but will look for the stations to have retractable cords for safety and maintenance reasons. In order to cultivate learnings, the program requires Level 2 and DCFC stations to be networked and able to provide usage data. If that is not possible for these Level 1 stations, the Company intends to either survey drivers or install loggers on the stations for a limited period of time to estimate utilization of these stations. In addition, the Company is proposing that these sites include Level 2 stations with the Level 1 stations. The assumption made for budgeting purposes is 40 Level 2 ports and 20 Level 1 ports. This is consistent with the 60 total ports stipulated in the ASA.

b) Install Level 2 stations for electric school bus charging

In its efforts to promote the electric school bus pilot to Rhode Island communities, the Company has learned that some electric school buses are charged using a Level 2 charger and not a DCFC charger as proposed and funded in the ASA. The Company is proposing the flexibility to install Level 2 chargers if required for the electric school buses as part of the Charging Station Demonstration Program.

Below is a summary of the RY Lessons and planned modifications.

Current Program Attributes/Equipment	**Lesson Learned**	**Program Change/Clarification**
Program funds Level 2 and DCFC charging stations	Level 1 charging stations can provide charging for commuters with long-dwell times (e.g. public transit stations, park and rides	Fund Level 1 stations at locations with long-dwell times such as commuter parking lots
Program allocates DCFC ports for the charging of electric school buses	Some electric school buses can be charged using Level 2 stations instead of DCFC	Install Level 2 stations for electric school bus charging if required

Current Program Attributes/Process	**Lesson Learned**	**Program Change/Clarification**
Program does not limit a customer's number of locations	Some customers are seeking to maximize the number of their locations with stations	Establish a maximum of three (3) locations (12 ports) per customer to allow for multiple participants for certain segments (e.g. EJ, MUD)
Some segments will be fully subscribed in the near future	Establish waitlist status for segments	Allows the Company to track and report out on waitlisted projects

Modification Budget Impacts

The Company is projecting a Charging Station Demonstration Program three-year budget of $6.3M, approximately $1.0M below the original budget for the Charging Station Demonstration Program ($7.3M)(See Table 1) primarily because Level 2 charging station projects paid to date have not required new service. The program budget assumed these stations would require new service.

The Company is also proposing two charging station equipment changes based on feedback from customers and electric bus manufacturers. Implementing the modifications described above is forecasted to decrease the projected spend by an additional $0.3M (See Table 2), resulting in the three-year budget forecast for the Charging Station Demonstration Program of $6.1M, approximately $1.3M less than the budget contained in the ASA (See Table 2).

TABLE 1: PROGRAM BUDGET PROJECTIONS

	Charging Station Demonstration Program		
	Settlement Agreement Budget (Original)	Revised Budget	Variance (+/-)
RY1-RY3 Budget Projection (Source: PST ET Advisory Meeting, Slide 19)	$7,348,586	$6,316,704	-$1,031,882
Net Impact of RY1 Program Modifications		-$252,609	
Revised RY1-RY3 Budget Projection	$7,348,586	$6,064,095	-$1,284,491

TABLE 2: RATE YEAR 1 PROGRAM MODIFICATIONS BUDGET IMPACTS

Rate Year 1 Program Modifications	Charging Station Demonstration Program		
	Settlement Agreement Budget (Original)	Revised Budget	Variance (+/-)
Fund Level 1 stations at locations with long-dwell times (e.g. commuter parking lots)	$586,110	$512,840	-$73,270
Install Level 2 stations for electric school bus charging if required	$435,750	$256,411	-$179,339
Net Impact of RY1 Program Modifications			**-$252,609**

DISCOUNT PILOT FOR DCFC STATION ACCOUNTS

In RY1 there were two customers approved for the Discount Pilot for DCFC Station Accounts that were eligible for credits on their electric bills equal to one hundred percent (100%) of the distribution demand charge for a period of three years from the start of service. In RY1 this resulted in approximately $13,000.00 in credits.

Lessons Learned & Modifications

For RY2 the Company is proposing to maintain this discount level (100% for a period of three years) because DCFC vendors and customers believe this program addresses a key concern associated with DCFC stations, which could help prioritize future DCFC station development in Rhode Island. In addition, the Company anticipates publicly-accessible DCFC stations being proposed and installed in RY2 based on this program, the Charging Station Demonstration Program, and the Electrify RI Program - which is expected to be launched in Q4, 2019 and fund a portion of the cost of publicly-accessible DCFC charging stations which is also a significant barrier.

Lastly, the Company is both cognizant of and intends to comply with the ASA requirement that "twenty five percent (25%) of the stations receiving the discount shall be in stations that enable electric public transit" with continued collaboration with

Rhode Island's Public Transit Authority ("RIPTA") as well as cities and towns interested in purchasing electric school buses.

Modifications Budget Impacts

Based on RY1 data, the Company does not seek budget modifications at this time.

FLEET ADVISORY PROGRAM

The Fleet Advisory program has been available to customers since Q4, 2018. There are currently five studies ongoing, four of which involve government or public transit fleets. A total of 807 vehicles are included in the study participants' fleets with the fleet study vendor's analysis identifying that electric vehicle options exist for 116 of these vehicles, at this time. The Fleet Program is on pace to meet the sectors identified in the ASA.

Lessons Learned & Modifications

Below is a summary of the RY lessons learned and planned modifications.

Lessons Learned	**Program Change/Clarification**
Some customers have been slow or non-committal after initial study kick-off	Participants provided a "study expectations" form detailing the customer and vendor commitments and requirements. Continued non-response by the customer can result in the study being "paused" until the customer re-engages with us
Fleet vehicle oversight can span multiple departments in a company, resulting in limited availability or significant delays in compiling vehicle mileage and cost data	The Fleet Study vendor now attempts to collect the data from the study participant but then proposes other means of compiling the information including a drivers' survey/log and vehicle monitoring device
Fleet vehicles, for example in the medium and heavy-duty class, have limited electric options available today.	The fleet studies will focus most of the analysis on electric vehicles available today and provide cursory information about vehicles with limited or no electric options in today's marketplace. The intent is to revisit the electric vehicle options and share updates with study participants on a regular basis.
The Fleet Studies provide the benefit of educating participants, but the Company is seeking to transition gas-powered vehicles to electric vehicles through these studies	The Company will track and report on the "Number of Electric Vehicles Purchased/Leased" to increase visibility on this key metric
Vendor time and costs to conduct site surveys to identify charging station installations could adversely impact the program budget	Site surveys will be conducted by a local installation vendor, reducing the cost for the fleet studies.

Modification Budget Impact

Based on RY1 data, the Company does not seek budget modifications at this time.

PROPOSED MODIFICATIONS UNDER THE ASA

1) Company Ownership of EVSE

By letter dated August 29, 2019, the Company notified the PUC that is was considering whether to propose to re-evaluate utility ownership of Level 2 and DCFC ports and/or whether to propose that the time in which the Company may make any such proposal be extended to prior to Rate Year 3. The Company proposes in this filing that the time in which the Company may propose to re-evaluate utility ownership of Level 2 and DCFC ports be extended to prior to Rate Year 3.

The Company is evaluating the extent to which providing customers the choice between utility-owned and site-host-owned EVSE would help to overcome barriers that might otherwise prevent potential site hosts from participating in the Charging Station Demonstration Program, particularly in site categories where progress has lagged targets. The initial version of the settlement agreement filed on June 6, 2018 (the Initial Settlement Agreement) permitted Company ownership of Level 2 EVSE in the following site categories: multi-unit dwellings, environmental justice communities, public transit (up to 50% of sites), and government light-duty fleet. It also permitted Company ownership of up to 50% of public DCFC sites. Although utility

ownership of EVSE was not allowed in the ASA, the ASA provides a pathway for reevaluation of this issue.

Under its current program, as noted in the RY1 Evaluation Report, the Company is on track to achieve its targets for multi-unit dwellings and environmental justice communities and multi-unit dwellings. The report notes that government light-duty fleets and public transit stations may require additional outreach in order to meet program targets. Further, DCFC targets have not been achieved, although Electrify RI funds are expected to increase DCFC deployment. The Company continues to evaluate barriers across all site categories expected to be underserved by the private market, and the extent to which a utility ownership option might alleviate these barriers in order to inform both the current Charging Station Demonstration Program, as well as future proposals. Depending on its findings, the Company may propose that the option of utility owned EVSE may be permitted under the Charging Station Demonstration Program for certain site categories.

2) EV CO2: Consumer Electric Vehicles

The ASA established a metric for the incremental avoided tons of CO2 resulting from the Company's proposed ET Initiative and provided for the PUC to evaluate whether to allow a financial performance incentive to be attached to the achievement of this metric, before Rate Year 2. Compliance Filing, Book 1 at 69/71-70/72 (August 16, 2018).

The Company is proposing that the PUC allow a Performance Incentive Mechanism (PIM) for CO2: Consumer Electric Vehicles effective for 2020 and 2021. This is an outcome-based PIM intended to reward the Company for accelerating EV adoption (and consequently CO2

reductions) in the state beyond levels projected over calendar years 2019-2021. The Company proposes to maintain the targets and incentives for 2020 and 2021 that were set forth Initial Settlement Agreement, with one exception: the Company has recalculated the incentive values to exclude the qualitative benefits that were included in the total incentive for this PIM in the Initial Settlement Agreement, in accordance with the PUC's determination that currently, the Company shall not earn any performance incentives based on values associated with unquantified benefits. Compliance Filing, Book 1 at 66/68. The Company's rationale for this proposal is below, followed by an overview of the metric, target, and incentive, a summary of the underlying benefit-cost analysis (BCA) and an evaluation of the incentive against the draft principles for Performance Incentive Mechanisms being considered under Docket No. 4943.

a) Incenting Company efforts to promote EV adoption will benefit our customers

Increasing electric vehicle (EV) adoption will provide quantifiable benefits to all Rhode Island customers. Incremental load from transportation electrification is expected to provide downward pressure on electric rates. In addition, all customers will benefit from the reduction in air emissions of CO2, NOx, and particulate matter that result from displacement of gasoline combustion by electricity generation.

EV adoption in Rhode Island remains far below the state's EV target of 43,000 vehicles by 2025, putting the state in danger of not achieving this important target, [1] and increasing the

[1]On October 24, 2013, the eight governors of California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont signed a Zero Emissions Vehicle Memorandum of Understanding (ZEV MOU) with a goal of reducing greenhouse gas and smog-causing emissions. Under the ZEV MOU, the signatory states collectively committed to having at least 3.3 million ZEVs on our roads by 2025, along with the infrastructure to support these vehicles. In Rhode Island, that goal is roughly 43,000 vehicles. See *State of Rhode Island Zero Emission Vehicle Action Plan* (2016) at http://www.energy.ri.gov/documents/Transportation/Rhode%20Island%20ZEV%20Action%20Plan%20Final%202016.pdf.

challenge of achieving the state's goal of achieving and 80% reduction in GHG emissions by 2050.[2] As of the end of Q2 2019, there were 1,971 registered electric vehicles in Rhode Island, less than 5% percent of the 2025 goal.[3] At the halfway point in 2019, there had been 238 incremental EVs added in the Company's territory, about 28% of the Company 2019 incremental EV forecast (discussed in more detail below) included in the ASA of 857 incremental EVs.

The Company, through its relationship with electric customers, and ongoing implementation of the ET Initiative, has a unique strategic role to play in advancing transportation electrification in Rhode Island. However, under the current regulatory framework, the Company lacks a direct incentive to advance customer adoption of electric vehicles. A performance incentive targeting EV adoption, and, ultimately CO2 emissions in Rhode Island, ensures ongoing alignment of Company and state policy interests around electrification of transportation. As an outcome-focused incentive, it will also encourage the Company to focus beyond its ongoing programs and innovate in new ways to collaborate with third parties in order to help facilitate EV market growth.

Recognizing the current statutory restrictions on marketing associated with increased kilowatt hours (kWh), the Company is evaluating how it might use funds not collected from customers to conduct education and outreach to customers about the benefits of EV adoption in a manner that is consistent with state policy and leverages Company experience for the benefit

[2] Pursuant to RIGL §46-6.2-2, the Executive Climate Change Coordinating Council submitted to the Governor and General Assembly the Rhode Island Greenhouse Gas Emissions Reduction Plan that includes strategies, programs and actions to meet specific targets for greenhouse gas emissions reductions as follows: (i) ten percent (10%) below 1990 levels by 2020; (ii) forty-five percent (45%) below 1990 levels by 2035; and (iii) eighty percent (80%) below 1990 levels by 2050. The Plan notes that "Further initiatives to incentivize the adoption of electric vehicles and charging infrastructure would be needed to achieve the aggressive market penetration levels necessary to meet long-term GHG reduction targets." (p. 20).
[3] IHS Markit/R.F. Polk data submitted to the Company.

of customers. For instance, through its direct relationship with customers and its extensive, long-term, energy efficiency marketing efforts, the Company, and utilities in general, have the ability to integrate existing customer interactions and marketing efforts for multiple programs to build customers' knowledge base of electric vehicle and charging technologies, available incentives, potential energy savings from EV ownership, and broader environmental and system benefits of EV ownership in ways that can help to stimulate the market for electric vehicles. This outreach could be done in partnership with automakers and dealers, and could target both residential customers and those customers operating large vehicle fleets, in order to accelerate electrification.

In addition, this performance incentive mechanism will ensure that the Company implements the ET Initiative with a focus on the broader policy goals of EV adoption and CO2 emissions across all aspects of the program.

While the Company recognizes that some stakeholders may be hesitant to support an outcome-based metric given the inability to fully distinguish the influence of the utility and other actors or market conditions on the outcome, it is important to note that an incentive focused solely on specific utility actions or programs would likely fail to encourage the Company to undertake broader opportunities to engage third parties in innovative ways to enable the market growth that will be necessary to achieve state goals and maximize the benefits of electrification to customers. The setting of a minimum target at a level that is 30% above the Company's forecast was intended by the settling parties to increase confidence that target achievement is due to utility activity. It is also worth noting that in jurisdictions where load is not decoupled

from revenue, the regulatory framework provides an inherent outcome-based incentive that awards utilities incremental revenue from transportation electrification without assessment of whether EV purchases are attributable to specific utility actions. Ultimately, the objective of an incentive in this area is to ensure alignment of the Company's financial interests and state policy goals to achieve the customer benefits described above.

b) Overview of the *CO2: Consumer Electric Vehicles* Performance Incentive Mechanism

The metric for this performance incentive mechanism is the incremental avoided tons of CO2 resulting from the Company's efforts to advance electric transportation, as shown in the table below. The targets were set to represent the CO2 reductions from incremental vehicle adoption above Company forecast levels. The Company forecast was developed by applying a growth rate in EV sales for New England for 2018 through 2021 derived from the Energy Information Administration's Annual Energy Outlook (AEO) 2018 projection of EV sales in New England, to historic data on EV registrations in Rhode Island from IHS Markit/R.L. Polk.[4] This historical data, calculation of the growth rate, and calculation of the Company forecast are detailed in Appendix 2. The Company's forecast for incremental EVs adopted for years 2019 through 2021 is provided in the table below. See also, Compliance Filing, Book 1 at 70/72.

Table 1. Narragansett Electric Forecast of Incremental EVs Registered in Rhode Island (Number of incremental vehicles)

	2019	2020	2021
Forecast incremental EVs	857	1,180	1,644

[4] National Grid has a contract with R.L. Polk and Company (IHS Automotive), a company that is a leader in compiling EV registration information.

In preparing to re-propose this incentive, the Company evaluated updating its incremental vehicle forecast and the targets for this incentive using the methodology described above but with updated historical data and an updated growth rate derived from the Energy Information Administration's AEO 2019. However, as shown in Appendix 2, the compound average growth rate in EV sales for the region calculated based on EIA's 2019 projections is lower than the compound average growth rate in EV sales calculated for the settlement agreement using AEO 2018 projections.[5] Application of a revised growth rate to create a new forecast, and then calculating new targets using the threshold percentages above that new forecast, would result in less ambitious performance targets. The Company thinks the more ambitious performance targets included in the Initial Settlement Agreement will more effectively drive Company performance and benefits to Rhode Island customers, as well as provide increased confidence that outcomes are due to Company impact on the marketplace.

The proposed CO2 targets and potential earnings are summarized in Table 3; targets reflect a 30%, 55%, and 80% improvement over the Company's projected incremental annual EV adoption levels in the ASA (corresponding to the minimum, target, and maximum levels, respectively). The implied incremental vehicles associated with the CO2 targets are provided in Table 2, below.

[5] As shown in Appendix 2, the projected Compound Average Growth Rate (CAGR) in EV sales for New England for the period covered by the PIM based on AEO 2018 was 44%, falling to 31% when using the AEO 2019 forecast.

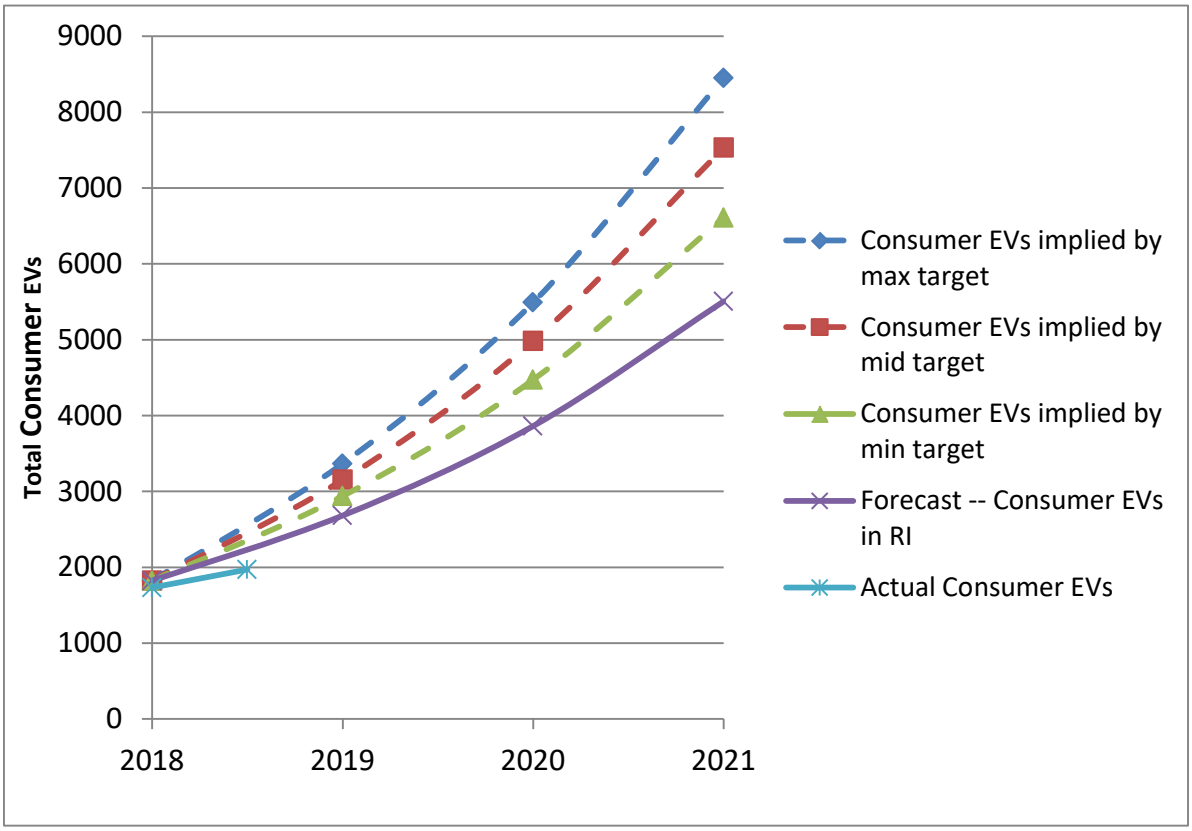
Table 2. Implied Incremental Electric Vehicles at the CO2 Consumer Electric Vehicles

See Targets in Table 3

	2020	2021
Minimum	354	493
Target	649	904
Maximum	944	1,315

For example, the minimum target for 2020 represents the CO2 emissions impact of the adoption of an additional 354 EVs above the Company's forecast. The CO2 targets reflect a weighted average annual CO2 metric tons-per-vehicle factor of 2.15. This emissions factor was derived from the Company's EV program BCA, based on the expect mix of battery electric vehicles and plug-in hybrid electric vehicles. The Company's consumer vehicle forecast and target calculations are provided in Appendix 2. Figure 1 summarizes the implications of the Company's forecast and targets for cumulative consumer EVs in Rhode Island. It displays the cumulative EV implied by Company's Settlement forecast, actual total consumer EVs through mid-2018, and the total consumer EVs implied by the minimum, midpoint, and maximum targets if achieved.

Figure 1. Total Consumer EVs under Company forecast, targets, and actuals*.



*Note: Trajectories associated with target levels assume that the same target level is achieved in all three years. For example, the minimum target trajectory assumes that the minimum target in the initial version of the settlement agreement is achieved for 2019, 2020, and 2021.

The proposed earnings for this incentive are as determined in the Initial Settlement Agreement, but adjusted to remove the portion of the incentive designated for qualitative benefits (See Appendix 3). The value of this incentive derived from quantified benefits was based on the Company's BCA for the ET Initiative, as revised for settlement. The BCA is discussed further in the next section. As designed, the incentive provides customers with 55% of net benefits, the sharing ratio for all PIMs in the initial version of the settlement agreement, and included for the System Efficiency PIM in Compliance Filing, Book 1, at 71/73.

Table 3. CO2: Consumer Electric Vehicles – Targets (incremental avoided metric tons of CO2) and Maximum Earnings Opportunity

	2020	2021
Minimum	761	1,060
Target	1,396	1,944
Maximum	2,030	2,828
Settlement Earnings at Maximum ($1,000)	$367	$497
Adjusted Earnings at Maximum ($1,000)	$331	$461

c) Benefit Cost Analysis and Incentive Determination

As discussed in Section a), the Company plans to pursue achievement of the CO2: Consumer Electric Vehicles targets through its implementation of the ET Initiative, as well by identifying innovative ways to advance customer outreach and education through funds that are not collected from customers. The Company's BCA for the ET Initiative, as revised during settlement, was used to set the value for this incentive in the Initial Settlement Agreement. This BCA is summarized below, in Table 4 and included herewith in Appendix 4, from a societal cost perspective. [6] The societal cost test results do not include the value to customers of incremental revenue, which would flow back to customers through the revenue decoupling mechanism. The BCA estimated the NPV of this revenue to be about $4.6 million over the life of the ET Initiative.

[6] The Company recognizes that there is more recent data available to update some of the assumptions in this BCA. However, given that assumptions and BCA results for all PST programs were vetted and agreed to during settlement and memorialized in the Amended Settlement Agreement, the Company has not updated any BCA assumptions. This approach is consistent with the System Efficiency targets in the Amended Settlement Agreement and the determination that the incentive will not be modified based on after the-fact reassessment of benefits and costs of those initiatives. Compliance Filing, Book 1 at 71/73-72/74.

Table 4. Summary of ET Initiative BCA

	Electric Vehicles -- Total		
Benefit	Forward Commitment: Capacity Value	$	(438,031
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	(2,000,365
	Avoided Renewable Energy Credit (REC) Cost	$	(199,084
	Greenhouse Gas (GHG) Externality Costs	$	4,434,442
	Criteria Air Pollutant and Other Environmental Costs	$	971,849
	Non-Electric Avoided Fuel Cost	$	13,580,688
	Economic Development	$	-
		$	-
	Total	**$**	**16,349,499**
Cost	Total Program Administration Costs	$	8,449,148
	Incremental Purchase and Maintenance Cost	$	5,796,281
		$	-
	Total	**$**	**14,245,429**
	Net benefits	$	2,104,070
	BCA Ratio		**1.15**

The Company's incentive was developed by calculating the net benefits per ton of CO2 reduced, and sharing 55% of the value with customers, with an incentive equal to 45%. The incentive size also reflected a 75%/25% sharing of the net benefits value between the CO2: Consumer Electric Vehicles PIM and the Light Duty Fleet Vehicles PIM that was included in the Initial Settlement Agreement. The Company has opted not to re-propose the Light Duty Fleet Vehicles PIM, but has maintained the 75% assignment of net benefits to the CO2: Consumer Electric Vehicles PIM.

The following qualitative benefits were also referenced in the Company's original ET Initiative proposal,[7] and remain relevant in the context of this performance incentive mechanism. These include societal benefits such as reduced reliance on imported fossil fuels, local economic development from new and sustained jobs involving construction and maintenance of charging stations, and increased customer awareness of the benefits of electric vehicles, and advancement of state environmental priorities.

d) Consistency with Draft PIMs Principles in Docket No. 4943

Under Docket No. 4943, Commissioner Anthony has released a memorandum outlining draft principles for Performance Incentives. The Company has provided comments on these draft principles, and suggested changes in certain areas. The Company is in agreement with some of the high-level themes that emerged from the memorandum, namely:

- rationalization of incentives across dockets, to avoid the potential for duplicative earning for a single outcome or action;
- avoiding differently sized incentives for the same action or outcome in different dockets;[8]
- movement toward incentives focused on key outcomes and benefits, rather than actions or programs; and
- ensuring benefits of incentives exceed costs to customers and limit the risks to customers.

[7] PST Book 1, Bates page 119.
[8] The Company did note in its comments on Commissioner Anthony's memorandum, however, that in certain circumstances, ancillary benefits might warrant differently sized incentives.

While the final draft guidance that emerges from Docket 4943 may differ somewhat from the draft principles, the Company has evaluated this proposal for its consistency with the draft principles in the table below.

Table 4. Evaluation of CO2 Consumer Electric Vehicles PIM against Docket 4943 Draft PIMS Principles

Principle	Explanation
A performance incentive mechanism can be considered when the utility lacks an incentive (or has a disincentive) to better align utility performance with the public interest and there is evidence of underperformance or evidence that improved performance will deliver incremental benefits.	Under the revenue decoupling mechanism, the Company does not have direct incentive to advance EV adoption in its territory because incremental revenue growth would be returned to customers. Correction of this disincentive will support delivery of benefits of electrification to customers. Further, the Company, through its relationship with customers is in a strategically important position to advance electrification.
Incentives should be designed to enable a comparison of the cost of achieving the target to the potential quantifiable and cash benefits.	The EV Program BCA developed in Docket 4770 enables the comparison of benefits of target achievement to program costs. Given current statutory restrictions on marketing, no additional customer costs would be used to pursue outreach and education that could help increase adoption.
Incentives should be designed to maximize customers' share of total quantifiable, verifiable net benefits. Consideration will be given to the inherent risks and fairness of allocation of both cash and non-cash system, customer, and societal benefits	Per the Initial Settlement Agreement, Customers would retain 55% of the quantified benefits, while the Company would retain 45%. This sharing was agreed to by all parties to the settlement. Actual customer value is higher than the shared benefits because incremental revenue that will flow back to customers was not included in the total benefit number. Given the ambition level of the targets, a lower incentive might not be sufficient to drive Company action.
An incentive should offer the utility no more than necessary to align utility performance with the public interest.	The incentive level attached to this proposal is modest but sufficient to align utility performance with the public interest. It was agreed to by the settling parties.
The utility should be offered the same incentive for the same benefit. No action should be rewarded more than an alternative action that produces the same benefit.	The Company does not currently face other incentives that directly reward the Company for carbon emissions reductions.

APPENDIX 1

EVALUATION REPORT



Rhode Island Electric Transportation Initiative Evaluation Report – Rate Year 1

prepared for

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1 EXECUTIVE SUMMARY

This report presents the evaluation results and findings for Rate Year 1 (RY1) for National Grid Rhode Island's Electric Transportation Initiative. This is a three-year initiative containing four programs: an Off-Peak Charging Rebate Pilot, Charging Station Demonstration Program, Discount Pilot for Direct Current Fast Charging (DCFC) Station Accounts, and Fleet Advisory Services. Collectively, these programs are designed to accelerate electrification in Rhode Island by scaling the market for electric transportation charging equipment and increasing electric vehicle (EV) adoption. RY1 covers the period between September 1, 2018, and August 31, 2019.

ERS conducted an accelerated evaluation for RY1, issuing initial data requests in late August 2019 and conducting all evaluation activities in September 2019. These activities included review of all program materials, including program information, marketing collateral, process flows, and program tracking spreadsheets, as well as charging data analysis for the Off-Peak Charging Rebate Pilot and the Charging Station Demonstration Program. ERS supplemented this review and analyses with primary data collection, conducting 15 interviews that represented a range of program perspectives, including program staff, vendors, implementation contractors, and initial program participants across the Charging Station Demonstration Program, Discount Pilot for Direct Current Fast Charging Station Accounts, and Fleet Advisory Services.

We have developed the following RY1 program findings from these initial evaluation activities:

1. **Overall, the programs are well-run**, engaging multiple facets of the EV market, from direct engagement with EV owners to EVSE vendors and installers, charging station site hosts, and fleet operators responsible for the maintenance and regular upgrades of public and private vehicle fleets. National Grid staff are well-qualified for their roles, and the programs effectively leverage equipment vendors and implementation contractors.
2. **The Electric Transportation Initiative offerings are complementary**. There are opportunities for program participants to take advantage of several programs within the initiative offerings.
3. **The Off-Peak Charging Rebate Pilot experiment has been well designed and implemented effectively** addressing questions raised in other similar studies by using a randomized approach to provide a control group for establishing baseline charging behavior measured directly from vehicle charging and not influenced by utility off-peak charging objectives or based on survey results. This design and the metered data being

collected directly will improve the quality of the analysis for RY2 and inspire confidence in the representativeness of the eventual findings.

4. **Initial analysis of Off-Peak Charging Rebate Pilot participants suggests that there may be an opportunity to shift load to off-peak periods.** The majority of charging sessions and charging activity (kWh) in the initial period occurred during the latter half of the 1 p.m. to 9 p.m. peak window. The initial load profile suggests that most EV charging is unmanaged with respect to timing.

5. **The Charging Station Demonstration Program has started well, but it will require targeted outreach and attention to meet segment-specific program charging port targets**. Some Level 2 segments – such as workplaces, multi-unit dwellings (MUD), and environmental justice communities – are fully, or almost fully, subscribed, while other Level 2 and all DCFC segments will require additional attention in Rate Years 2 and 3 (RY2 and RY3) which National Grid staff are planning for and continue to execute on.

6. **Successful deployment of a robust EVSE network will likely require industry maturity to encompass more EVSE providers and installers.** Currently there is only one charging station equipment provider with activated stations in the Charging Station Demonstration Program. While there are relatively few EVs registered in Rhode Island, we anticipate that as this market grows, EVSE provider diversity will increase to meet growing demand for public charging infrastructure. In addition, National Grid is accelerating the number of qualified installers through its EV Charging Station Installers ("EV CSI") RFI, which is going out to bid shortly.

We have developed three recommendations based on the evaluation activities and RY1 findings:

- **Recommendation #1: Continue advocating for flexibility in program design to align program offerings with market intelligence.** These are new programs in an immature and fast-changing marketplace where primary participants appear to be early adopters. Flexibility in program design and offerings can increase the overall impact of the Electric Transportation Initiative. ERS interviews with program staff suggest that National Grid's RY1 proposed program changes, including proposals regarding support for Level 2 charging for electric school buses and Level 1 charging infrastructure development, are consistent with this recommendation for continued flexibility.

- **Recommendation #2**: **Standardize and enhance Rhode Island Electric Transportation Initiative program tracking methods**, with the highest priority being the Charging Station Demonstration Program**.** National Grid program staff retain program tracking spreadsheets for each of the Rhode Island programs. These spreadsheets track project-

specific information and program goals and budgets, and they serve as the system of record for the programs. Strengthening these tracking systems would expand accessibility internally, for others (e.g. evaluators), and would better enable National Grid to expand the Charging Station Demonstration Program in the future.

- **Recommendation #3: Increase direct engagement with program participants to explore additional station development opportunities.** Several initial participants expressed interest in additional direct engagement with National Grid to learn more about the suite of Electric Transportation Initiative programs to help identify additional station development prospects within their networks. The programs effectively leverage vendor relationships, and National Grid is actively working to expand the vendor network to support participants' continued expansion of charging infrastructure.

The remainder of this report presents a summary of the Electric Transportation Initiative, ERS's evaluation methodology, and program-specific details regarding results, findings, and recommendations.

2 INTRODUCTION

This section describes the National Grid's Electric Transportation Initiative in Rhode Island and the evaluation objectives for RY1, which covers the time period between September 1, 2018 and August 31, 2019. ERS was procured in August 2019 to conduct an independent evaluation of the Electric Transportation Initiative for each of the three rate years.

2.1 Electric Transportation Initiative

National Grid's Electric Transportation Initiative consists of several programs designed to encourage charging infrastructure development and EV deployment throughout Rhode Island. The initiative includes:

- **Off-Peak Charging Rebate Pilot**, marketed by National Grid as the "SmartCharge Rhode Island" program[1], that aims to understand EV charging patterns and the effect of rebates in shifting EV charging from on-peak to off-peak hours. Participants' charging activity is measured by a FleetCarma C2 device, which plugs into a vehicle's onboard diagnostics port and records data while the vehicle is actively charging. The peak period is defined as the hours of 1 p.m. to 9 p.m. on all days, including weekends.
  - To evaluate this program and determine the effects of rebates on participant charging behavior, ERS, National Grid, and FleetCarma are conducting an experiment modeled after a randomized controlled trial or RCT. An RCT is a highly structured and rigorous experimental approach commonly used in the medical and

[1] For more information, visit: https://www.fleetcarma.com/smartchargerhodeisland/

social science fields to test the effect of a treatment on a group of participants, minimizing bias by randomly allocating participants across treatment and control groups. The two groups receive different treatments during the experimental period, enabling assessment of the treatment on the outcome being measured. The experimental design of the Off-Peak Charging Rebate Pilot is depicted in Table 2.1 and explained below.

Table 2.1. Experimental Design for Off-Peak Charging Rebate Pilot

Participant Group	RY1 (6/19 – 8/31/19)	RY2 (9/1/19 – 8/31/20)	RY3 (9/1/20 – 8/31/21)
Control Group	Recruitment period. Participants enroll and are activated in the program	Receives access to online dashboard showing charging behavior (serves as baseline behavior)	All participants receive access to dashboard and the additional incentives
Treatment Group		Receives access to online dashboard, **plus additional incentives per kWh charged during off-peak periods**	

- In RY1, participant outreach and enrollment activities commenced in April 2019. Initial charging behavior data collection occurred from June 2019 through August 2019, with rolling enrollment continuing throughout that period and into RY2. No charging incentives or additional information on off-peak charging were provided to participants. This evaluation report covers the analysis results from this initial period in Section 4.1.
- In RY2, from September 1, 2019, to August 31, 2020, participating vehicles will be randomly assigned by ERS to either a control or treatment group. The first random allocation occurred in late August 2019, and additional allocations will continue through the end of 2019 as more vehicles are enrolled in this program. As part of this allocation process, ERS took steps to ensure that the two groups were appropriately representative along several metrics; the process and metrics are described in greater detail in Section 4.1.2. During RY2, the control group will receive access to an online dashboard showing their charging behavior, while the treatment group will receive access to the same dashboard as well as rebates for off-peak charging. These rebates are 6 cents per kWh charged off-peak in the summer months and 4 cents per kWh charged off-peak during the non-summer months. All participants also receive $50 for installing their C2 device and recording their first charge, as well as an additional $50 for each year they keep the device plugged in, for a maximum participation incentive of $150.
- In RY3, all participants will be placed in the treatment group, receiving access to the dashboard and the charging incentives. This will enable comparisons between RY2

and RY3 charging behavior to further identify impacts of the incentives. As this program continues into RY3, rebate levels, the peak period definition, and other program design considerations may be further modified. ERS plans to evaluate any additional changes, though they may impact the direct comparisons to prior rate year behaviors.

- **Charging Station Demonstration Program**, commonly referred to as the "infrastructure program" to incentivize Level 2[2] and DCFC[3] charging station and port deployment throughout Rhode Island. National Grid has targets for both Level 2 (320 ports) and DCFC stations (46 ports) by market segment, and the program engages internal marketing staff, as well as third-party vendors, to recruit potential host sites and facilitate EVSE installation. The charging port targets and incentives by segment for both Level 2 and DCFC are presented in Table 2-1.

Table 2-1. Charging Station Demonstration Program Targets and Rebate Levels

Charging Level	Segment	Target Number of Ports	Rebate Level
Level 2	Corporate light-duty fleet	24	50%
Level 2	Government light-duty fleet	24	50%
Level 2	Public transit stations	60	50%
Level 2	Environmental justice communities	36	100%
Level 2	Apartment buildings (MUD)	36	75%
Level 2	Workplaces	140	50%
DCFC	Municipal school buses	3	75%
DCFC	Other heavy-duty (port, airport)	8	50%
DCFC	Rideshare company hub	5	25%
DCFC	Public transit buses	10	50%
DCFC	Public DCFC	20	0%

- **Discount Pilot for DCFC Stations** to accelerate third-party DCFC stations by providing an electric rate discount equal to 100% of the DCFC's distribution demand charges for a three-year period. This program is available to both existing and new DCFC stations in Rhode Island.
- **Fleet Advisory Services** to conduct fleet electrification and other studies for 12 Rhode Island fleet operators aimed at promoting vehicle electrification. Managed by a National

[2] Level 2 charging uses a 240-volt AC service and typically has a power rating between 6 and 19.2 kW. Level 2 charging stations deliver charging speeds faster than Level 1 chargers (which use a standard 120-volt wall socket and charge at less than 1.8 kW) but slower than DCFC, defined below.
[3] Direct Current Fast Charging (DCFC) is the fastest type of commercially available EV charging. It typically features charging speeds of at least 50 kW and can restore approximately 80% of an EV's charge in about 30 minutes.

Grid Program Manager, a third-party implementation contractor has been retained to conduct these studies and present results to participating fleet operators.

2.2 Evaluation Objectives

The RY1 evaluation objectives are to:

- Characterize and describe the implementation of the Electric Transportation Initiative, assessing results and progress for each individual program component.
- Report incremental CO_2 reductions resulting from incremental vehicle adoption.
- Develop early recommendations to enhance the Electric Transportation Initiative.

3 METHODOLOGY

The ERS Team completed the following activities during RY1 of this evaluation:

- **Project Manager (PM) interviews** – ERS interviewed the National Grid program managers responsible for the suite of RI Electric Transportation programs. These interviews helped ERS understand initial program successes and challenges, and enabled ERS to refine the scope of participant interviews and other research.
- **National Grid staff interviews** – After the PM interviews, we also spoke with National Grid marketing and sales staff to learn how the suite of programs are advertised throughout the state, as well as the approach taken by National Grid's sales team to identify, contact, and pitch potential participant targets.
- **Third-party interviews –** In order to gather information about how the programs were implemented and delivered to end consumers, the team conducted interviews with third parties that were engaged to deliver the National Grid programs. These included interviews with program vendors managing project installations for the infrastructure program, as well as the program consultant leading the Fleet Advisory Services studies.
- **Participant interviews** – ERS conducted interviews with participants in the Charging Station Demonstration, Discount Pilot for DCFC Stations, and Fleet Advisory Services programs. These interviews were designed to solicit participants' experiences within the program, addressing program processes, successes and barriers, and satisfaction with their participation.
- **Program information review** – We reviewed program materials for the suite of the Electric Transportation Initiative programs to inform both the design of interview guides and our understanding of the program components and progress. Materials included

marketing collateral and campaign analytics, program information, logic models/process flows, tracking spreadsheets, and other materials.

- **Data analysis** – The team conducted data analysis across many of the programs to understand progress against program goals and to analyze EV charging behavior at deployed stations and vehicles.
  - ***Off-Peak Charging Rebate Pilot.*** For this program, ERS analyzed initial EV charging behavior data, collected from June 18 to August 31, 2019, to assess the prevalence and timing of both on-peak and off-peak charging. Note that due to the abbreviated initial data collection period, which covers only the summer season, we are unable to identify seasonal trends in initial charging behavior in RY1.
    - ERS performed quality control (QC) checks to ensure that blank, invalid, and inaccurate data was flagged for removal from the analysis. Through these checks, the evaluators flagged blank or negative charging data (kWh and max kW), charge rates that exceeded the existing output of Tesla Supercharger stations (approximately 150 kW), and vehicles that belonged to National Grid employees who might have knowledge of the program and could introduce bias into the results. ERS also converted the received data from UTC to the Eastern daylight time zone (EDT). In total, 88% of the charging data passed all QC checks, suggesting that overall data quality is sound. In general, the majority of C2 devices have a non-zero error rate, meaning that most devices return a small amount of irregular data, rather than a small number of devices providing largely bad data.
    - The team constructed 24-hour charging profiles for each vehicle based exclusively on the cleaned data, accounting for each vehicle's unique entry date into the program. In developing these profiles, ERS accounted for time periods during which the vehicle was not charging (zero-charging intervals). It is critical to include these zero-charging intervals to ensure that the load profiles reflect average charging activity, rather than just times when the vehicle is actively charging. Data points that failed QC checks were removed from the analysis prior to this step.
    - We aggregated the charging profile data across vehicles and dates to calculate average charging profiles.
    - To support the rollout of the experiment in RY2, the evaluation team conducted two rounds of random allocation to assign enrolled and active vehicles to either the control or treatment group. This allocation process will be repeated monthly through December 2019 to account for late program

enrollments and vehicles that are currently enrolled but do not yet meet allocation eligibility requirements. These eligibility requirements are explained in more detail in Section 4.1.2.

- ***Charging Demonstration Program.*** For this program, ERS analyzed the utilization of each of the charging stations activated under the program in RY1. Only two of the charging stations (4 ports), located at the same facility, logged sufficient charging activity to warrant utilization analysis; the remaining 8 stations (16 ports) were activated in late August 2019 and were not heavily used before the end of RY1. The two high-utilization stations were assessed on their total kWh throughput and the number of unique charge sessions and station users.

Table 3-1 summarizes the evaluation activities across the four RI programs; Table 3-2, below, summarizes the primary interviews conducted by the ERS Team.

Table 3-1. Summary of RY1 Evaluation Activities

Research Area	Program Operations	Data Analysis	Primary Research	Additional Activities
Off-Peak Charging Rebate Pilot Evaluation	Coordinated PM interviews across all RI programs; review of program documentation	FleetCarma charging data analysis for initial period	No activities during RY1	Randomization of 259 EVs into control and treatment groups
Charging Station Demonstration Evaluation	Coordinated PM interviews across all RI programs; review of program documentation	Review of program tracking data and initial site host charging data	Interviews with site host participants (n=3)	Interviewed three vendors, National Grid sales and marketing staff
Discount Pilot for DCFC Station Evaluation	Coordinated PM interviews across all RI programs; review of program documentation	Analysis of DCFC discount pilot progress	Interview with pilot participant (n=1)	N/A
Fleet Advisory Services	Coordinated PM interviews across all RI programs; review of program documentation	Review of study timelines and program scorecards	Interviews with program implementer (n=1) and initial participants (n=2)	Review and discussion of implementation contractor SOW

Table 3-2. RY1 Interview Summary

Interviewee	Number Completed
National Grid RI program managers	3
National Grid sales staff	1
National Grid marketing staff	1
Charging Infrastructure Program participants	3
Charging Infrastructure Program vendors	3
DCFC Pilot participants	1
Fleet Advisory Services implementation vendor	1
Fleet Advisory Services participant	2
Total Interviews	**15**

4 RESULTS AND FINDINGS

This section contains the RY1 results and findings for each of the RI Electric Transportation programs evaluated.

4.1 Off-Peak Charging Rebate Pilot

For RY1, ERS cleaned and analyzed the initial charging data to characterize the vehicles participating in the program, develop average charging load profiles, and determine the prevalence and timing of both on-peak and off-peak charging to assess the potential for load-shifting.

4.1.1 Program Implementation Approach

National Grid conducted a multi-faceted marketing campaign leveraging digital, email, print, paid search, and paid social media channels to encourage EV drivers to enroll in the program and to promote the financial and environmental benefits of participation. National Grid is working closely with FleetCarma on the implementation of this program to enroll participants and ensure that they install the C2 devices and meet all eligibility criteria. FleetCarma collects charging data and reports it regularly to National Grid. ERS supported National Grid in the design and implementation of an experiment being conducted in RY2 by randomly allocating participating vehicles to the control and treatment groups as well as advising on program rollout and continued enrollment.

4.1.2 ERS Experimental Design Support

To support the rollout of the experiment in RY2, we conducted two rounds of random allocation – one in August 2019 and one in September 2019 – to assign enrolled and active vehicles to either the control or treatment group. As described in Section 2.1, vehicles are

randomly assigned to the two groups to minimize bias in group allocation. The following sections outline the random allocation process and relevant metrics.

Allocation Process

Enrolled participants are considered eligible for allocation once they activate an account with FleetCarma, install their device, and record their first charge. The vehicles that do not meet those criteria are not assigned to a group but are eligible to be assigned in a subsequent allocation run if they meet the eligibility requirements. As of the latest allocation, a total of 434 vehicles were enrolled in the program, of which 309 had been assigned to either the control or treatment groups. Random allocation of previously unassigned vehicles and new enrollments is conducted on a monthly basis and is expected to end after the December 2019 run as the program nears its participant count target. National Grid program staff have implemented several strategies to drive enrolled-but-inactive participants to install their devices and start charging, including installation support and additional monetary incentives.

All vehicles are assigned to groups based on their home address. Thus, if a given household enrolled two vehicles in the program, both of those vehicles are assigned to the same group. This step is necessary to ensure that no home has vehicles in different groups, which would introduce bias by signaling to the driver of the vehicle in the control group that off-peak charging was desirable, even if that driver was not receiving rebates for charging off-peak.

Allocation Metrics

Several metrics were analyzed to ensure that the control and treatment groups were similar; these metrics are described below and are summarized in Table 4-1.

- **Vehicle type**. To representatively capture relevant differences in vehicle technologies and resulting driving and charging behavior, vehicles were classified as belonging to one of three strata – either a plug-in hybrid EV (PHEV), a non-Tesla battery electric vehicle (BEV), or a Tesla BEV – and randomly allocated so that each group had roughly equal numbers of each vehicle type.
- **Multi-vehicle homes**. The allocation process ensured that each group had roughly equal numbers of homes with multiple participating vehicles to capture differences in charging behavior from those participants.
- **EV experience**. The allocation process ensured that each group had approximately the same average number of years of EV experience to representatively capture differences in how a seasoned EV owner might charge vs. how a new owner would charge.

Table 4-1. Vehicle Population by Vehicle Type

Group	Vehicle Stratum	Vehicle Count	Percentage of Group	Number of Vehicles from Multiple-Vehicle Households	Average Years of EV Experience
Control	Tesla BEV	37	24%	4	1.5
	Non-Tesla BEV	45	29%	5	2.4
	PHEV	73	47%	11	2.6
Total		**155**	**100%**	**20**	**2.3**
Treatment	Tesla BEV	38	25%	9	1.4
	Non-Tesla BEV	49	32%	9	2.5
	PHEV	67	44%	6	2.4
Total		**154**	**100%**	**24**	**2.2**
Overall Total		**309**	**N/A**	**44**	**2.2**

4.1.3 FleetCarma Data Description

This section outlines the structure of the data provided by FleetCarma. Data from participating vehicles' C2 devices is provided regularly to ERS via National Grid. For each charging session, the FleetCarma data includes the following fields:

- Start and end time
- Session location (limited to "In National Grid territory," "Out of territory," and "No GPS/Inaccurate GPS")
- The max charge rate (kW)
- The total charged energy (kWh)
- The starting and ending state of charge (SOC, %)
- Vehicle make, model, model year, and trim (decoded from the vehicle identification number [VIN])

The C2 device only captures data when the vehicle is actively charging; thus, if a vehicle is plugged in but programmed to delay charging until a certain time, the device does not begin recording data until the vehicle starts to receive power. It should be noted that geographical data currently indicates whether a charge session occurred within or outside of National Grid territory. More granular geographical data may be available from FleetCarma to facilitate additional analysis.

4.1.4 Program Results

The following sections outline the results of the initial charging data analysis for the Off-Peak Charging Rebate Pilot program in RY1. Data was collected during the initial data collection

period, spanning early June 2019 through August 31, 2019. Of 290 vehicles reporting data, 276 of them recorded charging activity that passed QC checks and are shown in the tables and figures throughout this section. The remaining 14 vehicles are a mix of vehicles belonging to National Grid employees and a particular model of vehicle that does not provide a data field required for analysis. Data were filtered to include only charging activity that took place within National Grid's Rhode Island service territory.

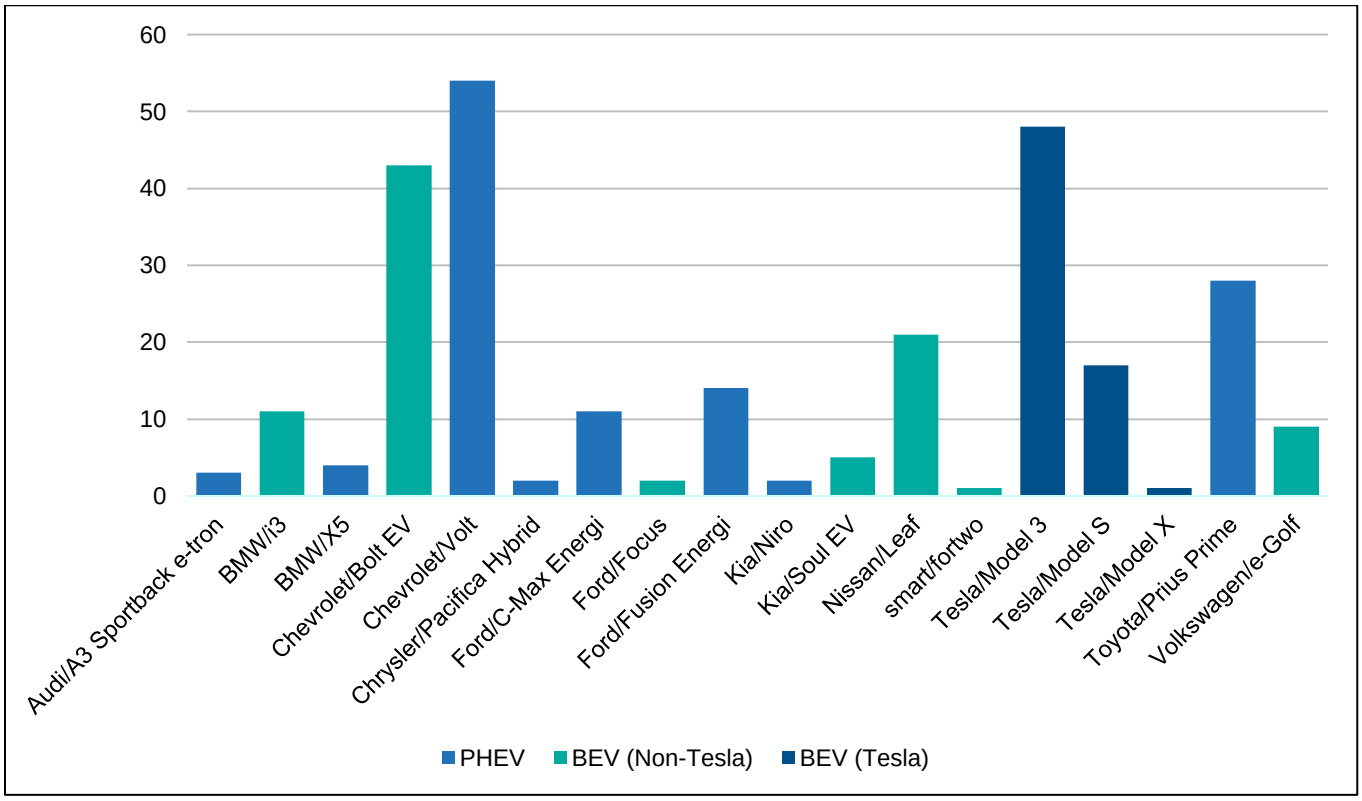
Participant Breakdown by Vehicle Type

Participating vehicles were assigned a vehicle type – either plug-in hybrid electric vehicle (PHEV), non-Tesla battery electric vehicle (BEV), or Tesla BEV – based on their make and model. These strata were used to assign vehicles to the control and treatment groups for RY2 and were chosen to ensure that relevant differences in vehicle technologies and resulting driving behavior were captured between the three groups. Categorizations may change as additional high-capacity BEVs enter the market. The breakdown of the vehicle population is presented in Table 4-2 by vehicle type and in Figure 4-1, below, by vehicle make and model.

Table 4-2. Vehicle Population by Vehicle Type

Vehicle Type	Count	Percentage of Total
BEV (non-Tesla)	92	33%
BEV (Tesla)	66	24%
PHEV	118	43%
Total	**276**	**100%**

Figure 4-1. Vehicle Population by Vehicle Make and Model



Peak-Period Charging Load Analysis

ERS assessed the total charging that occurred on-peak and off-peak during the initial period using two metrics: the total volume of charging in each period in kWh (charging load approach), and the total number of charging sessions that started in each period (session start time approach). Both metrics provide valuable insight into how Rhode Island EV drivers charge their vehicles, and both suggest that there is an opportunity to shift EV charging load away from on-peak hours. The following subsections describe each approach in more detail and present results.

Charging Load Approach – For this analysis, ERS calculated the total charging load that occurred during the initial period for the on-peak and off-peak periods. Table 4-3 shows the charging breakdown.

Table 4-3. Total Charging Load by Peak Period

Period	kWh	% of Total
Off-peak	46,136	64%
On-peak	25,447	36%
Total	**71,583**	**100%**

Table 4-4 provides a more granular view of the concentration of charging throughout the day. Half (50%) of the charging load (kWh) falls between the hours of 5 p.m. and 1 a.m., a window representing 33% of the day, showing that EV charging is concentrated in the evening. This result also shows that a significant amount of charging continues until 1 a.m., several hours after the end of the on-peak period, which likely indicates a high penetration of Level 1 home charging, the slowest type of EV charging. ERS plans to explore EV owner charging type in greater detail during RY2 surveys. Additionally, approximately 64% of the on-peak charging activity takes place in the second half of the period (5 p.m.–9 p.m.), which means that there is an opportunity to further target the latter half of the peak period and achieve a greater load shift.

Table 4-4. Total Charging Load by 4-Hour Bins

Bin	kWh	% of Total
1 a.m. – 5 a.m.	12,850	18%
5 a.m. – 9 a.m.	6,448	9%
9 a.m. – 1 p.m.	7,451	10%
1 p.m. – 5 p.m. (peak)	**9,053**	**13%**
5 p.m. – 9 p.m. (peak)	**16,394**	**23%**
9 p.m. – 1 a.m.	19,387	27%
Total	**71,583**	**100%**

Session Start Time Approach – ERS assessed the percentage of each vehicle's charging sessions that started in each four-hour bin and in each peak period to assess differences between when drivers plug in their vehicles versus when their vehicles consume energy. These results were then aggregated across all 276 vehicles that passed QC checks.

Table 4-5 shows the proportion of sessions that started in each of the peak periods.

Table 4-5. Proportion of Session Starts by Peak Period

Period	Percentage of Total Session Starts
Off-peak	51%
On-peak	49%
Total	**100%**

Approximately half (49%) of the charge sessions were initiated during the on-peak period, while only 36% of the total charged kWh occurred during the on-peak period. This indicates that drivers frequently plug in toward the end of the peak period, though most of their charging may occur once the on-peak period has ended. While these drivers would not contribute a large amount of volumetric load to the grid during the on-peak period, they would contribute to grid peaks, which this program is intended to shift.

As with the charging load approach above, it is beneficial to examine how session start times are concentrated within each peak period. Table 4-6 shows that 30% of charging sessions were initiated during the second half of the on-peak period, which supports the theory that most EV drivers plug in their vehicles when they get home for the day and do not utilize timers to delay active charging until later in the evening. ERS is aware of some home chargers that offer this functionality and plans to explore the availability of charging timers provided at the charger-level and the vehicle-level in RY2 surveys. Additionally, approximately 35% of charging sessions are initiated between the hours of 9 a.m. to 5 p.m. However, only 23% of charging load occurs in the same period, which may correspond to low-load or short-duration workplace, convenience, or "away" charging.

Table 4-6. Proportion of Session Starts by Four-Hour Bins

Bin	Percentage of Total Session Starts
1 a.m. – 5 a.m.	7%
5 a.m. – 9 a.m.	12%
9 a.m. – 1 p.m.	16%
1 p.m. – 5 p.m. (peak)	**19%**
5 p.m. – 9 p.m. (peak)	**30%**
9 p.m. – 1 a.m.	16%
Total	**100%**

Charging Load Profile Analysis

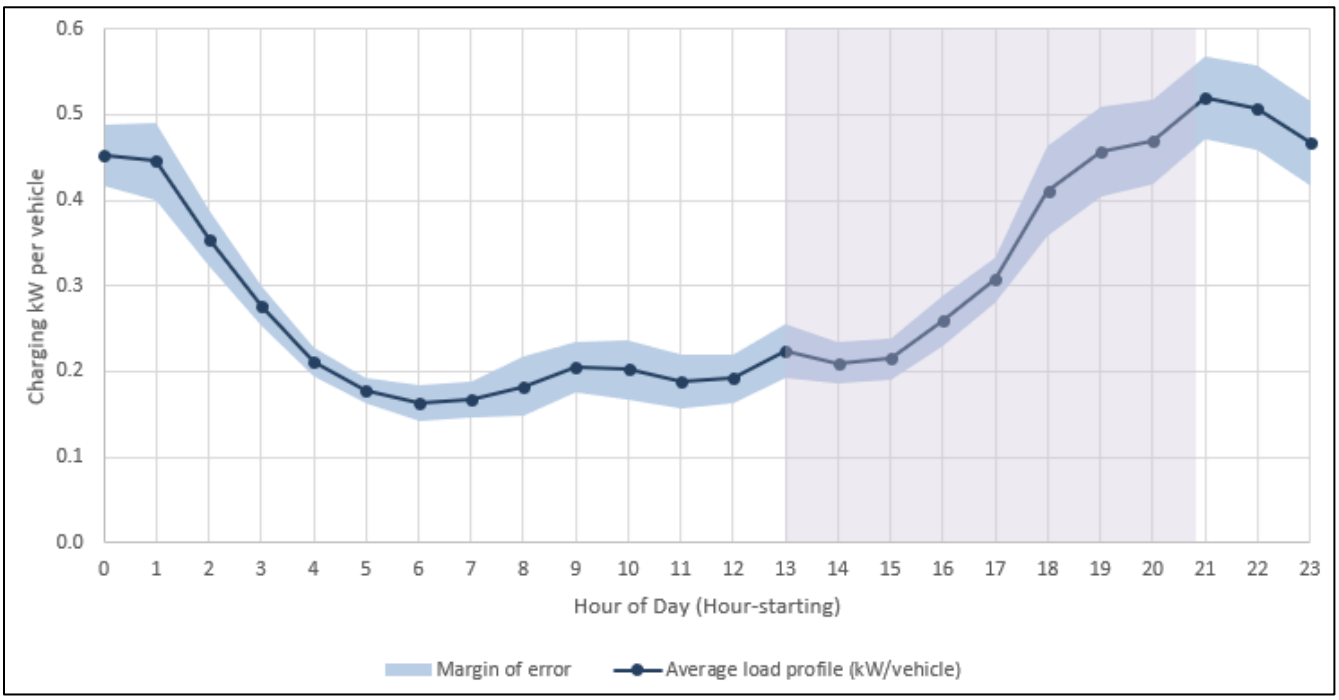
As part of the initial analysis, ERS developed a 24-hour charging load profile for the participant population. This profile was developed using the following process:

- For each day in the initial period (June 18 to August 31, 2019), we calculated the total hourly load (in kWh) across all participants for each hour of the day.
- For each day, we normalized the load at each hour by the number of participants who were actively enrolled in the program by that date (the rolling population size); the number of participants grew throughout the summer, as did the aggregate population load.
- We averaged the resulting normalized aggregate 24-hour load profile across all days in the initial period to determine a per-vehicle average charging load profile and calculated the margin of error around this average at the 90/10 confidence level.

The resulting load profile is presented in Figure 4-2, below, as the average charging load per vehicle (kW/vehicle), with the light purple box indicating the on-peak period hours of 1 p.m. to

9 p.m.; the box cuts off slightly before the 9 p.m. data point to make clear that the overhanging point represents off-peak charging activity (in the 9 p.m.–10 p.m. hour).

Figure 4-2. 24-Hour Charging Load Profile



This load profile exhibits the following attributes:

- Consistently low charging between the hours of 5 a.m. and 3 p.m.
- Slight load growth from 6 a.m. to 10 a.m. and from 12 p.m. to 2 p.m., which likely corresponds to workplace charging or other daytime "away" charging (e.g. shopping).
- A steady load ramp from approximately 3 p.m. until 10 p.m., corresponding to when drivers start to get home from work and plug in. This ramp largely overlaps with the second half of the on-peak period.
- An additional increase, or "bump," in load occurs within the afternoon ramp, between 6 p.m. and 8 p.m., which is when most drivers get home from work.
- The daily load peak occurs in the 9 p.m. to 10 p.m. hour before beginning to taper off until 5 a.m. the next day.

4.1.5 Initial Off-Peak Charging Rebate Pilot Evaluation Findings

The findings from the Off-Peak Charging Rebate Pilot initial analysis are summarized here:

- **The majority (64%) of on-peak charging (kWh) occurs between 5 p.m.–9 p.m. in the initial period**. This indicates that there is an opportunity to further target the latter half of the peak period to achieve a greater load shift.
- **Approximately 30% of charging sessions start between 5 p.m.–9 p.m. in the initial period**. This suggests that EV drivers likely plug their vehicles in when they arrive home for the day and likely do not leverage timers or other devices to delay active charging until later in the evening. This represents an opportunity for the pilot program.
- **The shape and magnitude of the initial load profile suggest that unmanaged EV charging could contribute meaningfully to the evening peak, particularly as EV adoption continues**. There is likely an opportunity to shift EV charging load to off-peak hours, particularly to the low-load window spanning 2 a.m. to 8 a.m.
- **The experiment has been designed and implemented effectively, which will improve the quality of the analysis for RY2 and inspire confidence in the representativeness of the eventual findings.** The program staff have demonstrated attention to detail and knowledge of program evaluation fundamentals and have worked effectively with ERS and FleetCarma to ensure that the RY2 experiment delivers high-quality and representative data for all participants.

4.1.6 Upcoming Activities for RY2 and RPY3

ERS will perform a second round of analysis for RY2 data to explore how the off-peak charging rebates affect the charging behavior of the treatment group relative to the control group. As part of that analysis, ERS will also assess charging behavior by vehicle type, by weekday vs. weekend, and by season. We will also conduct customer surveys with program participants to learn more about charging station types and utilization patterns, as well as program satisfaction.

4.2 Charging Station Demonstration Program

National Grid's Charging Infrastructure Program seeks to increase the deployment of Level 2 and DCFC stations throughout Rhode Island. The program covers 100% of the cost of electric service upgrades needed for the stations and provides a rebate for the installation cost of the EVSE themselves. This rebate varies by target charging segment, and covers station hardware. The program requires network and station monitoring for a minimum of five years after installation.

4.2.1 Program Implementation Approach

The Charging Station Demonstration Program leverages National Grid's existing sales staff and vendor networks to assist program staff in implementation. Sales staff solicit initial customer

interest and provide leads to program staff, who provide program details and engage the vendor network as appropriate. Typically, the vendors navigate customers through the application and installation activities. National Grid is actively expanding this network, qualifying additional vendors to deliver this program.

4.2.2 Program Results

The following sections outline program results for the Charging Infrastructure Program in RY1.

Charging Station Development

National Grid has made progress across several Level 2 segments, most notably in workplaces, multi-unit dwellings (MUD), environmental justice communities, and government light-duty fleets. During RY1, there were 10 Level 2 stations at 5 locations containing 20 ports in total, all using the same technology, activated through the program. An additional 104 Level 2 ports have been approved for the program, while 82 are under development, and more still are in the preliminary stages of the program. Of the activated and approved ports, 16% are located within environmental justice communities, defined as host sites within environmental justice areas (as defined by the RI Department of Environmental Management) and located at MUD or public parking lots.

Progress has been slower for corporate light-duty fleets, public transit stations, and for DCFC stations. National Grid program staff expect that continued outreach and the ongoing Fleet Advisory Studies will assist in future infrastructure development for both fleet and DCFC stations, and that proposed Electrify RI funding will also enable development of additional DCFC stations in RY2 and RY3.

Tables 4-7 and 4-8 present the program goals and RY1 progress for both Level 2 and DCFC stations, measured in the total number of charging ports.

Table 4-7. Charging Infrastructure Program Level 2 RY1 Progress

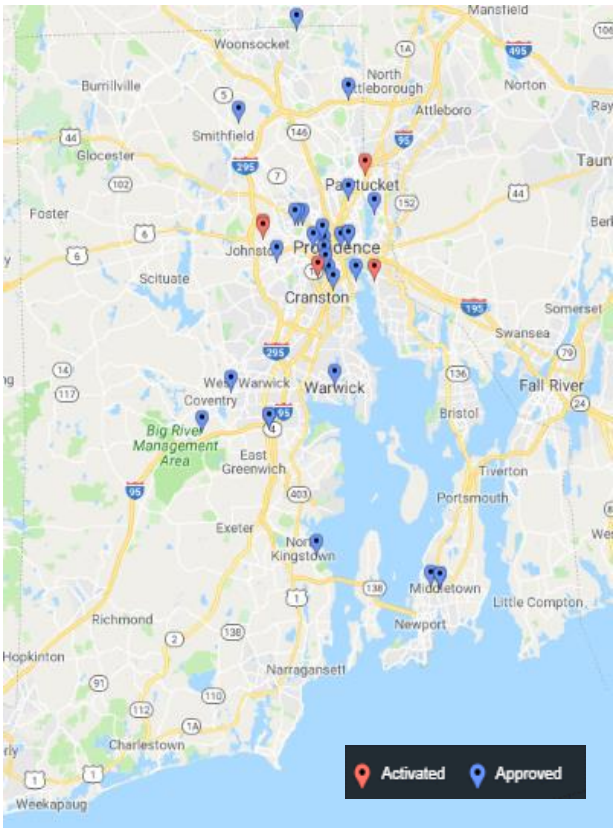
Level 2 Segment	Target Number of Ports	RY1 Activated	RY1 Approved	Under Development	Total
Corporate light-duty fleet	24	0	0	2	2
Government light-duty fleet	24	0	8	0	8
Public transit stations	60	0	0	0	0
Environmental justice communities	36	0	20	12	32
Multi-unit dwellings (MUD)	36	0	10	14	24
Workplaces	140	20	66	54	140
Total Level 2	**320**	**20**	**104**	**82**	**206**

Table 4-8. Charging Infrastructure Program DCFC RY1 Progress

DCFC Segment	Target Number of Ports	RY1 Activated	RY1 Approved	Under Development
Municipal school buses	3	0	0	0
Other heavy-duty (port, airport)	8	0	0	0
Rideshare company hub	5	0	0	0
Public transit buses	10	0	0	0
Public DCFC	20	0	0	1
Total DCFC	**46**	**0**	**0**	**1**

Figure 4-3, below, shows the distribution of the active and approved Level 2 stations throughout Rhode Island as of August 31, 2019.

Figure 4-3. Active and Approved Level 2 Stations in Rhode Island



Infrastructure Station Utilization

The infrastructure program requires a minimum of five years of network monitoring for each station installed through the program. Charging data from each session is reported to National Grid. ERS has analyzed the charging behavior in RY1 to help National Grid understand station utilization. Of the five station locations activated in RY1, two stations were activated at a single

location in May 2019 and have reported utilization data since May. The remaining three station locations were activated in late August and have limited RY1 charging data available. Table 4-9 provides a utilization summary for RY1.

Table 4-9. RY1 Charging Infrastructure Station Utilization

Station Name	Activation Date	Station Type	Number of Stations	Number of Ports	Number of Charge Sessions	Total kWh Charged
Workplace EVSE A	5/14/2019	Level 2	2	4	157	2,450
Workplace EVSE B	8/23/2019	Level 2	2	4	4	13
Workplace EVSE C	8/20/2019	Level 2	2	4	1	<1
Workplace EVSE D	8/20/2019	Level 2	2	4	2	0
Workplace EVSE E	8/28/2019	Level 2	2	4	0	0
Totals			**10**	**20**	**164**	**2,463**

ERS analyzed the charging station utilization for Workplace EVSE A, which has been in service since May 2019 and accounted for 99% of the total charging kWh in RY1. Table 4-10 shows the user data for this site; 13 unique users charged their vehicles, though the top four users (likely employees of this workplace) accounted for 84% of charging sessions and 85% of the total site charging kWh at the site. It is worth noting that this site host does not charge a usage fee for EV charging, so while this data shows site utilization, some of these drivers may in practice be shifting their charging from home charging stations to their workplace.

Table 4-10. Workplace EVSE A Charging Utilization Details

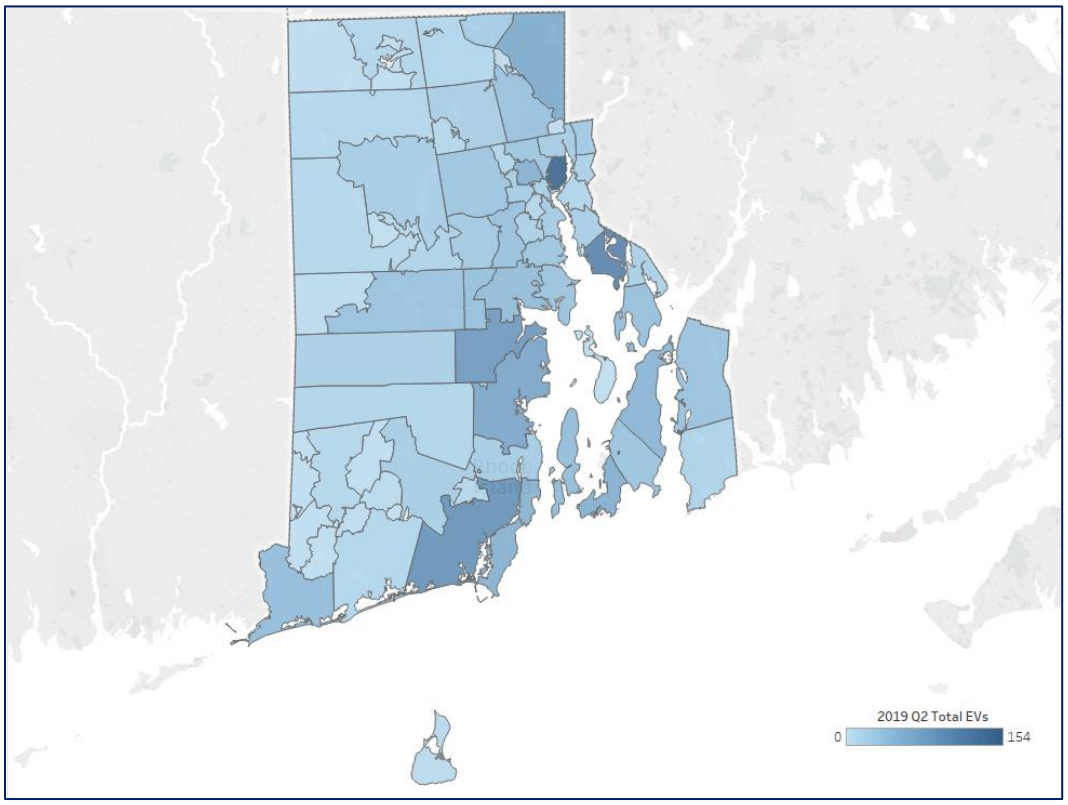
User ID	Vehicle Make/Model	Charge Session Count	% of Total Charge Sessions	Total kWh	% of Total kWh
User 1	Tesla/Model S	48	31%	535	22%
User 2	Volkswagen/e-Golf	30	19%	212	9%
User 3	Tesla/Model 3	30	19%	673	27%
User 4	Tesla/Model 3	24	15%	659	27%
User 5	Kia/Soul EV	6	4%	185	8%
User 6	BMW/i3	5	3%	45	2%
User 7	Kia/Niro Plug-in Hybrid	4	3%	21	1%
User 8	Tesla/Model 3	4	3%	69	3%
User 9	Honda/Clarity Plug-in Hybrid	2	1%	19	1%
User 10	Tesla/Model S	1	1%	10	0%
User 11	Honda/Clarity Plug-in Hybrid	1	1%	9	0%
User 12	Tesla/Model 3	1	1%	12	0%
User 13	Tesla/Model 3	1	1%	2	0%
Total		**157**	**100%**	**2,450**	**100%**

Incremental EV Adoption above National Grid Forecasts

National Grid's Amended Settlement Agreement, Docket Nos. 4770 and 4780, filed in August 2018, established annual company forecasts for EV adoption and planned to report incremental EV adoption beyond these forecasts. It identified the share of BEVs and PHEVs and provided annual CO_2 reduction conversions for each vehicle type. ERS compared the annual company forecast for 2019 to data provided by National Grid from IHS Markit, an organization that tracks EV registrations in Rhode Island and other states.

The National Grid forecast for 2019 was 857 vehicles, while the IHS Markit data for Q1 2019 and Q2 2019 included 151 BEV registrations and 87 PHEV registrations, for a total of 238 incremental EV registrations and a total population of Rhode Island EVs of 1971. Figure 4-4 shows the spatial distribution of Rhode Island's EV population by ZIP code as of 2019 Q2, with darker colors indicating greater EV penetration; this information is also presented in tabular format in Appendix A.

Figure 4-4. Rhode Island EVs by ZIP Code – through 2019 Q2



While the Q3 and Q4 2019 data are not yet available from IHS, the initial results suggest that actual EV registrations likely fell short of National Grid forecasts. As a result, there are no emissions reductions resulting from incremental EV registrations beyond the forecast. ERS will plan to revisit this analysis in RY2 and RY3 when additional data is available from IHS Markit and as the program continues to incentivize station development.

Additionally, ERS can use a proprietary EV Adoption (EVA) model to compare EV adoption outcomes under different assumptions and conditions to provide additional insights into this metric; this modeling was included in the optional Task 7 of this evaluation. Should National Grid elect to exercise this optional task, ERS can use this model to provide additional insights to determine the degree to which additional infrastructure deployment would enable increased EV adoption in Rhode Island.

4.2.3 Initial Charging Demonstration Program Evaluation Findings and Recommendations

The RY1 research conducted by the ERS Team has identified several initial program findings:

- **Overall, the program is making steady progress toward its goals**. Some segments, such as Level 2 workplaces, are fully subscribed. Other segments, such as corporate and government light-duty fleets and public transit stations, will require additional outreach in RY2 and RY3 to meet program port targets. National Grid staff are aware of this need and are actively planning for it. DCFC station volume is expected to increase as additional funds become available through the VW Settlement.
- **New DCFC stations are not meeting program targets, but this could change once Electrify RI funding from the VW Settlement Agreement becomes available.** Program staff and vendors anticipate that additional funding will alleviate the high charging equipment cost barriers faced by site hosts looking to deploy DCFC stations.
- **Program incentives are helping drive customer participation**. Several customers indicated that without the program benefits, particularly the coverage of electric service upgrades, they would likely not have participated in the program.
- **Participants and vendors are satisfied with the program offering.** While ERS only conducted three participant interviews in RY1, all participants rated their program satisfaction at a 9 on a 0 to 10 scale, indicating high satisfaction. All three program vendors interviewed by ERS also rated the program highly.
- **The program vendor network is an effective approach to enable EVSE development.** Participants expressed satisfaction and confidence in the vendors with which they work; two of the three participants interviewed identified that they had existing relationships with the vendors through prior energy efficiency projects, and the third had worked

with National Grid on prior Level 2 charging stations. Vendors are also working to source additional stations, often leveraging their existing relationships through National Grid energy efficiency programs and other channels. National Grid is actively working to expand its network of vendors qualified to install charging infrastructure through the EV CSI Program.

Recommendation: National Grid should directly engage site hosts throughout program participation. The sales team and program staff typically engage potential site hosts at the onset of the projects, but participants indicated that their primary contact throughout installation and commissioning of charging stations is with the program vendors. Several participants expressed interest in additional direct engagement with National Grid to learn more about the suite of Electric Transportation Initiative programs to help identify additional station development prospects within their networks.

- **Program vendors are most comfortable with one individual EVSE**. While there are many approved EVSE vendors for the National Grid programs, all activated stations during RY1 (and most, if not all, planned stations) are using equipment from a single EVSE provider. Vendors indicated that they have confidence in the quality and performance of this equipment, and they do not seem to be seriously considering the other approved vendors at this time.
- **Tracking program data is a manual process with the risk of manual errors and missing information**. The program uses Microsoft Excel to track projects. While ERS did not identify any missing information for any activated or approved stations, there are many blank data fields for stations earlier in the development process. This is expected as project details are finalized; however, it is not explicitly clear what data points are "to-be-determined" and what data points are missing.

Recommendation: Formalize and standardize the infrastructure program tracking spreadsheet to enable better monitoring and evaluation of program activities. Additional file structure enhancements and data fields, such as a separate site address field, a date of first contact, and better tracking of communication with site hosts, would strengthen this tracking spreadsheet.

4.2.4 Upcoming Activities for RY2 and RY3

During RY2 and RY3, ERS will continue to interview program participants, and potentially additional program vendors. We will continue to analyze charging station utilization and review program progress against metrics. As additional funds become available to support DCFC stations, we anticipate investigating factors and influences related to DCFC station development in greater detail. The evaluation scope also includes EV owner and potential

owner surveying conducted in RY2 to further investigate EV perceptions and charging behavior.

4.3 Discount Pilot for DCFC Station Accounts

The Discount Pilot for DCFC Station Accounts provides incentives to owners of existing and new DCFC charging stations to offset demand charges incurred from usage of these high-kW-drawing stations (typically 150 kW and up).

4.3.1 Program Implementation Approach

National Grid has established a process to identify and enroll eligible site hosts, and works across its Marketing, Customer Solutions, Sales Processing, and Accounts Processing teams to calculate and process monthly credits. National Grid program staff manage the program, regularly monitoring and reporting program progress.

4.3.2 Program Results

While there were no DCFC chargers installed from the charging demonstration program, two sites were approved for the DCFC program in RY1. One participant received credits throughout RY1, and the other participant was activated in the program late in RY1 and expects to receive rate discounts in RY2. Table 4-11 shows the total charging kWh, peak site kW, and total discounts provided in RY1. Figure 4-5, below, shows the locations of both of the DCFC stations activated for the DCFC discount rate pilot in RY1.

Table 4-11. DCFC RY1 Program Summary Metrics

Program Participant	In-Service Date	Charging kWh	Peak Site kW	Total Discount Received RY1
DCFC A	2013 (existing site)[4]	549,400	516	$13,412.92
DCFC B	New site	0	0	0

[4] The Amended Settlement Agreement explicitly allows both existing and new sites to participate in this program.

Figure 4-5. Location of DCFC Pilot Program Participants

4.3.3 Initial DCFC Rate Discount Evaluation Findings and Recommendations

The ERS Team conducted one interview with the DCFC pilot participant who received rate discounts during RY1. This interview, along with ERS conversations with National Grid program and support staff and program vendors, lead to the following initial evaluation findings:

- **The DCFC Discount Pilot helps site hosts alleviate demand charges and may influence future infrastructure development.** While the station receiving the rate discount was an existing station, the participant indicated that knowing that this program is available could help prioritize future DCFC station development in Rhode Island. This organization must balance charging infrastructure development across New England.
- **More clarity is needed in utility billing for the rate discount.** The participant indicated that they receive the rate credit as a single line item on their bill and would like more clarity regarding how the rate discount is calculated each month.

Recommendation: Provide more detail regarding the calculation of the rate discount. Participants are shown a single line item on their bill, and would like additional information regarding exactly how this discount is calculated. National Grid should provide current and

prospective participants with a supplemental document explaining exactly how the discount is calculated.

4.3.4 Upcoming Activities for RY2 and RY3

During RY2 and RY3, the ERS Team will continue to interview DCFC discount rate pilot participants to learn about program successes and barriers, including any potential free ridership and/or spillover effects. The team will also continue to review program documentation and tracking information.

4.4 Fleet Advisory Services

National Grid's Fleet Advisory Services program offers fleet electrification studies and other services to qualifying fleet operators throughout RI, including corporate light-duty, government light/medium/heavy-duty, public transit, and municipal school buses.

4.4.1 Program Implementation Approach

National Grid program staff have retained an implementation contractor for this program in order to evaluate the current fleet inventory of a participating fleet operator and propose fleet electrification options for consideration. The implementation contractor works closely with National Grid during the selection of participants, and National Grid regularly monitors study progress. No studies were completed during RY1, but once completed, final reports will be delivered to participants and National Grid.

4.4.2 Program Results

The Fleet Advisory Services program enrolled five participants in RY1. Since the program became available to customers in Q4 2018, the program has already met their goal of recruiting 25% of program participants from the government or public transit sectors. The study is projected to meet the remaining sector goals identified in the rate case settlement agreement and has already recruited 50% of the overall program participants. Table 4-12 summarizes the program participants to date.

Table 4-12. Fleet Advisory Study Participants

RY1 Participants	Number of Participants
Public transit	1
Government, light/medium/heavy-duty	3
Corporate light-duty fleet	1
Total	**5**

Table 4-13, below, summarizes the metrics for this program in RY1.

Table 4-13. Fleet Advisory Study Metrics

Program Metric	RY1 Result
Total number of vehicles leased/purchased	Zero vehicles leased/purchased
Total number of fleet vehicles converted to EVs	Zero vehicles converted to EVs
Estimated greenhouse gases avoided due to fleet vehicles converted to EVs	No vehicles converted, so no greenhouse gases avoided

4.4.3 Initial Fleet Advisory Services Evaluation Findings and Recommendations

In RY1, the ERS Team interviewed two participants undergoing active fleet electrification studies, as well as the implementation contractor conducting these studies. None of the five active participants in this program have completed studies, so the evaluators were unable to review completed studies and determined that vehicle conversions were zero for RY1. The following are initial program findings from these interviews:

- **Early participants and implementation contractors are very pleased with the program.** Overall, the program participants and implementation contractor were very positive about their experiences; all participants mentioned that the program runs efficiently, and that National Grid's management of the program is very effective. Both participants indicated that they likely would not have conducted fleet electrification studies on their own without National Grid support. Program participants commended the implementation contractor on their level of knowledge of the program, technical expertise, and availability to provide guidance throughout the program. The participants were understanding of the pace of the study, but voiced a desire for more transparency on the timeline from the implementation vendor and National Grid program staff.
- **Motivations for participation often stem from state goals.** The participants' motivations to enroll in the program primarily stem from state and city initiatives to reduce CO_2 emissions. In addition to changing people's perceptions on EVs, both participants interviewed viewed this program as an opportunity to incorporate EV options into their existing vehicle replacement schedules. These participants recognized this program as an opportunity to provide a thoughtful approach to future fleet electrification, and that it presents fleet owners with long-term EV options to replace gas-powered vehicles.
- **Study participants lack existing inventories and fleet data required by the implementation contractor.** Interviews with the implementation contractor and program participants identified that many study participants do not actively track and manage the program data required for the study, such as vehicle inventories and

locations. One participant mentioned that it took them two months to gather the required data that the implementation contractor requested for the study.

Recommendation: Refine and simplify implementation contractor requests for participant fleet information. The implementation contractor should streamline their data request, asking participants for fleet information only for vehicles for which there are viable electrification options on the market or projected in the near future. The implementation contractor can present the customer with organized visuals of vehicles that qualify for electrification. This would help participants easily classify which vehicles they own so they can efficiently gather and deliver data for the program.

- **The Fleet Advisory Services will likely drive participation for other EV programs.** From the participant interviews, ERS learned that one participant is already involved in the Charging Station Demonstration Program. The second participant interviewed stated that they are waiting for the final report from the implementation to determine how many charging stations they will apply for under the infrastructure program. As additional fleet electrification studies are completed, we expect participants that pursue electrification will take advantage of the infrastructure program for Level 2 and DCFC stations.

4.4.4 Upcoming Activities for RY2 and RY3

Given the staged onboarding of the 12 anticipated program participants, the evaluation team will conduct additional data analysis and interview the majority of program participants in RY2 and RY3 after the majority of fleet electrification studies are complete and the program is likely to have the largest impacts on EV conversions. The team will also conduct follow-up interviews with program participants interviewed in RY1 to follow-up on their program experience and inquire about actions taken to electrify their fleets after their completion of the study.

5 Summary of Key Findings & Recommendations

The RY1 evaluation activities conducted by ERS included data analysis for the Off-Peak Rebate Pilot and the Charging Demonstration Program, as well as interviews with National Grid program and support staff, vendors and implementation contractors, and a limited set of initial program participants.

As the ERS Team conducted interviews and mined the program data, there were certain recurring themes that presented themselves. These themes were organized into the following key findings that incorporate all the data collected throughout the evaluation effort:

1. **Overall, the programs are well-run**. The programs engage multiple facets of the EV market, from direct engagement with EV owners, EVSE vendors and installers, and

charging station site hosts and fleet operators responsible for maintenance and regular upgrades of public and private vehicle fleets. National Grid staff are well-qualified and effective in their roles of recruiting and educating potential program participants. The programs effectively engage vendors to facilitate the design and installation of EVSE, leveraging their existing relationships and networks throughout Rhode Island from prior energy efficiency and other work to aid in recruitment. Initial participants are satisfied with the program offerings.

2. **The Electric Transportation Initiative offerings are complementary**. There are opportunities for program participants to take advantage of several programs within the initiative offerings and program staff are encouraging participants to leverage the different programs. DCFC site hosts participating in the infrastructure program can also receive DCFC rate discounts, and the initial participants in the Fleet Advisory Services program anticipate taking advantage of both the infrastructure and rate discount programs, as applicable.
3. **The Off-Peak Charging Rebate Pilot experiment has been well designed and implemented effectively** addressing questions raised in other similar studies by using a randomized approach to provide a control group for establishing baseline charging behavior measured directly from vehicle charging and not influenced by utility off-peak charging objectives or based on survey results. This design and the metered data being collected directly will improve the quality of the analysis for RY2 and inspire confidence in the representativeness of the eventual findings.
4. **Initial analysis of Off-Peak Rebate Pilot participants suggests that there may be an opportunity to shift load to off-peak periods.** The majority of charging sessions and charging activity (kWh) in the initial period occur during the latter half of the 1 p.m. to 9 p.m. peak window, and the initial load profile suggests that most EV charging is unmanaged with respect to timing. RY2 analysis will explore the impacts of the pilot incentives in encouraging participants to shift their charging towards off-peak time periods.
5. **The Charging Station Demonstration has started well, but will require targeted outreach and attention to meet segment-specific program charging port targets**. Segments such as workplaces, MUD, and environmental justice communities have significant market interest and are on track to meet goals, while light-duty fleets, public transit stations, and all DCFC segments will require additional attention in future years. National Grid is aware of this need and is actively engaged in developing additional outreach strategies targeting hard-to-reach segments. Interviewees across several

programs and functions anticipate that the Electrify RI funds will further encourage DCFC station development.

6. **Successful deployment of a robust EVSE network will likely require industry maturity to encompass more EVSE providers**. Currently, there is only one charging station equipment provider with activated stations in the programs. Vendors trust this equipment and seem hesitant to promote the other manufacturers on the approved equipment list. While Rhode Island has a relatively small number of EV registrations, as this market grows, we anticipate that EVSE provider diversity will increase to meet growing demand for public charging infrastructure.

The ERS Team has developed three recommendations based on the evaluation activities completed in RY1, with the goals of strengthening program operations and continued progress toward program targets:

- **Recommendation #1: Continue advocating for flexibility in program design to align program offerings with market intelligence**. These are new programs in an immature and fast-changing marketplace, where the primary participants are early adopters. Flexibility in program design and offerings can increase the overall impact of the Electric Transportation Initiative. ERS interviews with program staff suggest that National Grid's RY1 proposed program changes, including proposals regarding support for Level 2 charging for electric school buses and Level 1 charging infrastructure development, are consistent with this recommendation for continued flexibility.
- **Recommendation #2**: **Standardize and enhance Rhode Island Electric Transportation Initiative program tracking methods.** National Grid program staff retain program tracking spreadsheets for each of the Rhode Island programs. These spreadsheets track project-specific information and program goals and budgets, and they serve as the system of record for the programs. ERS reviewed these spreadsheets while conducting program analyses for this evaluation, and we recommend that they be standardized and enhanced to improve the level of detail and clarity throughout. While a best practice would be to migrate these spreadsheets to a more holistic platform, such as Salesforce, that captures all project details and retains a record of customer contacts and communication, minor enhancements can improve the usability and likely streamline Program Scorecard and other reporting. Formalizing and standardizing tracking spreadsheets will better position National Grid should the programs be expanded in the future.
  - Specific enhancements to the Charging Station Demonstration Program tracking spreadsheet include ensuring that project details such as host site address, charging station market segment, EVSE provider, and first site contact date are captured

explicitly and for each record in the spreadsheet. Additionally, a "Read Me" worksheet that defines all the content contained in the spreadsheet, as well as definitions of various status fields, would improve readability and evaluability.

- **Recommendation #3: Increase National Grid's direct engagement with program participants.** Several initial participants expressed interest in additional direct engagement with National Grid to learn more about the suite of Electric Transportation Initiative programs to help identify additional station development prospects within their networks. The Rhode Island programs have effectively engaged vendors and implementation contractors to support program delivery, fleet studies, and station development, and National Grid is actively expanding the network of vendors qualified for station installation.

Appendix A: Electric Vehicle Population Breakdown by ZIP Code

Table A-1. Number of EVs by ZIP Code and Vehicle Type – 2019 Q2

ZIP Code	PHEV	BEV (Non-Tesla)	BEV (Tesla)	Total
02802	2	0	0	2
02804	1	1	0	2
02806	57	20	38	115
02807	5	0	0	5
02808	1	0	1	2
02809	19	8	13	40
02812	5	1	0	6
02813	9	4	0	13
02814	10	2	0	12
02815	0	0	1	1
02816	31	4	2	37
02817	14	3	4	21
02818	45	13	29	87
02822	9	3	2	14
02825	7	3	1	11
02826	2	0	0	2
02827	3	1	0	4
02828	5	2	4	11
02829	0	0	0	0
02830	9	1	2	12
02831	11	1	4	16
02832	8	2	1	11
02833	1	1	0	2
02835	27	9	9	45
02837	12	2	4	18
02838	4	0	0	4
02839	1	0	1	2
02840	32	18	11	61
02842	27	4	5	36
02852	40	10	22	72
02857	18	3	4	25
02859	2	0	2	4
02860	18	3	5	26
02861	16	8	6	30
02863	2	1	0	3
02864	43	10	16	69
02865	20	6	11	37
02871	34	9	10	53
02872	0	0	0	0
02873	0	0	0	0
02874	17	3	5	25
02875	0	0	0	0
02876	0	1	0	1
02877	3	0	0	3

ZIP Code	PHEV	BEV (Non-Tesla)	BEV (Tesla)	Total
02878	14	9	14	37
02879	53	28	16	97
02880	1	0	0	1
02881	8	2	1	11
02882	42	11	5	58
02885	14	3	3	20
02886	31	7	6	44
02888	21	6	6	33
02889	27	6	3	36
02891	29	10	6	45
02892	17	4	3	24
02893	26	7	7	40
02894	2	1	0	3
02895	20	2	4	26
02896	11	1	1	13
02898	2	0	0	2
02903	10	6	5	21
02904	21	3	8	32
02905	15	5	6	26
02906	87	30	37	154
02907	6	6	1	13
02908	40	15	4	59
02909	15	4	5	24
02910	13	7	0	20
02911	8	2	3	13
02912	1	0	0	1
02914	10	0	2	12
02915	12	7	3	22
02916	9	8	2	19
02917	18	1	4	23
02919	25	2	6	33
02920	29	5	4	38
02921	19	1	8	28
02940	1	0	2	3
Total	**1,227**	**356**	**388**	**1,971**

APPENDIX 2

CO2: Consumer Electric Vehicles Target Calculation

Registered EVs in Company's RI Territory -- Summary of R.F. Polk Vehicles in Operation Data

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
BEV(PEV)				32	41	117	193	366				
HEV(PHEV)				178	182	413	538	831				
Registered EVs in Company's RI Territory with Projections Based on AEO 2018 EV Sales Growth for New England									*Forecast (adds forecast incremental vehicles to previous year)*			
BEV				32	41	117	193	366	631	1,035	1,654	2,600
PHEV				178	182	413	538	831	1,195	1,647	2,209	2,907
Total Ev				210	223	530	731	1197	1,826	2,682	3,863	5,507
Annual New BEV Registrations					9	76	76	173				
Annual New PHEV Registrations					4	231	125	293				
Annual New EV Registrations Total					13	307	201	466	*629*	*857*	*1,180*	*1,644*

Annual New Registrations

	Actual				*Forecast*			
					(applies calculated compound average growth rate for PHEVs to previous year's data)			
BEVs - Incremental	2015	2016	**2017**	**2018**	**2019**	**2020**	**2021**	
Actuals and Forecast	76	76	173	265	405	619	946	

	Actual				*Forecast*			
					(applies calculated compound average growth rate for PHEVs to previous year's data)			
PHEVs - Incremental	2015	2016	**2017**	**2018**	**2019**	**2020**	**2021**	
Actuals and Forecast	231	125	293	364	452	562	698	

		2019	**2020**	**2021**
Total EVs - Incremental (BEVs + PHEVs)	Forecast	857	1,180	1,644

New registrations target based on adjustment of forecast (includes forecast)

	2019	**2020**	**2021**	
Min	1,114	1,535	2,137	forecast*130%
Target	1,328	1,830	2,548	forecast*155%
Max	1,542	2,125	2,959	forecast*180%

Incremental Annual New Registrations (above forecast)

2018-2021 Compound Average Growth Rate calculated using AEO 2018 data			**2019**	**2020**	**2021**	incremental vehicles over 3 years	Factor for converting to metric tons
		Min	257	354	493	1,104	0.907185
BEV	0.53	Target	471	649	904	2,025	
PHEV	0.24	Max	685	944	1,315	2,945	
Total	0.44						

Incremental Annual CO2 reduction (short tons) Weighted emission factor of 2.37 tons per vehicle*

	2019	**2020**	**2021**	tons over 3 years
Min	609	839	1,169	2,617
Target	1,117	1,539	2,143	4,798
Max	1,624	2,238	3,117	6,979

FINAL TARGETS IN METRIC TONS (2.15 metric tons/vehicle)

	2019	**2020**	**2021**	cumulative
Min	553	761	1,060	2,374
Target	1,013	1,396	1,944	4,353
Max	1,474	2,030	2,828	6,332

* Average per vehicle net emissions reduction per program BCA

Light-Duty Vehicle Sales (Case Reference case Region New England)
Source: U.S. Energy Information Administration, AEO 2018

Year	Conventional Cars: Gasoline thousands	Alternative-Fuel Cars: Ethanol-Flex Fuel ICE thousands	Alternative-Fuel Cars: 100 Mile Electric Vehicle thousands	Alternative-Fuel Cars: 200 Mile Electric Vehicle thousands	Alternative-Fuel Cars: 300 Mile Electric Vehicle thousands	Alternative-Fuel Cars: Plug-in 10 Gasoline Hybrid thousands	Alternative-Fuel Cars: Plug-in 40 Gasoline Hybrid thousands	Alternative-Fuel Cars: Electric-Diesel Hybrid thousands	Alternative-Fuel Cars: Electric-Gasoline Hybrid thousands	Alternative-Fuel Cars: Natural Gas ICE thousands	Alternative-Fuel Cars: Natural Gas Bi-fuel thousands	Alternative-Fuel Cars: Propane thousands	Alternative-Fuel Cars: Fuel Cell Methanol thousands	Alternative-Fuel cars: Fuel Cell Hydrogen thousands	Alternative-Fuel Cars: Total thousands	Total BEV (thousands)	Total PHEV (thousands)	Total (BEV+PHEV) (thousands)
2050	355.345398	20.214737	5.602141	38.633205	36.172871	4.398753	5.196405	2.3959	35.953003	0.510001	0.872672	0.149481	0	1.619605	151.820114	80.408217	9.595158	90.003375
2049	353.642273	20.14179	5.491755	37.543312	35.23542	4.348643	5.133052	2.300105	35.863472	0.507992	0.868197	0.148707	0	1.592154	149.27504	78.270487	9.481695	87.752182
2048	351.753662	20.053083	5.403951	36.554832	34.329487	4.306846	5.08089	2.192646	35.751457	0.505412	0.862891	0.147837	0	1.568198	146.857056	76.28827	9.387736	85.676006
2047	353.321625	20.654562	5.309847	35.558769	33.491611	4.279058	5.024273	2.125003	35.940578	0.507565	0.865571	0.148306	0	1.550405	145.55513	74.360227	9.303331	83.663558
2046	352.144745	20.824108	5.188287	34.392513	32.513676	4.236733	4.939371	2.057598	35.889168	0.505952	0.86164	0.147632	0	1.52972	143.185287	72.094476	9.176104	81.27058
2045	350.304901	20.758434	5.102717	33.397022	31.570978	4.208997	4.87436	1.988463	35.84206	0.503642	0.856632	0.146813	0	1.514753	140.862839	70.070717	9.083357	79.154074
2044	347.485352	20.579248	4.994624	32.259674	30.547705	4.167288	4.789601	1.905477	35.635536	0.499565	0.84861	0.145489	0	1.495994	137.965607	67.802003	8.956889	76.758892
2043	343.846741	20.844721	4.905899	31.27088	29.646082	4.130421	4.722566	1.815935	35.368679	0.495101	0.839968	0.144031	0	1.479477	135.759201	65.822861	8.852987	74.675848
2042	340.831299	20.972698	4.839626	30.3423	28.809624	4.113112	4.666744	1.733382	35.14933	0.491304	0.832508	0.142805	0	1.471085	133.658798	63.99155	8.779856	72.771406
2041	338.803894	21.15185	4.787501	29.535984	28.15877	4.094975	4.621519	1.653306	34.997391	0.48887	0.827369	0.141945	0	1.462314	132.015152	62.482255	8.716494	71.198749
2040	336.055084	21.26626	4.747665	28.519258	27.513409	4.078499	4.562747	1.5773	34.641888	0.484997	0.819879	0.14071	0	1.455493	129.900314	60.780332	8.641246	69.421578
2039	334.660522	21.416235	4.691761	26.856398	27.008698	4.07231	4.4656	1.503382	34.381016	0.484053	0.817369	0.140302	0	1.456311	127.384979	58.556857	8.53791	67.094767
2038	332.245483	21.442406	4.662393	25.281816	26.348032	4.086331	4.380548	1.436091	34.060417	0.481681	0.8126	0.139518	0	1.466491	124.689011	56.292241	8.466879	64.75912
2037	330.455383	21.396805	4.650105	23.785894	25.510975	4.102295	4.299524	1.366113	33.775967	0.479568	0.808386	0.138922	0	1.476855	121.881378	53.946974	8.401819	62.348793
2036	330.079895	21.351496	4.597928	22.267881	24.562798	4.09251	4.190804	1.308329	33.540657	0.478907	0.806347	0.138557	0	1.478011	118.903664	51.428607	8.283314	59.711921
2035	330.183441	21.310509	4.568686	21.00374	23.635248	4.079502	4.102505	1.244618	33.413799	0.479047	0.806014	0.138577	0	1.475968	116.347412	49.207674	8.182007	57.389681
2034	330.694122	21.098669	4.54547	19.762232	22.531775	4.069067	4.007761	1.156005	33.295868	0.478168	0.804143	0.138348	0	1.475613	113.451927	46.839477	8.076828	54.916305
2033	331.385162	20.815838	4.487601	18.442158	21.258623	4.033783	3.881815	1.015213	33.12175	0.476647	0.80108	0.137873	0	1.466845	110.027512	44.188382	7.915598	52.10398
2032	333.990295	20.665154	4.46349	17.29084	20.243418	4.014398	3.78396	0.787073	33.165543	0.478508	0.803349	0.138357	0	1.463139	107.385674	41.997748	7.798358	49.796106
2031	336.482849	20.750486	4.410666	15.907731	19.569527	3.981	3.665496	0.436888	33.161896	0.479889	0.804924	0.138733	0	1.455458	104.851173	39.887924	7.646496	47.53442
2030	335.987152	20.94309	4.345813	14.566785	18.552511	3.950255	3.541918	0.094041	32.751087	0.476728	0.799587	0.137859	0	1.45416	101.701637	37.465109	7.492173	44.957282
2029	335.757507	20.794701	4.277223	13.800777	17.286728	3.911695	3.177356	0	32.107693	0.472823	0.793534	0.136865	0	1.449152	98.295448	35.364728	7.089051	42.453779
2028	336.828278	20.516396	4.186686	12.985898	15.936916	3.849896	2.794904	0	31.366304	0.47008	0.788095	0.135997	0	1.436774	94.554176	33.1095	6.6448	39.7543
2027	336.122986	20.213121	4.128845	12.147217	14.525044	3.736123	2.597331	0	30.377541	0.465604	0.777897	0.134285	0	1.440348	90.628372	30.801106	6.333454	37.13456
2026	336.227722	19.364838	4.169695	11.421202	13.25938	3.744987	2.508586	0	29.443655	0.460868	0.769547	0.132898	0	1.484693	86.84436	28.850277	6.253573	35.10385
2025	337.683746	19.554213	4.173252	10.614833	12.019748	3.684446	2.406016	0	28.618664	0.455651	0.76476	0.13219	0	1.493011	84.000153	26.807833	6.090462	32.898295
2024	341.234924	18.970907	3.626055	8.562238	9.985023	3.286909	2.133315	0	28.787758	0.451035	0.759374	0.131395	0	1.282162	78.060097	22.173316	5.420224	27.59354
2023	342.954163	18.72925	3.191939	7.615645	9.43925	2.896113	1.870249	0	27.829237	0.447937	0.748327	0.129625	0	1.072243	74.054657	20.246834	4.766362	25.013196
2022	341.471252	18.314096	2.918794	6.499039	7.795858	2.435257	1.575278	0	26.695114	0.444987	0.733393	0.127222	0	0.941399	68.566467	17.213691	4.010535	21.224226
2021	340.566132	18.404573	2.539417	5.847369	6.638853	2.502763	1.5951	0	25.708946	0.433651	0.72481	0.125845	0	0.781343	65.388618	15.025639	4.097863	19.123502
2020	347.052032	18.824343	2.002526	4.747928	4.791523	2.041853	1.304471	0	24.766338	0.422442	0.730017	0.12672	0	0.544925	60.387497	11.541977	3.346324	14.888301
2019	342.466919	18.540531	1.420105	2.95272	2.451552	1.429988	0.92671	0	23.000076	0.418397	0.71887	0.124295	0	0.291664	52.35611	6.824377	2.356698	9.181075
2018	346.906952	17.696617	1.307958	1.686958	1.206584	1.273967	0.863506	0	22.024769	0.443079	0.709516	0.123161	0	0.157599	47.573231	4.2015	2.137473	6.338973
2017	332.62146	17.204187	1.415067	0.649601	0.507921	1.588685	5.256105	0	23.503204	0.914017	0.701392	0.121784	0	0.088083	52.025845	2.572589	6.84479	9.417379
2016	347.271362	20.222425	1.805895	1.015956	0.088408	3.422762	2.934831	0	20.245571	0.904959	0.744257	0.129047	0	0.088409	51.681202	2.910259	6.357593	9.267852

Compound Average Growth Rate BEV (2018-2021)	Compound Average Growth Rate PHEV (2018-2021)	Compound Average Growth Rate All EV (2018-2021)
0.53	**0.24**	**0.44**

Light-Duty Vehicle Sales by Technology Type

Source: Annual Energy Outlook, 2019

(thousands)

New England - 01

Technology Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2018-2050
New Car Sales 1/																																			
Conventional Cars																																			
Gasoline ICE Vehicles	332.2	347.1	346.3	346.1	341.8	334.3	337.6	340.0	342.4	343.6	347.3	350.7	351.9	357.0	363.8	366.5	369.6	372.5	374.2	374.9	376.5	378.4	378.8	379.4	380.6	381.3	382.1	384.4	386.1	386.6	384.9	382.8	381.9	380.1	0.3%
TDI Diesel ICE	0.1	0.4	1.2	2.0	2.3	2.8	3.3	3.9	4.7	5.7	6.8	8.2	9.0	10.0	10.3	10.3	10.1	10.5	10.3	10.0	9.9	9.8	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	8.9	8.7	10.3%
Total Conventional Cars	332.3	347.4	347.4	348.1	344.1	337.1	340.9	344.0	347.1	349.2	354.0	358.9	361.0	366.9	374.1	376.8	379.7	383.0	384.4	384.9	386.4	388.2	388.4	389.0	390.1	390.7	391.4	393.7	395.3	395.8	394.1	391.8	390.8	388.8	0.4%
Alternative-Fuel Cars																																			
Ethanol-Flex Fuel ICE	10.7	10.7	10.7	10.7	10.7	10.5	10.6	10.7	10.8	10.8	11.0	11.6	12.1	12.9	13.2	13.5	13.8	14.3	14.6	14.8	15.0	15.0	14.9	14.7	14.3	13.9	13.4	13.1	12.9	12.4	12.3	12.2	12.2	12.2	0.4%
100 Mile Electric Vehicle	2.1	0.7	2.3	2.4	2.8	3.4	3.6	4.1	4.4	4.2	4.3	4.1	4.1	4.1	4.1	3.9	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.3	4.3	4.4	4.4	4.5	4.5	4.6	4.6	4.6	4.7	6.0%
200 Mile Electric Vehicle	2.3	2.2	7.3	8.9	9.6	9.9	10.7	11.9	12.9	12.9	13.1	13.4	14.0	14.4	15.6	16.7	18.1	19.7	21.1	22.5	24.0	25.6	27.2	29.0	30.1	30.9	31.7	32.5	33.3	34.1	34.8	35.5	36.1	36.8	9.1%
300 Mile Electric Vehicle	1.9	6.9	9.5	12.0	15.4	16.2	17.2	17.6	17.8	18.0	18.7	19.5	20.5	22.3	24.4	26.3	28.3	30.3	31.9	33.4	34.7	35.9	36.7	37.6	38.5	39.3	40.3	41.3	42.2	43.1	43.9	44.6	45.3	46.1	6.1%
Total BEV	**6.3**	**9.9**	**19.1**	**23.4**	**27.8**	**29.4**	**31.6**	**33.6**	**35.1**	**35.2**	**36.1**	**37.0**	**38.6**	**40.8**	**44.1**	**47.0**	**50.3**	**53.9**	**57.1**	**60.0**	**62.8**	**65.5**	**68.1**	**70.8**	**72.9**	**74.5**	**76.4**	**78.3**	**79.9**	**81.7**	**83.2**	**84.7**	**86.1**	**87.6**	
Compound Average Growth Rate					***0.41***																														
Plug-in 10 Gasoline Hybrid	1.7	1.4	1.6	1.9	2.7	3.1	3.3	3.6	3.9	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.6	4.6	4.6	4.6	3.7%
Plug-in 40 Gasoline Hybrid	5.5	4.4	4.7	4.8	4.6	4.3	4.2	4.2	4.2	4.2	4.4	4.6	5.0	5.3	5.6	5.8	6.1	6.4	6.6	6.8	7.1	7.3	7.5	7.7	7.8	8.0	8.0	8.2	8.2	8.3	8.4	8.5	8.5	8.6	2.1%
Total PHEV	**7.2**	**5.8**	**6.3**	**6.7**	**7.3**	**7.4**	**7.5**	**7.8**	**8.1**	**8.2**	**8.5**	**8.8**	**9.2**	**9.5**	**9.8**	**10.1**	**10.4**	**10.7**	**11.0**	**11.2**	**11.5**	**11.6**	**11.9**	**12.1**	**12.3**	**12.4**	**12.5**	**12.7**	**12.7**	**12.9**	**12.9**	**13.0**	**13.1**	**13.1**	
Compound Average Growth Rate					***0.08***																														
Total EV	**13.5**	**15.7**	**25.4**	**30.1**	**35.0**	**36.8**	**39.1**	**41.4**	**43.2**	**43.4**	**44.6**	**45.8**	**47.8**	**50.3**	**54.0**	**57.1**	**60.7**	**64.7**	**68.0**	**71.2**	**74.3**	**77.2**	**79.9**	**83.0**	**85.2**	**87.0**	**88.9**	**90.9**	**92.6**	**94.5**	**96.2**	**97.7**	**99.2**	**100.7**	
Compound Average Growth Rate					***0.31***																														
Electric-Diesel Hybrid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	- -
Electric-Gasoline Hybrid	25.5	23.5	24.6	25.2	25.5	25.8	27.2	28.7	29.4	30.8	32.4	34.0	35.2	36.7	38.1	39.0	39.8	40.7	41.3	41.8	42.3	42.8	43.1	43.5	43.8	44.0	44.0	44.3	44.4	44.4	44.2	44.0	43.8	43.6	2.0%
Natural Gas ICE	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8%
Natural Gas Bi-fuel	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.8%
Propane ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8%
Propane Bi-fuel	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7%
Fuel Cell Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- -
Fuel Cell Hydrogen	0.1	0.1	0.3	0.4	0.8	1.1	1.2	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	7.2%
Total Alternative Cars	50.5	50.3	61.2	66.7	72.3	74.5	78.3	82.5	85.1	86.7	89.7	93.0	96.7	101.5	107.2	111.5	116.5	121.9	126.2	130.1	133.7	137.2	140.2	143.4	145.6	147.2	148.7	150.7	152.3	153.8	155.2	156.4	157.7	158.9	3.7%
Percent Alternative Car Sales	13.2	12.6	15.0	16.1	17.4	18.1	18.7	19.3	19.7	19.9	20.2	20.6	21.1	21.7	22.3	22.8	23.5	24.1	24.7	25.3	25.7	26.1	26.5	26.9	27.2	27.4	27.5	27.7	27.8	28.0	28.3	28.5	28.7	29.0	2.6%
Total New Car Sales	**382.7**	**397.7**	**408.6**	**414.9**	**416.4**	**411.6**	**419.2**	**426.4**	**432.2**	**435.9**	**443.7**	**451.9**	**457.7**	**468.5**	**481.3**	**488.4**	**496.2**	**504.9**	**510.6**	**515.0**	**520.1**	**525.4**	**528.6**	**532.4**	**535.7**	**537.9**	**540.0**	**544.4**	**547.6**	**549.6**	**549.2**	**548.1**	**548.5**	**547.7**	**1.0%**

APPENDIX 3

SUMMARY
SETTLEMENT AGREEMENT

Updated from Attachment 28 Submitted with Settlement

						Targets									Quantified Net Benefits ($1000) (before incentive)								
						2019			2020			2021			2019			2020			2021		
Performance Incentive Mechanism	Bps or Shared Savings	% to Company	Assumed Costs as % of Benefits	BCR	Target Units	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																							
FCM Peak Demand Reduction	bps	45%	70%	1.43	MW below baseline	14	17	20	17	21	25	21	24	29	#N/A	$ 684	$ 805	$ 940	$ 1,162	$ 1,383	#####	$ 1,736	$ 2,098
Distributed Energy Resources																							
Electric Vehicle Initiative	bps	45%	0%	1.15	Incremental Tonnes CO2	553	1,013	1,474	761	1,396	2,030	1,060	1,944	2,828	$ 267	$ 490	$ 712	$ 368	$ 675	$ 981	$ 512	$ 940	$ 1,367
Total PIMs															#N/A	$1,174	$1,517	$1,308	$1,837	$2,364	$2,032	$2,676	$3,465

						Incentives (Basis Points)									Incentives ($1000)								
						2019			2020			2021			2019			2020			2021		
Performance Incentive Mechanism	Bps or Shared Savings	% to Company	Assumed Costs as % of Benefits	BCR	Target Units	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low ($1,000)	Medium ($1,000)	High ($1,000)	Low ($1,000)	Medium ($1,000)	High ($1,000)	Low ($1,000)	Medium ($1,000)	High ($1,000)
System Efficiency																							
FCM Peak Demand Reduction	bps	45%	70%	1.43	MW below baseline	#N/A	7	8	9	11	13	14	16	20	#N/A	$ 308	$ 362	$ 423	$ 523	$ 622	$ 684	$ 781	$ 944
Distributed Energy Resources																							
Electric Vehicle Initiative	bps	45%	0%	1.15	Incremental Tonnes CO2	3	5	7	4	6	9	5	9	13	$ 120	$ 220	$ 321	$ 166	$ 304	$ 442	$ 231	$ 423	$ 615
Total PIMs						#N/A	11	15	12	18	23	19	25	33	#N/A	$528	$683	$589	$826	$1,064	$914	$1,204	$1,559

Assumed costs as % of benefits are zero for EVs as benefits are altready netted for program costs

Sharing of EV incentives between consumer/fleet

		2019 max	2020 max	2021 max		2019 max	2020 max	2021 max
75%	Consumer	5.1	7.0	9.7	Consumer	$240	$331	$461
25%	Fleet	1.7	2.3	3.2	Fleet	$80	$110	$154

OUTCOMES
Settlement Agreement

		FCM Savings (MW-yr)									Transmission Savings (MW-yr)									Distribution Savings (MW-yr)									Energy Peak (MWh)									GHG (Tons)								
		2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	Incentives	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021
Performance Incentive Mechanism	**Target Units**	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																																													
FCM Peak Demand Reduction	MW below baseline	14	17	20	17	21	25	21	24	29	14	17	20	17	21	25	21	24	29	7	9	10	9	11	13	11	12	15	14	17	20	17	21	25	21	24	29	0	0	0	0	0	0	0	0	0
Distributed Energy Resources																																													
Electric Vehicle Initiative	Incremental Tonnes CO2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	553	1,013	1474	761	1396	2030	1060	1944	2,828
Total PIMs	-	**14**	**17**	**20**	**17**	**21**	**25**	**21**	**24**	**29**	**14**	**17**	**20**	**17**	**21**	**25**	**21**	**24**	**29**	**7**	**9**	**10**	**9**	**11**	**13**	**11**	**12**	**15**	**14**	**17**	**20**	**17**	**21**	**25**	**21**	**24**	**29**	**553**	**1,013**	**1,474**	**761**	**1,396**	**2,030**	**1,060**	**1,944**	**2,828**

INCENTIVES
Settlement Agreement

						Incentive for Quantified Net Benefits									Incentives (Basis Points)									Incentives ($1000)								
						2019			2020			2021			2019			Incentives (Basis Points)			2021			2019			2020			2021		
Performance Incentive Mechanism	Bps or Shared Savings	% to Company	Assumed Costs as % of Benefits	BCR	Target Units	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low (bps)	Medium (bps)	High (bps)	Low ($1,000)	Medium ($1,000)	High ($1,000)	Low ($1,000)	Medium ($1,000)	High ($1,000)	Low ($1,000)	Medium ($1,000)	High ($1,000)
System Efficiency																															
FCM Peak Demand Reduction	bps	45%	70%	1.43	MW below baseline	#N/A	6.55	7.70	#N/A	11.09	13.20	15	17	20	#N/A	7	8	#N/A	11	13	15	17	20	#N/A	$308	$362	$423	$523	$622	$684	$781	$944
Distributed Energy Resources							-	-		#N/A	-		-	-																	
Electric Vehicle Initiative	bps	45%	0%	1.15	Incremental Tonnes C	2.56	4.69	6.82	#N/A	#N/A	9.37	4.89	8.97	12.99	3	5	7	#N/A	#N/A	9	5	9	13	$120	$220	$321	$166	$304	$442	$231	$423	$615
Total PIMs						#N/A	11	15	#N/A	#N/A	23	19	26	33	#N/A	11	15	#N/A	#N/A	23	19	26	33	#N/A	$528	$683	$589	$826	$1,064	$914	$1,204	$1,559

Assumed costs as % of benefits are zero for EVs as benefits are altready netted for program costs

Sharing of EV incentives between consumer/fleet

	2019 max	2020 max	2021 max		2019 max	2020 max	2021 max
75%	5.1	7.0	9.7	Consumer	$240	$331	$461
25%	1.7	2.3	3.2	Fleet	$80	$110	$154

Benefits of Settlement Agreement

						FCM Benefits ($/MW-yr)									Transmission Peak Benefits ($/MW-yr)									Distribution Benefits ($/MW-yr)									Energy Peak Benefits				
						2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020
Performance Incentive Mechanism	**Assumed Measure Life (yrs)**					Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium
System Efficiency																																				
FCM Peak Demand Reduction	4					$43,429	$43,429	$43,429	$91,907	$91,907	$91,907	$146,807	$146,807	$146,807	$22,683	$22,683	$22,683	$23,137	$23,137	$23,137	$23,600	$23,600	$23,600	#N/A	$135,726	$135,726	$138,441	$138,441	$138,441	$141,209	$141,209	$141,209	$130	$130	$130	$142	$142
Distributed Energy Resources																																				
Electric Vehicle Initiative	10					$302,845	$302,845	$302,845	$374,999	$374,999	$374,999	$451,150	$451,150	$451,150	$48,910	$48,910	$48,910	$49,889	$49,889	$49,889	$50,886	$50,886	$50,886	#N/A	$292,657	$292,657	$298,511	$298,511	$298,511	$304,481	$304,481	$304,481	$298	$298	$298	$316	$316

Outcomes

						FCM Savings (MW-yr)									Transmission Savings (MW-yr)									Distribution Savings (MW-yr)									Energy Peak (MW				
						2019	2019	2019	2019	2020	2020	2021	2021	2021	2019	2019	2019	2019	2020	2020	2021	2021	2021	2019	2019	2019	2019	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020
Performance Incentive Mechanism	**Target Units**	**Convert Tx Months of Savings to Years**	**FCM Peak Coincidence**	**Transmission Peak Coincidence**	**Distribution Peak Coincidence**	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium
System Efficiency																																				
FCM Peak Demand Reduction	MW below baseline	100%	100%	100%	50%	14	17	20	17	21	25	21	24	29	14	17	20	17	21	25	21	24	29	7	8.5	10	8.5	10.5	12.5	10.5	12	14.5	14	17	20	17	21
Distributed Energy Resources																																				
Electric Vehicle Initiative	Incremental Tonnes CO2	100%	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Total PIMs						**14**	**17**	**20**	**17**	**21**	**25**	**21**	**24**	**29**	**14**	**17**	**20**	**17**	**21**	**25**	**21**	**24**	**29**	**7**	**9**	**10**	**9**	**11**	**13**	**11**	**12**	**15**	**14**	**17**	**20**	**17**	**21**

Calculate $ Value of Outcomes

						FCM Benefits ($)									Transmission Benefits ($)									Distribution Benefits ($)									Energy Peak ($
						2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020
Performance Incentive Mechanism						Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium
System Efficiency																																				
FCM Peak Demand Reduction						$608,007	$738,295	$868,582	$1,562,416	$1,930,044	$2,297,671	$3,082,957	$3,523,379	$4,257,416	$317,566	$385,615	$453,665	$393,328	$485,875	$578,423	$495,593	$566,392	$684,390	#N/A	$1,153,671	$1,357,260	$1,176,745	$1,453,626	$1,730,507	$1,482,698	$1,694,512	$2,047,536	$1,823	$2,214	$2,605	$2,412	$2,979
Distributed Energy Resources																																				
Electric Vehicle Initiative						$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0										$0	$0	$0	$0	$0
Total PIMS						**$608,007**	**$738,295**	**$ 868,582**	**$1,562,416**	**$1,930,044**	**$2,297,671**	**$3,082,957**	**$3,523,379**	**$4,257,416**	**$317,566**	**$385,615**	**$453,665**	**$393,328**	**$485,875**	**$578,423**	**$495,593**	**$566,392**	**$684,390**	**#N/A**	**$1,153,671**	**$1,357,260**	**$1,176,745**	**$1,453,626**	**$1,730,507**	**$1,482,698**	**$1,694,512**	**$2,047,536**	**$ 1,823**	**$ 2,214**	**$ 2,605**	**$ 2,412**	**$ 2,979**

Benefits of Settlement Agreement

	($/MW)				GHG ($/Tonne)									Initiative Net Benefits ($/tonne over study period)								
	2020	2021	2021	2021	2029	2019	2019	2020	2020	2020	2021	2021	2021	2029	2019	2019	2020	2020	2020	2021	2021	2021
Performance Incentive Mechanism	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																						
FCM Peak Demand Reduction	$142	$148	$148	$148	$270	$267	$267	$267	$267	$267	$264	$264	$264									
Distributed Energy Resources																						
Electric Vehicle Initiative	$316	$332	$332	$332	$610	$537	$537	$533	$533	$533	$528	$528	$528	$483	$483	$483	$483	$483	$483	$483	$483	$483

Outcomes	MWh				GHG (Tonnes)									Initiative (tonnes)								
	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021
Performance Incentive Mechanism	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																						
FCM Peak Demand Reduction	25	21	24	29																		
Distributed Energy Resources																						
Electric Vehicle Initiative					553	1013	1474	761	1396	2030	1060	1944	2828	553	1013	1474	761	1396	2030	1060	1944	2828
Total PIMs	**25**	**21**	**24**	**29**	**553**	**1013**	**1474**	**761**	**1396**	**2030**	**1060**	**1944**	**2828**	**553**	**1013**	**1474**	**761**	**1396**	**2030**	**1060**	**1944**	**2828**

Calculate $ Value of Outcomes	$)				GHG Benefits ($)									Initiative Net Benefits ($)									Benefits (Benefits are net for EVs and Heat)											
	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021	2019-21 Cumulative		
Performance Incentive Mechanism	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																																		
FCM Peak Demand Reduction	$3,547	$3,109	$3,553	$4,294	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	#N/A	$2,279,795	$2,682,112	$3,134,900	$3,872,524	$4,610,148	$5,064,357	$5,787,837	$6,993,636	#N/A	$11,940,156	$14,285,896
Distributed Energy Resources																																		
Electric Vehicle Initiative	$0	$0	$0	$0	$337,592	$544,054	$791,645	$405,824	$744,454	$1,082,552	$559,475	$1,026,056	$1,492,637	$267,299	$489,645	$712,474	$367,838	$674,772	$981,223	$512,363	$939,654	$1,366,945	$267,299	$489,645	$712,474	$367,838	$674,772	$981,223	$512,363	$939,654	$1,366,945	$1,147,499	$2,104,070	$3,060,641
Total PIMS	**$ 3,547**	**$ 3,109**	**$ 3,553**	**$ 4,294**	**$337,592**	**$544,054**	**$791,645**	**$405,824**	**$744,454**	**$1,082,552**	**$559,475**	**$ 1,026,056**	**$ 1,492,637**	**$267,299**	**$489,645**	**$712,474**	**$367,838**	**$674,772**	**$981,223**	**$512,363**	**$939,654**	**$ 1,366,945**	**#N/A**	**$ 2,769,440**	**$ 3,394,586**	**$ 3,502,738**	**$ 4,547,296**	**$ 5,591,370**	**$ 5,576,720**	**$ 6,727,490**	**$ 8,360,580**	**#N/A**	**$14,044,226**	**$17,346,537**

Note -- GHG tonne benefits not counted because EV and Heat total initiative benefits are counted

Key Assumptions and Inputs

Company WACC	7.50%
Inflation	2.00%

Initiative Net Benefits and BCA Ratio			Source:
EVs	$2,104,070	1.15	program BCA revised for settlement
Heat	$ 776,660	1.27	program BCA revised for settlement

EV -- 3 year CO2 tons reduced at target	4353	Heat -- 3 year CO2 tons reduced at target	726
EV Net benefits per ton	$ 483	Heat Net Benefits per ton	$ 1,070

Incentives (Basis Points)

Outcomes

		Incremental Outcomes									Cumulative Outcomes								
											2019Low	2019Medium	2019High	2020Low	2020Medium	2020High	2021Low	2021Medium	2021High
		2019	2019	2019	2020	2020	2020	2021	2021	2021	2019	2019	2019	2020	2020	2020	2021	2021	2021
Performance Incentive Mechanism	**Outcome Units**	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
System Efficiency																			
FCM Peak Demand Reduction	MW reduced	14	17	20	17	21	25	21	24	29	14	17	20	17	21	25	21	24	29
Distributed Energy Resources												0	0		0	0		0	0
Electric Vehicle Initiative	Incremental Tonnes CO2	553	1,013	1,474	761	1,396	2,030	1,060	1,944	2,828	553.0	1,013	1,474	1314.0	2,409	3504.0	2374.0	4,353	6332.0

FCM		**Source/Notes**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
($/MW-yr)	**Ngrid BCA**	I: Attachment DIV B-6; AESC 2015 Update - Appendix	$0	$0	$0	$151,748	$145,443	$154,497	$173,685	$193,939	$214,296	$235,795	$259,373	$290,551	$308,170	$314,333	$320,620	$327,032	$333,573	$340,244	$347,049	$353,990
	Division	Daymark Email Rec'd 3/16/18	$0	$0	$0	$55,042	$55,936	$62,393	$64,297	$69,950	$75,749	$84,529	$102,516	$97,070	$108,661	$111,185	$114,424	$117,749	$121,160	$124,661	$128,254	$131,940
	Ngrid EE Screening																					
	NG Settlement	AESC 2018	$0	$0	$0	$62,348	$64,920	$68,921	$75,469	$83,422	$91,903	$100,567	$109,541	$106,405	$106,723	$116,246	$112,918	$113,255	$123,361	$127,971	$132,715	$137,599

Transmission			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
($/MW-yr)	**Ngrid BCA**	Attachment DIV I-36-I	$114,808	$117,104	$119,446																	
	Division	Daymark Email Rec'd 3/16/18	$124,913	$133,170	$141,612	$150,390	$159,312	$168,380	$177,593	$186,950	$196,453	$206,100	$215,893	$225,830	$235,913	$246,141	$256,513	$267,031	$277,693	$288,501	$299,454	$310,551
	Ngrid EE Screening		$14,157	$14,440	$14,728	$15,023	$15,323	$15,630	$15,943	$16,261	$16,587	$16,918	$17,257	$17,602	$17,954	$18,313	$18,679	$19,053	$19,434	$19,823	$20,219	$20,623
	NG Settlement	50% of EE values	$7,078	$7,220	$7,364	$7,512	$7,662	$7,815	$7,971	$8,131	$8,293	$8,459	$8,628	$8,801	$8,977	$9,156	$9,340	$9,526	$9,717	$9,911	$10,109	$10,312

Distribution			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
($/MW-yr)	**Ngrid BCA**																														
	Division		$84,706	$86,400	$88,128	$89,891	$91,688	$93,522	$95,393	$97,301	$99,247	$101,232	$103,256	$105,321	$107,428	$109,576	$111,768	$114,003	$116,283	$118,609	$120,981	$123,401	$125,869	$128,386	$130,954	$133,573	$136,244	$138,969	$141,749	$144,584	$147,475	$150,425
	Ngrid EE Screening		$84,706	$86,400	$88,128	$89,891	$91,688	$93,522	$95,393	$97,301	$99,247	$101,232	$103,256	$105,321	$107,428	$109,576	$111,768	$114,003	$116,283	$118,609	$120,981	$123,401	$125,869	$128,386	$130,954	$133,573	$136,244	$138,969	$141,749	$144,584	$147,475	$150,425
	NG Settlement	50% of EE values	$42,353	$43,200	$44,064	$44,945	$45,844	$46,761	$47,696	$48,650	$49,623	$50,616	$51,628	$52,661	$53,714	$54,788	$55,884	$57,002	$58,142	$59,304	$60,491	$61,700	$62,934	$64,193	$65,477	$66,786	$68,122	$69,485	$70,874	$72,292	$73,738	$75,212

Note:. Ngrid EE Screenting Tool values for Transmission and Distribution for 2019 reflect a 2% inflation rate applied to the original 2016 estimates used in EE screeing

Energy Peak			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**										
($/MWh)	**Ngrid BCA**																															
	Division	Daymark Email Rec'd 3/16/18	$80	$82	$74	$76	$77	$83	$87	$94	$96	$101	$110	$116	$121	$128	$136	$142	$151	$156	$166	$174										
	Ngrid EE Screening																															
	NG Settlement	AESC 2018	$33	$40	$49	$48	$46	$46	$50	$55	$54	$60	$60	$64	$60	$62	$64	$69	$79	$84	$90	$97	$104	$111	$119	$128	$137	$147	$158	$169	$181	

GHG MWh			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
($/MWh)	**Ngrid BCA**		$49	$49	$49	$48	$48	$47	$47	$46	$46	$45	$45	$44	$54	$55	$56	$58	$59	$60	$61	$62	$63	$65	$66	$67	$69	$70	$71	$73	$74	
	Division		$49	$49	$49	$48	$48	$47	$47	$46	$46	$45	$45	$44	$54	$55	$56	$58	$59	$60	$61	$62	$63	$65	$66	$67	$69	$70	$71	$73	$74	
	Ngrid EE Screening		---																													
	NG Settlement		$49	$49	$49	$48	$48	$47	$47	$46	$46	$45	$45	$44	$54	$55	$56	$58	$59	$60	$61	$62	$63	$65	$66	$67	$69	$70	$71	$73	$74	$0

GHG tons			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
$/metric tonne	**Ngrid BCA**		$86	$86	$86	$85	$84	$84	$83	$82	$81	$80	$79	$78	$96	$98	$99	$101	$103	$106	$108	$110	$112	$114	$116	$119	$121	$124	$126	$128	$131	
	Division		$86	$86	$86	$85	$84	$84	$83	$82	$81	$80	$79	$78	$96	$98	$99	$101	$103	$106	$108	$110	$112	$114	$116	$119	$121	$124	$126	$128	$131	
	Ngrid EE Screening		---																													
	NG Settlement		$86	$86	$86	$85	$84	$84	$83	$82	$81	$80	$79	$78	$96	$98	$99	$101	$103	$106	$108	$110	$112	$114	$116	$119	$121	$124	$126	$128	$131	

			Basis Points 2019	**Basis Points 2020**	**Basis Points 2021**
Basis Points	Bps	**Ngrid**	$47,010	$47,145	$47,356

SETTLEMENT AGREEMENT

BC **EV - BCA Summary**

Societal Cost Test

RI Electric Vehicles BCA

	Electric Vehicles -- Total	
Benefit	Forward Commitment: Capacity Value	$ (438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$ (2,000,365)
	Avoided Renewable Energy Credit (REC) Cost	$ (199,084)
	Greenhouse Gas (GHG) Externality Costs	$ 4,411,354
	Criteria Air Pollutant and Other Environmental	$ 971,849
	Non-Electric Avoided Fuel Cost	$ 13,580,688
	Economic Development	$ -
		$ -
	Total	**$ 16,326,412**
Cost	Total Program Administration Costs	$ 8,022,917
	Incremental Purchase and Maintenance Cost	$ 5,796,281
		$ -
	Total	**$ 13,819,198**
	Net benefits	$ 2,507,213
	BCA Ratio	**1.18**

RIM Cost Test

RI Electric Vehicles BCA

	Electric Vehicles -- Total	
Benefit	Forward Commitment: Capacity Value	$ (438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$ (2,000,365)
	Avoided Renewable Energy Credit (REC) C	$ (199,084)
	Wholesale Market Price Effect	$ (7,207)
	Net Utility Revenue Increase	$ 4,571,791
	Total	**$ 1,927,104**
Cost	Total Program Administration Costs	$ 8,022,917
	Net Utility Revenue Decrease	$ 326,937
	Total	**$ 8,349,854**
	BCA Ratio	**0.23**

Comprehensive Benefits & Costs

	Applicable Cost Test			Electric Vehicles -- Total	
	SCT	UCT	RIM		
Benefit	x	x	x	Forward Commitment: Capacity Value	$ (438,031)
	x	x	x	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$ (2,000,365)
	x	x	x	Avoided Renewable Energy Credit (REC) Cost	$ (199,084)
		x	x	Wholesale Market Price Effect	$ (7,207)
	x			Greenhouse Gas (GHG) Externality Costs	$ 4,411,354
	x			Criteria Air Pollutant and Other Environmental Costs	$ 971,849
	x			Non-Electric Avoided Fuel Cost	$ 13,580,688
	x			Economic Development	$ -
		x	x	Net Utility Revenue Increase	$ 4,571,791
				Total	**$ 20,890,996**
Cost	x	x	x	Total Program Administration Costs	$ 8,022,917
	x			Incremental Purchase and Maintenance Cost	$ 5,796,281
		x	x	Net Utility Revenue Decrease	$ 326,937
				Total	**$ 14,146,135**

Breakdown of Benefits & Costs

	Electric Vehicles -- EV conversion	
Benefit	Forward Commitment: Capacity Value	$ (438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$ (2,043,551)
	Avoided Renewable Energy Credit (REC) Cost	$ (199,084)
	Wholesale Market Price Effect	$ (7,207)
	Greenhouse Gas (GHG) Externality Costs	$ 4,411,354
	Criteria Air Pollutant and Other Environmental Costs	$ 971,849
	Non-Electric Avoided Fuel Cost	$ 13,580,688
	Economic Development	$ -
	Net Utility Revenue Increase	$ 4,571,791
	Total	**$ 20,847,810**
Cost	Total Program Administration Costs	$ 7,144,101
	Incremental Purchase and Maintenance Cost	$ 5,796,281
	Total	**$ 12,940,382**

	Electric Vehicles -- National Grid Heavy Duty Fleet	
Benefit	Forward Commitment: Capacity Value	$ -
	Provided or Saved	$ -
	Avoided Renewable Energy Credit (REC) Cost	$ -
	Wholesale Market Price Effect	$ -
	Greenhouse Gas (GHG) Externality Costs	$ -
	Criteria Air Pollutant and Other Environmental Costs	$ -
	Non-Electric Avoided Fuel Cost	$ -
	Net Utility Revenue Increase	$ -
	Total	**$ -**
Cost	Total Program Administration Costs	$ -
	Incremental Purchase and Maintenance Cost	$ -
	Total	**$ -**

	Electric Vehicles -- Off Peak Rebate	
Benefit	Forward Commitment: Capacity Value	$ -
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$ 43,185
	Greenhouse Gas (GHG) Externality Costs	$ 6,897
	Total	**$ 50,083**
Cost	Total Program Administration Costs	$ 492,495
	Total	**$ 492,495**

	Electric Vehicles -- Other costs	
Cost	Total Program Administration Costs	$386,321
	Net Utility Revenue Decrease	$326,937
	Total	**$713,258**

APPENDIX 4

##
EV BCA ratios and comprehensive benefits and costs

EV - BCA Summary

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Societal Cost Test

RI Electric Vehicles BCA

	Electric Vehicles -- Total		
Benefit	Forward Commitment: Capacity Value	$	(438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	(2,000,365)
	Avoided Renewable Energy Credit (REC) Cost	$	(199,084)
	Greenhouse Gas (GHG) Externality Costs	$	4,434,442
	Criteria Air Pollutant and Other Environmental Costs	$	971,849
	Non-Electric Avoided Fuel Cost	$	13,580,688
	Economic Development	$	-
		$	-
	Total	**$**	**16,349,499**
Cost	Total Program Administration Costs	$	8,449,148
	Incremental Purchase and Maintenance Cost	$	5,796,281
		$	-
	Total	**$**	**14,245,429**

BCA Ratio **1.15**

RIM Cost Test

RI Electric Vehicles BCA

	Electric Vehicles -- Total		
Benefit	Forward Commitment: Capacity Value	$	(438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	(2,000,365)
	Avoided Renewable Energy Credit (REC) Cost	$	(199,084)
	Wholesale Market Price Effect	$	(7,207)
	Net Utility Revenue Increase	$	4,571,791
	Total	**$**	**1,927,104**
Cost	Total Program Administration Costs	$	8,449,148
	Net Utility Revenue Decrease	$	326,937
	Total	**$**	**8,776,085**

BCA Ratio **0.22**

Comprehensive Benefits & Costs

	Applicable Cost Test			Electric Vehicles -- Total		
	SCT	UCT	RIM			
Benefit	x	x	x	Forward Commitment: Capacity Value	$	(438,031)
	x	x	x	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	(2,000,365)
	x	x	x	Avoided Renewable Energy Credit (REC) Cost	$	(199,084)
		x	x	Wholesale Market Price Effect	$	(7,207)
	x			Greenhouse Gas (GHG) Externality Costs	$	4,434,442
	x			Criteria Air Pollutant and Other Environmental Costs	$	971,849
	x			Non-Electric Avoided Fuel Cost	$	13,580,688
	x			Economic Development	$	-
		x	x	Net Utility Revenue Increase	$	4,571,791
				Total	**$**	**20,914,083**
Cost	x	x	x	Total Program Administration Costs	$	8,449,148
	x			Incremental Purchase and Maintenance Cost	$	5,796,281
		x	x	Net Utility Revenue Decrease	$	326,937
				Total	**$**	**14,572,366**

Breakdown of Benefits & Costs

	Electric Vehicles -- EV conversion		
Benefit	Forward Commitment: Capacity Value	$	(438,031)
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	(2,043,551)
	Avoided Renewable Energy Credit (REC) Cost	$	(199,084)
	Wholesale Market Price Effect	$	(7,207)
	Greenhouse Gas (GHG) Externality Costs	$	4,434,442
	Criteria Air Pollutant and Other Environmental Costs	$	971,849
	Non-Electric Avoided Fuel Cost	$	13,580,688
	Economic Development	$	-
	Net Utility Revenue Increase	$	4,571,791
	Total	**$**	**20,870,898**
Cost	Total Program Administration Costs	$	7,570,332
	Incremental Purchase and Maintenance Cost	$	5,796,281
	Total	**$**	**13,366,613**

	Electric Vehicles -- National Grid Heavy Duty Fleet		
Benefit	Forward Commitment: Capacity Value	$	-
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	-
	Avoided Renewable Energy Credit (REC) Cost	$	-
	Wholesale Market Price Effect	$	-
	Greenhouse Gas (GHG) Externality Costs	$	-
	Criteria Air Pollutant and Other Environmental Costs	$	-
	Non-Electric Avoided Fuel Cost	$	-
	Net Utility Revenue Increase	$	-
	Total	**$**	**-**
Cost	Total Program Administration Costs	$	-
	Incremental Purchase and Maintenance Cost	$	-
	Total	**$**	**-**

	Electric Vehicles -- Off Peak Rebate		
Benefit	Forward Commitment: Capacity Value	$	-
	Energy Supply & Transmission Operating Value of Energy Provided or Saved	$	43,185
	Greenhouse Gas (GHG) Externality Costs	$	6,897
	Total	**$**	**50,083**
Cost	Total Program Administration Costs	$	492,495
	Total	**$**	**492,495**

	Electric Vehicles -- Other costs	
Cost	Total Program Administration Costs	$386,321
	Net Utility Revenue Decrease	$326,937
	Total	**$713,258**

EV - Inputs

Return to Contents -->

Control Panel

Switch Key

Switch to change inputs

EV Enablement Ratio

5.25

VMT per capita -- RI

8612.949159

BEB Enablement Ratio

4

BEB Rebate %-- Airport Vehicles

0

Economic Development

Off

EV - General Assumptions

Assumption	Value	Unit	Source
Gasoline Price	2.5	$ / gallon	Transportation Initiative - Draft Testimony (Karsten Barde)
Vehicle Efficiency	30	miles / gallon	Transportation Initiative - Draft Testimony (Karsten Barde)
Electric vehicle efficiency	3.5	miles / kWh	Transportation Initiative - Draft Testimony (Karsten Barde)
Electric equivalent cost per unit	9.50	cents per kWh	Transportation Initiative - Draft Testimony (Karsten Barde)
Charging Rate at Utility-operated Station -- Consume	0.15	$/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)
Charging Rate at Utility-operated Station -- Consumer Level 2 (transaction fee only)	0.05		
Charging Rate at Utility-operated Station - Consume	0.35	$/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)
Charging Rate at Utility-operated Station - Consume	0.25		
EV Enablement Ratio - Low	3	EV / Charge Point	https://autoalliance.org/
EV Enablement Ratio - Average	5.25	EV / Charge Point	https://autoalliance.org/
EV Enablement Ratio - High	10	EV / Charge Point	https://autoalliance.org/
EV Enablement Ratio-DCFC	44	EV/DCFC	https://autoalliance.org/ Alternative Fuels Data Center
VMT per capita in RI	8612.949159	miles / pop.	http://www.dot.ri.gov/documents/community/safety/Highway_Safety_Performance_Plan.p
Average CO2 emitted per mile driven	0.411	kilograms	https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle-0
Average SO2 emitted per mile driven	0.000018	kilograms	http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381
Average NOx emitted per mile driven	0.0076	kilograms	https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/factbook2016.
VMT Growth Rate - RI	1%	%	https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf
% of miles covered by PHEV batteries	85%	%	Accenture Assumption
% of miles covered by BEV batteries	95%	%	Accenture Assumption
At Home Charging Percentage	80%	%	https://energy.gov/eere/electricvehicles/charging-home
On-Site Charging Percentage	20%	%	https://energy.gov/eere/electricvehicles/charging-home
Charging Port -- Useful Life	10	years	Transportation Initiative - Draft Testimony (Karsten Barde)
Derating Factor	75%	%	KPMG Assumption

General Assumptions - Fleet and Transit

Assumption-- Light Duty Fleet	Value	Unit	Source
VMT per light duty fleet vehicle -- RI	6,723.31	miles/vehicle	Calculated Below
Average mpg -- light duty vehicle	35.5	miles/gallon	https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZ7C.P dfsd
Average CO2 emitted per mile dirven -- light duty ve	0.25	kilograms	https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZ7C.PDF?Dockey=P100EZ7C.PDF

Assumption-- Bus	Value	Unit	Source
VMT per bus -- RI	17385.0	miles/vehicle	https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportatio
Average mpg -- Diesel Bus	3.3	miles/gallon	https://www.faa.gov/airports/environmental/zero_emissions_vehicles/media/Zero-Emissio
Average CO2 Emitted per mile driven -- diesel bus	2.5	kg/mile	FAA
Battery Electric Bus (BEB) Efficiency	2.15	miles/kWh	MJ Bradley and Associates: Comparison of Modern CNG, Diesel and Diesel Hybrid Electric Bu
Price Per Gallon of Diesel Fuel	2.5	$/gallon	https://www.faa.gov/airports/environmental/zero_emissions_vehicles/media/Zero-Emissio
SO2 Emissions -- Heavy Duty Vehicles	0.0000000200	tons/mile	http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381
NOX Emissions-- Heavy Duty Vehicles	0.0000178400	tons/mile	http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381
BEV Enablement Ratio--Low	1	buses/port	http://www.calstart.org/Libraries/Publications/Electric_Truck_Bus_Grid_Integration_Oppor
BEV Enablement Ratio--Medium	2	buses/port	http://www.calstart.org/Libraries/Publications/Electric_Truck_Bus_Grid_Integration_Oppor
BEV Enablement Ratio--Low	4	buses/port	http://www.calstart.org/Libraries/Publications/Electric_Truck_Bus_Grid_Integration_Oppor

Assumption-- Other Heavy Duty	Value	Unit	Source	Comment
Airport Bus Rebates	0.50	%	Airport ZEV and Infrastructure Pilot Program	FAA has a program that will cover 50% of c
Partial Rebate Included	25%	%	Airport ZEV and Infrastructure Pilot Program	
No Rebate Included	0%	%	Airport ZEV and Infrastructure Pilot Program	
# of Aiport Buses	32	#	Calculated	
Average Diesel Bus Maintenance Cost	2	$/mile driven	CARB	
Average BEB Maintenance Cost	0.5	$/mile driven	Handouts/VW_Zero_Emission_Bus_Factsheet.pdf	

	2018	2019	2020
Rebate Value per Bus	0	0	0

Assumption-- Ridesharing	Value	Unit	Source	Comment
Enablement Ratio -- Ridesharing	5.25	vehicles/port	KPMG Assumption	
Full Time Driver Percentage	19%	%	http://time.com/3678507/uber-driver-questions/	
Part Time Driver Percentage	81%	%	http://time.com/3678507/uber-driver-questions/	
Average VMT -- Full Time Driver	45000	miles/driver	Uber Forums	
Average VMT -- Median Driver	20000	miles/driver	https://fee.org/articles/do-uber-drivers-lose-money/	

VMT Assumptions - Fleet & Transit Vehicles

VMT Assumptions	Value	Unit	Source
Light Duty Fleet			
VMT per light duty fleet vehicle -- National	7,486.00	miles/vehicle	General Services Administration
Average RI VMT	8612.949159	miles/vehicle	RI DOT
Average National VMT	9590	miles/vehicle	RITA
RI / National Proportion	90%	%	Calculated
VMT per light duty vehicle -- RI	**6723.309427**	**miles/vehicle**	**Calculated**
Ridesharing			
Weighted Average VMT -- Ridesharing	**24,750**	**miles/driver**	**Calculated**
Buses/Heavy Duty Vehicles			
VMT per bus- National	18300	miles/vehicle	General Services Administration
Assumed RI/National Transit Proportion	95%	%	KPMG Assumption based on discussion with Karsten Barde
VMT per bus-- RI	**17,385**	**miles/vehicle**	Calculated

Enablement Ratios - L2 Charging

Assumption	Value	Unit	Comment	Source 1	Source 2
EV Enablement Ratio -- L2 Charging	5.25	EV/Charge Point	Number used in NY model. It is fairly conservative.	https://autoalliance.org/	
EV Enablement Ratio -- L2 Charging	8.3	EV/Charge Point	Average number we arrived at based off a nationwide average of EV's per charge point.	https://autoalliance.org/	Alternative Fuels Data Cente

Adjusted VMT Calculation

	Value	Unit		Comment	Source 1	Source 2
% of Miles Driven on Local Roads (Urban Area)	0.13905	%		5 Year Average	https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publicat	
% of Miles Driven on Local Roads (Rural Area)	13.995%		%	5 Year Average	https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publicat	
% of Population Living in Urban Area	90.73%		%		https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=we	
% of Population Living in Rural Area	9.27%		%		https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=we	
Average % of Miles Driven on Local Roads	13.91%		%	Weighted Average Calculation	https://www.rita.dot.gov/bts/sites/r	https://www.google.com/u
VMT per capita--RI	7414.6	miles/pop		This is a number taken from RI DOT for the year 2015. It is unclear whether this includes only	http://www.dot.ri.gov/documents/community/safety/Highway_	
Average VMT (Midpoint of VMT and Adjusted VMT)	8013.8	miles/pop				
Adjusted VMT per capita--RI	8612.9	miles/pop		Calculated below. Takes highway miles and divides by the percentage of the miles driven on	https://www.rita.dot.gov/bts/sites/r	https://www.google.com/u
VMT per capita--RI	7414.60		miles/pop.			
1 - Average % of Miles Driven on Local Roads	86.09%		%			
Adjusted VMT per capita--RI	8612.95		miles/pop	Calculated		

Cost Assumptions

	Value	Units		Source	Comments	Source 2
Average Cost of EV	30,196.25		$	Average MSRP	Calculated in NY Model	
Average Cost of ICE	17,508.33		$	Average MSRP	Calculated in NY Model	
Federal BEV Grant	7500.00		$	https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d		
State Tax Credit	0.00		$	http://www.drive.ri.gov/	Out of funding	
Federal PHEV Grant	5500.00		$	https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d		
Average PHEV vehicle maintenance	0.03		$ per mile	https://pluginamerica.org/how-much-does-it-cost-charge-electric-car/		
Average BEV vehicle maintenance	0.03		$ per mile	https://pluginamerica.org/how-much-does-it-cost-charge-electric-car/		
Average ICE vehicle maintenance	766.50		$	http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa-archive/		
Average Annual PHEV maintenance	258.39		$	Calculated		
Average Annual BEV maintenance	258.39		$	Calculated		
Average annual ICE vehicle cost growth rate	0.02		%	http://mediaroom.kbb.com/new-car-transaction-prices-up-2-percent-march-2016		
Average annual ICE vehicle mpg growth rate	0.03		%	Carried over from NY		
Average BEV/PHEV mi/kwh growth rate	0.03		%	EIA		
Average EV maintenance growth rate	-2%		%	Carried over from NY		
Average ICE cost growth rate	2%		%	http://mediaroom.kbb.com/new-car-transaction-prices-up-2-percent-march-2016		
Average EV vehicle cost growth rate	(0.01)		%	Carried over from NY		
Average Cost of Diesel Bus	480,000		$	https://www.faa.gov/airports/environmental/zero_emissions_vehicles/media/Zero-Emissions-Vehicles-Tech-Guidance.pdf		
BEB Battery Size	330		kWh			

Time Series -- Buses

	2017	2018	2019	2020	Unit	Source
Battery Price per kWh	600	533.33	467.67	400	$/kWh	https://www.arb.ca.gov/ms
Forecasted Cost Electric Bus Battery	198,000	175,999	154,331	132,000	$	https://www.arb.ca.gov/ms
Forecasted BEB	750,000	727,999	706,331	684,000	$	https://www.faa.gov/airpor

Efficiency and VMT Time Series

	Value	Units	Growth Rate	Source
Electric Vehicle Efficiency Time Series	3.50	miles / kWh	1.00	EIA
VMT per capita Time Series	8612.95	miles/pop	1.01	RITA
ICE Vehicle Efficiency	30.00	miles/gallon	1.00	http://mediaroom.kbb.com/new-car-transaction-prices-up-2-percent-march-2016
VMT per Bus -- RI Time Series	17385	miles/vehicle	1.01	RITA
VMT per LD Fleet Vehicle -- RI Time Series	6723.31	miles/vehicle	1.01	RITA

Time Series Values	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Electric Vehicle Efficiency Time Series	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
VMT per capita Time Series	8612.949159	8700.542852	8789.027373	8878.411781	8968.705229	9059.916961	9152.056317	9245.132729	9339.155729	9434.134943	9530.080095	9627.00101	9724.90761	9823.80992
ICE Vehicle Efficiency	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
VMT per Bus -- RI Time Series	17385	17561.80545	17740.40901	17920.82897	18103.0838	18287.19216	18473.17291	18661.04508	18850.82791	19042.54082	19236.20347	19431.83565	19629.45742	19829.08901
VMT per LD Fleet Vehicle -- RI Time Series	6723.31	6790.542521	6858.447946	6927.032426	6996.30275	7066.265778	7136.928435	7208.29772	7280.380697	7353.184504	7426.716349	7500.983512	7575.993347	7651.753281

Charging Station Demonstration Program Inputs

Assumption	Value	Unit	Source	Comment	
Utility Operated Ports	136	#	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Utlity Operated Ports %	43%	%	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Utility Operated L2 Ports	126	#	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Utility Operated L2 Port %	39.873%	%	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Utility Operated DCFC Ports	10	#	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Utility Operated DCFC Port %	3%	%	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement
Make Ready Port %	56.96%	%	RI Electric Transportation Initiative - Cost Estimates		Revised in Settlement

Charging Segments - Preliminary	Type	Sites	Ports per Site	Ports per Segment	% Make-Ready	Make-Ready Ports	Maximum % Utility-O	Utility-Operated Ports	Make-Ready EVSE Rebate Level	Source	
Workplaces	L2	14	10	140	100%	140	0%	0	50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Apartment buildings	L2	6	6	36	0%	0	100%	36	75%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Disadvantaged community sites	L2	6	6	36	0%	0	100%	36	100%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Public transit stations	L2	6	10	60	50%	30	50%	30	50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Public DCFC	DCFC	4	5	20	50%	10	50%	10	0%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Government light-duty fleet	L2	3	8	24	0%	0	100%	24	50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Corporate light-duty fleet	L2	3	8	24	100%	24			50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Public transit buses	Other	2	5	10	100%	10			50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Rideshare company charging hub	DCFC	1	5	5	100%	5			25%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Other heavy-duty/DCFC (port, airport)	Other	2	4	8	100%	8			50%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement
Municipal school buses	Other	3	1	3	100%	3			75%	RI Electric Transportation Initiative - Cost Estimates	Revised in Settlement

Total			**50**	**68**	**366**		**230**		**136**						

Time Assumptions -- Cost

Assumption	**Unit**		**Source**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Capital Expenditures		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	**1,005,232**	**1,620,406**	**3,785,464**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
EDC Costs (New Service)		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	136,285	340,713	885,854									
Customer Premise Costs		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	323,142	807,855	2,100,422									
EVSE Costs (Utility Operated Only)		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	80,484	201,211	523,148									
Project Management Office (PMO) Labor		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	365,321	270,627	276,040									
Project Management / CRM Tool Modifications		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	50,000											
Data Analysis & Reporting Tools		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	50,000											
Operating Expenditures (O&M)		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	**319,621**	**468,046**	**909,964**	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	85,680.00	61,880.00
Station O&M		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	9,520	33,320	95,200	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	95,200.00	85,680.00	61,880.00
Project Managers and Account Managers		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	170,963	174,382	177,870									
Charging Program Marketing		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	45,000	25,000	25,000									
Site Agreement Contracting Costs ($2000/site)		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	10,000	25,000	65,000									
Customer Site Cost Estimation ($2500/site)		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	12,500	31,250	81,250									
EVSE Rebate Cost for Make-Ready Sites		$ USD	sportation Initiative - Draft Testimony (Karsten Ba	71,638	179,094	465,644									
Participation Payment		$USD	sportation Initiative - Draft Testimony (Karsten Ba	17,500	43,750	113,750									

Cost Assumptions -- Education and Outreach

Assumption	**Source**	**2018**	**2019**	**2020**
Bill inserts/Opower reports/etc	Transportation Initiative - Draft Testimony (Karste	$15,000	$15,000	$22,000
Ride-n-Drive Events		$10,000	$40,000	$40,000
EV Education & Awareness Page	Transportation Initiative - Draft Testimony (Karste	$5,000	$10,000	$25,000
Facebook	Transportation Initiative - Draft Testimony (Karste	$4,000	$4,000	$5,000
Twitter	Transportation Initiative - Draft Testimony (Karste	$1,500	$1,500	$3,000
Instagram	Transportation Initiative - Draft Testimony (Karste	$4,000	$4,000	$4,000
Billboard or Radio	Transportation Initiative - Draft Testimony (Karste	$10,000	$20,000	$45,000
Online Banners and SEO/SEM	Transportation Initiative - Draft Testimony (Karste	$5,000	$10,000	$15,000
Agency Contract	Transportation Initiative - Draft Testimony (Karste	$10,000	$10,000	$10,000
Staff Time	Transportation Initiative - Draft Testimony (Karste	$49,470	$50,459	$51,468
Total		**$113,969.55**	**$164,958.94**	**$220,468.12**

Site Construction Assumptions

	2018	**2019**	**2020**	**Source**
Sites Built each year	5	13	32	RI Electric Transportation Initiative - Cost Estimates
Cumulative Sites in Operation	5	18	50	RI Electric Transportation Initiative - Cost Estimates
Percent Complete	10%	36%	100%	RI Electric Transportation Initiative - Cost Estimates

Charging Site Breakdown

Charging Segments - Preliminary	**Type**	**Sites**	**Ports per Site**	**Ports per Segment**	**Estimated Max KW per Port**	**Diversity Factor**	**Coincidence Factor**	**Peak Site KW**	**Source**
Workplaces	L2	14	10	140	7	0.5	0.5	17.5	RI Electric Transportation Initiative - Cost Estimates
Apartment buildings	L2	6	6	36	7	0.5	0.5	10.5	RI Electric Transportation Initiative - Cost Estimates
Disadvantaged community sites	L2	6	6	36	7	0.5	0.5	10.5	RI Electric Transportation Initiative - Cost Estimates
Public transit stations	L2	6	10	60	7	0.5	0.5	17.5	RI Electric Transportation Initiative - Cost Estimates
Public DCFC	DCFC	4	5	20	50	0.5	0.5	62.5	RI Electric Transportation Initiative - Cost Estimates
Government light-duty fleet	L2	3	8	24	7	1	0.5	28	RI Electric Transportation Initiative - Cost Estimates
Corporate light-duty fleet	L2	3	8	24	7	1	0.5	28	RI Electric Transportation Initiative - Cost Estimates
Public transit buses	Other	2	5	10	50	1	0.5	125	RI Electric Transportation Initiative - Cost Estimates
Rideshare company charging hub	DCFC	1	5	5	50	1	0.5	125	RI Electric Transportation Initiative - Cost Estimates
Other heavy-duty/DCFC (port, airport)	Other	2	4	8	50	1	0.5	100	RI Electric Transportation Initiative - Cost Estimates
Municipal school buses	Other	3	1	3	50	1	0.5	25	RI Electric Transportation Initiative - Cost Estimates
Total		50	68	366					
Consumer Facing L2		**32**		**272**					
Consumer Facing DCFC		**4**		**20**					
Industrial L2		**6**		**48**					
Industrial DCFC		**1**		**5**					
Industrial Other		**7**		**21**					

Total Capacity Increase

Segment	**Sites**	**Peak Site kW**	**Segment Capacity**	**Source**
Workplaces	14	17.5	**245**	RI Electric Transportation Initiative - Cost Estimates
Apartment buildings	6	10.5	**63**	RI Electric Transportation Initiative - Cost Estimates
Disadvantaged community sites	6	10.5	**63**	RI Electric Transportation Initiative - Cost Estimates
Public transit stations	6	17.5	**105**	RI Electric Transportation Initiative - Cost Estimates
Public DCFC	4	62.5	**250**	RI Electric Transportation Initiative - Cost Estimates
Government light-duty fleet	3	28	**84**	RI Electric Transportation Initiative - Cost Estimates
Corporate light-duty fleet	3	28	**84**	RI Electric Transportation Initiative - Cost Estimates
Public transit buses	2	125	**250**	RI Electric Transportation Initiative - Cost Estimates
Rideshare company charging hub	1	125	**125**	RI Electric Transportation Initiative - Cost Estimates
Other heavy-duty/DCFC (port, airport)	2	100	**200**	RI Electric Transportation Initiative - Cost Estimates
Municipal school buses	3	25	**75**	RI Electric Transportation Initiative - Cost Estimates

Total Demand Increase Calculation -- Consumer Facing						Source	RI Electric Transportation Initiative - Cost Estimates						
Assumptions	**Type**	**Units**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Workplaces	L2	#	1.4	5.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	12.6	9.0
Peak Site Capacity		kW	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Demand Increase (Workplaces)		kW	24.5	88.2	245.0	245.0	245.0	245.0	245.0	245.0	245.0	245.0	220.5	156.8
Apartment Buildings	L2	#	0.6	2.2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.4	3.8
Peak Site Capacity		kW	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Demand Increase (Apartment buildings)		kW	6.30	22.68	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	56.70	40.32
Disadvantaged community sites	L2	#	0.6	2.2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.4	3.8
Peak Site Capacity		kW	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Demand Increase (Disadvantaged community sties)		kW	6.30	22.68	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	56.70	40.32
Public Transit Stations	L2	#	0.6	2.2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.4	3.8
Peak Site Capacity		kW	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Demand Increase (Public transit stations)		kW	10.50	37.80	105.00	105.00	105.00	105.00	105.00	105.00	105.00	105.00	94.50	67.20
Public DCFC	DCFC	#	0.4	1.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.6	2.6
Peak Site Capacity		kW	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
Demand Increase (Public DCFC)		kW	25.00	90.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00	225.00	160.00
Total Demand Increase at Meter (Consumer Facing)		**MW**	**0.07**	**0.26**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.65**	**0.46**

Total Demand Increase Calculation -- Fleet & Transit Vehicles						Source	RI Electric Transportation Initiative - Cost Estimates						
Assumptions	**Type**	**Units**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Government light-duty fleet	L2	#	0.3	1.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.7	1.9
Peak Site Capacity		kW	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Demand Increase (Government light-duty fleet)		kW	8.40	30.24	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	75.60	53.76
Corporate light-duty fleet	L2	#	0.3	1.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.7	1.9
Peak Site Capacity		kW	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Demand Increase (Corporate light-duty fleet)		kW	8.40	30.24	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	75.60	53.76
Public transit buses	Other	#	0.2	0.7	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.3
Peak Site Capacity		kW	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Demand Increase (Public transit buses)		kW	25.00	90.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00	225.00	160.00
Rideshare company charging hub	DCFC	#	0.1	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.6
Peak Site Capacity		kW	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Demand Increase (Rideshare company charging hub)		kW	12.50	45.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	112.50	80.00
Other heavy-duty/DCFC (port, airport)	Other	#	0.2	0.7	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.3
Peak Site Capacity		kW	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Demand Increase at Meter (Other heavy-duty/DCFC)		kW	20.00	72.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	180.00	128.00
Municipal school buses	Other	#	0.3	1.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.7	1.9
Peak Site Capacity		kW	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Demand Increase at Meter (Municipal school buses)		kW	7.50	27.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	67.50	48.00
Total Demand Increase at Meter (Fleet & Transit Vehicles)		**MW**	**0.08**	**0.29**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.74**	**0.52**

Usage Increase Calculation and Time Series - Consumer Facing			
Assumpions	**Unit**	**Source**	**Value**
L2 Charge Port Count -- RI	stations	RI Electric Transportation Initiative - Cost Estimates	272
EV Enabled Ratio -- Average	number	https://autoalliance.org/	5.25
Attributable Market Evs -- L2	number	Calculated	1428
DCFC Charge Port Count -- RI	stations	RI Electric Transportation Initiative - Cost Estimates	20
EV Enabled Ratio -- Average	number	https://autoalliance.org/	5.25
Attributable Market EVs -- DCFC	number	Calculated	105
Attributable Market EV's	**number**	**Calculated**	**1533**

Annual Usage Increase - Consumer Facing			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
VMT per capita in RI	miles/pop	RITA	8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13	9,339.16	9,434.13	9,530.08	9,627.00
Attributable Market BEVs	number	Calculated	72.11	188.35	459.90	459.90	459.90	459.90	459.90	459.90	459.90	459.90	387.79
Total Attributable BEV VMT	miles	Calculated	627,398.59	1,655,413.23	4,083,181.58	4,124,707.53	4,166,655.81	4,209,030.70	4,251,836.54	4,295,077.72	4,338,758.66	4,382,883.84	3,733,252.01
% VMT covered by BEV battery capacity	%	Accenture Assumption	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Total VMT covered by BEV battery	miles	Calculated	596,028.66	1,572,642.57	3,879,022.50	3,918,472.16	3,958,323.02	3,998,579.16	4,039,244.72	4,080,323.83	4,121,820.73	4,163,739.64	3,546,589.41
BEV efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total BEV MWh charge	MWh	Calculated	170.29	449.33	1,108.29	1,119.56	1,130.95	1,142.45	1,154.07	1,165.81	1,177.66	1,189.64	1,013.31
VMT per capita in RI	miles/pop	RITA	8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13	9,339.16	9,434.13	9,530.08	9,627.00
Attributable Market PHEVs	number	Calculated	168.26	439.48	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	904.84
Total Attributable PHEV VMT	miles	Calculated	1,463,930.05	3,862,630.88	9,527,423.68	9,624,317.58	9,722,196.89	9,821,071.63	9,920,951.93	10,021,848.01	10,123,770.21	10,226,728.95	8,710,921.36
% VMT covered by PHEV battery capacity	%	Accenture Assumption	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Total VMT covered by PHEV battery	miles	Calculated	1,244,340.54	3,283,236.25	8,098,310.13	8,180,669.94	8,263,867.36	8,347,910.89	8,432,809.14	8,518,570.81	8,605,204.68	8,692,719.61	7,404,283.16
EV efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total PHEV MWh charge	MWh	Calculated	355.53	938.07	2,313.80	2,337.33	2,361.10	2,385.12	2,409.37	2,433.88	2,458.63	2,483.63	2,115.51
Total Attributable Usage Increase at Meter	**MWh**	**Calculated**	**526**	**1387**	**3422**	**3457**	**3492**	**3528**	**3563**	**3600**	**3636**	**3673**	**3129**

Usage Increase Calculation and Time Series -- Fleet & Transit			
Assumptions	**Unit**	**Source**	**Value**
Industrial L2 Charge Port Count -- RI	charging ports	RI Electric Transportation Initiative - Cost Estimates	48
EV Enablement Ratio -- Light Duty Fleet	number	KPMG Assumption	2
Attributable Market EV's -- Light Duty Fleet	number	Calculated	96
Industrial DCFC Charge Port Count -- RI	charging ports	RI Electric Transportation Initiative - Cost Estimates	5
EV Enabled Ratio -- Ridesharing	number	KPMG Assumption	5.25
Attributable Market EVs -- Ridesharing	number	Calculated	26.25
Industrial Bus/Port Charge Port Count -- RI	charging ports	RI Electric Transportation Initiative - Cost Estimates	21
EV Enabled Ratio -- Buses	number	KPMG Assumption	4
Attributable Market EVs -- Buses	number	Calculated	84

Annual Usage Increase - Fleet & Transit			**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
VMT per LD Fleet vehicle -- RI	miles/vehicle	Calculated	6,790.54	6,858.45	6,927.03	6,996.30	7,066.27	7,136.93	7,208.30	7,280.38	7,353.18	7,426.72	7,500.98
Attributable LD Fleet BEV's	number	Calculated	4.52	11.79	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	24.28
Total Attributable LD Fleet BEV VMT	miles	Calculated	30,664.14	80,894.79	199,498.53	201,493.52	203,508.45	205,543.54	207,598.97	209,674.96	211,771.71	213,889.43	182,156.04
% VMT covered by BEV battery capacity	%	Accenture Assumption	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Total LD Fleet VMT covered by BEV battery	miles	Calculated	29,130.93	76,850.05	189,523.61	191,418.84	193,333.03	195,266.36	197,219.03	199,191.22	201,183.13	203,194.96	173,048.24
BEV efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total BEV MWh charge -- LD Fleet	MWh	Calculated	8.32	21.96	54.15	54.69	55.24	55.79	56.35	56.91	57.48	58.06	49.44
VMT per LD Fleet vehicle -- RI	miles/pop	RITA	6,790.54	6,858.45	6,927.03	6,996.30	7,066.27	7,136.93	7,208.30	7,280.38	7,353.18	7,426.72	7,500.98
Attributable LD Fleet PHEV's	number	Calculated	10.54	27.52	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	56.66
Total Attributable LD Fleet PHEV VMT	miles	Calculated	71,549.65	188,754.50	465,496.58	470,151.54	474,853.06	479,601.59	484,397.61	489,241.58	494,134.00	499,075.34	425,030.76
% VMT covered by PHEV battery capacity	%	Accenture Assumption	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Total LD Fleet VMT covered by PHEV battery	miles	Calculated	60,817.20	160,441.33	395,672.09	399,628.81	403,625.10	407,661.35	411,737.97	415,855.35	420,013.90	424,214.04	361,276.15
EV efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total PHEV MWh charge -- LD Fleet	MWh	Calculated	17.38	45.84	113.05	114.18	115.32	116.47	117.64	118.82	120.00	121.20	103.22
Total PHEV + BEV MWh charge -- LD Fleet	**MWh**	**Calculated**	**25.70**	**67.80**	**167.20**	**168.87**	**170.56**	**172.27**	**173.99**	**175.73**	**177.48**	**179.26**	**152.66**
VMT per Ridesharing vehicle -- RI	miles/vehicle	Calculated	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00
Attributable Ridesharing BEV's	number	Calculated	4	11	26	26.25	26.25	26.25	26.25	26.25	26.25	26.25	22.13
Total Attributable Ridesharing BEV VMT	miles	Calculated	101,868	266,077	649,688	649,687.50	649,687.50	649,687.50	649,687.50	649,687.50	649,687.50	649,687.50	547,819.38
% VMT covered by BEV battery capacity	%	Accenture Assumption	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Total Ridesharing VMT covered by BEV battery	miles	Calculated	96,774.71	252,772.78	617,203.13	617,203.13	617,203.13	617,203.13	617,203.13	617,203.13	617,203.13	617,203.13	520,428.41
BEV efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total BEV MWh charge -- Ridesharing	**MWh**	**Calculated**	**27.65**	**72.22**	**176.34**	**176.34**	**176.34**	**176.34**	**176.34**	**176.34**	**176.34**	**176.34**	**148.69**
VMT per bus -- RI	miles/vehicle	Calculated	17,561.81	17,740.41	17,920.83	18,103.08	18,287.19	18,473.17	18,661.05	18,850.83	19,042.54	19,236.20	19,431.84
Attributable BEB's	number	Calculated	13.17	34.40	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	70.83
Total Attributable BEB VMT	miles	Calculated	231,303.51	610,302.45	1,505,349.63	1,520,659.04	1,536,124.14	1,551,746.52	1,567,527.79	1,583,469.54	1,599,573.43	1,615,841.09	1,376,340.84
% VMT covered by BEB battery capacity	%	Accenture Assumption	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Total Diesel Bus miles covered by BEB battery	miles	Calculated	219,738.34	579,787.32	1,430,082.15	1,444,626.09	1,459,317.93	1,474,159.20	1,489,151.40	1,504,296.07	1,519,594.76	1,535,049.04	1,307,523.79
BEB efficiency	miles/kWh	Transportation Initiative - Draft Testimony (Karsten Barde)	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Total BEB MWh Charge	**MWh**	**Calculated**	**102.20**	**269.67**	**665.15**	**671.92**	**678.75**	**685.66**	**692.63**	**699.67**	**706.79**	**713.98**	**608.15**
Total Attributable Demand Increase at Meter	**MWh**	**Calculated**	**156**	**410**	**1009**	**1017**	**1026**	**1034**	**1043**	**1052**	**1061**	**1070**	**910**

Electric Vehicles - Adoption

Year	**2019**	**2020**	**2021**	**Unit**	**Source**
BEV	30%			%	https://autoalliance.org/
PHEV	70%			%	https://autoalliance.org/

Ownership Cost Time Series

EV Type	**Value**	**Units**	**Growth Rate**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
EV Vehicle Maintenance Time Series	258.39	$/year	0.98	258.39	253.22	248.16	243.19	238.33	233.56	228.89	224.31	219.83	215.43
EV Cost Time Series	30196.25	$	0.99	30,196.25	29,894.29	29,595.34	29,299.39	29,006.40	28,716.33	28,429.17	28,144.88	27,863.43	27,584.80
ICE Cost Time Series	17508.33	$	1.02	17,508.33	17,858.50	18,215.67	18,579.98	18,951.58	19,330.61	19,717.23	20,111.57	20,513.80	20,924.08
BEB Cost Time Series	Decrease in price based on projected battery price decrease.			750,000.00	727,998.90	706,331.10							
Diesel Bus Maintenance Cost Time Series	2.00	$/mile driven		34770	35123.6109	35480.81802	35841.65794	36206.1676	36574.38433	36946.34582	37322.09015	37701.65581	38085.08165
BEB Maintenance Cost Time Series	0.50	$/mile driven		8692.5	8780.902725	8870.204506	8960.414486	9051.541901	9143.596082	9236.586454	9330.522538	9425.413953	9521.270412

Station Installation and EV Implementation Schedule

	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
CAPEX	1,005,232.36	1,620,405.80	3,785,463.75	-	-	-	-	-	-	-	-	-	-	-
% CAPEX	16%	25%	59%	-	-	-	-	-	-	-	-	-	-	-
Stations Built														
Consumer Charging Stations Built	45.78	73.80	172.41	-	-	-	-	-	-	-	-	-	-	-
Fleet Charging Stations	7.53	12.13	28.34	-	-	-	-	-	-	-	-	-	-	-
Ridesharing Charging Stations built	0.78	1.26	2.95	-	-	-	-	-	-	-	-	-	-	-
Bus Charging Stations built	3.29	5.31	12.40	-	-	-	-	-	-	-	-	-	-	-
Lag from install to receiving operating benefit	0 year													
EV Breakdown														
Total Consumer EV's		**240**	**387**	**905**	-	-	-	-	-	-	-	-	-	-
PHEV's		168	271	634	-	-	-	-	-	-	-	-	-	-
BEV's		72	116	272	-	-	-	-	-	-	-	-	-	-
Light Duty Fleet EV's		**15**	**24**	**57**	-	-	-	-	-	-	-	-	-	-
Light Duty Fleet PHEV's		11	17	40	-	-	-	-	-	-	-	-	-	-
Light Duty Fleet BEV's		5	7	17	-	-	-	-	-	-	-	-	-	-
Ridesharing BEV's		**4**	**7**	**15**	-	-	-	-	-	-	-	-	-	-
BEB's		**13**	**21**	**50**	-	-	-	-	-	-	-	-	-	-
Airport BEB's		**5**	**8**	**19**	0	0	0	0	0	0	0	0	0	0

Cumulative EV Schedule

Cum. Schedule	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Consumer EV's		**240**	**628**	**1533**	1533.0	1533.0	1533.0	1533.0	1533.0	1533.0	1533.0	1292.6	905.2	0.0
Consumer PHEV's		168	439	1073	1073.1	1073.1	1073.1	1073.1	1073.1	1073.1	1073.1	904.8	633.6	0.0
Consumer BEV's		72	188	460	459.9	459.9	459.9	459.9	459.9	459.9	459.9	387.8	271.6	0.0
Light Duty Fleet EV's		**15**	**39**	**96**	96.0	96.0	96.0	96.0	96.0	96.0	96.0	80.9	56.7	0.0
Light Duty Fleet PHEV's		11	28	67	67.2	67.2	67.2	67.2	67.2	67.2	67.2	56.7	39.7	0.0
Light Duty Fleet BEV's		5	12	29	28.8	28.8	28.8	28.8	28.8	28.8	28.8	24.3	17.0	0.0
Ridesharing BEV's		**4**	**11**	**26**	26.3	26.3	26.3	26.3	26.3	26.3	26.3	22.1	15.5	0.0
Battery Electric Buses (BEB's)		**13**	**34**	**84**	84.0	84.0	84.0	84.0	84.0	84.0	84.0	70.8	49.6	0.0
Airport BEB's		**5**	**13**	**32**	32.0	32.0	32.0	32.0	32.0	32.0	32.0	27.0	18.9	0.0

State and Local Tax Revenue

Year	**2018**	**2019**	**2020**	**Unit**	**Source**
Value	**81,424.00**	**166,096.00**	**404,992.00**	$	NG Economic Impact Analysis

RI GDP Increase

Year	**2018**	**2019**	**2020**	**Unit**	**Source**
Selected GDP Value (choose from switch)	-	-	-	$	NG Economic Impact Analysis
Base value before switch selection	$1.114	$2.263	$5.369		

Off-Peak Rebate Program

Off Peak Rebate Pilot

Assumption	**Unit**	**Value**	**Year1**	**Year 2**	**Year 3**	**Source**
Cumulative Participants	Vehicles	Time Series	100	250	500	Transportation Initiative - Draft Testimony (Karsten Barde)
Avoided Capacity per Vehicle	MW		0.825			Transportation Initiative - Draft Testimony (Karsten Barde)
Total Avoided Capacity (kW)		Time Series	82.5	206.25	412.5	Transportation Initiative - Draft Testimony (Karsten Barde)
$ per kW/year	$/kWyear	$	120			Transportation Initiative - Draft Testimony (Karsten Barde)
Shifted Energy per Vehicle (kWh)	kWh		3,000			Transportation Initiative - Draft Testimony (Karsten Barde)
Total Shifted Energy (kWh)	kWh	Time Series	300,000	750,000	1,500,000	Transportation Initiative - Draft Testimony (Karsten Barde)

Difference between Peak & Off-Peak	$	$ 0.02				Transportation Initiative - Draft Testimony (Karsten Barde)		
Rebate per kWh	$	0.05				Transportation Initiative - Draft Testimony (Karsten Barde)		
Costs								
Program Admin	$	Time Series	133,745	169,420	208,817	Transportation Initiative - Draft Testimony (Karsten Barde)		Revised in Settlement
Rebate to Customers	$	Time Series	7,500	18,750	37,500	Transportation Initiative - Draft Testimony (Karsten Barde)		Revised in Settlement

Demand Reduction At Meter

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Total Demand Reduction at Meter		0.0825	0.20625	0.4125								
Total Shifted Energy		300	750	1,500								

Off Peak Rebate Time Series

Time Series	Unit	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Program Administation Costs	$	133744.9331	169419.8317	208816.6142	0	0	0	0	0	0	0	0	0
Rebate To customers	$	7500	18750	37500	0	0	0	0	0	0	0	0	0

National Grid Heavy Duty Program

NG Fleet Program

Assumption	Unit	Value	Year 1	Year 2	Year 3	Source
Net Cost per vehicle	$	80,000				Transportation Initiative - Draft Testimony (Karsten Barde)
Lease Length	years	10				
Cost per vehicle per year	$	8,000				
System Coincidence Factor	%	10%				
Diversity Factor	%	50%				
Enablement Ratio	Vehicles/Port	1				
Average VMT per vehicle	Miles/vehicle	8,583				Fleet Management Team
Heavy Duty PHEV Efficiency	Miles/kWh	0.933333333				Calculated
Heavy Duty Diesel Efficiency	mpg	8				https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812146-commercialmdhd-truckfuelefficien
% Miles Covered by battery	%	50%				KPMG Assumption
Annual Maintenance Cost (HD PHEV)	$/mile	0.5				CARB
Annual Maintenance Cost (HD Diesel)	$/mile	2				http://www.sierraclub.org/sites/www.sierraclub.org/files/sce/new-jersey-chapter/Handouts
Source	Transportation Initiative - Draft Testimony (Karsten Barde)					

				2019	2020	2021	
L2 Charging Stations Built	#	Time Series		0	0	0	Initiative replaced with Customer Fleet Advisory services
Vehicle Deployment Schedule	vehicles	Time Series		0	0	0	Initiative replaced with Customer Fleet Advisory services
Vehicle Operating Cost	$/vehicle annually		8,000	$ -	$ -	$ -	
Total Vehicle Cost	$	Time Series		$ -	$ -	$ -	
Tota Expense	$	Time Series		$ -	$ -	$ -	

Heavy Duty Fleet Efficiency

Heavy Duty PHEV Efficiency Calculation	Values	Units
PHEV efficiency	3.5	miles/kWh
Average mpg	30	mpg
Ratio	0.116666667	%
Heavy Duty Diesel Efficiency	8	mpg
Heavy Duty PHEV Efficienct	0.933333333	miles/kWh

NG Fleet Program

Assumption	Unit	Source	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NG HD Fleet PHEVs	#	Transportation Initiative - Draft Testimony (Karst	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average VMT per Vehicle	miles/vehicle	Transportation Initiative - Draft Testimony (Karst	8,670.63	8,758.81	8,847.88	8,937.87	9,028.76	9,120.59	9,213.34	9,307.04	9,401.70	9,497.31	9,593.90	9,691.47
Total miles traveled by HD Fleet PHEV's	miles	Calculated	-	-	-	-	-	-	-	-	-	-	-	-
% of miles covered by PHEV batteries	%	KPMG Assumption	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Total HD Fleet VMT covered by PHEV battery	miles	Calculated	-	-	-	-	-	-	-	-	-	-	-	-
PHEV Efficiency	miles/kWh	Calculated	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Total MWh charge by HD Fleet PHEV's	MWh	Calculated	-	-	-	-	-	-	-	-	-	-	-	-
Total Usage Increase at Meter	**MWh**	**Calculated**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Heavy Duty Fleet Deployment Schedule

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Consumer Charging Stations Built	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Duty Fleet PHEVs		-	-	-	-	-	-	-	-	-	-	-	-	-

Heavy Duty - Cumulative Deployment Schedule

Cum. Schedule	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Heavy Duty Fleet PHEV's		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Charging Station Breakdown

Year	Ports Built	Estimate Max Capacity Per Port	System Coincidence Factor	Diversity Factor	Peak Capacity Per Port (kW)
2018	-	**7**	**10%**	**50%**	**0**
2019	-	**7**	**10%**	**50%**	**0**
2020	-	**7**	**10%**	**50%**	**0**

Heavy Duty Charging Station Annual Capacity

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capacity Time Series	**-**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Capacity Increase Schedule

Cum. Schedule	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capacity Increase Schedule		0	0	0	0	0	0	0	0	0	0	0	0	-
Converted to MW		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-**

NG Heavy Duty Fleet Time Series

Time Series Assumption	Units	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Average VMT per vehicle	miles/vehicle	8583.333333	8670.625833	8758.806098	8847.883156	8937.866128	9028.764226	9120.586758	9213.343126	9307.042825	9401.695451	9497.310694	9593.898343	9691.46829
HD PHEV Maintenance Cost	$	$ 4,291.67	$ 4,335.31	$ 4,379.40	$ 4,423.94	$ 4,468.93	$ 4,514.38	$ 4,560.29	$ 4,606.67	$ 4,653.52	$ 4,700.85	$ 4,748.66	$ 4,796.95	$ 4,845.73
Diesel HD Truck Maintenance Cost	$	$ 17,166.67	$ 17,341.25	$ 17,517.61	$ 17,695.77	$ 17,875.73	$ 18,057.53	$ 18,241.17	$ 18,426.69	$ 18,614.09	$ 18,803.39	$ 18,994.62	$ 19,187.80	$ 19,382.94
Vehicle Upfit -- NG Fleet	$		0	0	0	0	0	0	0	0	0	0	0	0
Vehicle Operating Cost -- NG Fleet	$	-	-	-	-	-	-	-	-	-	-	-	-	-
NG Fleet EVSE Installation	$	-	-	-	-	-	-	-	-	-	-	-	-	-

Other costs

Time Series Assumption	Units	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Rate Discount -- Implementation	$	50,000	50,000	50,000	0	0	0	0	0	0	0	0	0	0
Rate Discount -- Potential Value of Discount		53,622	120,650	214,488										
Customer Fleet Advisory Services		40,000	70,000	100,000										
Evaluation	$	30,000	30,000	30,000	0	0	0	0	0	0	0	0	0	0

PM2.5 Emission

Assumption	Value	Unit	Source
PM2.5 Price Per ton	320000	$/ton	https://www.epa.gov/sites/production/files/2014-10/documents/sourceapportionmentbpt
Average PM2.5 Emissions per mile driven -- Light Du	0.0000041	$/kg	https://nepis.epa.gov/Exe/ZyNET.exe/P100EVXP.txt?ZyActionD=ZyDocument&Client=EPA&I
Average PM2.5 Emissions per mile driven -- Heavy D	0.000202	$/kg	https://nepis.epa.gov/Exe/ZyNET.exe/P100EVY6.txt?ZyActionD=ZyDocument&Client=EPA&I

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023

PM2.5 Price Time Series	320,000.00	326,400.00	332,928.00	339,586.56	346,378.29	353,305.86	360,371.97	367,579.41	374,931.00	382,429.62	390,078.21	397,879.78	405,837.37	413,954.12

CapEx Splits

Assumption	Unit		%	Source
EDC Costs (New Service)		$1,267,769.46	21.3%	Transportation Initiative - Draft Testimony (Karsten Barde)
Customer Premise Costs		$3,005,971.00	50.4%	Transportation Initiative - Draft Testimony (Karsten Barde)
EVSE Costs		$748,690.70	12.6%	Transportation Initiative - Draft Testimony (Karsten Barde)
Project Management Office (PMO) Labor		$848,361.33	14.2%	Transportation Initiative - Draft Testimony (Karsten Barde)
Project Management / CRM Tool Modifications		$46,511.63	0.8%	Transportation Initiative - Draft Testimony (Karsten Barde)
Data Analysis & Reporting Tools		$46,511.63	0.8%	Transportation Initiative - Draft Testimony (Karsten Barde)

OpEx Splits

Assumption	Unit		%	Source
Station O&M		$128,409.30	8.1%	Transportation Initiative - Draft Testimony (Karsten Barde)
Account Managers		$486,711.82	30.8%	Transportation Initiative - Draft Testimony (Karsten Barde)
Charging Program Marketing		$88,372.09	5.6%	Transportation Initiative - Draft Testimony (Karsten Barde)
Site Agreement Contracting Costs		$93,023.26	5.9%	Transportation Initiative - Draft Testimony (Karsten Barde)
Customer Site Cost Estimation		$116,279.07	7.4%	Transportation Initiative - Draft Testimony (Karsten Barde)
EVSE Rebate Cost for Make-Ready Sites		$666,395.35	42.2%	Transportation Initiative - Draft Testimony (Karsten Barde)

EV - Utility Revenue Impact Prices

Source: NG Utility Revenue Model, updated by KPMG

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hourly Wgt. Avg. Prices ($ / kW)	0.118830309	0.12508929	0.131426211	0.138914727	0.159273191	0.163985171	0.169503283	0.176278421	0.180208113	0.184876206	0.191290985	0.198907758	0.206535541	0.213199123

Change in Avoided Energy Costs - Electric Vehicle

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Winter (On-peak less Off-Peak)	0.006072108	0.005890367	0.007548271	0.007712723	0.007972695	0.008510651	0.008881423	0.008667927	0.008759138	0.008899516	0.009027358	0.00886891	0.008219687	0.007666194
Summer (On-peak less Off-Peak)	0.006919855	0.007010642	0.011238019	0.010804297	0.010919743	0.010862426	0.010015095	0.012359334	0.01314233	0.012969372	0.014676591	0.01567688	0.016072814	0.020148293
% Year Winter	67%													
% Year Summer	33%													
Wgtd. Avg. Price Reduction from Shifting from Peak	0.00635469	0.006263792	0.008778187	0.008743248	0.008955044	0.009294576	0.009259314	0.009898396	0.010220202	0.010256134	0.010910436	0.011138239	0.010837396	0.011826894

Gas Price Schedule

Inflation percentage 1.00%

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas Price ($ / gallon)	2.50	2.53	2.55	2.58	2.60	2.63	2.65	2.68	2.71	2.73	2.76	2.79	2.82	2.85

RI Renewable Rate Case | Benefit-Cost Analysis (BCA)
EV control panel, inputs, and sub-models

EV - Inputs

Return to Contents -->

Control Panel	
Switch Key	
EV Enablement Ratio	
	5.25
VMT per capita -- RI	
	8612.949159
BEB Enablement Ratio	
	4
BEB Rebate %-- Airport Vehicles	
	0
Economic Development	
	Off

EV - General Assumptions	
Assumption	
Gasoline Price	
Vehicle Efficiency	
Electric vehicle efficiency	
Electric equivalent cost per unit	
Charging Rate at Utility-operated Station -- Consume	
Charging Rate at Utility-operated Station --	
Consumer Level 2 (transaction fee only)	
Charging Rate at Utility-operated Station - Consume	
Charging Rate at Utility-operated Station - Consume	
EV Enablement Ratio - Low	
EV Enablement Ratio - Average	
EV Enablement Ratio - High	
EV Enablement Ratio-DCFC	
VMT per capita in RI	
Average CO2 emitted per mile driven	
Average SO2 emitted per mile driven	
Average NOx emitted per mile driven	
VMT Growth Rate - RI	
% of miles covered by PHEV batteries	
% of miles covered by BEV batteries	
At Home Charging Percentage	
On-Site Charging Percentage	
Charging Port -- Useful Life	
Derating Factor	

General Assumptions - Fleet and Transit	
Assumption-- Light Duty Fleet	
VMT per light duty fleet vehicle -- RI	
Average mpg -- light duty vehicle	
Average CO2 emitted per mile dirven -- light duty ve	
Assumption-- Bus	
VMT per bus -- RI	
Average mpg -- Diesel Bus	
Average CO2 Emitted per mile driven -- diesel bus	
Battery Electric Bus (BEB) Efficiency	
Price Per Gallon of Diesel Fuel	
SO2 Emissions -- Heavy Duty Vehicles	
NOX Emissions-- Heavy Duty Vehicles	
BEV Enablement Ratio--Low	
BEV Enablement Ratio--Medium	
BEV Enablement Ratio--Low	
Assumption-- Other Heavy Duty	
Airport Bus Rebates	
Partial Rebate Included	
No Rebate Included	
# of Aiport Buses	
Average Diesel Bus Maintenance Cost	
Average BEB Maintenance Cost	
Rebate Value per Bus	
Assumption-- Ridesharing	
Enablement Ratio -- Ridesharing	
Full Time Driver Percentage	
Part Time Driver Percentage	
Average VMT -- Full Time Driver	
Average VMT -- Median Driver	

VMT Assumptions - Fleet & Transit Vehicles

VMT Assumptions
Light Duty Fleet
VMT per light duty fleet vehicle -- National
Average RI VMT
Average National VMT
RI / National Proportion
VMT per light duty vehicle -- RI
Ridesharing
Weighted Average VMT -- Ridesharing
Buses/Heavy Duty Vehicles
VMT per bus- National
Assumed RI/National Transit Proportion
VMT per bus-- RI

Enablement Ratios - L2 Charging

Assumption
EV Enablement Ratio -- L2 Charging
EV Enablement Ratio -- L2 Charging

Adjusted VMT Calculation

% of Miles Driven on Local Roads (Urban Area)
% of Miles Driven on Local Roads (Rural Area)
% of Population Living in Urban Area
% of Population Living in Rural Area
Average % of Miles Driven on Local Roads
VMT per capita--RI
Average VMT (Midpoint of VMT and Adjusted VMT)
Adjusted VMT per capita--RI
VMT per capita--RI
1 - Average % of Miles Driven on Local Roads
Adjusted VMT per capita--RI

Cost Assumptions

Average Cost of EV
Average Cost of ICE
Federal BEV Grant
State Tax Credit
Federal PHEV Grant
Average PHEV vehicle maintenance
Average BEV vehicle maintenance
Average ICE vehicle maintenance
Average Annual PHEV maintenance
Average Annual BEV maintenance
Average annual ICE vehicle cost growth rate
Average annual ICE vehicle mpg growth rate
Average BEV/PHEV mi/kwh growth rate
Average EV maintenance growth rate
Average ICE cost growth rate
Average EV vehicle cost growth rate
Average Cost of Diesel Bus
BEB Battery Size

Time Series -- Buses

Battery Price per kWh
Forecasted Cost Electric Bus Battery
Forecasted BEB

Efficiency and VMT Time Series

Electric Vehicle Efficiency Time Series
VMT per capita Time Series
ICE Vehicle Efficiency
VMT per Bus -- RI Time Series
VMT per LD Fleet Vehicle -- RI Time Series

Time Series Values	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
Electric Vehicle Efficiency Time Series	3.50	3.50	3.50	3.50	3.50	3.50	3.50
VMT per capita Time Series	9923.718067	10024.64228	10126.59289	10229.58034	10333.61517	10438.70804	10544.8697
ICE Vehicle Efficiency	30.00	30.00	30.00	30.00	30.00	30.00	30.00
VMT per Bus -- RI Time Series	20030.75084	20234.46358	20440.24807	20648.12539	20858.11683	21070.24388	21284.52826
VMT per LD Fleet Vehicle -- RI Time Series	7728.270814	7805.553522	7883.609057	7962.445148	8042.069599	8122.490295	8203.715198

Charging Station Demonstration Program Inputs

Assumption
Utility Operated Ports
Utlity Operated Ports %
Utility Operated L2 Ports
Utility Operated L2 Port %
Utility Operated DCFC Ports
Utility Operated DCFC Port %
Make Ready Port %
Charging Segments - Preliminary
Workplaces
Apartment buildings
Disadvantaged community sites
Public transit stations
Public DCFC
Government light-duty fleet
Corporate light-duty fleet
Public transit buses
Rideshare company charging hub
Other heavy-duty/DCFC (port, airport)
Municipal school buses

Total

Time Assumptions -- Cost														
Assumption	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	
Capital Expenditures	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
EDC Costs (New Service)														Revised in Settlement
Customer Premise Costs														Revised in Settlement
EVSE Costs (Utility Operated Only)														Revised in Settlement
Project Management Office (PMO) Labor														Revised in Settlement
Project Management / CRM Tool Modifications														Revised in Settlement
Data Analysis & Reporting Tools														Revised in Settlement
														Revised in Settlement
Operating Expenditures (O&M)	-													Revised in Settlement
Station O&M	-													Revised in Settlement
Project Managers and Account Managers														Revised in Settlement
Charging Program Marketing														Revised in Settlement
Site Agreement Contracting Costs ($2000/site)														Revised in Settlement
Customer Site Cost Estimation ($2500/site)														Revised in Settlement
EVSE Rebate Cost for Make-Ready Sites														Revised in Settlement
														Revised in Settlement
Participation Payment														Revised in Settlement
														Revised in Settlement

Cost Assumptions -- Education and Outreach
Assumption
Bill inserts/Opower reports/etc
Ride-n-Drive Events
EV Education & Awareness Page
Facebook
Twitter
Instagram
Billboard or Radio
Online Banners and SEO/SEM
Agency Contract
Staff Time
Total

Site Construction Assumptions
Sites Built each year
Cumulative Sites in Operation
Percent Complete

Charging Site Breakdown
Charging Segments - Preliminary
Workplaces
Apartment buildings
Disadvantaged community sites
Public transit stations
Public DCFC
Government light-duty fleet
Corporate light-duty fleet
Public transit buses
Rideshare company charging hub
Other heavy-duty/DCFC (port, airport)
Municipal school buses
Total
Consumer Facing L2
Consumer Facing DCFC
Industrial L2
Industrial DCFC
Industrial Other

Total Capacity Increase
Segment
Workplaces
Apartment buildings
Disadvantaged community sites
Public transit stations
Public DCFC
Government light-duty fleet
Corporate light-duty fleet
Public transit buses
Rideshare company charging hub
Other heavy-duty/DCFC (port, airport)
Municipal school buses

Total Demand Increase Calculation -- Consumer Fa	
Assumptions	**2030**
Workplaces	0.0
Peak Site Capacity	17.5
Demand Increase (Workplaces)	0.0
Apartment Buildings	0.0
Peak Site Capacity	10.5
Demand Increase (Apartment buildings)	0.00
Disadvantaged community sites	0.0
Peak Site Capacity	10.5
Demand Increase (Disadvantaged community sties)	0.00
Public Transit Stations	0.0
Peak Site Capacity	17.5
Demand Increase (Public transit stations)	0.00
Public DCFC	0.0
Peak Site Capacity	62.5
Demand Increase (Public DCFC)	0.00
Total Demand Increase at Meter (Consumer Facing	**-**

Total Demand Increase Calculation -- Fleet & Trans	
Assumptions	**2030**
Government light-duty fleet	0.0
Peak Site Capacity	28.0
Demand Increase (Government light-duty fleet)	0.00
Corporate light-duty fleet	0.0
Peak Site Capacity	28.0
Demand Increase (Corporate light-duty fleet)	0.00
Public transit buses	0.0
Peak Site Capacity	125.0
Demand Increase (Public transit buses)	0.00
Rideshare company charging hub	0.0
Peak Site Capacity	125.0
Demand Increase (Rideshare company charging hub	0.00
Other heavy-duty/DCFC (port, airport)	0.0
Peak Site Capacity	100.0
Demand Increase at Meter (Other heavy-duty/DCFC	0.00
Municipal school buses	0.0
Peak Site Capacity	25.0
Demand Increase at Meter (Municipal school buses)	0.00
Total Demand Increase at Meter (Fleet & Transit V	**-**

Usage Increase Calculation and Time Series - Consu										
Assumpions										
L2 Charge Port Count -- RI										
EV Enabled Ratio -- Average										
Attributable Market Evs -- L2										
DCFC Charge Port Count -- RI										
EV Enabled Ratio -- Average										
Attributable Market EVs -- DCFC										
Attributable Market EV's										
Annual Usage Increase - Consumer Facing	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
VMT per capita in RI	9,724.91	9,823.81	9,923.72	10,024.64	10,126.59	10,229.58	10,333.62	10,438.71	10,544.87	-
Attributable Market BEVs	271.55	(0.00)	-	-	-	-	-	-	-	-
Total Attributable BEV VMT	2,640,798.74	(0.00)	-	-	-	-	-	-	-	-
% VMT covered by BEV battery capacity	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Total VMT covered by BEV battery	2,508,758.80	(0.00)	-	-	-	-	-	-	-	-
BEV efficiency	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total BEV MWh charge	716.79	(0.00)	-	-	-	-	-	-	-	-
VMT per capita in RI	9,724.91	9,823.81	9,923.72	10,024.64	10,126.59	10,229.58	10,333.62	10,438.71	10,544.87	-
Attributable Market PHEVs	633.62	(0.00)	-	-	-	-	-	-	-	-
Total Attributable PHEV VMT	6,161,863.73	(0.00)	-	-	-	-	-	-	-	-
% VMT covered by PHEV battery capacity	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Total VMT covered by PHEV battery	5,237,584.17	(0.00)	-	-	-	-	-	-	-	-
EV efficiency	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Total PHEV MWh charge	1,496.45	(0.00)	-	-	-	-	-	-	-	-
Total Attributable Usage Increase at Meter	**2213**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Usage Increase Calculation and Time Series -- Fleet	
Assumptions	
Industrial L2 Charge Port Count -- RI	
EV Enablement Ratio -- Light Duty Fleet	
Attributable Market EV's -- Light Duty Fleet	
Industrial DCFC Charge Port Count -- RI	
EV Enabled Ratio -- Ridesharing	
Attributable Market EVs -- Ridesharing	
Industrial Bus/Port Charge Port Count -- RI	
EV Enabled Ratio -- Buses	
Attributable Market EVs -- Buses	

Annual Usage Increase - Fleet & Transit	**2030**	**2031**
VMT per LD Fleet vehicle -- RI	7,575.99	7,651.75
Attributable LD Fleet BEV's	17.01	-
Total Attributable LD Fleet BEV VMT	128,830.44	-
% VMT covered by BEV battery capacity	0.95	0.95
Total LD Fleet VMT covered by BEV battery	122,388.92	-
BEV efficiency	3.50	3.50
Total BEV MWh charge -- LD Fleet	34.97	-
VMT per LD Fleet vehicle -- RI	7,575.99	7,651.75
Attributable LD Fleet PHEV's	39.68	-
Total Attributable LD Fleet PHEV VMT	300,604.36	-
% VMT covered by PHEV battery capacity	0.85	0.85
Total LD Fleet VMT covered by PHEV battery	255,513.70	-
EV efficiency	3.50	3.50
Total PHEV MWh charge -- LD Fleet	73.00	-
Total PHEV + BEV MWh charge -- LD Fleet	**107.97**	**-**
VMT per Ridesharing vehicle -- RI	24,750.00	24,750.00
Attributable Ridesharing BEV's	15.50	(0.00)
Total Attributable Ridesharing BEV VMT	383,610.88	(0.00)
% VMT covered by BEV battery capacity	0.95	0.95
Total Ridesharing VMT covered by BEV battery	364,430.34	(0.00)
BEV efficiency	3.50	3.50
Total BEV MWh charge -- Ridesharing	**104.12**	**(0.00)**
VMT per bus -- RI	19,629.46	19,829.09
Attributable BEB's	49.60	-
Total Attributable BEB VMT	973,585.26	-
% VMT covered by BEB battery capacity	0.95	0.95
Total Diesel Bus miles covered by BEB battery	924,906.00	-
BEB efficiency	2.15	2.15
Total BEB MWh Charge	**430.19**	**-**
Total Attributable Demand Increase at Meter	**642**	**0**

Electric Vehicles - Adoption
Year
BEV
PHEV

Ownership Cost Time Series											
EV Type	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
EV Vehicle Maintenance Time Series	211.12	206.90	202.76	198.71	194.73	190.84	187.02	183.28	179.61	176.02	172.50
EV Cost Time Series	27,308.95	27,035.86	26,765.50	26,497.84	26,232.87	25,970.54	25,710.83	25,453.72	25,199.19	24,947.19	24,697.72
ICE Cost Time Series	21,342.56	21,769.41	22,204.80	22,648.90	23,101.87	23,563.91	24,035.19	24,515.89	25,006.21	25,506.34	26,016.46
BEB Cost Time Series											
Diesel Bus Maintenance Cost Time Series	38472.40693	38863.67131	39258.91485	39658.17801	40061.50168	40468.92715	40880.49614	41296.25079	41716.23366	42140.48775	42569.05651
BEB Maintenance Cost Time Series	9618.101733	9715.917827	9814.728712	9914.544503	10015.37542	10117.23179	10220.12404	10324.0627	10429.05841	10535.12194	10642.26413

Station Installation and EV Implementation Schedu	
	Total
CAPEX	6,411,101.92
% CAPEX	
Stations Built	
Consumer Charging Stations Built	
Fleet Charging Stations	
Ridesharing Charging Stations built	
Bus Charging Stations built	
Lag from install to receiving operating benefit	
EV Breakdown	
Total Consumer EV's	-
PHEV's	-
BEV's	-
Light Duty Fleet EV's	-
Light Duty Fleet PHEV's	-
Light Duty Fleet BEV's	-
Ridesharing BEV's	-
BEB's	-
Airport BEB's	0

Cumulative EV Schedule
Cum. Schedule
Consumer EV's
Consumer PHEV's
Consumer BEV's
Light Duty Fleet EV's
Light Duty Fleet PHEV's
Light Duty Fleet BEV's
Ridesharing BEV's
Battery Electric Buses (BEB's)
Airport BEB's

State and Local Tax Revenue
Year
Value

RI GDP Increase
Year
Selected GDP Value (choose from switch)
Base value before switch selection

Off-Peak Rebate Program

Off Peak Rebate Pilot
Assumption
Cumulative Participants
Avoided Capacity per Vehicle
Total Avoided Capacity (kW)
$ per kW/year
Shifted Energy per Vehicle (kWh)
Total Shifted Energy (kWh)

Difference between Peak & Off-Peak
Rebate per kWh
Costs
Program Admin
Rebate to Customers
Demand Reduction At Meter
Total Demand Reduction at Meter
Total Shifted Energy

Off Peak Rebate Time Series
Time Series
Program Administation Costs
Rebate To customers

National Grid Heavy Duty Program

NG Fleet Program
Assumption
Net Cost per vehicle
Lease Length
Cost per vehicle per year
System Coincidence Factor
Diversity Factor
Enablement Ratio
Average VMT per vehicle
Heavy Duty PHEV Efficiency
Heavy Duty Diesel Efficiency
% Miles Covered by battery
Annual Maintenance Cost (HD PHEV)
Annual Maintenance Cost (HD Diesel)
Source
L2 Charging Stations Built
Vehicle Deployment Schedule
Vehicle Operating Cost
Total Vehicle Cost
Tota Expense

Heavy Duty Fleet Efficiency
Heavy Duty PHEV Efficiency Calculation
PHEV efficiency
Average mpg
Ratio
Heavy Duty Diesel Efficiency
Heavy Duty PHEV Efficienct

NG Fleet Program	
Assumption	**2031**
NG HD Fleet PHEVs	0.0
Average VMT per Vehicle	9,790.03
Total miles traveled by HD Fleet PHEV's	-
% of miles covered by PHEV batteries	50%
Total HD Fleet VMT covered by PHEV battery	-
PHEV Efficiency	0.93
Total MWh charge by HD Fleet PHEV's	-
Total Usage Increase at Meter	**-**

Heavy Duty Fleet Deployment Schedule	
Consumer Charging Stations Built	
Heavy Duty Fleet PHEVs	-

Heavy Duty - Cumulative Deployment Schedule
Cum. Schedule
Heavy Duty Fleet PHEV's

Charging Station Breakdown	
Year	
	2018
	2019
	2020
Heavy Duty Charging Station Annual Capacity	
	2031
Capacity Time Series	**0**

Capacity Increase Schedule	
Cum. Schedule	**2031**
Capacity Increase Schedule	-
Converted to MW	**-**

NG Heavy Duty Fleet Time Series				
Time Series Assumption		**2031**	**2032**	
Average VMT per vehicle		9790.030522	9889.595132	
HD PHEV Maintenance Cost	$	4,895.02	$ 4,944.80	
Diesel HD Truck Maintenance Cost	$	19,580.06	$ 19,779.19	
Vehicle Upfit -- NG Fleet		0		
Vehicle Operating Cost -- NG Fleet		-	-	
NG Fleet EVSE Installation		-	-	Removed $200K cost in 2019

Other costs		
Time Series Assumption	**2031**	
Rate Discount -- Implementation	0	
Rate Discount -- Potential Value of Discount		
Customer Fleet Advisory Services		Added in Settlement, using portion of NG Fleet $
Evaluation	0	

PM2.5 Emission								
Assumption								
PM2.5 Price Per ton								
Average PM2.5 Emissions per mile driven -- Light Du								
Average PM2.5 Emissions per mile driven -- Heavy D								
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**

PM2.5 Price Time Series	422,233.20	430,677.87	439,291.43	448,077.25	457,038.80	466,179.58	475,503.17	485,013.23

CapEx Splits
Assumption
EDC Costs (New Service)
Customer Premise Costs
EVSE Costs
Project Management Office (PMO) Labor
Project Management / CRM Tool Modifications
Data Analysis & Reporting Tools

OpEx Splits
Assumption
Station O&M
Account Managers
Charging Program Marketing
Site Agreement Contracting Costs
Customer Site Cost Estimation
EVSE Rebate Cost for Make-Ready Sites

EV - Utility Revenue Impact Prices

Source: NG Utility Revenue Model, updated by KPI

	2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
Hourly Wgt. Avg. Prices ($ / kW)	0.218671069	0.224388493	0.230363711	0.236609709	0.243140183	0.249969575	0.257113124	0.264586902	0.272407874	0.280593941	0.289163997	0.29813799	0.307536981	0.317383208	0.327700159	0.33851264

Change in Avoided Energy Costs - Electric Vehicle

	2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
Winter (On-peak less Off-Peak)	0.007410664	0.007141868	0.006859373	0.006562735	0.006251497	0.005925191	0.005583334	0.005225432	0.004850973	0.004459435	0.004050281	0.003622956	0.003176892	0.002711507	0.0022262	0.00172035
Summer (On-peak less Off-Peak)	0.021809165	0.02356731	0.025427771	0.027395841	0.029477071	0.03167728	0.034002573	0.036459349	0.03905432	0.041794521	0.04468733	0.047740478	0.050962073	0.054360611	0.057944998	0.06172457
% Year Winter																
% Year Summer																
Wgtd. Avg. Price Reduction from Shifting from Peak	0.012210165	0.012617015	0.013048839	0.013507103	0.013993355	0.014509221	0.015056414	0.015636737	0.016252089	0.016904464	0.017595964	0.018328796	0.019105286	0.019927875	0.020799132	0.02172176

Gas Price Schedule

Inflation percentage

	2031	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
Gas Price ($ / gallon)	2.87	2.90	2.93	2.96	2.99	3.02	3.05	3.08	3.11	3.14	3.17	3.21	3.24	3.27	3.30	3.34	3.37

###
Detailed build-up of EV benefits

EV - Benefits

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LINKS TO EV SUB-BENEFITS
Benefits - EV Consumer Conversion
Benefits - Fleet & Transit
Benefits - National Grid Heavy Duty Fleet
Benefits - Off Peak Rebate Program

	RI Benefit Description / Calculations	Unit	SCT	UTC	RIM	Source	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
Benefits - EV Consumer Conversion														
	Forward Commitment: Capacity Value													
	Total Demand Increase at Meter (MW)	MW				Calculated	-	(0.07)	(0.26)	(0.73)	(0.73)	(0.73)	(0.73)	(0.73)
/	1 - Losses	%				AESC 2015, ISO Distribution Losses, p.286	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Electric Demand at System	MW				Calculated	-	(0.08)	(0.28)	(0.79)	(0.79)	(0.79)	(0.79)	(0.79)
x	Derating Factor	%				Assumption	75%	75%	75%	75%	75%	75%	75%	75%
x	Avoided Unit Cost of Electric Capacity	$ / MW				AESC Appendix B	-	-	-	-	62,348.09	64,919.95	68,921.14	75,468.65
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**x**	**x**	**x**		**$ -**	**$ -**	**$ -**	**$ -**	**$ (36,901)**	**$ (38,423)**	**$ (40,791)**	**$ (44,666)**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved													
	Change in Energy Usage	MWh				Calculated		(525.82)	(1,387.39)	(3,422.10)	(3,456.90)	(3,492.05)	(3,527.57)	(3,563.44)
/	1 - Losses	%				AESC Appendix B	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh				Calculated		(571.54)	(1,508.04)	(3,719.67)	(3,757.50)	(3,795.71)	(3,834.31)	(3,873.31)
x	Avoided Energy Cost	$ / MWh				AESC Appendix B	40.12	45.63	52.07	57.95	60.82	66.58	71.17	75.96
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**x**	**x**	**x**		$ -	**$ (26,082)**	**$ (78,525)**	**$ (215,566)**	**$ (228,548)**	**$ (252,720)**	**$ (272,891)**	**$ (294,225)**
	Avoided Renewable Energy Credit (REC) Cost													
	Change in Energy Usage	MWh				Calculated		(525.82)	(1,387.39)	(3,422.10)	(3,456.90)	(3,492.05)	(3,527.57)	(3,563.44)
/	1 - Losses	%				AESC Appendix B	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh				Calculated		(571.54)	(1,508.04)	(3,719.67)	(3,757.50)	(3,795.71)	(3,834.31)	(3,873.31)
x	Avoided REC Cost	$ / MWh				AESC Appendix B	6.12	6.76	6.55	8.02	7.83	7.43	7.23	6.90
=	**Total Avoided REC Cost**	**$**	**x**	**x**	**x**		0	**$ (3,862)**	**$ (9,873)**	**$ (29,844)**	**$ (29,438)**	**$ (28,197)**	**$ (27,711)**	**$ (26,737)**
	Wholesale Market Price Effect													
	Change in Energy Usage	MWh				Calculated		(525.82)	(1,387.39)	(3,422.10)	(3,456.90)	(3,492.05)	(3,527.57)	(3,563.44)
/	1 - Losses	%				AESC Appendix B	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh				Calculated		(571.54)	(1,508.04)	(3,719.67)	(3,757.50)	(3,795.71)	(3,834.31)	(3,873.31)
x	DRIPE	$ / MWh				AESC Appendix B		0.88	0.88	0.19	0.19	0.19	0.20	0.20
=	**Wholesale Market Price Effect**	**$**	**x**	**x**	**x**		**$ -**	**$ (504)**	**$ (1,330)**	**$ (695)**	**$ (713)**	**$ (732)**	**$ (751)**	**$ (771)**
	Greenhouse Gas (GHG) Externality Costs													
	ICE													
	Total ICE VMT Converted	miles/pop				DOT		1,840,369.21	4,855,878.82	11,977,332.63	12,099,142.10	12,222,190.38	12,346,490.05	12,472,053.86
x	Average CO2 emitted per mile	kg/mile				EPA		0.41	0.41	0.41	0.41	0.41	0.41	0.41
x	Kilograms to pounds conversion	pounds				Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total Pounds of CO2 emitted	pounds				Calculated		1,667,541.24	4,399,866.15	10,852,548.51	10,962,918.93	11,074,411.81	11,187,038.58	11,300,810.76
x	Pounds to Tons Conversion Factor	#				Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	CO2 abatement cost	$/short ton				2015 AESC. Exhibit 4-7		100.00	100.00	100.00	100.00	100.00	100.00	100.00
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**						**$ 83,377**	**$ 219,993**	**$ 542,627**	**$ 548,146**	**$ 553,721**	**$ 559,352**	**$ 565,041**
	BEV													
x	Total BEVs Enabled -- Consumer	number				Calculated		72.11	188.35	459.90	459.90	459.90	459.90	459.90
x	VMT per capita in RI	miles/pop				https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% VMT covered by battery capacity	%				Assumption from NY BCA Model Assumption		0.95	0.95	0.95	0.95	0.95	0.95	0.95
=	Total BEV VMT covered by battery	miles				Calculated		596,028.66	1,572,642.57	3,879,022.50	3,918,472.16	3,958,323.02	3,998,579.16	4,039,244.72
/	Electric vehicle efficiency	miles/kWh				Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
/	kWh to MWh conversion	number				Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery	MWh				Calculated		170.29	449.33	1,108.29	1,119.56	1,130.95	1,142.45	1,154.07
x	Non-embedded CO2 cost	$/MWh				Calculated		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of BEVs**	**$**				**Calculated**		**$ 8,266**	**$ 22,040**	**$ 53,982**	**$ 54,108**	**$ 54,192**	**$ 54,238**	**$ 54,229**
	PHEV													
	Total PHEVs Enabled -- Consumer	number				Calculated		168.26	439.48	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10
x	VMT per capita in RI	miles/pop				https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% VMT covered by battery capacity	%				Assumption from NY BCA Model Assumption		0.85	0.85	0.85	0.85	0.85	0.85	0.85
=	Total PHEV VMT covered by battery	miles				Calculated		1,244,340.54	3,283,236.25	8,098,310.13	8,180,669.94	8,263,867.36	8,347,910.89	8,432,809.14
/	Electric vehicle efficiency	miles/kWh				Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
/	kWh to MWh conversion	number				Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery capacity	MWh				Calculated		355.53	938.07	2,313.80	2,337.33	2,361.10	2,385.12	2,409.37
x	Non-embedded CO2 cost	$/MWh				2015 AESC. Exhibit 4-7		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of PHEVs**	**$**				**Calculated**		**$ 17,257**	**$ 46,014**	**$ 112,699**	**$ 112,963**	**$ 113,138**	**$ 113,233**	**$ 113,216**
=	**Total CO2 emissions combined BEV + PHEV cost**	**$**				**Calculated**		**$ 25,523**	**$ 68,054**	**$ 166,682**	**$ 167,071**	**$ 167,330**	**$ 167,471**	**$ 167,445**
=	**Net C02 emissions benefit**	**$**	**x**			**Calculated**	**$ -**	**$ 57,854**	**$ 151,939**	**$ 375,946**	**$ 381,075**	**$ 386,391**	**$ 391,881**	**$ 397,595**

	RI Benefit				Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
	Criteria Air Pollutant and Other Environmental Costs											
	Total ICE VMT Converted	miles		Calculated		1,840,369.21	4,855,878.82	11,977,332.63	12,099,142.10	12,222,190.38	12,346,490.05	12,472,053.86
x	Average SO2 emitted per mile driven	kg/mile		http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE SO2 emitted	pounds		Calculated		73.03	192.69	475.29	480.13	485.01	489.94	494.93
x	Pounds to Tons Conversion Factor	#		Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	SO2 Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		1.25	1.30	1.35	1.41	1.46	1.52	1.59
=	**Total SO2 emissions cost avoided by ICE vehicles**	**$**				**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**
	Total ICE VMT Converted	miles		Calculated		1,840,369.21	4,855,878.82	11,977,332.63	12,099,142.10	12,222,190.38	12,346,490.05	12,472,053.86
x	Average NOX emitted per mile driven	kg/mile		https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/f		0.01	0.01	0.01	0.01	0.01	0.01	0.01
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE NOX emitted	pounds		Calculated		30,835.31	81,360.06	200,679.73	202,720.64	204,782.31	206,864.95	208,968.76
x	Pounds to Tons Conversion Factor	#		Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	NOX Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		11.26	11.72	12.19	12.68	13.19	13.73	14.28
=	**Total NOX emissions cost avoided by ICE vehicles**	**$**				**$ 174**	**$ 477**	**$ 1,223**	**$ 1,285**	**$ 1,351**	**$ 1,420**	**$ 1,492**
	Total ICE VMT Converted	miles		Calculated		1,840,369.21	4,855,878.82	11,977,332.63	12,099,142.10	12,222,190.38	12,346,490.05	12,472,053.86
x	Average PM2.5 emitted per mile dirven	kg/mile		EPA		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE PM2.5 emitted	pounds		Calculated		16.63	43.89	108.26	109.36	110.47	111.60	112.73
x	Pounds to Tons Conversion Factor	#		Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	PM2.5 Pollutant Cost	$/tons		EPA		382,429.62	390,078.21	397,879.78	405,837.37	413,954.12	422,233.20	430,677.87
=	**Total PM2.5 emission cost avoided by ICE vehicles**	**$**		**Calculated**		**$ 3,181**	**$ 8,561**	**$ 21,538**	**$ 22,192**	**$ 22,866**	**$ 23,560**	**$ 24,276**
=	**Total Avoided Cost from SO2, NOX, and PM2.5 Reduction**	**$**	**x**	**Calculated**	**$ -**	**$ 3,354.50**	**$ 9,037.34**	**$ 22,760.98**	**$ 23,477.52**	**$ 24,217.11**	**$ 24,980.51**	**$ 25,768.52**
	Non-Electric Avoided Fuel Cost											
	Total ICE VMT Converted	miles		Calculated		1,840,369.21	4,855,878.82	11,977,332.63	12,099,142.10	12,222,190.38	12,346,490.05	12,472,053.86
/	Average mpg -- ICE vehicle	mpg		Transportation Initiative - Draft Testimony (Karsten Barde)		30.00	30.00	30.00	30.00	30.00	30.00	30.00
=	Gallons of gasoline consumed	gallons		Calculated		61,345.64	161,862.63	399,244.42	403,304.74	407,406.35	411,549.67	415,735.13
x	Price per gallon of gasoline	$/gallon		Transportation Initiative - Draft Testimony (Karsten Barde)		2.55	2.58	2.60	2.63	2.65	2.68	2.71
=	Total avoided cost of gasoline	$		Calculated		$ 156,447	$ 416,918	$ 1,038,638	$ 1,059,693	$ 1,081,175	$ 1,103,092	$ 1,125,454
=	**Total Benefit from Non-Electric Avoided Fuel Cost**		**x**		**$ -**	**$ 156,446.72**	**$ 416,918.07**	**$ 1,038,638.36**	**$ 1,059,693.33**	**$ 1,081,175.11**	**$ 1,103,092.37**	**$ 1,125,453.93**
	Economic Development											
	Rhode Island GDP Increase	**$**	**x**	**NG Economic Impact Analysis**	**$ -**	**$ -**	**$ -**					
	Net Utility Revenue Increase - Consumer											
	Total Number of BEVs - Consumer Facing	number		Calculated		72.11	188.35	459.90	459.90	459.90	459.90	459.90
x	VMT per capita in RI	miles		Calculated		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumptioin		95%	95%	95%	95%	95%	95%	95%
x	At home charging percentage	%		Department of Energy		80%	80%	80%	80%	80%	80%	80%
/	Average miles/kWh of BEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total BEV kWh charge	kWh		Calculated		136,235.12	359,461.16	886,633.71	895,650.78	904,759.55	913,960.95	923,255.93
	Total Number of PHEVs - Consumer Facing	number		Calculated		168.26	439.48	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10
x	VMT per capita in RI	miles		Calculated		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumption		85%	85%	85%	85%	85%	85%	85%
x	At Home Charging Percentage	%		Department of Energy		80%	80%	80%	80%	80%	80%	80%
/	Average miles/kWh of PHEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total PHEV kWh charge	kWh		Calculated		284,420.70	750,454.00	1,851,042.32	1,869,867.42	1,888,883.97	1,908,093.92	1,927,499.23
=	**Total combined kWh charge (BEV + PHEV)**	kWh		Calculated		420,655.82	1,109,915.16	2,737,676.03	2,765,518.19	2,793,643.51	2,822,054.87	2,850,755.17
x	Price per kWh (at home charging)	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.125	0.131	0.139	0.159	0.164	0.170	0.176
=	**Total revenue of combined BEV & PHEV charges**	**$**				**$ 52,620**	**$ 145,872**	**$ 380,304**	**$ 440,473**	**$ 458,116**	**$ 478,348**	**$ 502,527**
	Total Number of PHEVs - Consumer Facing	number		https://autoalliance.org/		168.26	439.48	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10
x	VMT per capita in RI	miles		Calculated		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumption		85%	85%	85%	85%	85%	85%	85%
/	Average miles/kWh of PHEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total PHEV kWh charge	kWh		Calculated		355,525.87	938,067.50	2,313,802.89	2,337,334.27	2,361,104.96	2,385,117.40	2,409,374.04
x	On-Site Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Charging Rate at Utility-operated Station -- Consumer Level 2	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.1751	0.1814	0.1889	0.2093	0.2140	0.2195	0.2263
x	Utility-Operated L2 Ports Percentage	%		Calculated		40%	40%	40%	40%	40%	40%	40%
=	**Total Estimated L2 Delivery Fee (PHEV)**	**$**				**$ 4,964**	**$ 13,572**	**$ 34,858**	**$ 39,007**	**$ 40,291**	**$ 41,751**	**$ 43,477**
	Total Number of BEVs - Consumer Facing	number		https://autoalliance.org/		72.11	188.35	459.90	459.90	459.90	459.90	459.90
x	VMT per capita in RI	miles		Calculated		8,700.54	8,789.03	8,878.41	8,968.71	9,059.92	9,152.06	9,245.13
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumptioin		95%	95%	95%	95%	95%	95%	95%
/	Average miles/kWh of BEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total BEV kWh charge	kWh		Calculated		170,293.90	449,326.45	1,108,292.14	1,119,563.47	1,130,949.43	1,142,451.19	1,154,069.92
x	Charging Rate at Utility-operated Station -- Consumer Level 2	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.18	0.18	0.19	0.21	0.21	0.22	0.23
x	On-Site Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Utility-Operated Ports Percentage	%		Calculated		40%	40%	40%	40%	40%	40%	40%
=	**Total Estimated L2 Delivery Fee (BEV)**	**$**				**$ 2,378**	**$ 6,501**	**$ 16,697**	**$ 18,684**	**$ 19,299**	**$ 19,998**	**$ 20,825**
	Charging Rate at Utility-operated Station - Consumer DCFC	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.38	0.38	0.39	0.41	0.41	0.42	0.43
x	Total PHEV kWh charge	kWh		Calculated		355,525.87	938,067.50	2,313,802.89	2,337,334.27	2,361,104.96	2,385,117.40	2,409,374.04
x	At-Station Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Utility-Operated L2 Ports Percentage	%		Calculated		3%	3%	3%	3%	3%	3%	3%
=	**Total Estimated DCFC Delivery Fee (PHEV)**	**$**				**$ 844**	**$ 2,265**	**$ 5,695**	**$ 6,054**	**$ 6,186**	**$ 6,333**	**$ 6,500**

	RI Benefit				Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
	Charging Rate at Utility-operated Station - Consumer DCFC	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.38	0.38	0.39	0.41	0.41	0.42	0.43
x	BEV kWh Charge at Applicable Station	kWh		Calculated		170,293.90	449,326.45	1,108,292.14	1,119,563.47	1,130,949.43	1,142,451.19	1,154,069.92
x	At-Station Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Utility-Operated Ports Percentage	%		Calculated		3%	3%	3%	3%	3%	3%	3%
=	**Total Estimated DCFC Delivery Fee (BEV)**	**$**				**$ 404**	**$ 1,085**	**$ 2,728**	**$ 2,900**	**$ 2,963**	**$ 3,033**	**$ 3,114**
	Utility Revenue per kWh (Make-ready charging)	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.13	0.13	0.14	0.16	0.16	0.17	0.18
x	Total PHEV kWh charge	kWh		Calculated		355,525.87	938,067.50	2,313,802.89	2,337,334.27	2,361,104.96	2,385,117.40	2,409,374.04
x	On-Site Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Make Ready Port %	%		Calculated		57%	57%	57%	57%	57%	57%	57%
=	**Total Estimated Revenue from Make-Ready charging - PHEV's**	**$**				**$ 5,066**	**$ 14,045**	**$ 36,618**	**$ 42,411**	**$ 44,110**	**$ 46,058**	**$ 48,386**
	Utility Revenue per kWh (Make-ready charging)	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.13	0.13	0.14	0.16	0.16	0.17	0.18
x	Total BEV kWh Charge	kWh		Calculated		170,293.90	449,326.45	1,108,292.14	1,119,563.47	1,130,949.43	1,142,451.19	1,154,069.92
x	On-Site Charging Percentage	%		Department of Energy		20%	20%	20%	20%	20%	20%	20%
x	Make Ready Port %	%		Calculated		57%	57%	57%	57%	57%	57%	57%
=	**Total Estimated Revenue from Make-Ready charging- BEV's**	**$**				**$ 2,427**	**$ 6,728**	**$ 17,540**	**$ 20,315**	**$ 21,128**	**$ 22,061**	**$ 23,176**
	Total estimated revenue from Make-Ready Charging			Calculated		$ 7,493	$ 20,773	$ 54,157	$ 62,726	$ 65,238	$ 68,119	$ 71,562
+	Total estimated revenue from Utility-Operated Charging	$		Calculated		$ 8,590	$ 23,422	$ 59,979	$ 66,646	$ 68,740	$ 71,115	$ 73,916
+	Total estimated revenue from At-Home Charging	$		Calculated		$ 52,620	$ 145,872	$ 380,304	$ 440,473	$ 458,116	$ 478,348	$ 502,527
=	**Total utility revenue increase - Consumer**	$			$ -	**$ 68,703**	**$ 190,067**	**$ 494,439**	**$ 569,845**	**$ 592,095**	**$ 617,582**	**$ 648,005**

Return Benefits Home

Benefits - Fleet & Transit

	Forward Commitment: Capacity Value											
	Total Demand Increase at Meter (MW)	MW		Calculated	(0.08)	(0.29)	(0.82)	(0.82)	(0.82)	(0.82)	(0.82)	(0.82)
/	1 - Losses	%		AESC 2015, ISO Distribution Losses, p.286	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Electric Demand at System	MW			(0.09)	(0.32)	(0.89)	(0.89)	(0.89)	(0.89)	(0.89)	(0.89)
x	Derating Factor	%		KPMG Assumption	75%	75%	75%	75%	75%	75%	75%	75%
x	Avoided Unit Cost of Electric Capacity	$ / MW		AESC Appendix B	-	-	-	-	62,348.09	64,919.95	68,921.14	75,468.65
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**x x x**		**$ -**	**$ -**	**$ -**	**$ -**	**$ (41,577)**	**$ (43,292)**	**$ (45,960)**	**$ (50,326)**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)											
	Change in Energy Usage	MWh		Calculated		(155.55)	(409.69)	(1,008.70)	(1,017.13)	(1,025.66)	(1,034.26)	(1,042.96)
/	1 - Losses	%		AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh		Calculated		(169.08)	(445.31)	(1,096.41)	(1,105.58)	(1,114.84)	(1,124.20)	(1,133.65)
x	Avoided Energy Cost	$ / MWh		AESC Appendix B	40.12	45.63	52.07	57.95	60.82	66.58	71.17	75.96
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**x x**		**$ -**	**$ (7,716)**	**$ (23,188)**	**$ (63,540)**	**$ (67,246)**	**$ (74,227)**	**$ (80,010)**	**$ (86,115)**
	Avoided Renewable Energy Credit (REC) Cost											
	Change in Energy Usage	MWh		Calculated		(155.55)	(409.69)	(1,008.70)	(1,017.13)	(1,025.66)	(1,034.26)	(1,042.96)
/	1 - Losses	%		AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh		Calculated		(169.08)	(445.31)	(1,096.41)	(1,105.58)	(1,114.84)	(1,124.20)	(1,133.65)
x	Avoided REC Cost	$ / MWh		AESC Appendix B	6.12	6.76	6.55	8.02	7.83	7.43	7.23	6.90
=	**Total Avoided REC Cost**	**$**	**x x**		**$ -**	**$ (1,142)**	**$ (2,915)**	**$ (8,797)**	**$ (8,662)**	**$ (8,282)**	**$ (8,125)**	**$ (7,826)**
	Wholesale Market Price Effect											
	Change in Energy Usage	MWh		Calculated		(155.55)	(409.69)	(1,008.70)	(1,017.13)	(1,025.66)	(1,034.26)	(1,042.96)
/	1 - Losses	%		AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh		Calculated		(169.08)	(445.31)	(1,096.41)	(1,105.58)	(1,114.84)	(1,124.20)	(1,133.65)
x	DRIPE	$ / MWh		AESC Appendix B		0.88	0.88	0.19	0.19	0.19	0.20	0.20
=	**Wholesale Market Price Effect**	**$**	**x x**		**$ -**	**$ (149)**	**$ (393)**	**$ (205)**	**$ (210)**	**$ (215)**	**$ (220)**	**$ (226)**
	Greenhouse Gas (GHG) Externality Costs											
	LD Fleet--ICE											
	Total Converted ICE VMT -- LD Fleet	miles		Calculated		89,948.13	237,291.37	585,195.70	591,047.66	596,958.13	602,927.71	608,956.99
x	Average CO2 emitted per mile	kg/mile		https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passen		0.41	0.41	0.41	0.41	0.41	0.41	0.41
x	Kilograms to pounds conversion	pounds		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total Pounds of CO2 emitted	pounds		Calculated		81,501.16	215,007.48	530,240.32	535,542.73	540,898.15	546,307.13	551,770.21
x	Pounds to Tons Conversion Factor			Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Non-embedded CO2 cost	$/short ton		2015 AESC. Exhibit 4-7		94.34	95.34	94.67	93.94	93.13	92.27	91.33
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**				**$ 3,845**	**$ 10,249**	**$ 25,099**	**$ 25,153**	**$ 25,188**	**$ 25,205**	**$ 25,197**
	LD Fleet--BEV											
	Total LD Fleet BEV VMT covered by battery	miles		Calculated		29,130.93	76,850.05	189,523.61	191,418.84	193,333.03	195,266.36	197,219.03
/	Average miles/kWh BEVs	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
/	kWh to MWh conversion	number		Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery	MWh		Calculated		8.32	21.96	54.15	54.69	55.24	55.79	56.35
x	Non-embedded CO2 cost	$/MWh		Calculated		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of BEVs**	**$**		**Calculated**		**$ 404**	**$ 1,077**	**$ 2,637**	**$ 2,643**	**$ 2,647**	**$ 2,649**	**$ 2,648**
	LD Fleet--PHEV											
	Total LD Fleet PHEV VMT covered by battery	miles		Calculated		60,817.20	160,441.33	395,672.09	399,628.81	403,625.10	407,661.35	411,737.97
/	Electric vehicle efficiency	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
/	kWh to MWh conversion	number		Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery	MWh		Calculated		17.38	45.84	113.05	114.18	115.32	116.47	117.64
x	Non-embedded CO2 cost	$/MWh		2015 AESC. Exhibit 4-7		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of PHEVs**	**$**		**Calculated**		**$ 843**	**$ 2,249**	**$ 5,506**	**$ 5,518**	**$ 5,526**	**$ 5,530**	**$ 5,528**
=	**Total CO2 emissions combined BEV + PHEV cost**	$		Calculated		**$ 1,247**	**$ 3,326**	**$ 8,144**	**$ 8,161**	**$ 8,173**	**$ 8,178**	**$ 8,176**

	RI Benefit				Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
=	**Net C02 emissions benefit -- LD Fleet**	**$**		**Calculated**	**$ -**	**$ 2,597**	**$ 6,924**	**$ 16,955**	**$ 16,992**	**$ 17,015**	**$ 17,027**	**$ 17,021**
	Ridesharing-ICE											
	Total Converted ICE VMT -- Ridesharing	miles		Calculated		96,774.71	252,772.78	617,203.13	617,203.13	617,203.13	617,203.13	617,203.13
x	Average CO2 emitted per mile	kg/mile		https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passen		0.41	0.41	0.41	0.41	0.41	0.41	0.41
x	Kilograms to pounds conversion	pounds		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total Pounds of CO2 emitted	pounds		Calculated		87,686.66	229,035.04	559,241.95	559,241.95	559,241.95	559,241.95	559,241.95
x	Pounds to Tons Conversion Factor	#				0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Non-embedded CO2 cost	$/short ton		2015 AESC. Exhibit 4-7		94.34	95.34	94.67	93.94	93.13	92.27	91.33
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**				**$ 4,136**	**$ 10,918**	**$ 26,472**	**$ 26,266**	**$ 26,042**	**$ 25,802**	**$ 25,538**
	Ridesharing-BEV											
	Total Ridesharing BEV VMT covered by battery	miles		Calculated		101,868.12	266,076.62	649,687.50	649,687.50	649,687.50	649,687.50	649,687.50
/	Average miles/kWh BEVs	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
/	kWh to MWh conversion	number		Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery	MWh		Calculated		29.11	76.02	185.63	185.63	185.63	185.63	185.63
x	Non-embedded CO2 cost	$/MWh		Calculated		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of BEVs**	**$**		**Calculated**		**$ 1,413**	**$ 3,729**	**$ 9,041**	**$ 8,971**	**$ 8,895**	**$ 8,813**	**$ 8,722**
=	**Net C02 emissions benefit -- Ridesharing**	**$**		**Calculated**	**$ -**	**$ 2,724**	**$ 7,189**	**$ 17,430**	**$ 17,295**	**$ 17,147**	**$ 16,989**	**$ 16,816**
	Buses--Diesel											
	Total diesel VMT Converted -- Buses	miles		Calculated		219,738.34	579,787.32	1,430,082.15	1,444,626.09	1,459,317.93	1,474,159.20	1,489,151.40
x	Average CO2 emitted per mile	kg/mile		FAA		2.50	2.50	2.50	2.50	2.50	2.50	2.50
x	Kilograms to pounds conversion	pounds		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total Pounds of CO2 emitted	pounds		Calculated		1,211,087.85	3,195,497.83	7,881,897.78	7,962,056.68	8,043,030.80	8,124,828.42	8,207,457.93
x	Pounds to Tons Conversion Factor	#				0.0005	0.00	0.00	0.00	0.00	0.00	0.00
x	Non-embedded CO2 cost	$/short ton		2015 AESC. Exhibit 4-7		94.34	95.34	94.67	93.94	93.13	92.27	91.33
=	**Total CO2 emissions cost avoided by diesel buses**	**$**		**Calculated**		**$ 57,129**	**$ 152,328**	**$ 373,088**	**$ 373,959**	**$ 374,538**	**$ 374,855**	**$ 374,797**
	Battery Electric Buses (BEBs)											
	Total BEB VMT covered by battery	miles		Calculated		219,738.34	579,787.32	1,430,082.15	1,444,626.09	1,459,317.93	1,474,159.20	1,489,151.40
/	Average miles/kWh BEB	miles/kWh		NREL		2.15	2.15	2.15	2.15	2.15	2.15	2.15
/	kWh to MWh conversion	number		Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery	MWh		Calculated		102.20	269.67	665.15	671.92	678.75	685.66	692.63
x	Non-embedded CO2 cost	$/MWh		Calculated		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of BEBs**	**$**		**Calculated**		**$ 4,961**	**$ 13,228**	**$ 32,398**	**$ 32,474**	**$ 32,524**	**$ 32,551**	**$ 32,546**
=	**Net C02 emissions benefit -- BEB's**	**$**		**Calculated**	**$ -**	**$ 52,168**	**$ 139,100**	**$ 340,690**	**$ 341,485**	**$ 342,014**	**$ 342,303**	**$ 342,251**
=	**Net CO2 emissions benefit -- Fleet & Transit**	**$**	**x**	**Calculated**	**$ -**	**$ 57,489**	**$ 153,213**	**$ 375,075**	**$ 375,772**	**$ 376,177**	**$ 376,319**	**$ 376,087**
	Criteria Air Pollutant and Other Environmental Costs											
	Total ICE VMT Converted	miles		Calculated		186,722.85	490,064.16	1,202,398.82	1,208,250.78	1,214,161.26	1,220,130.84	1,226,160.12
x	Average SO2 emitted per mile driven	kg/mile		http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE SO2 emitted	pounds		Calculated		7.41	19.45	47.71	47.95	48.18	48.42	48.66
x	Pounds to Tons Conversion Factor	#		Calculated		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	SO2 Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		1.25	1.30	1.35	1.41	1.46	1.52	1.59
=	**Total SO2 emissions cost avoided by ICE vehicles**	**$**		**Calculated**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**
	Total ICE VMT Converted	miles		Calculated		186,722.85	490,064.16	1,202,398.82	1,208,250.78	1,214,161.26	1,220,130.84	1,226,160.12
x	Average NOX emitted per mile driven	kg/mile		https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/fi		0.01	0.01	0.01	0.01	0.01	0.01	0.01
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE NOX emitted	pounds		Calculated		3,128.53	8,211.01	20,146.14	20,244.19	20,343.22	20,443.24	20,544.26
x	Pounds to Tons Conversion Factor	tons		Calculated		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	NOX Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		11.26	11.72	12.19	12.68	13.19	13.73	14.28
=	**Total NOX emissions cost avoided by ICE vehicles**	**$**		**Calculated**		**$ 18**	**$ 48**	**$ 123**	**$ 128**	**$ 134**	**$ 140**	**$ 147**
	Total ICE VMT Converted	miles		Calculated		186,722.85	490,064.16	1,202,398.82	1,208,250.78	1,214,161.26	1,220,130.84	1,226,160.12
x	Average PM2.5 emitted per mile dirven	kg/mile		EPA		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds ICE PM2.5 emitted	pounds				1.69	4.43	10.87	10.92	10.97	11.03	11.08
x	Pounds to Tons Conversion Factor	tons		Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	PM2.5 Pollutant Cost	$/tons		EPA		382,429.62	390,078.21	397,879.78	405,837.37	413,954.12	422,233.20	430,677.87
=	**Total PM2.5 emission cost avoided by ICE vehicles**	**$**				**$ 323**	**$ 864**	**$ 2,162**	**$ 2,216**	**$ 2,271**	**$ 2,328**	**$ 2,387**
	Total Diesel VMT Converted	miles		Calculated		219738.34	579787.32	1430082.15	1444626.09	1459317.93	1474159.20	1489151.40
x	Average SO2 emitted per mile driven	tons/mile		http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381		0.00	0.00	0.00	0.00	0.00	0.00	0.00
=	Total tons Diesel SO2 emitted	tons		Calculated		0.00	0.01	0.03	0.03	0.03	0.03	0.03
x	SO2 Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		1.25	1.30	1.35	1.41	1.46	1.52	1.59
=	**Total SO2 emissions cost avoided by diesel buses**	**$**		**Calculated**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**
	Total Diesel VMT Converted	miles		Calculated		219738.34	579787.32	1430082.15	1444626.09	1459317.93	1474159.20	1489151.40
x	Average NOX emitted per mile driven	tons/mile		http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381		0.00	0.00	0.00	0.00	0.00	0.00	0.00
=	Total tons Diesel NOX emitted	tons		Calculated		3.92	10.34	25.51	25.77	26.03	26.30	26.57
x	NOX Pollutant Cost	$ / short ton		AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		11.26	11.72	12.19	12.68	13.19	13.73	14.28
=	**Total NOX emissions cost avoided by diesel buses**	**$**		**Calculated**		**$ 44**	**$ 121**	**$ 311**	**$ 327**	**$ 344**	**$ 361**	**$ 379**
	Total Diesel VMT Converted	miles		Calculated		219,738.34	579,787.32	1,430,082.15	1,444,626.09	1,459,317.93	1,474,159.20	1,489,151.40
x	Average PM2.5 emitted per mile dirven	kg/mile		EPA		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number		Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds Diesel PM2.5 emitted	pounds				97.86	258.20	636.86	643.33	649.88	656.49	663.16
x	Pounds to Tons Conversion Factor	tons		Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	PM2.5 Pollutant Cost	$/tons		EPA		382,429.62	390,078.21	397,879.78	405,837.37	413,954.12	422,233.20	430,677.87
=	**Total PM2.5 emission cost avoided by diesel buses**	**$**				**$ 18,711**	**$ 50,358**	**$ 126,696**	**$ 130,545**	**$ 134,510**	**$ 138,595**	**$ 142,805**

	RI Benefit				Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
=	**Total Avoided Cost from SO2, NOX, and PM 2.5 Reduction -- Fleet &**	**$**	**x**	**Calculated**	**$ -**	**$ 19,096**	**$ 51,392**	**$ 129,292**	**$ 133,216**	**$ 137,259**	**$ 141,425**	**$ 145,718**
	Non-Electric Avoided Fuel Cost											
	Total ICE VMT Converted	miles				186,722.85	490,064.16	1,202,398.82	1,208,250.78	1,214,161.26	1,220,130.84	1,226,160.12
/	Average mpg -- ICE vehicle	mpg		Transportation Initiative - Draft Testimony (Karsten Barde)		30.00	30.00	30.00	30.00	30.00	30.00	30.00
=	Gallons of gasoline consumed	gallons		Calculated		6,224.09	16,335.47	40,079.96	40,275.03	40,472.04	40,671.03	40,872.00
x	Price per gallon of gasoline	$/gallon		Transportation Initiative - Draft Testimony (Karsten Barde)		2.55	2.58	2.60	2.63	2.65	2.68	2.71
=	**Total avoided cost of gasoline**	**$**		**Calculated**		**$ 15,873**	**$ 42,076**	**$ 104,268**	**$ 105,824**	**$ 107,405**	**$ 109,012**	**$ 110,646**
	Total Diesel VMT Converted	miles		Calculated		219,738.34	579,787.32	1,430,082.15	1,444,626.09	1,459,317.93	1,474,159.20	1,489,151.40
x	Average mpg -- Diesel Bus	%		FAA		3.26	3.26	3.26	3.26	3.26	3.26	3.26
=	Gallons of diesel fuel consumed	miles		Calculated		67,404.40	177,848.87	438,675.51	443,136.84	447,643.54	452,196.07	456,794.91
x	Price per gallon of diesel fuel	miles / gallon		FAA		2.50	2.50	2.50	2.50	2.50	2.50	2.50
=	**Total Cost of Diesel Fuel**	**gallons**		**Calculated**		**168,510.99**	**444,622.18**	**1,096,688.77**	**1,107,842.09**	**1,119,108.85**	**1,130,490.18**	**1,141,987.27**
=	**Total Non-Electric Avoided Fuel Cost**		**x**		**$ -**	**$ 184,384**	**$ 486,698**	**$ 1,200,957**	**$ 1,213,666**	**$ 1,226,514**	**$ 1,239,502**	**$ 1,252,634**
	Net Utility Revenue Increase: Fleet & Transit											
	Total Number of BEV's - Light Duty Fleet	number		Calculated		4.5	11.8	28.8	28.8	28.8	28.8	28.8
x	VMT per LD Fleet vehicle -- RI	miles		Calculated		6,790.54	6,858.45	6,927.03	6,996.30	7,066.27	7,136.93	7,208.30
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumptioin		95%	95%	95%	95%	95%	95%	95%
/	Average miles/kWh of BEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total BEV kWh charge -- Light Duty Fleet	kWh		Calculated		8,323.12	21,957.16	54,149.60	54,691.10	55,238.01	55,790.39	56,348.29
	Total Number of PHEVs - Light Duty Fleet	number		Calculated		10.54	27.52	67.20	67.20	67.20	67.20	67.20
x	VMT per LD Fleet vehicle -- RI	miles		Calculated		6,790.54	6,858.45	6,927.03	6,996.30	7,066.27	7,136.93	7,208.30
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumption		85%	85%	85%	85%	85%	85%	85%
/	Average miles/kWh of PHEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total PHEV kWh charge -- Light Duty Fleet	kWh		Calculated		17,376.34	45,840.38	113,049.17	114,179.66	115,321.46	116,474.67	117,639.42
=	Total combined kWh charge (BEV + PHEV)	kWh		Calculated		25,699.47	67,797.53	167,198.77	168,870.76	170,559.47	172,265.06	173,987.71
x	Price per kWh	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.125	0.131	0.139	0.159	0.164	0.170	0.176
=	**Total revenue from Light Duty Fleet charges**	**$**			$ -	**$ 3,215**	**$ 8,910**	**$ 23,226**	**$ 26,897**	**$ 27,969**	**$ 29,199**	**$ 30,670**
	Total Number of BEV's - Ridesharing	number		Calculated		4.1	10.8	26.3	26.3	26.3	26.3	26.3
x	VMT per Ridesharing vehicle -- RI	miles		Calculated		24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00
x	% miles covered by battery capacity	%		Assumption from NY BCA Model Assumptioin		95%	95%	95%	95%	95%	95%	95%
/	Average miles/kWh of BEV's	miles/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		3.50	3.50	3.50	3.50	3.50	3.50	3.50
=	Total BEV kWh charge -- Ridesharing	kWh		Calculated		27,649.92	72,220.80	176,343.75	176,343.75	176,343.75	176,343.75	176,343.75
x	Price per kWh	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.125	0.131	0.139	0.159	0.164	0.170	0.176
=	**Total revenue from Ridesharing charges**	**$**			**$ -**	**$ 3,459**	**$ 9,492**	**$ 24,497**	**$ 28,087**	**$ 28,918**	**$ 29,891**	**$ 31,086**
	Total Number of BEB's	number		Calculated		13.17	34.40	84.00	84.00	84.00	84.00	84.00
x	VMT per Bus	miles		Calculated		17,561.81	17,740.41	17,920.83	18,103.08	18,287.19	18,473.17	18,661.05
x	% miles covered by capacity	%		Assumption from NY BCA Model Assumption		95%	95%	95%	95%	95%	95%	95%
/	Average miles/kWh of BEB's	miles/kWh		MJ Bradley and Associates		2.15	2.15	2.15	2.15	2.15	2.15	2.15
=	Total BEB kWh charge	kWh		Calculated	$ -	102,203.88	269,668.52	665,154.49	671,919.11	678,752.53	685,655.44	692,628.56
x	Price per kWh	$/kWh		Transportation Initiative - Draft Testimony (Karsten Barde)		0.125	0.131	0.139	0.159	0.164	0.170	0.176
=	**Total revenue from BEB charges**	**$**		**Calculated**	**$ -**	**$ 12,785**	**$ 35,442**	**$ 92,400**	**$ 107,019**	**$ 111,305**	**$ 116,221**	**$ 122,095**
=	**Total utility revenue increase -- Fleet & Transit**	**$**			**$ -**	**$ 19,458**	**$ 53,844**	**$ 140,123**	**$ 162,002**	**$ 168,192**	**$ 175,311**	**$ 183,851**
=	**Total utility revenue increase -- EV Conversion**	**$**	**x**	**x**	**$ -**	**$ 88,161**	**$ 243,911**	**$ 634,562**	**$ 731,847**	**$ 760,287**	**$ 792,893**	**$ 831,857**

Return Benefits Home

Benefits - National Grid Heavy Duty Fleet

	Forward Commitment: Capacity Value											
	Total Demand Increase at Meter (MW)	MW		Calculated	-	-	-	-	-	-	-	-
/	1 - Losses	%		AESC 2015, ISO Distribution Losses, p.286	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Electric Demand at System	MW		Calculated	-	0.09	0.22	0.45	-	-	-	-
x	Derating Factor	%		Assumption	75%	75%	75%	75%	75%	75%	75%	75%
x	Avoided Unit Cost of Electric Capacity	$ / MW		AESC Appendix B	-	-	-	-	62,348.09	64,919.95	68,921.14	75,468.65
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**x x x**	**Calculated**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)											
	Change in Energy Usage	MWh		Calculated		-	-	-	-	-	-	-
/	1 - Losses	%		AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh		Calculated		-	-	-	-	-	-	-
x	Avoided Energy Cost	$ / MWh		AESC Appendix B	40.12	45.63	52.07	57.95	60.82	66.58	71.17	75.96
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**x x x**	**Calculated**	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Avoided Renewable Energy Credit (REC) Cost											
	Change in Energy Usage	MWh		Calculated		-	-	-	-	-	-	-
/	1 - Losses	%		AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh		Calculated		-	-	-	-	-	-	-
x	Avoided REC Cost	$ / MWh		AESC Appendix B	6.12	6.76	6.55	8.02	7.83	7.43	7.23	6.90
=	**Total Avoided REC Cost**	**$**	**x x x**	**Calculated**	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

	RI Benefit					Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
	Wholesale Market Price Effect												
	Change in Energy Usage	MWh			Calculated		-	-	-	-	-	-	-
/	1 - Losses	%			AESC Appendix B		92%	92%	92%	92%	92%	92%	92%
=	Change in Energy Usage at System	MWh			Calculated		-	-	-	-	-	-	-
x	DRIPE	$ / MWh			AESC Appendix B		0.88	0.88	0.19	0.19	0.19	0.20	0.20
=	**Wholesale Market Price Effect**	**$**	**x**	**x**	**x** **Calculated**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Greenhouse Gas (GHG) Externality Cost												
	Diesel												
x	Total Diesel VMT Converted	miles/pop					-	-	-	-	-	-	-
x	Average CO2 emitted per mile	kg/mile					2.50	2.50	2.50	2.50	2.50	2.50	2.50
x	Kilograms to pounds conversion	pounds			Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total Pounds of CO2 emitted	pounds			Calculated		-	-	-	-	-	-	-
x	Pounds to Tons Conversion Factor	#			Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Non-embedded CO2 cost	$/short ton			2015 AESC. Exhibit 4-7		94.34	95.34	94.67	93.94	93.13	92.27	91.33
=	**Total CO2 emissions cost avoided by Heavy Duty Diesel vehicles**	**$**			**Calculated**		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PHEV												
	Total Heavy duty (HD) fleet PHEV's	number			Calculated		-	-	-	-	-	-	-
x	VMT per vehicle -- HD Fleet	miles/vehicle			Transportation Initiative - Draft Testimony (Karsten Barde)		8,670.63	8,758.81	8,847.88	8,937.87	9,028.76	9,120.59	9,213.34
x	% VMT covered by battery capacity	%			Assumption from NY BCA Model Assumption		50%	50%	50%	50%	50%	50%	50%
=	Total PHEV VMT covered by battery	miles			Calculated		-	-	-	-	-	-	-
/	Heavy duty PHEV efficiency	miles/kWh			Transportation Initiative - Draft Testimony (Karsten Barde)		0.93	0.93	0.93	0.93	0.93	0.93	0.93
/	kWh to MWh conversion	number			Conversion Factor		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
=	Total MWh covered by battery -- Heavy Duty Fleet	MWh			Calculated		-	-	-	-	-	-	-
x	Non-embedded CO2 cost	$/MWh			2015 AESC. Exhibit 4-7		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Total CO2 emissions cost of Heavy Duty PHEVs**	**$**			**Calculated**		$ -	$ -	$ -	$ -	$ -	$ -	$ -
=	**Net C02 emissions benefit**	**$**	**x**		**Calculated**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Criteria Air Pollutant and Other Environmental Costs												
	Total Diesel VMT Converted	miles			Calculated		-	-	-	-	-	-	-
x	Average SO2 emitted per mile driven	tons/mile			http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7381		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	SO2 Pollutant Cost	$ / short ton			AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		1.25	1.30	1.35	1.41	1.46	1.52	1.59
=	**Total SO2 emissions cost avoided by HD diesel vehicles**	**$**					$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Diesel VMT Converted	miles			Calculated		-	-	-	-	-	-	-
x	Average NOX emitted per mile driven	tons/mile			https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/fi		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	NOX Pollutant Cost	$ / short ton			AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pu		11.26	11.72	12.19	12.68	13.19	13.73	14.28
=	**Total NOX emissions cost avoided by HD diesel vehicles**	**$**					$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Diesel VMT Converted	miles			Calculated		-	-	-	-	-	-	-
x	Average PM2.5 emitted per mile dirven	kg/mile			EPA		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	Kilograms to pounds conversion	number			Conversion Factor		2.20	2.20	2.20	2.20	2.20	2.20	2.20
=	Total pounds PM2.5 emitted	pounds			Calculated		-	-	-	-	-	-	-
x	Pounds to Tons Conversion Factor	#			Conversion Factor		0.00	0.00	0.00	0.00	0.00	0.00	0.00
x	PM2.5 Pollutant Cost	$/tons			EPA		382,429.62	390,078.21	397,879.78	405,837.37	413,954.12	422,233.20	430,677.87
=	**Total PM2.5 emission cost avoided by HD diesel vehicles**	**$**			**Calculated**		$ -	$ -	$ -	$ -	$ -	$ -	$ -
=	**Total Avoided Cost from SO2, NOX, and PM2.5 Reduction**	**$**	**x**		**Calculated**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Non-Electric Avoided Fuel Cost												
	Total Diesel VMT Converted	miles					-	-	-	-	-	-	-
/	Average mpg -- HD diesel vehicle	mpg			Transportation Initiative - Draft Testimony (Karsten Barde)		8.00	8.00	8.00	8.00	8.00	8.00	8.00
=	Gallons of diesel fuel consumed	gallons			Calculated		-	-	-	-	-	-	-
x	Price per gallon of diesel fuel	$/gallon			FAA		2.50	2.50	2.50	2.50	2.50	2.50	2.50
=	**Total avoided cost of diesel fuel**	**$**			**Calculated**		$ -	$ -	$ -	$ -	$ -	$ -	$ -
=	**Total Benefit from Non-Electric Avoided Fuel Cost**		**x**		**Calculated**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Net Utility Revenue Increase												
	Total Number of PHEVs -- NG Heavy Duty Fleet	number			Calculated		-	-	-	-	-	-	-
x	Average VMT -- NG Heavy Duty Fleet	miles			Calculated		8,670.63	8,758.81	8,847.88	8,937.87	9,028.76	9,120.59	9,213.34
x	% miles covered by battery capacity	%			Assumption from NY BCA Model Assumption		0.50	0.50	0.50	0.50	0.50	0.50	0.50
/	Average miles/kWh of PHEV's	miles/kWh			Transportation Initiative - Draft Testimony (Karsten Barde)		0.93	0.93	0.93	0.93	0.93	0.93	0.93
=	Total PHEV kWh charge -- NG Heavy Duty Fleet	kWh			Calculated		-	-	-	-	-	-	-
x	Price per kWh	$/kWh			Transportation Initiative - Draft Testimony (Karsten Barde)		0.095	0.095	0.095	0.095	0.095	0.095	0.095
=	**Total revenue increase -- NG Heavy Duty Fleet**	$		**x**	**x**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Return Benefits Home

Benefits - Off Peak Rebate Program

	Forward Commitment: Capacity Value												
	Total Demand Increase at Meter (MW)	MW			Calculated	-	0.08	0.21	0.41	-	-	-	-
/	1 - Losses	%			AESC 2015, ISO Distribution Losses, p.286	92%	92%	92%	92%	92%	92%	92%	92%
=	Change in Electric Demand at System	MW			Calculated	-	0.09	0.22	0.45	-	-	-	-
x	Derating Factor	%			Assumption	75%	75%	75%	75%	75%	75%	75%	75%
x	Avoided Unit Cost of Electric Capacity	$ / MW			AESC Appendix B	-	-	-	-	62,348.09	64,919.95	68,921.14	75,468.65
=	**Benefit from Forward Commitment: Capacity Value**[1]	**$**	**x**	**x**	**x**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

	RI Benefit				Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)											
	Net Energy Displaced (On-Peak)	MWh		Transportation Initiative - Draft Testimony (Karsten Barde)		300	750	1500				
/	1-Losses (at system level)	%		AESC Appendix B		92%	92%	92%				
=	Total Energy Displaced On-peak	MWh		Calculated		326.09	815.22	1,630.43				
	Shifted Energy Usage from On- to Off-Peak	MWh		Calculated		326.09	815.22	1,630.43				
x	Differential price from On- and Off-peak	$ / MWh		Differential pricing analysis from NG pricing team and K. Barde	$ 20	$ 20	$ 20	$ 20				
=	**Benefit from Supply & Transmission**	**$**		**Calculated**	**$ -**	**$ 6,522**	**$ 16,304**	**$ 32,609**				
	Greenhouse Gas (GHG) Externality Costs											
	NE-ISO Off-Peak LMU Marginal CO2 Emissions Rate	lbs / MWh		2015 ISO New England Electric Generator Air Emissions Report, Table 5.3, https		832.00	832.00	832.00	832.00	832.00	832.00	832.00
/	NE-ISO On-Peak LMU Marginal CO2 Emissions Rate	lbs / MWh		2015 ISO New England Electric Generator Air Emissions Report, Table 5.3, https		891.00	891.00	891.00	891.00	891.00	891.00	891.00
=	NE-ISO CO2 Off-Peak/On Peak Emission Ratio	ratio		Calculated		0.93	0.93	0.93	0.93	0.93	0.93	0.93
	Non-Embedded CO2 Cost	$ / MWh		AESC Appendix B		48.54	49.05	48.71	48.33	47.92	47.47	46.99
x	NE-ISO CO2 Off-Peak/On Peak Emission Ratio	%		Calculated		0.93	0.93	0.93	0.93	0.93	0.93	0.93
=	Value of CO2 to Charge at Off-Peak	$/MWh		Calculated		45.33	45.33	45.80	45.48	45.13	44.74	44.33
x	Net Energy Displaced (Off-peak)	MWh		Calculated		$ 300	$ 750	$ 1,500	$ -	$ -	$ -	$ -
/	1-Loss	%		AESC Framework		92%	92%	92%	92%	92%	92%	92%
=	**Value of CO2 to Displace Off-Peak**	**$**		**Calculated**		**$ 14,780**	**$ 36,950**	**$ 74,680**	**$ -**	**$ -**	**$ -**	**$ -**
	Net Energy Displaced (On-peak)	MWh		AESC Appendix B		300	750	1500	0	0	0	0
/	1 - Loss	%		AESC Framework		92%	92%	92%	92%	92%	92%	92%
=	Total On-Peak Energy Displaced			Calculated		326.09	815.22	1,630.43	-	-	-	-
x	Non-Embedded CO2 Cost	$ / MWh		AESC Appendix B		48.54	49.05	48.71	48.33	47.92	47.47	46.99
=	**Value of CO2 to Displace On-peak**	**$**		**Calculated**		**$ 15,828**	**$ 39,988**	**$ 79,414**	**$ -**	**$ -**	**$ -**	**$ -**
	Value of CO2 to Displace On-peak	$		Calculated		$ 15,828	$ 39,988	$ 79,414	$ -	$ -	$ -	$ -
-	Value of CO2 to Charge at Off-Peak	$		Calculated		$ 14,780	$ 36,950	$ 74,680	$ -	$ -	$ -	$ -
=	**Benefit from Reduced Greenhouse Gas Externality Costs**	**$**	x		**$ -**	**$ 1,048**	**$ 3,038**	**$ 4,734**	**$ -**	**$ -**	**$ -**	**$ -**
	Footnotes	1. See Transportation Handbook for explanation.										

###
Detailed build-up of EV benefits

EV - Benefits

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LINKS TO EV SUB-BENEFITS
Benefits - EV Consumer Conversion
Benefits - Fleet & Transit
Benefits - National Grid Heavy Duty Fleet
Benefits - Off Peak Rebate Program

	RI Benefit Description / Calculations	Unit	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Nominal Value	NPV
Benefits - EV Consumer Conversion									
	Forward Commitment: Capacity Value								
	Total Demand Increase at Meter (MW)	MW	(0.73)	(0.73)	(0.73)	(0.65)	(0.46)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Electric Demand at System	MW	(0.79)	(0.79)	(0.79)	(0.71)	(0.51)		
x	Derating Factor	%	75%	75%	75%	75%	75%		
x	Avoided Unit Cost of Electric Capacity	$ / MW	83,422.15	91,902.62	100,567.04	109,541.28	106,405.49		
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**$ (49,373)**	**$ (54,392)**	**$ (59,520)**	**$ (58,349)**	**$ (40,305)**	**$ (422,719)**	**$ (219,478)**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved								
	Change in Energy Usage	MWh	(3,599.68)	(3,636.29)	(3,673.27)	(3,128.82)	(2,213.24)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(3,912.70)	(3,952.49)	(3,992.69)	(3,400.89)	(2,405.70)		
x	Avoided Energy Cost	$ / MWh	77.92	80.58	84.83	89.02	93.26		
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**$ (304,881)**	**$ (318,506)**	**$ (338,683)**	**$ (302,741)**	**$ (224,355)**	**$ (2,857,724)**	**$ (1,580,757)**
	Avoided Renewable Energy Credit (REC) Cost								
	Change in Energy Usage	MWh	(3,599.68)	(3,636.29)	(3,673.27)	(3,128.82)	(2,213.24)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(3,912.70)	(3,952.49)	(3,992.69)	(3,400.89)	(2,405.70)		
x	Avoided REC Cost	$ / MWh	6.49	6.09	5.70	6.30	6.00		
=	**Total Avoided REC Cost**	**$**	**$ (25,409)**	**$ (24,087)**	**$ (22,764)**	**$ (21,433)**	**$ (14,427)**	**$ (263,780)**	**$ (153,953)**
	Wholesale Market Price Effect								
	Change in Energy Usage	MWh	(3,599.68)	(3,636.29)	(3,673.27)	(3,128.82)	(2,213.24)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(3,912.70)	(3,952.49)	(3,992.69)	(3,400.89)	(2,405.70)		
x	DRIPE	$ / MWh	0.20	0.21	0.21	0.21	0.22		
=	**Wholesale Market Price Effect**	**$**	**$ (791)**	**$ (812)**	**$ (833)**	**$ (721)**	**$ (518)**	**$ (9,173)**	**$ (5,571)**
	Greenhouse Gas (GHG) Externality Costs								
	ICE								
	Total ICE VMT Converted	miles/pop	12,598,894.64	12,727,025.40	12,856,459.25	10,950,872.57	7,746,342.98		
x	Average CO2 emitted per mile	kg/mile	0.41	0.41	0.41	0.41	0.41		
x	Kilograms to pounds conversion	pounds	2.20	2.20	2.20	2.20	2.20		
=	Total Pounds of CO2 emitted	pounds	11,415,740.01	11,531,838.08	11,649,116.88	9,922,482.70	7,018,888.56		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	CO2 abatement cost	$/short ton	100.00	100.00	100.00	100.00	100.00		
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**	**$ 570,787**	**$ 576,592**	**$ 582,456**	**$ 496,124**	**$ 350,944**		
	BEV								
x	Total BEVs Enabled -- Consumer	number	459.90	459.90	459.90	387.79	271.55		
x	VMT per capita in RI	miles/pop	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% VMT covered by battery capacity	%	0.95	0.95	0.95	0.95	0.95		
=	Total BEV VMT covered by battery	miles	4,080,323.83	4,121,820.73	4,163,739.64	3,546,589.41	2,508,758.80		
/	Electric vehicle efficiency	miles/kWh	3.50	3.50	3.50	3.50	3.50		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery	MWh	1,165.81	1,177.66	1,189.64	1,013.31	716.79		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of BEVs**	**$**	**$ 54,171**	**$ 54,065**	**$ 53,896**	**$ 45,252**	**$ 31,515**		
	PHEV								
	Total PHEVs Enabled -- Consumer	number	1,073.10	1,073.10	1,073.10	904.84	633.62		
x	VMT per capita in RI	miles/pop	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% VMT covered by battery capacity	%	0.85	0.85	0.85	0.85	0.85		
=	Total PHEV VMT covered by battery	miles	8,518,570.81	8,605,204.68	8,692,719.61	7,404,283.16	5,237,584.17		
/	Electric vehicle efficiency	miles/kWh	3.50	3.50	3.50	3.50	3.50		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery capacity	MWh	2,433.88	2,458.63	2,483.63	2,115.51	1,496.45		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of PHEVs**	**$**	**$ 113,093**	**$ 112,873**	**$ 112,520**	**$ 94,474**	**$ 65,794**		
=	**Total CO2 emissions combined BEV + PHEV cost**	**$**	**$ 167,263**	**$ 166,939**	**$ 166,417**	**$ 139,726**	**$ 97,309**		
=	**Net C02 emissions benefit**	**$**	**$ 403,524**	**$ 409,653**	**$ 416,039**	**$ 356,398**	**$ 253,635**	**$ 3,981,930**	**$ 2,274,529**

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
	Criteria Air Pollutant and Other Environmental Costs								
	Total ICE VMT Converted	miles	12,598,894.64	12,727,025.40	12,856,459.25	10,950,872.57	7,746,342.98		
x	Average SO2 emitted per mile driven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE SO2 emitted	pounds	499.96	505.04	510.18	434.56	307.40		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	SO2 Pollutant Cost	$ / short ton	1.65	1.72	1.79	1.86	1.93		
=	**Total SO2 emissions cost avoided by ICE vehicles**	**$**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**		
	Total ICE VMT Converted	miles	12,598,894.64	12,727,025.40	12,856,459.25	10,950,872.57	7,746,342.98		
x	Average NOX emitted per mile driven	kg/mile	0.01	0.01	0.01	0.01	0.01		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE NOX emitted	pounds	211,093.98	213,240.80	215,409.46	183,481.43	129,789.67		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	NOX Pollutant Cost	$ / short ton	14.86	15.46	16.08	16.73	17.41		
=	**Total NOX emissions cost avoided by ICE vehicles**	**$**	**$ 1,568**	**$ 1,648**	**$ 1,732**	**$ 1,535**	**$ 1,130**		
	Total ICE VMT Converted	miles	12,598,894.64	12,727,025.40	12,856,459.25	10,950,872.57	7,746,342.98		
x	Average PM2.5 emitted per mile dirven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE PM2.5 emitted	pounds	113.88	115.04	116.21	98.98	70.02		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	PM2.5 Pollutant Cost	$/tons	439,291.43	448,077.25	457,038.80	466,179.58	475,503.17		
=	**Total PM2.5 emission cost avoided by ICE vehicles**	**$**	**$ 25,013**	**$ 25,773**	**$ 26,556**	**$ 23,072**	**$ 16,647**		
=	**Total Avoided Cost from SO2, NOX, and PM2.5 Reduction**	**$**	**$ 26,581.96**	**$ 27,421.67**	**$ 28,288.54**	**$ 24,607.63**	**$ 17,777.05**	**$ 258,273.33**	**$145,984**
	Non-Electric Avoided Fuel Cost								
	Total ICE VMT Converted	miles	12,598,894.64	12,727,025.40	12,856,459.25	10,950,872.57	7,746,342.98		
/	Average mpg -- ICE vehicle	mpg	30.00	30.00	30.00	30.00	30.00		
=	Gallons of gasoline consumed	gallons	419,963.15	424,234.18	428,548.64	365,029.09	258,211.43		
x	Price per gallon of gasoline	$/gallon	2.73	2.76	2.79	2.82	2.85		
=	Total avoided cost of gasoline	$	$ 1,148,269	$ 1,171,546	$ 1,195,295	$ 1,028,310	$ 734,672		
=	**Total Benefit from Non-Electric Avoided Fuel Cost**		**$ 1,148,268.79**	**$ 1,171,546.15**	**$ 1,195,295.39**	**$ 1,028,309.78**	**$ 734,671.74**	**$ 11,259,510**	**$ 6,408,860**
	Economic Development								
	Rhode Island GDP Increase	**$**						**$ -**	**$ -**
	Net Utility Revenue Increase - Consumer								
	Total Number of BEVs - Consumer Facing	number	459.90	459.90	459.90	387.79	271.55		
x	VMT per capita in RI	miles	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% miles covered by battery capacity	%	95%	95%	95%	95%	95%		
x	At home charging percentage	%	80%	80%	80%	80%	80%		
/	Average miles/kWh of BEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total BEV kWh charge	kWh	932,645.45	942,130.45	951,711.92	810,649.01	573,430.58		
	Total Number of PHEVs - Consumer Facing	number	1,073.10	1,073.10	1,073.10	904.84	633.62		
x	VMT per capita in RI	miles	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% miles covered by battery capacity	%	85%	85%	85%	85%	85%		
x	At Home Charging Percentage	%	80%	80%	80%	80%	80%		
/	Average miles/kWh of PHEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total PHEV kWh charge	kWh	1,947,101.90	1,966,903.93	1,986,907.34	1,692,407.58	1,197,162.10		
=	**Total combined kWh charge (BEV + PHEV)**	kWh	2,879,747.35	2,909,034.38	2,938,619.26	2,503,056.59	1,770,592.68		
x	Price per kWh (at home charging)	$/kWh	0.180	0.185	0.191	0.199	0.207		
=	**Total revenue of combined BEV & PHEV charges**	**$**	**$ 518,954**	**$ 537,811**	**$ 562,131**	**$ 497,877**	**$ 365,690**		
	Total Number of PHEVs - Consumer Facing	number	1,073.10	1,073.10	1,073.10	904.84	633.62		
x	VMT per capita in RI	miles	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% miles covered by battery capacity	%	85%	85%	85%	85%	85%		
/	Average miles/kWh of PHEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total PHEV kWh charge	kWh	2,433,877.37	2,458,629.91	2,483,634.17	2,115,509.47	1,496,452.62		
x	On-Site Charging Percentage	%	20%	20%	20%	20%	20%		
x	Charging Rate at Utility-operated Station -- Consumer Level 2	$/kWh	0.2302	0.2349	0.2413	0.2489	0.2565		
x	Utility-Operated L2 Ports Percentage	%	40%	40%	40%	40%	40%		
=	**Total Estimated L2 Delivery Fee (PHEV)**	**$**	**$ 44,682**	**$ 46,052**	**$ 47,791**	**$ 41,992**	**$ 30,614**		
	Total Number of BEVs - Consumer Facing	number	459.90	459.90	459.90	387.79	271.55		
x	VMT per capita in RI	miles	9,339.16	9,434.13	9,530.08	9,627.00	9,724.91		
x	% miles covered by battery capacity	%	95%	95%	95%	95%	95%		
/	Average miles/kWh of BEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total BEV kWh charge	kWh	1,165,806.81	1,177,663.06	1,189,639.90	1,013,311.26	716,788.23		
x	Charging Rate at Utility-operated Station -- Consumer Level 2	$/kWh	0.23	0.23	0.24	0.25	0.26		
x	On-Site Charging Percentage	%	20%	20%	20%	20%	20%		
x	Utility-Operated Ports Percentage	%	40%	40%	40%	40%	40%		
=	**Total Estimated L2 Delivery Fee (BEV)**	**$**	**$ 21,402**	**$ 22,058**	**$ 22,891**	**$ 20,114**	**$ 14,664**		
	Charging Rate at Utility-operated Station - Consumer DCFC	$/kWh	0.43	0.43	0.44	0.45	0.46		
x	Total PHEV kWh charge	kWh	2,433,877.37	2,458,629.91	2,483,634.17	2,115,509.47	1,496,452.62		
x	At-Station Charging Percentage	%	20%	20%	20%	20%	20%		
x	Utility-Operated L2 Ports Percentage	%	3%	3%	3%	3%	3%		
=	**Total Estimated DCFC Delivery Fee (PHEV)**	**$**	**$ 6,627**	**$ 6,767**	**$ 6,937**	**$ 6,011**	**$ 4,324**		

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
	Charging Rate at Utility-operated Station - Consumer DCFC	$/kWh	0.43	0.43	0.44	0.45	0.46		
x	BEV kWh Charge at Applicable Station	kWh	1,165,806.81	1,177,663.06	1,189,639.90	1,013,311.26	716,788.23		
x	At-Station Charging Percentage	%	20%	20%	20%	20%	20%		
x	Utility-Operated Ports Percentage	%	3%	3%	3%	3%	3%		
=	**Total Estimated DCFC Delivery Fee (BEV)**	**$**	**$ 3,174**	**$ 3,241**	**$ 3,323**	**$ 2,879**	**$ 2,071**		
	Utility Revenue per kWh (Make-ready charging)	$/kWh	0.18	0.18	0.19	0.20	0.21		
x	Total PHEV kWh charge	kWh	2,433,877.37	2,458,629.91	2,483,634.17	2,115,509.47	1,496,452.62		
x	On-Site Charging Percentage	%	20%	20%	20%	20%	20%		
x	Make Ready Port %	%	57%	57%	57%	57%	57%		
=	**Total Estimated Revenue from Make-Ready charging - PHEV's**	**$**	**$ 49,968**	**$ 51,783**	**$ 54,125**	**$ 47,938**	**$ 35,211**		
	Utility Revenue per kWh (Make-ready charging)	$/kWh	0.18	0.18	0.19	0.20	0.21		
x	Total BEV kWh Charge	kWh	1,165,806.81	1,177,663.06	1,189,639.90	1,013,311.26	716,788.23		
x	On-Site Charging Percentage	%	20%	20%	20%	20%	20%		
x	Make Ready Port %	%	57%	57%	57%	57%	57%		
=	**Total Estimated Revenue from Make-Ready charging- BEV's**	**$**	**$ 23,934**	**$ 24,804**	**$ 25,925**	**$ 22,962**	**$ 16,866**		
	Total estimated revenue from Make-Ready Charging		$ 73,902	$ 76,587	$ 80,050	$ 70,900	$ 52,076		
+	Total estimated revenue from Utility-Operated Charging	$	$ 75,886	$ 78,119	$ 80,941	$ 70,995	$ 51,673		
+	Total estimated revenue from At-Home Charging	$	$ 518,954	$ 537,811	$ 562,131	$ 497,877	$ 365,690		
=	**Total utility revenue increase - Consumer**	$	**$ 668,741**	**$ 692,517**	**$ 723,123**	**$ 639,773**	**$ 469,440**	**$ 6,374,329**	**$ 3,562,000**

Return Benefits Home

Benefits - Fleet & Transit

	Forward Commitment: Capacity Value								
	Total Demand Increase at Meter (MW)	MW	(0.82)	(0.82)	(0.74)	(0.52)	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Electric Demand at System	MW	(0.89)	(0.89)	(0.80)	(0.57)	-		
x	Derating Factor	%	75%	75%	75%	75%	75%		
x	Avoided Unit Cost of Electric Capacity	$ / MW	83,422.15	91,902.62	100,567.04	109,541.28	106,405.49		
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**$ (55,630)**	**$ (61,285)**	**$ (60,357)**	**$ (46,750)**	**$ -**	**$ (405,176)**	**$ (218,553)**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)								
	Change in Energy Usage	MWh	(1,051.74)	(1,060.62)	(1,069.58)	(909.51)	(642.28)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(1,143.20)	(1,152.84)	(1,162.59)	(988.60)	(698.13)		
x	Avoided Energy Cost	$ / MWh	77.92	80.58	84.83	89.02	93.26		
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**$ (89,079)**	**$ (92,900)**	**$ (98,617)**	**$ (88,003)**	**$ (65,108)**	**$ (835,750)**	**$ (462,794)**
	Avoided Renewable Energy Credit (REC) Cost								
	Change in Energy Usage	MWh	(1,051.74)	(1,060.62)	(1,069.58)	(909.51)	(642.28)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(1,143.20)	(1,152.84)	(1,162.59)	(988.60)	(698.13)		
x	Avoided REC Cost	$ / MWh	6.49	6.09	5.70	6.30	6.00		
=	**Total Avoided REC Cost**	**$**	**$ (7,424)**	**$ (7,026)**	**$ (6,628)**	**$ (6,230)**	**$ (4,187)**	**$ (77,243)**	**$ (45,130)**
	Wholesale Market Price Effect								
	Change in Energy Usage	MWh	(1,051.74)	(1,060.62)	(1,069.58)	(909.51)	(642.28)		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	(1,143.20)	(1,152.84)	(1,162.59)	(988.60)	(698.13)		
x	DRIPE	$ / MWh	0.20	0.21	0.21	0.21	0.22		
=	**Wholesale Market Price Effect**	**$**	**$ (231)**	**$ (237)**	**$ (243)**	**$ (210)**	**$ (150)**	**$ (2,688)**	**$ (1,635)**
	Greenhouse Gas (GHG) Externality Costs								
	LD Fleet--ICE								
	Total Converted ICE VMT -- LD Fleet	miles	615,046.56	621,197.03	627,409.00	534,324.39	377,902.62		
x	Average CO2 emitted per mile	kg/mile	0.41	0.41	0.41	0.41	0.41		
x	Kilograms to pounds conversion	pounds	2.20	2.20	2.20	2.20	2.20		
=	Total Pounds of CO2 emitted	pounds	557,287.91	562,860.79	568,489.39	484,146.31	342,414.01		
x	Pounds to Tons Conversion Factor		0.00	0.00	0.00	0.00	0.00		
x	Non-embedded CO2 cost	$/short ton	90.31	89.23	88.06	86.80	85.46		
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**	**$ 25,165**	**$ 25,112**	**$ 25,029**	**$ 21,012**	**$ 14,631**		
	LD Fleet--BEV								
	Total LD Fleet BEV VMT covered by battery	miles	199,191.22	201,183.13	203,194.96	173,048.24	122,388.92		
/	Average miles/kWh BEVs	miles/kWh	3.50	3.50	3.50	3.50	3.50		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery	MWh	56.91	57.48	58.06	49.44	34.97		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of BEVs**	**$**	**$ 2,644**	**$ 2,639**	**$ 2,630**	**$ 2,208**	**$ 1,537**		
	LD Fleet--PHEV								
	Total LD Fleet PHEV VMT covered by battery	miles	415,855.35	420,013.90	424,214.04	361,276.15	255,513.70		
/	Electric vehicle efficiency	miles/kWh	3.50	3.50	3.50	3.50	3.50		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery	MWh	118.82	120.00	121.20	103.22	73.00		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of PHEVs**	**$**	**$ 5,521**	**$ 5,509**	**$ 5,491**	**$ 4,610**	**$ 3,210**		
=	**Total CO2 emissions combined BEV + PHEV cost**	$	**$ 8,165**	**$ 8,148**	**$ 8,121**	**$ 6,818**	**$ 4,747**		

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
=	**Net C02 emissions benefit -- LD Fleet**	**$**	**$ 17,000**	**$ 16,964**	**$ 16,908**	**$ 14,194**	**$ 9,883**	**$ 169,480**	**$ 97,733**
	Ridesharing-ICE								
	Total Converted ICE VMT -- Ridesharing	miles	617,203.13	617,203.13	617,203.13	520,428.41	364,430.34		
x	Average CO2 emitted per mile	kg/mile	0.41	0.41	0.41	0.41	0.41		
x	Kilograms to pounds conversion	pounds	2.20	2.20	2.20	2.20	2.20		
=	Total Pounds of CO2 emitted	pounds	559,241.95	559,241.95	559,241.95	471,555.29	330,206.91		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	Non-embedded CO2 cost	$/short ton	90.31	89.23	88.06	86.80	85.46		
=	**Total CO2 emissions cost avoided by ICE vehicles**	**$**	**$ 25,253**	**$ 24,951**	**$ 24,622**	**$ 20,465**	**$ 14,109**		
	Ridesharing-BEV								
	Total Ridesharing BEV VMT covered by battery	miles	649,687.50	649,687.50	649,687.50	547,819.38	383,610.88		
/	Average miles/kWh BEVs	miles/kWh	3.50	3.50	3.50	3.50	3.50		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery	MWh	185.63	185.63	185.63	156.52	109.60		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of BEVs**	**$**	**$ 8,625**	**$ 8,522**	**$ 8,410**	**$ 6,990**	**$ 4,819**		
=	**Net C02 emissions benefit -- Ridesharing**	**$**	**$ 16,628**	**$ 16,429**	**$ 16,213**	**$ 13,475**	**$ 9,290**	**$ 167,625**	**$ 97,270**
	Buses--Diesel								
	Total diesel VMT Converted -- Buses	miles	1,504,296.07	1,519,594.76	1,535,049.04	1,307,523.79	924,906.00		
x	Average CO2 emitted per mile	kg/mile	2.50	2.50	2.50	2.50	2.50		
x	Kilograms to pounds conversion	pounds	2.20	2.20	2.20	2.20	2.20		
=	Total Pounds of CO2 emitted	pounds	8,290,927.77	8,375,246.51	8,460,422.76	7,206,417.40	5,097,619.43		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	Non-embedded CO2 cost	$/short ton	90.31	89.23	88.06	86.80	85.46		
=	**Total CO2 emissions cost avoided by diesel buses**	**$**	**$ 374,390**	**$ 373,663**	**$ 372,495**	**$ 312,753**	**$ 217,810**		
	Battery Electric Buses (BEBs)								
	Total BEB VMT covered by battery	miles	1,504,296.07	1,519,594.76	1,535,049.04	1,307,523.79	924,906.00		
/	Average miles/kWh BEB	miles/kWh	2.15	2.15	2.15	2.15	2.15		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery	MWh	699.67	706.79	713.98	608.15	430.19		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of BEBs**	**$**	**$ 32,511**	**$ 32,448**	**$ 32,346**	**$ 27,159**	**$ 18,914**		
=	**Net C02 emissions benefit -- BEB's**	**$**	**$ 341,879**	**$ 341,215**	**$ 340,148**	**$ 285,594**	**$ 198,896**	**$ 3,407,744**	**$ 1,964,910**
=	**Net CO2 emissions benefit -- Fleet & Transit**	**$**	**$ 375,507**	**$ 374,608**	**$ 373,269**	**$ 313,264**	**$ 218,070**	**$ 3,744,849**	**$ 2,159,913**
	Criteria Air Pollutant and Other Environmental Costs								
	Total ICE VMT Converted	miles	1,232,249.69	1,238,400.15	1,244,612.12	1,054,752.80	742,332.96		
x	Average SO2 emitted per mile driven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE SO2 emitted	pounds	48.90	49.14	49.39	41.86	29.46		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	SO2 Pollutant Cost	$ / short ton	1.65	1.72	1.79	1.86	1.93		
=	**Total SO2 emissions cost avoided by ICE vehicles**	**$**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**		
	Total ICE VMT Converted	miles	1,232,249.69	1,238,400.15	1,244,612.12	1,054,752.80	742,332.96		
x	Average NOX emitted per mile driven	kg/mile	0.01	0.01	0.01	0.01	0.01		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE NOX emitted	pounds	20,646.29	20,749.35	20,853.43	17,672.34	12,437.76		
x	Pounds to Tons Conversion Factor	tons	0.00	0.00	0.00	0.00	0.00		
x	NOX Pollutant Cost	$ / short ton	14.86	15.46	16.08	16.73	17.41		
=	**Total NOX emissions cost avoided by ICE vehicles**	**$**	**$ 153**	**$ 160**	**$ 168**	**$ 148**	**$ 108**		
	Total ICE VMT Converted	miles	1,232,249.69	1,238,400.15	1,244,612.12	1,054,752.80	742,332.96		
x	Average PM2.5 emitted per mile dirven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds ICE PM2.5 emitted	pounds	11.14	11.19	11.25	9.53	6.71		
x	Pounds to Tons Conversion Factor	tons	0.00	0.00	0.00	0.00	0.00		
x	PM2.5 Pollutant Cost	$/tons	439,291.43	448,077.25	457,038.80	466,179.58	475,503.17		
=	**Total PM2.5 emission cost avoided by ICE vehicles**	**$**	**$ 2,446**	**$ 2,508**	**$ 2,571**	**$ 2,222**	**$ 1,595**		
	Total Diesel VMT Converted	miles	1504296.07	1519594.76	1535049.04	1307523.79	924906.00		
x	Average SO2 emitted per mile driven	tons/mile	0.00	0.00	0.00	0.00	0.00		
=	Total tons Diesel SO2 emitted	tons	0.03	0.03	0.03	0.03	0.02		
x	SO2 Pollutant Cost	$ / short ton	1.65	1.72	1.79	1.86	1.93		
=	**Total SO2 emissions cost avoided by diesel buses**	**$**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**		
	Total Diesel VMT Converted	miles	1504296.07	1519594.76	1535049.04	1307523.79	924906.00		
x	Average NOX emitted per mile driven	tons/mile	0.00	0.00	0.00	0.00	0.00		
=	Total tons Diesel NOX emitted	tons	26.84	27.11	27.39	23.33	16.50		
x	NOX Pollutant Cost	$ / short ton	14.86	15.46	16.08	16.73	17.41		
=	**Total NOX emissions cost avoided by diesel buses**	**$**	**$ 399**	**$ 419**	**$ 440**	**$ 390**	**$ 287**		
	Total Diesel VMT Converted	miles	1,504,296.07	1,519,594.76	1,535,049.04	1,307,523.79	924,906.00		
x	Average PM2.5 emitted per mile dirven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds Diesel PM2.5 emitted	pounds	669.91	676.72	683.60	582.28	411.89		
x	Pounds to Tons Conversion Factor	tons	0.00	0.00	0.00	0.00	0.00		
x	PM2.5 Pollutant Cost	$/tons	439,291.43	448,077.25	457,038.80	466,179.58	475,503.17		
=	**Total PM2.5 emission cost avoided by diesel buses**	**$**	**$ 147,142**	**$ 151,611**	**$ 156,216**	**$ 135,723**	**$ 97,927**		

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
=	**Total Avoided Cost from SO2, NOX, and PM 2.5 Reduction -- Fleet &**	**$**	**$ 150,141**	**$ 154,699**	**$ 159,395**	**$ 138,484**	**$ 99,918**	**$ 1,460,034**	**$ 825,866**
	Non-Electric Avoided Fuel Cost								
	Total ICE VMT Converted	miles	1,232,249.69	1,238,400.15	1,244,612.12	1,054,752.80	742,332.96		
/	Average mpg -- ICE vehicle	mpg	30.00	30.00	30.00	30.00	30.00		
=	Gallons of gasoline consumed	gallons	41,074.99	41,280.01	41,487.07	35,158.43	24,744.43		
x	Price per gallon of gasoline	$/gallon	2.73	2.76	2.79	2.82	2.85		
=	**Total avoided cost of gasoline**	**$**	**$ 112,308**	**$ 113,997**	**$ 115,715**	**$ 99,043**	**$ 70,404**		
	Total Diesel VMT Converted	miles	1,504,296.07	1,519,594.76	1,535,049.04	1,307,523.79	924,906.00		
x	Average mpg -- Diesel Bus	%	3.26	3.26	3.26	3.26	3.26		
=	Gallons of diesel fuel consumed	miles	461,440.51	466,133.36	470,873.94	401,080.92	283,713.50		
x	Price per gallon of diesel fuel	miles / gallon	2.50	2.50	2.50	2.50	2.50		
=	**Total Cost of Diesel Fuel**	**gallons**	**1,153,601.28**	**1,165,333.40**	**1,177,184.84**	**1,002,702.30**	**709,283.74**		
=	**Total Non-Electric Avoided Fuel Cost**		**$ 1,265,909**	**$ 1,279,330**	**$ 1,292,899**	**$ 1,101,746**	**$ 779,687**	**$ 12,523,927**	**$ 7,171,828**
	Net Utility Revenue Increase: Fleet & Transit								
	Total Number of BEV's - Light Duty Fleet	number	28.8	28.8	28.8	24.3	17.0		
x	VMT per LD Fleet vehicle -- RI	miles	7,280.38	7,353.18	7,426.72	7,500.98	7,575.99		
x	% miles covered by battery capacity	%	95%	95%	95%	95%	95%		
/	Average miles/kWh of BEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total BEV kWh charge -- Light Duty Fleet	kWh	56,911.78	57,480.89	58,055.70	49,442.35	34,968.26		
	Total Number of PHEVs - Light Duty Fleet	number	67.20	67.20	67.20	56.66	39.68		
x	VMT per LD Fleet vehicle -- RI	miles	7,280.38	7,353.18	7,426.72	7,500.98	7,575.99		
x	% miles covered by battery capacity	%	85%	85%	85%	85%	85%		
/	Average miles/kWh of PHEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total PHEV kWh charge -- Light Duty Fleet	kWh	118,815.81	120,003.97	121,204.01	103,221.76	73,003.91		
=	Total combined kWh charge (BEV + PHEV)	kWh	175,727.59	177,484.86	179,259.71	152,664.11	107,972.18		
x	Price per kWh	$/kWh	0.180	0.185	0.191	0.199	0.207		
=	**Total revenue from Light Duty Fleet charges**	**$**	**$ 31,668**	**$ 32,813**	**$ 34,291**	**$ 30,366**	**$ 22,300**	**$ 301,524**	**$ 168,375**
	Total Number of BEV's - Ridesharing	number	26.3	26.3	26.3	22.1	15.5		
x	VMT per Ridesharing vehicle -- RI	miles	24,750.00	24,750.00	24,750.00	24,750.00	24,750.00		
x	% miles covered by battery capacity	%	95%	95%	95%	95%	95%		
/	Average miles/kWh of BEV's	miles/kWh	3.50	3.50	3.50	3.50	3.50		
=	Total BEV kWh charge -- Ridesharing	kWh	176,343.75	176,343.75	176,343.75	148,693.83	104,122.95		
x	Price per kWh	$/kWh	0.180	0.185	0.191	0.199	0.207		
=	**Total revenue from Ridesharing charges**	**$**	**$ 31,779**	**$ 32,602**	**$ 33,733**	**$ 29,576**	**$ 21,505**	**$ 304,623**	**$ 171,160**
	Total Number of BEB's	number	84.00	84.00	84.00	70.83	49.60		
x	VMT per Bus	miles	18,850.83	19,042.54	19,236.20	19,431.84	19,629.46		
x	% miles covered by capacity	%	95%	95%	95%	95%	95%		
/	Average miles/kWh of BEB's	miles/kWh	2.15	2.15	2.15	2.15	2.15		
=	Total BEB kWh charge	kWh	699,672.59	706,788.26	713,976.30	608,150.60	430,188.84		
x	Price per kWh	$/kWh	0.180	0.185	0.191	0.199	0.207		
=	**Total revenue from BEB charges**	**$**	**$ 126,087**	**$ 130,668**	**$ 136,577**	**$ 120,966**	**$ 88,849**	**$ 1,200,414**	**$ 670,256**
=	**Total utility revenue increase -- Fleet & Transit**	**$**	**$ 189,533**	**$ 196,083**	**$ 204,601**	**$ 180,908**	**$ 132,654**	**$ 1,806,561**	**$ 1,009,791**
=	**Total utility revenue increase -- EV Conversion**	**$**	**$ 858,274**	**$ 888,600**	**$ 927,724**	**$ 820,681**	**$ 602,094**	**$ 8,180,890**	**$ 4,571,791**

Return Benefits Home

Benefits - National Grid Heavy Duty Fleet

	Forward Commitment: Capacity Value								
	Total Demand Increase at Meter (MW)	MW	-	-	-	-	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Electric Demand at System	MW	-	-	-	-	-		
x	Derating Factor	%	75%	75%	75%	75%	75%		
x	Avoided Unit Cost of Electric Capacity	$ / MW	83,422.15	91,902.62	100,567.04	109,541.28	106,405.49		
=	**Benefit from Forward Commitment: Capacity Value**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)								
	Change in Energy Usage	MWh	-	-	-	-	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	-	-	-	-	-		
x	Avoided Energy Cost	$ / MWh	77.92	80.58	84.83	89.02	93.26		
=	**Benefit from Energy Supply & Transmission Operating Value**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Avoided Renewable Energy Credit (REC) Cost								
	Change in Energy Usage	MWh	-	-	-	-	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	-	-	-	-	-		
x	Avoided REC Cost	$ / MWh	6.49	6.09	5.70	6.30	6.00		
=	**Total Avoided REC Cost**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
	Wholesale Market Price Effect								
	Change in Energy Usage	MWh	-	-	-	-	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Energy Usage at System	MWh	-	-	-	-	-		
x	DRIPE	$ / MWh	0.20	0.21	0.21	0.21	0.22		
=	**Wholesale Market Price Effect**	**$**	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Greenhouse Gas (GHG) Externality Cost								
	Diesel								
x	Total Diesel VMT Converted	miles/pop	-	-	-	-	-		
x	Average CO2 emitted per mile	kg/mile	2.50	2.50	2.50	2.50	2.50		
x	Kilograms to pounds conversion	pounds	2.20	2.20	2.20	2.20	2.20		
=	Total Pounds of CO2 emitted	pounds	-	-	-	-	-		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	Non-embedded CO2 cost	$/short ton	90.31	89.23	88.06	86.80	85.46		
=	**Total CO2 emissions cost avoided by Heavy Duty Diesel vehicles**	**$**	$ -	$ -	$ -	$ -	$ -		
	PHEV								
	Total Heavy duty (HD) fleet PHEV's	number	-	-	-	-	-		
x	VMT per vehicle -- HD Fleet	miles/vehicle	9,307.04	9,401.70	9,497.31	9,593.90	9,691.47		
x	% VMT covered by battery capacity	%	50%	50%	50%	50%	50%		
=	Total PHEV VMT covered by battery	miles	-	-	-	-	-		
/	Heavy duty PHEV efficiency	miles/kWh	0.93	0.93	0.93	0.93	0.93		
/	kWh to MWh conversion	number	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00		
=	Total MWh covered by battery -- Heavy Duty Fleet	MWh	-	-	-	-	-		
x	Non-embedded CO2 cost	$/MWh	46.47	45.91	45.30	44.66	43.97		
=	**Total CO2 emissions cost of Heavy Duty PHEVs**	**$**	$ -	$ -	$ -	$ -	$ -		
=	**Net C02 emissions benefit**	**$**	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Criteria Air Pollutant and Other Environmental Costs								
	Total Diesel VMT Converted	miles	-	-	-	-	-		
x	Average SO2 emitted per mile driven	tons/mile	0.00	0.00	0.00	0.00	0.00		
x	SO2 Pollutant Cost	$ / short ton	1.65	1.72	1.79	1.86	1.93		
=	**Total SO2 emissions cost avoided by HD diesel vehicles**	**$**	$ -	$ -	$ -	$ -	$ -		
	Total Diesel VMT Converted	miles	-	-	-	-	-		
x	Average NOX emitted per mile driven	tons/mile	0.00	0.00	0.00	0.00	0.00		
x	NOX Pollutant Cost	$ / short ton	14.86	15.46	16.08	16.73	17.41		
=	**Total NOX emissions cost avoided by HD diesel vehicles**	**$**	$ -	$ -	$ -	$ -	$ -		
	Total Diesel VMT Converted	miles	-	-	-	-	-		
x	Average PM2.5 emitted per mile dirven	kg/mile	0.00	0.00	0.00	0.00	0.00		
x	Kilograms to pounds conversion	number	2.20	2.20	2.20	2.20	2.20		
=	Total pounds PM2.5 emitted	pounds	-	-	-	-	-		
x	Pounds to Tons Conversion Factor	#	0.00	0.00	0.00	0.00	0.00		
x	PM2.5 Pollutant Cost	$/tons	439,291.43	448,077.25	457,038.80	466,179.58	475,503.17		
=	**Total PM2.5 emission cost avoided by HD diesel vehicles**	**$**	$ -	$ -	$ -	$ -	$ -		
=	**Total Avoided Cost from SO2, NOX, and PM2.5 Reduction**	**$**	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Non-Electric Avoided Fuel Cost								
	Total Diesel VMT Converted	miles	-	-	-	-	-		
/	Average mpg -- HD diesel vehicle	mpg	8.00	8.00	8.00	8.00	8.00		
=	Gallons of diesel fuel consumed	gallons	-	-	-	-	-		
x	Price per gallon of diesel fuel	$/gallon	2.50	2.50	2.50	2.50	2.50		
=	**Total avoided cost of diesel fuel**	**$**	$ -	$ -	$ -	$ -	$ -		
=	**Total Benefit from Non-Electric Avoided Fuel Cost**		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Net Utility Revenue Increase								
	Total Number of PHEVs -- NG Heavy Duty Fleet	number	-	-	-	-	-		
x	Average VMT -- NG Heavy Duty Fleet	miles	9,307.04	9,401.70	9,497.31	9,593.90	9,691.47		
x	% miles covered by battery capacity	%	0.50	0.50	0.50	0.50	0.50		
/	Average miles/kWh of PHEV's	miles/kWh	0.93	0.93	0.93	0.93	0.93		
=	Total PHEV kWh charge -- NG Heavy Duty Fleet	kWh	-	-	-	-	-		
x	Price per kWh	$/kWh	0.095	0.095	0.095	0.095	0.095		
=	**Total revenue increase -- NG Heavy Duty Fleet**	$	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Return Benefits Home

Benefits - Off Peak Rebate Program

	Forward Commitment: Capacity Value								
	Total Demand Increase at Meter (MW)	MW	-	-	-	-	-		
/	1 - Losses	%	92%	92%	92%	92%	92%		
=	Change in Electric Demand at System	MW	-	-	-	-	-		
x	Derating Factor	%	75%	75%	75%	75%	75%		
x	Avoided Unit Cost of Electric Capacity	$ / MW	83,422.15	91,902.62	100,567.04	109,541.28	106,405.49		
=	**Benefit from Forward Commitment: Capacity Value**[1]	**$**	$ -	$ -	$ -	$ -	$ -	$ -	$ -

	RI Benefit		Yr 9	Yr 10	Yr 11	Yr 12	Yr 13		
	Energy Supply & Transmission Operating Value of Energy Provided or Saved (time- and location-specific LMP)								
	Net Energy Displaced (On-Peak)	MWh							
/	1-Losses (at system level)	%							
=	Total Energy Displaced On-peak	MWh							
	Shifted Energy Usage from On- to Off-Peak	MWh							
x	Differential price from On- and Off-peak	$ / MWh							
=	**Benefit from Supply & Transmission**	**$**						**$ 55,435**	**$ 43,185**
	Greenhouse Gas (GHG) Externality Costs								
	NE-ISO Off-Peak LMU Marginal CO2 Emissions Rate	lbs / MWh	832.00	832.00	832.00				
/	NE-ISO On-Peak LMU Marginal CO2 Emissions Rate	lbs / MWh	891.00	891.00	891.00				
=	NE-ISO CO2 Off-Peak/On Peak Emission Ratio	ratio	0.93	0.93	0.93				
	Non-Embedded CO2 Cost	$ / MWh	46.47	45.91	45.30				
x	NE-ISO CO2 Off-Peak/On Peak Emission Ratio	%	0.93	0.93	0.93				
=	Value of CO2 to Charge at Off-Peak	$/MWh	43.88	43.39	42.87				
x	Net Energy Displaced (Off-peak)	MWh	$ -	$ -	$ -				
/	1-Loss	%	92%	92%	92%				
=	**Value of CO2 to Displace Off-Peak**	**$**	**$ -**	**$ -**	**$ -**				
	Net Energy Displaced (On-peak)	MWh	0	0	0				
/	1 - Loss	%	92%	92%	92%				
=	Total On-Peak Energy Displaced		-	-	-				
x	Non-Embedded CO2 Cost	$ / MWh	46.47	45.91	45.30				
=	**Value of CO2 to Displace On-peak**	**$**	**$ -**	**$ -**	**$ -**				
	Value of CO2 to Displace On-peak	$	$ -	$ -	$ -				
-	Value of CO2 to Charge at Off-Peak	$	$ -	$ -	$ -				
=	**Benefit from Reduced Greenhouse Gas Externality Costs**	**$**	**$ -**	**$ -**	**$ -**			**$ 8,820**	**$ 6,897**
	Footnotes	1. See Transpor							

###
Detailed build-up of EV costs

EV - Costs

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LINKS TO EV SUB-BENEFITS
Costs - (a) EV Consumer Conversion & (b) Fleet and Transit
Costs - National Grid Heavy Duty Fleet
Costs - Off Peak Rebate Program
Costs - Other

	RI Cost Description / Calculations	Unit	SCT	UTC	RIM	Source	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Costs - (a) EV Consumer Conversion & (b) Fleet and Transit															
	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs														
	Capital Expenditures	$				RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 1,005,232	$ 1,620,406	$ 3,785,464						
+	Operating Expenditures (Utility-Controlled Stations and Make-Ready)	$				RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 319,621	$ 468,046	$ 909,964	$ 95,200	$ 95,200	$ 95,200	$ 95,200	$ 95,200	$ 95,200
+	Education and Outreach Costs	$				RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 113,970	$ 164,959	$ 220,468						
=	Program Administration Costs (Before Participation Payments)	$				Calculated	$ 1,438,822	$ 2,253,411	$ 4,915,896	$ 95,200	$ 95,200	$ 95,200	$ 95,200	$ 95,200	$ 95,200
-	Participation Payments	$				RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ (17,500)	$ (43,750)	$ (113,750)						
=	**Total Program Administration Costs**	**$**	**x**	**x**	**x**	**Calculated**	**$ 1,421,322**	**$ 2,209,661**	**$ 4,802,146**	**$ 95,200**	**$ 95,200**	**$ 95,200**	**$ 95,200**	**$ 95,200**	**$ 95,200**
	Incremental Cost and Maintenance (Consumer)														
	Incremental Cost of Ownership														
	BEV														
	Average Cost of EV	$				Average MSRP	$ 29,894	$ 29,595	$ 29,299	$ 29,006	$ 28,716	$ 28,429	$ 28,145	$ 27,863	
-	Federal Tax Credit	$				https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	
-	State Tax Credit	$				http://www.drive.ri.gov/	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
=	Net cost of EV	$				Calculated	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	
-	Average Cost of ICE Vehicle	$				Average MSRP	$ 17,859	$ 18,216	$ 18,580	$ 18,952	$ 19,331	$ 19,717	$ 20,112	$ 20,514	
=	TCO per BEV	$				Calculated	$ 4,536	$ 4,179	$ 3,814	$ 3,443	$ 3,064	$ 2,677	$ 2,283	$ 1,880	
	BEV Purchases	#				Calculated	72.11	116.24	271.55						
=	**Total Cost of BEV Purchases**	**$**					**$ 327,077**	**$ 485,721**	**$ 1,035,774**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
	PHEV														
	Average Cost of EV	$				Average MSRP	$ 29,894	$ 29,595	$ 29,299	$ 29,006	$ 28,716	$ 28,429	$ 28,145	$ 27,863	
-	Federal Tax Credit	$				https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	
-	State Tax Credit	$				http://www.drive.ri.gov/	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
=	Net cost of EV	$				Calculated	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	
-	Average Cost of ICE Vehicle	$				Average MSRP	$ 17,859	$ 18,216	$ 18,580	$ 18,952	$ 19,331	$ 19,717	$ 20,112	$ 20,514	
=	TCO per PHEV	$				Calculated	$ 6,535.79	$ 6,178.62	$ 5,814.30	$ 5,442.70	$ 5,063.67	$ 4,677.06	$ 4,282.72	$ 3,880.48	
	PHEV Purchases	#				Calculated	168.26	271.23	633.62						
=	**Total Cost of PHEV Purchases**	**$**					**$ 1,099,694**	**$ 1,675,802**	**$ 3,684,040**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
=	**EV Cost of Ownership (before Maintenance)**	**$**				**Calculated**	**$ 1,426,771**	**$ 2,161,523**	**$ 4,719,814**						
	Incremental Maintenance Cost (Consumer)														
	Cumulative BEVs enabled	#					72.11	188.35	459.90	459.90	459.90	459.90	459.90	459.90	
	Cumulative PHEVs enabled	#					168.26	439.48	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	1,073.10	
+	PHEV Maintenance Costs	$/year				http://newsroom.aaa.com/2015/04/annual-cost-operate-vehi -	128,969.24	336,863.96	822,531.15	822,531.15	822,531.15	822,531.15	822,531.15	822,531.15	
-	ICE Maintenance Costs	$/year				http://newsroom.aaa.com/2015/04/annual-cost-operate-vehi -	184,241.77	481,234.23	1,175,044.50	1,175,044.50	1,175,044.50	1,175,044.50	1,175,044.50	1,175,044.50	
=	**Total Incremental Cost and Maintenance - Consumer**	**$**				$ -	**$ 1,371,498**	**$ 2,017,153**	**$ 4,367,301**	**$ (352,513)**	**$ (352,513)**	**$ (352,513)**	**$ (352,513)**	**$ (352,513)**	
	Incremental Cost and Maintenance (Fleet & Transit)														
	Incremental Cost of Ownership														
	BEV														
	Average Cost of EV	$				Average MSRP	$ 29,894	$ 29,894	$ 29,595	$ 29,299	$ 29,006	$ 28,716	$ 28,429	$ 28,145	
-	Federal Tax Credit	$				https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	
-	State Tax Credit	$				http://www.drive.ri.gov/	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
=	Net cost of EV	$				Calculated	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	$ 22,394	
-	Average Cost of ICE Vehicle	$				Average MSRP	$ 17,508	$ 17,859	$ 18,216	$ 18,580	$ 18,952	$ 19,331	$ 19,717	$ 20,112	
=	TCO per BEV	$				Calculated	$ 4,886	$ 4,536	$ 4,179	$ 3,814	$ 3,443	$ 3,064	$ 2,677	$ 2,283	
	BEV Purchases	#				Calculated	8.63	13.91	32.50						
=	**Total Cost of BEV Purchases**	**$**					**$ 42,174**	**$ 63,110**	**$ 135,824**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
	PHEV														
	Average Cost of EV	$				Average MSRP	$ 29,894	$ 29,595	$ 29,299	$ 29,006	$ 28,716	$ 28,429	$ 28,145	$ 27,863	
-	Federal Tax Credit	$				https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	$ 5,500	
-	State Tax Credit	$				http://www.drive.ri.gov/	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
=	Net cost of EV	$				Calculated	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	$ 24,394	
-	Average Cost of ICE Vehicle	$				Average MSRP	$ 17,859	$ 18,216	$ 18,580	$ 18,952	$ 19,331	$ 19,717	$ 20,112	$ 20,514	
=	TCO per PHEV	$				Calculated	$ 6,536	$ 6,179	$ 5,814	$ 5,443	$ 5,064	$ 4,677	$ 4,283	$ 3,880	
	PHEV Purchases	#				Calculated	10.54	16.98	39.68						
=	**Total Cost of PHEV Purchases**	**$**					**$ 68,865**	**$ 104,943**	**$ 230,703**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	
	BEB														
	BEB Purchases	#				Calculated	13.17	21.23	49.60						

	RI Cost			Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
x	Average Cost of BEB	$	CARB; FAA		727,998.90	706,331.10	684,000.00					
=	Total Cost of BEB's	$			$ 9,588,348	$ 14,996,114	$ 33,925,152					
	Airport BEB Purchases		Calculated		5.02	8.09	18.89					
-	Federal Tax Incentive (Airport Buses)	$	FAA		$ -	$ -	$ -					
=	Cost of BEBs, Net of Tax Incentive for Airport Buses	$	Calculated		$ 9,588,348	$ 14,996,114	$ 33,925,152					
-	Total Cost of Standard Diesel Buses	$	FAA		$ 6,321,997	$ 10,190,879	$ 23,807,124					
=	**Incremental Ownership Cost of BEB Purchases**	**$**			**$ 3,266,351**	**$ 4,805,235**	**$ 10,118,028**					
=	**EV Cost of Ownership before Maintenance**	**$**	**Calculated**		**$ 3,377,390**	**$ 4,973,288**	**$ 10,484,555**					

	RI Cost					Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
	Incremental Maintenance Cost													
	BEVs and PHEVs													
	Cumulative Number of BEVs	#					4.52	11.79	28.80	28.80	28.80	28.80	28.80	28.80
	Cumulative Number of PHEVs	#					10.54	27.52	67.20	67.20	67.20	67.20	67.20	67.20
+	PHEV Maintenance Costs	$/year			http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds		$ 8,076	$ 21,095	$ 51,509	$ 51,509	$ 51,509	$ 51,509	$ 51,509	$ 51,509
-	ICE Maintenance Costs	$/year			http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds		$ 11,538	$ 30,136	$ 73,584	$ 73,584	$ 73,584	$ 73,584	$ 73,584	$ 73,584
=	Incremental BEV and PHEV Maintenance Cost						$ (3,461)	$ (9,041)	$ (22,075)	$ (22,075)	$ (22,075)	$ (22,075)	$ (22,075)	$ (22,075)
	BEBs													
	Cumulative Number of BEBs	#					13.17	34.40	84.00	84.00	84.00	84.00	84.00	84.00
+	BEB Maintenance Costs	$/year			Sierrra Club		$ 114,487	$ 302,079	$ 745,097	$ 752,675	$ 760,330	$ 768,062	$ 775,873	$ 783,764
-	Diesel Bus Maintenance Costs	$/year			CARB		$ 457,950	$ 1,208,316	$ 2,980,389	$ 3,010,699	$ 3,041,318	$ 3,072,248	$ 3,103,493	$ 3,135,056
=	**Incremental BEB Maintenance Cost**						$ (343,462)	$ (906,237)	$ (2,235,292)	$ (2,258,024)	$ (2,280,989)	$ (2,304,186)	$ (2,327,620)	$ (2,351,292)
=	**Total Incremental Cost and Maintenance - Fleet & Transit**	**$**	x			**$ -**	**$ 3,030,466**	**$ 4,058,010**	**$ 8,227,188**	**$ (2,280,100)**	**$ (2,303,064)**	**$ (2,326,261)**	**$ (2,349,695)**	**$ (2,373,367)**

Return Costs Home

Costs - National Grid Heavy Duty Fleet

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs													
	Vehicle Upfit -- NG Fleet	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
+	Vehicle Operating Cost -- NG Fleet	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
+	NG Fleet EVSE Installation	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
=	**Total Program Administration Costs - NG Heavy Duty Fleet**	**$**	x x x			**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Incremental Cost and Maintenance - Maintenance Cost													
	Total Number of PHEVs -- NG Heavy Duty Fleet	#					0	0	0	0	0	0	0	0
+	PHEV maintenance costs	$/year			http://newsroom.aaa.com/2015/04/annual-cost-operate-vehi	$ -	$ 4,335	$ 4,379	$ 4,424	$ 4,469	$ 4,514	$ 4,560	$ 4,607	$ 4,654
-	Diesel maintenance costs	$/year			http://newsroom.aaa.com/2015/04/annual-cost-operate-vehi	$ -	$ 17,341	$ 17,518	$ 17,696	$ 17,876	$ 18,058	$ 18,241	$ 18,427	$ 18,614
=		$	x			**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Total Incremental Cost and Maintenance -- NG Heavy Duty Fleet													

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Costs - Off Peak Rebate Program

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs													
	Program Administatration Costs	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 133,745	$ 169,420	$ 208,817						
+	Rebate to Customers	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 7,500	$ 18,750	$ 37,500						
=	**Total Program Administration Costs -- Off-Peak Rebate**	**$**	x x x			**$ 141,245**	**$ 188,170**	**$ 246,317**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Return Costs Home

Costs - Other

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs													
	Rate Discount -- Implementation	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 50,000	$ 50,000	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -
	Customer Fleet Advisory Services				Added in Settlement, using portion of NG Fleet $	$ 40,000	$ 70,000	$ 100,000						
+	Evaluation	$			RI Electric Transportation Initiative_Cost Estimates_11-17-17	$ 30,000	$ 30,000	$ 30,000	$ -	$ -	$ -	$ -	$ -	$ -
=	**Total Other Costs**	**$**			**Calculated**	**$ 120,000**	**$ 150,000**	**$ 180,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net Utility Revenue Decrease													
	Rate Discount - Potential Value of Discount				RI Electric Transportation Initiative_Cost Estimates_11-17-17	**$ 53,622**	**$ 120,650**	**$ 214,488**						

###
Detailed build-up of EV costs

EV - Costs

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LINKS TO EV SUB-BENEFITS
Costs - (a) EV Consumer Conversion & (b) Fleet and Transit
Costs - National Grid Heavy Duty Fleet
Costs - Off Peak Rebate Program
Costs - Other

	RI Cost Description / Calculations	Unit	Yr 10	Yr 11	Yr 12	Yr 13	Nominal Value	NPV
Costs - (a) EV Consumer Conversion & (b) Fleet and Transit								
	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs							
	Capital Expenditures	$						
+	Operating Expenditures (Utility-Controlled Stations and Make-Ready)	$	$ 95,200	$ 85,680	$ 61,880	$ -		
+	Education and Outreach Costs	$						
=	Program Administration Costs (Before Participation Payments)	$	$ 95,200	$ 85,680	$ 61,880	$ -	$ 9,422,089	$ 7,716,033
-	Participation Payments	$					$ (175,000)	$ (145,702)
=	**Total Program Administration Costs**	**$**	**$ 95,200**	**$ 85,680**	**$ 61,880**	**$ -**	**$ 9,247,089**	**$ 7,570,332**
	Incremental Cost and Maintenance (Consumer)							
	Incremental Cost of Ownership							
	BEV							
	Average Cost of EV	$	$ 27,585	$ 27,309	$ 27,036	$ 26,765		
-	Federal Tax Credit	$	$ 7,500	$ 7,500	$ 7,500	$ 7,500		
-	State Tax Credit	$	$ -	$ -	$ -	$ -		
=	Net cost of EV	$	$ 22,394	$ 22,394	$ 22,394	$ 22,394		
-	Average Cost of ICE Vehicle	$	$ 20,924	$ 21,343	$ 21,769	$ 22,205		
=	TCO per BEV	$	$ 1,470	$ 1,052	$ 625	$ 189		
	BEV Purchases	#						
=	**Total Cost of BEV Purchases**	**$**	**$ -**	**$ -**	**$ -**	**$ -**		
	PHEV							
	Average Cost of EV	$	$ 27,585	$ 27,309	$ 27,036	$ 26,765		
-	Federal Tax Credit	$	$ 5,500	$ 5,500	$ 5,500	$ 5,500		
-	State Tax Credit	$	$ -	$ -	$ -	$ -		
=	Net cost of EV	$	$ 24,394	$ 24,394	$ 24,394	$ 24,394		
-	Average Cost of ICE Vehicle	$	$ 20,924	$ 21,343	$ 21,769	$ 22,205		
=	TCO per PHEV	$	$ 3,470.21	$ 3,051.73	$ 2,624.88	$ 2,189.49		
	PHEV Purchases	#						
=	**Total Cost of PHEV Purchases**	**$**	**$ -**	**$ -**	**$ -**	**$ -**		
=	**EV Cost of Ownership (before Maintenance)**	**$**						
	Incremental Maintenance Cost (Consumer)							
	Cumulative BEVs enabled	#	459.90	459.90	387.79	271.55		
	Cumulative PHEVs enabled	#	1,073.10	1,073.10	904.84	633.62		
+	PHEV Maintenance Costs	$/year	822,531.15	822,531.15	693,561.91	485,667.19		
-	ICE Maintenance Costs	$/year	1,175,044.50	1,175,044.50	990,802.73	693,810.27		
=	**Total Incremental Cost and Maintenance - Consumer**	**$**	**$ (352,513)**	**$ (352,513)**	**$ (297,241)**	**$ (208,143)**	**$ 4,782,975**	**$ 4,476,575**
	Incremental Cost and Maintenance (Fleet & Transit)							
	Incremental Cost of Ownership							
	BEV							
	Average Cost of EV	$	$ 27,863	$ 27,585	$ 27,309	$ 27,036		
-	Federal Tax Credit	$	$ 7,500	$ 7,500	$ 7,500	$ 7,500		
-	State Tax Credit	$	$ -	$ -	$ -	$ -		
=	Net cost of EV	$	$ 22,394	$ 22,394	$ 22,394	$ 22,394		
-	Average Cost of ICE Vehicle	$	$ 20,514	$ 20,924	$ 21,343	$ 21,769		
=	TCO per BEV	$	$ 1,880	$ 1,470	$ 1,052	$ 625		
	BEV Purchases	#						
=	**Total Cost of BEV Purchases**	**$**	**$ -**	**$ -**	**$ -**	**$ -**		
	PHEV							
	Average Cost of EV	$	$ 27,585	$ 27,309	$ 27,036	$ 26,765		
-	Federal Tax Credit	$	$ 5,500	$ 5,500	$ 5,500	$ 5,500		
-	State Tax Credit	$	$ -	$ -	$ -	$ -		
=	Net cost of EV	$	$ 24,394	$ 24,394	$ 24,394	$ 24,394		
-	Average Cost of ICE Vehicle	$	$ 20,924	$ 21,343	$ 21,769	$ 22,205		
=	TCO per PHEV	$	$ 3,470	$ 3,052	$ 2,625	$ 2,189		
	PHEV Purchases	#						
=	**Total Cost of PHEV Purchases**	**$**	**$ -**	**$ -**	**$ -**	**$ -**		
	BEB							
	BEB Purchases	#						

	RI Cost		Yr 10	Yr 11	Yr 12	Yr 13
x	Average Cost of BEB	$				
=	Total Cost of BEB's	$				
	Airport BEB Purchases					
-	Federal Tax Incentive (Airport Buses)	$				
=	Cost of BEBs, Net of Tax Incentive for Airport Buses	$				
-	Total Cost of Standard Diesel Buses	$				
=	**Incremental Ownership Cost of BEB Purchases**	**$**				
=	**EV Cost of Ownership before Maintenance**	**$**				

	RI Cost		Yr 10	Yr 11	Yr 12	Yr 13		
	Incremental Maintenance Cost							
	BEVs and PHEVs							
	Cumulative Number of BEVs	#	28.80	28.80	24.28	17.01		
	Cumulative Number of PHEVs	#	67.20	67.20	56.66	39.68		
+	PHEV Maintenance Costs	$/year	$ 51,509	$ 51,509	$ 43,432	$ 30,414		
-	ICE Maintenance Costs	$/year	$ 73,584	$ 73,584	$ 62,046	$ 43,448		
=	Incremental BEV and PHEV Maintenance Cost		$ (22,075)	$ (22,075)	$ (18,614)	$ (13,034)		
	BEBs							
	Cumulative Number of BEBs	#	84.00	84.00	70.83	49.60		
+	BEB Maintenance Costs	$/year	$ 791,735	$ 799,787	$ 681,242	$ 481,892		
-	Diesel Bus Maintenance Costs	$/year	$ 3,166,939	$ 3,199,147	$ 2,724,969	$ 1,927,567		
=	**Incremental BEB Maintenance Cost**		$ (2,375,204)	$ (2,399,360)	$ (2,043,727)	$ (1,445,675)		
=	**Total Incremental Cost and Maintenance - Fleet & Transit**	**$**	**$ (2,397,280)**	**$ (2,421,435)**	**$ (2,062,340)**	**$ (1,458,710)**	**$ (4,656,588)**	**$ 1,319,706**

Return Costs Home

Costs - National Grid Heavy Duty Fleet

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs							
	Vehicle Upfit -- NG Fleet	$	$ -	$ -	$ -	$ -		
+	Vehicle Operating Cost -- NG Fleet	$	$ -	$ -	$ -	$ -		
+	NG Fleet EVSE Installation	$	$ -	$ -	$ -	$ -		
=	**Total Program Administration Costs - NG Heavy Duty Fleet**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Incremental Cost and Maintenance - Maintenance Cost							
	Total Number of PHEVs -- NG Heavy Duty Fleet	#	0	0	0	0		
+	PHEV maintenance costs	$/year	$ 4,701	$ 4,749	$ 4,797	$ 4,846		
-	Diesel maintenance costs	$/year	$ 18,803	$ 18,995	$ 19,188	$ 19,383		
=		**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Total Incremental Cost and Maintenance -- NG Heavy Duty Fleet							

Return Costs Home

Costs - Off Peak Rebate Program

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs							
	Program Administatration Costs	$						
+	Rebate to Customers	$						
=	**Total Program Administration Costs -- Off-Peak Rebate**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 575,731**	**$ 492,495**

Return Costs Home

Costs - Other

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER Costs							
	Rate Discount -- Implementation	$	$ -	$ -	$ -	$ -		
	Customer Fleet Advisory Services							
+	Evaluation	$	$ -	$ -	$ -	$ -		
=	**Total Other Costs**	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 450,000**	**$ 386,321**
	Net Utility Revenue Decrease							
	Rate Discount - Potential Value of Discount						**$ 388,760**	**$ 326,937**

###
Summary of key EV assumptions

EV - Key Assumptions Summary

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REMOVED in SETTLEMENT

Summary Information	Consumer EV's	Unit	Light Duty Fleet Vehicles	Unit	Ridesharing EV's	Unit	Battery Electric Buses	Unit	NG Heavy Duty Fleet Vehicles	Unit
Enablement ratio	5.25	vehicles/port	2.0	vehicles/port	5.25	vehicles/port	4.0	buses/port	1	vehicle/port
Total vehicles enabled -- 2021	1533	vehicles	96	vehicles	26	vehicles	84	buses	0	vehicles
Average VMT -- 2021	8878	miles/capita	6927	miles/vehicle	24,750	miles/vehicle	17,921	miles/bus	8847.883156	miles/vehicle
Average purchase price -- 2021	29,299	$	29,299	$	29,299	$	684,000	$	80,000 (Net)	$
Total attributable usage increase at meter --2021	3422.10	MWh	167.20	MWh	176.34	MWh	665.15	MWh	-	MWh
Electricity usage/vehicle	2.23	MWh	1.74	MWh	6.72	MWh	7.92	MWh	#DIV/0!	MWh
Net utility revenue increase (NPV)	($3,561,999.67)	$	($168,374.88)	$	($171,160.22)	$	(670,255.80)	$	$0.00	$
Net utility revenue/vehicle enabled	(2,323.55)	$/vehicle	(1,753.91)	$/vehicle	(6,520.39)	$/vehicle	(7,979.24)	$/vehicle	#DIV/0!	$/vehicle

###
General assumptions applied to investment categories

Inputs - General

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General Assumptions

Assumption	Value	Unit	Source
Line Losses	8.0%	%	AESC 2015, p. 286. ISO Distribution Losses.
Wholesale Risk Premium (WRP)	9.0%	%	AESC 2015. Appendix B
Distribution Losses	8.0%	%	AESC 2015. Appendix B
Real Discount Rate	1.4%	%	AESC 2015. Appendix B
Percent of Capacity Bid into FCM (%Bid)	75.0%	%	AESC 2015. Appendix B
After-tax WACC	7.5%	%	See email from Josh Nowak
Inflation Rate	2.0%	%	

Emissions Assumptions

Assumption	Value	Unit	Source	Comments
CO2 Grid Emissions Factors	1029	lbs / MWh	http://www.neep.org/sites/default/files/Emission_Factors_Annual_Wr	1 short ton = 1 US ton = 2,000 lbs
SO2 Grid Emissions Factor	0.17	lbs / MWh	http://www.neep.org/sites/default/files/Emission_Factors_Annual_Wr	1 short ton = 1 US ton = 2,000 lbs
NOX Grid Emissions Factor	0.35	lbs / MWh	http://www.neep.org/sites/default/files/Emission_Factors_Annual_Wr	1 short ton = 1 US ton = 2,000 lbs
NE-ISO Off-Peak LMU Marginal CO2 Emission rate	832	lbs / MWh	2015 ISO New England Electric Generator Air Emissions Report, Table 5.3, https://www.iso-ne.com/static-assets/documents/2017/01/2015_e	
NE-ISO On-Peak LMU Marginal CO2 Emission rate	891	lbs / MWh	2015 ISO New England Electric Generator Air Emissions Report, Table 5.3, https://www.iso-ne.com/static-assets/documents/2017/01/2015_e	

Unit Conversions

Assumption	Value	Unit	Source
Pounds to Tons conversion	0.0005	#	Standard value
kg to pounds conversion	2.2046		
kWh to MWh conversion	1000		

Time Assumptions

Assumption	Unit	Source	Comments	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
CO2 Abatement Cost	$ / short ton	2015 AESC. Exhibit 4-7	AESC duration terminated at 2030. Kept same value through 2042	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Embedded Cost in Electric Energy Market Prices	$ / short ton	2015 AESC. Exhibit 4-7	AESC duration terminated at 2030. Projected linear trend through 2042	8.47	9.32	10.16	12.54	14.92	17.30	19.67	22.05	24.43	26.80	29.18	31.56	33.94	20.11
Non-embedded CO2 Costs (pre-inflation)	$ / short ton	2015 AESC. Exhibit 4-7		91.53	90.68	89.84	87.46	85.08	82.70	80.33	77.95	75.57	73.20	70.82	68.44	66.06	79.89
Non-embedded CO2 Costs (post-inflation)	$ / short ton	2015 AESC. Exhibit 4-7		93.36	94.34	95.34	94.67	93.94	93.13	92.27	91.33	90.31	89.23	88.06	86.80	85.46	105.41
Non-embedded CO2 Costs (pre-inflation)	$ / MWh	Calculated		47.09	46.65	46.22	45.00	43.77	42.55	41.33	40.11	38.88	37.66	36.44	35.21	33.99	41.10
Non-embedded CO2 Costs (post-inflation)	$ / MWh	Calculated		48.03	48.54	49.05	48.71	48.33	47.92	47.47	46.99	46.47	45.91	45.30	44.66	43.97	54.23

SO2 & NOx Emissions Factors - non-electric fuels

Fuel	Physical Units				Conversion Factors			Short Tons/MMBTU			Source
	Reported Unit	SO2 Constant	S value	SO2	NOx	MMBTU	Short Tons	SO2	NOx	lbs/MMBTU	
Natural Gas	lb/million cuft	0.6	2000	0.6	94	1032	2000	2.90698E-07	4.55426E-05	0.000581395	EPA
Propane	lb/thousand gallons	0.1	0.54	0.054	13	91.333	2000	2.95622E-07	7.11681E-05	0.000591243	https://www3.epa.g
Fuel Oil	lb/thousand gallons	142	0.003	42.6	18	138.5	2000	0.000153791	6.49819E-05	0.307581227	https://www3.epa.g

SO2 and NOX - AESC 2015 Update

Source: AESC 2015 Exhibit 4.1. Emission Allowance Prices per Short Ton. AESC notes pulled from SNL Financial.

Year	NOX		SO2	
	2015$	2017$	2015$	2017$
2015	10	10	1.11	1.11
2016	10	10.2	1.11	1.1322
2017	10	10.404	1.11	1.154844
2018	10	10.61208	1.11	1.17794088
2019	10	10.8243216	1.11	1.201499698
2020	10	11.04080803	1.11	1.225529692
2021	10	11.26162419	1.11	1.250040285
2022	10	11.48685668	1.11	1.275041091
2023	10	11.71659381	1.11	1.300541913
2024	10	11.95092569	1.11	1.326552751
2025	10	12.1899442	1.11	1.353083806
2026	10	12.43374308	1.11	1.380145482
2027	10	12.68241795	1.11	1.407748392
2028	10	12.9360663	1.11	1.43590336
2029	10	13.19478763	1.11	1.464621427
2030	10	13.45868338	1.11	1.493913856
2031	10	13.72785705	1.11	1.523792133
2032	10	14.00241419	1.11	1.554267975
2033	10	14.28246248	1.11	1.585353335
2034	10	14.56811173	1.11	1.617060402
2035	10	14.85947396	1.11	1.64940161
2036	10	15.15666344	1.11	1.682389642
2037	10	15.45979671	1.11	1.716037435
2038	10	15.76899264	1.11	1.750358183
2039	10	16.08437249	1.11	1.785365347
2040	10	16.40605994	1.11	1.821072654
2041	10	16.73418114	1.11	1.857494107
2042	10	17.06886477	1.11	1.894643989
2043	10	17.41024206	1.11	1.932536869
2044	10	17.7584469	1.11	1.971187606
2045	10	18.11361584	1.11	2.010611358
2046	10	18.47588816	1.11	2.050823586
2047	10	18.84540592	1.11	2.091840057

NOX & SO2 Costs (pre-inflation)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
NOX Cost	10.61208	10.8243216	11.04080803	11.26162419	11.48685668	11.71659381	11.95092569	12.1899442	12.43374308	12.68241795	12.9360663	13.19478763
SO2 Cost	1.17794088	1.201499698	1.225529692	1.250040285	1.275041091	1.300541913	1.326552751	1.353083806	1.380145482	1.407748392	1.43590336	1.464621427

NOX & SO2 Costs (post-inflation)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
NOX Cost	10.8243216	11.26162419	11.71659381	12.1899442	12.68241795	13.19478763	13.72785705	14.28246248	14.85947396	15.45979671	16.08437249	16.73418114
SO2 Cost	1.201499698	1.250040285	1.300541913	1.353083806	1.407748392	1.464621427	1.523792133	1.585353335	1.64940161	1.716037435	1.785365347	1.857494107

Avoided Unit Cost of Electric Capacity

Source		AESC 2015 Update, Appendix B														
Period	**Unit**	**Value**	**Source**		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
2018	$/kW-yr	0	AESC 2015 Update-Appendix B	Avoided Capacity Cost (pre-	-	-	-	-	137.44	129.15	134.50	148.24	162.28	175.80	189.64	204.51	224.61	233.55
2019	$/kW-yr	0	AESC 2015 Update-Appendix B															
2020	$/kW-yr	0	AESC 2015 Update-Appendix B															
2021	$/kW-yr	0	AESC 2015 Update-Appendix B	Inflation	2%													
2022	$/kW-yr	137.4430625	AESC 2015 Update-Appendix B	Conversion to MW	1000													
2023	$/kW-yr	129.149657	AESC 2015 Update-Appendix B															
2024	$/kW-yr	134.4992808	AESC 2015 Update-Appendix B	Avoided Capacity Cost (post-	-	$0	$0	$0	$62,348	$64,920	$68,921	$75,469	$83,422	$91,903	$100,567	$109,541	$106,405	$106,723
2025	$/kW-yr	148.2384617	AESC 2015 Update-Appendix B															
2026	$/kW-yr	162.2792734	AESC 2015 Update-Appendix B															
2027	$/kW-yr	175.7974832	AESC 2015 Update-Appendix B															
2028	$/kW-yr	189.6410963	AESC 2015 Update-Appendix B															
2029	$/kW-yr	204.5142091	AESC 2015 Update-Appendix B															
2030	$/kW-yr	224.6053249	AESC 2015 Update-Appendix B															
2031	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2032	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2033	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2034	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2035	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2036	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2037	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2038	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2039	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2040	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2041	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2042	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2043	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2044	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2045	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2046	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															
2047	$/kW-yr	233.5542486	AESC 2015 Update-Appendix B															

Avoided Unit Cost of Energy

Source		AESC 2015 Update, Appendix B				
Period	**Units**	**Winter Peak**	**Winter Off Peak**	**Summer Peak**	**Summer Off Peak**	**Electric Heat Weighted Avg.**
2018	$/kWh	0.042948462	0.036876354	0.028704835	0.02178498	0.032578658
2019	$/kWh	0.046553286	0.04066292	0.033877957	0.026867315	0.03699037
2020	$/kWh	0.050901503	0.043353232	0.042024216	0.030786197	0.041766287
2021	$/kWh	0.055575249	0.047862525	0.044949693	0.034145396	0.045633216
2022	$/kWh	0.056916434	0.048943738	0.046748022	0.03582828	0.047109119
2023	$/kWh	0.060706346	0.052195695	0.050601754	0.039739327	0.050810781
2024	$/kWh	0.063356121	0.054474697	0.053075039	0.043059944	0.05349145
2025	$/kWh	0.065459372	0.056791445	0.057419018	0.045059684	0.05618238
2026	$/kWh	0.065377361	0.056618223	0.058916675	0.045774345	0.056671651
2027	$/kWh	0.066370041	0.057470526	0.059460932	0.04649156	0.057448265
2028	$/kWh	0.067678713	0.058651355	0.063320806	0.048644215	0.059573772
2029	$/kWh	0.069197745	0.060328826	0.065926997	0.050250116	0.061425921
2030	$/kWh	0.070740047	0.06252036	0.067778112	0.051705298	0.063185955
2031	$/kWh	0.071133805	0.063467611	0.073302463	0.05315417	0.065264512
2032	$/kWh	0.072344541	0.064933877	0.076576345	0.05476718	0.067155486
2033	$/kWh	0.073575886	0.066434018	0.079996448	0.056429138	0.069108872
2034	$/kWh	0.074828188	0.067968815	0.083569301	0.05814153	0.071126959
2035	$/kWh	0.076101805	0.069539071	0.087301728	0.059905886	0.073212123
2036	$/kWh	0.0773971	0.071145603	0.091200854	0.061723783	0.075366835
2037	$/kWh	0.078714442	0.072789251	0.095274126	0.063596846	0.077593666
2038	$/kWh	0.080054206	0.074470871	0.099529321	0.065526748	0.079895286
2039	$/kWh	0.081416773	0.076191341	0.103974564	0.067515215	0.082274473
2040	$/kWh	0.082802531	0.077951558	0.108618344	0.069564024	0.084734114
2041	$/kWh	0.084211876	0.079752441	0.113469527	0.071675006	0.087277212
2042	$/kWh	0.085645209	0.081594929	0.118537377	0.073850047	0.08990689
2043	$/kWh	0.087102938	0.083479983	0.12383157	0.076091092	0.092626396
2044	$/kWh	0.088585479	0.085408586	0.129362216	0.078400143	0.095439106
2045	$/kWh	0.090093253	0.087381746	0.135139876	0.080779265	0.098348535
2046	$/kWh	0.09162669	0.08940049	0.141175581	0.083230583	0.101358336
2047	$/kWh	0.093186227	0.091465873	0.147480857	0.085756288	0.104472311

Avoided Energy Costs Electric Heat and Electric Vehicles Weighted Average

Seasonal Avoided Energy Costs (pre-inflation)

Period	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Winter On-Peak	0.042948462	0.046553286	0.050901503	0.055575249	0.056916434	0.060706346	0.063356121	0.065459372	0.065377361	0.066370041	0.067678713	0.069197745	0.070740047	0.071133805	0.072344541	0.073575886	0.074828188	0.076101805
Winter Off-Peak	0.036876354	0.04066292	0.043353232	0.047862525	0.048943738	0.052195695	0.054474697	0.056791445	0.056618223	0.057470526	0.058651355	0.060328826	0.06252036	0.063467611	0.064933877	0.066434018	0.067968815	0.069539071
Summer On-Peak	0.028704835	0.033877957	0.042024216	0.044949693	0.046748022	0.050601754	0.053075039	0.057419018	0.058916675	0.059460932	0.063320806	0.065926997	0.067778112	0.073302463	0.076576345	0.079996448	0.083569301	0.087301728
Summer Off-Peak	0.02178498	0.026867315	0.030786197	0.034145396	0.03582828	0.039739327	0.043059944	0.045059684	0.045774345	0.04649156	0.048644215	0.050250116	0.051705298	0.05315417	0.05476718	0.056429138	0.05814153	0.059905886

Seasonal and Peak Segmentation

Winter months / year	8
Summer months / year	4
Hours / year	8760
On-peak hours / day	16
Off-peak hours / day	8

Season	On-Peak	Off-Peak	Total
Winter	3,893.33	1,946.67	5,840.00
Summer	1,946.67	973.33	2,920.00

Electric Heat & EV Seasonal Load Segmentation

Season	Ratio
Summer Off-Peak	11.11%
Summer On-Peak	22.22%
Winter Off-Peak	22.22%
Winter On-Peak	44.44%
	100.00%

Weighted Average Annual Price (pre-inflation & WRP)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hourly Wght. Avg. YOY	0.0361	0.0402	0.0450	0.0491	0.0505	0.0542	0.0568	0.0595	0.0598	0.0606	0.0626	0.0644	0.0661	0.0679	0.0697	0.0715	0.0734	0.0753

Add MRP & Inflation

MRP	1.09
Inflation	0.02

Weighted Average Annual Price (pre-inflation & WRP)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hourly Wght. Avg. YOY	0.0401	0.0456	0.0521	0.0580	0.0608	0.0666	0.0712	0.0760	0.0779	0.0806	0.0848	0.0890	0.0933	0.0977	0.1022	0.1070	0.1120	0.1173

Avoided REC Cost

Source AESC 2015 Update, Appendix B

Period	Units	Value
2018	$/kWh	0.005508139
2019	$/kWh	0.005958249
2020	$/kWh	0.005659665
2021	$/kWh	0.00680032
2022	$/kWh	0.006509963
2023	$/kWh	0.006051674
2024	$/kWh	0.005772086
2025	$/kWh	0.005405181
2026	$/kWh	0.004985127
2027	$/kWh	0.004586611
2028	$/kWh	0.004206788
2029	$/kWh	0.004558828
2030	$/kWh	0.004253013
2031	$/kWh	0.004253013
2032	$/kWh	0.004253013
2033	$/kWh	0.004253013
2034	$/kWh	0.004253013
2035	$/kWh	0.004253013
2036	$/kWh	0.004253013
2037	$/kWh	0.004253013
2038	$/kWh	0.004253013
2039	$/kWh	0.004253013
2040	$/kWh	0.004253013
2041	$/kWh	0.004253013
2042	$/kWh	0.004253013
2043	$/kWh	0.004253013
2044	$/kWh	0.004253013
2045	$/kWh	0.004253013
2046	$/kWh	0.004253013
2047	$/kWh	0.004253013

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Avoided Capacity Cost (pre-infla	0.0055	0.0060	0.0057	0.0068	0.0065	0.0061	0.0058	0.0054	0.0050	0.0046	0.0042	0.0046	0.0043	0.0043
MRP	1.09													
Inflation	2%													
Convert to MW	1,000.00													
Avoided Capacity Cost (post-infl	6.12	6.76	6.55	8.02	7.83	7.43	7.23	6.90	6.49	6.09	5.70	6.30	6.00	6.12

DRIPE

Source AESC 2015 Update, Appendix B

Energy

Period	Unit	Winter Peak	Winter Off Peak	Summer Peak	Summer Off Peak	Electric Heat -Wgt. Avg.	Seasonal Weighted Average	Energy Storage - Wgt. Avg.
2018	$/kWh	1.25566E-06	5.06517E-07	0	0	4.40545E-07	7.39688E-07	8.12081E-07
2019	$/kWh	0	0	0	0	0	0	0
2020	$/kWh	0	0	0	0	0	0	0

Capacity

Period	Unit	Winter	Summer	Electric Heat - Weighted Average	Solar - Seasonal Weighted Average	Energy Storage - Wgt. Avg.
2018	$/kWh	0.001583956	0.00103838	0.001311168	0.00136285	0.001402097
2019	$/kWh	0.001012791	0.00068337	0.00084808	0.000879286	0.000902984
2020	$/kWh	0.000991781	0.000669757	0.000830769	0.000861274	0.00088444
2021	$/kWh	0.000179686	0.000165304	0.000172495	0.000173857	0.000174892
2022	$/kWh	0.000179201	0.000164577	0.000171889	0.000173274	0.000174326
2023	$/kWh	0.000178737	0.000163881	0.000171309	0.000172717	0.000173785
2024	$/kWh	0.000178182	0.000163048	0.000170615	0.000172049	0.000173137
2025	$/kWh	0.00017763	0.000162221	0.000169925	0.000171385	0.000172494
2026	$/kWh	0.000177082	0.000161399	0.000169241	0.000170726	0.000171855
2027	$/kWh	0.000176538	0.000160583	0.00016856	0.000170072	0.00017122
2028	$/kWh	0.000175998	0.000159772	0.000167885	0.000169422	0.000170589
2029	$/kWh	0.000175461	0.000158967	0.000167214	0.000168776	0.000169963
2030	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2031	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2032	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2033	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2034	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2035	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2036	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2037	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2038	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2039	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2040	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2041	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2042	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2043	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2044	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2045	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2046	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341
2047	$/kWh	0.000174928	0.000158167	0.000166548	0.000168135	0.000169341

Electric Heat and Electric Vehicles - DRIPE (pre-inflation)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Energy	4.40545E-07	0	0															
Capacity	0.001311168	0.00084808	0.000830769	0.000172495	0.000171889	0.000171309	0.000170615	0.000169925	0.000169241	0.00016856	0.000167885	0.000167214	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548
Total DRIPE	0.001311609	0.00084808	0.000830769	0.000172495	0.000171889	0.000171309	0.000170615	0.000169925	0.000169241	0.00016856	0.000167885	0.000167214	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548

Inflation	2%
Conversion to MW	1,000.00

Electric Heat DRIPE (post inflation)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total DRIPE	1.337840737	0.882342644	0.881618693	0.186713876	0.189779136	0.19292199	0.195982934	0.199094693	0.202258148	0.205474195	0.208743747	0.212067732	0.215447097	0.219756039	0.22415116	0.228634183	0.233206867	0.237871004

Solar DRIPE

Solar DRIPE (pre-inflation)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Energy	7.39688E-07	0	0															
Capacity	0.00136285	0.000879286	0.000861274	0.000173857	0.000173274	0.000172717	0.000172049	0.000171385	0.000170726	0.000170072	0.000169422	0.000168776	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135
Total DRIPE	0.00136359	0.000879286	0.000861274	0.000173857	0.000173274	0.000172717	0.000172049	0.000171385	0.000170726	0.000170072	0.000169422	0.000168776	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135

Inflation	2%
Conversion to MW	1,000.00

Solar DRIPE (post-inflation)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total DRIPE	1.39086186	0.914809363	0.913991069	0.188188586	0.19130869	0.194506868	0.197629728	0.200805036	0.20403371	0.207316685	0.210654913	0.214049364	0.217501024	0.221851045	0.226288066	0.230813827	0.235430104	0.240138706

Solar - Seasonal Demand by System Type

Season	Sum of 250 kW System - Annual Output (MW)	Sum of 500 kW System - Annual Output (MW)	Sum of 1,500 kW System - Annual Output (MW)
Summer Off-Peak	1%	1%	1%
Summer On-Peak	39%	39%	39%
Winter Off-Peak	1%	1%	1%
Winter On-Peak	59%	59%	59%
Total	**1**	**1**	**1**

Energy Storage DRIPE (pre-inflation)

Energy Storage DRIPE (pre-inflation)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Energy	8.12081E-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	0.001402097	0.000902984	0.00088444	0.000174892	0.000174326	0.000173785	0.000173137	0.000172494	0.000171855	0.00017122	0.000170589	0.000169963	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341
Total DRIPE	0.001402909	0.000902984	0.00088444	0.000174892	0.000174326	0.000173785	0.000173137	0.000172494	0.000171855	0.00017122	0.000170589	0.000169963	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341

Inflation	2.00%
Convert to MWh	1,000.00

Energy Storage DRIPE (post-inflation)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total	1.430967683	0.939464253	0.938574317	0.189308465	0.192470217	0.195710408	0.198880287	0.202103853	0.205382054	0.208715853	0.212106234	0.215554195	0.219060755	0.22344197	0.22791081	0.232469026	0.237118407	0.241860775

New England Residential Energy Prices

Energy Prices Residential (Case Reference case Region New England)
https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2017&region=1-1&cases=ref2017~ref_no_cpp&start=2015&end=2050&f=A&linechart=~~~ref2017-d120816a.
09:51:48 GMT-0400 (Eastern Daylight Time)
Source: U.S. Energy Information Administration

New England Residential Energy Prices

Year	**Propane 2016 $/MMBtu**	**Distillate Fuel Oil 2016 $/MMBtu**	**Natural Gas 2016 $/MMBtu**	**Electricity 2016 $/MMBtu**
2015	20.059196	19.634937	12.999855	57.913372
2016	18.986731	15.391558	12.499926	52.962849
2017	19.159531	18.481035	12.559583	53.759666
2018	20.3908	20.35202	12.730404	46.24337
2019	20.428343	21.432173	12.863449	47.102016
2020	20.36684	21.913502	13.038426	45.619492
2021	20.38199	22.292168	13.248834	45.495861
2022	20.818222	22.562029	13.447027	47.376621
2023	21.09973	22.895624	13.598397	49.17429
2024	21.193447	23.217937	13.719156	50.349106
2025	21.149662	23.695726	13.810126	51.765896
2026	21.188416	24.066542	13.868716	52.806141
2027	21.388361	24.263973	13.997381	53.399616
2028	21.446894	24.305296	14.186235	53.822887
2029	21.470636	24.524441	14.388145	54.817307
2030	21.637087	24.984591	14.524349	55.649223
2031	22.067629	25.394388	14.584588	55.851391
2032	22.390608	25.889307	14.683081	55.949352
2033	22.452869	25.806747	14.751159	56.23835
2034	22.691654	26.115984	14.936297	56.59457
2035	22.800667	26.332081	15.181598	57.886639
2036	23.140226	26.861704	15.332048	58.283558
2037	23.296213	26.936857	15.496017	58.576546
2038	23.60668	27.103247	15.618446	58.816032
2039	24.046312	27.475222	15.740956	57.837711
2040	24.210247	27.673616	15.790576	59.10891
2041	24.474936	27.717131	15.916462	59.452782
2042	24.614227	27.769522	16.047209	59.981743
2043	24.814363	27.830799	16.209641	60.750565
2044	24.986708	27.928757	16.403036	61.422989
2045	25.068331	28.020597	16.601873	61.820881
2046	25.256636	28.191952	16.78653	62.281025
2047	25.456972	28.537254	16.932384	63.031494
2048	25.692049	28.555511	17.094194	63.291729
2049	25.812935	28.743196	17.232834	63.588299
2050	26.039854	29.019983	17.207699	65.033279

Spot vs. Long-term Fuel Purchases

Category	**Percent of Total**	**Discount from Base Residential**
Long-term	10%	10%
Spot Purchase	90%	0%
Total	100%	N/A
Source	http://www.treesfullofmoney.com/2017-heating-oil-price-predictions/	
Assumptions	Based on EIA forecast, assume prices are increasing and customers experience historical 5 - 15% savings from pre-buy contracts	

Spot vs. Long-term - Natural Gas		
Category	Percent of Total	Discount from Base Residential
Long-term	5%	5%
Spot Purchase	95%	0%
Total	100%	N/A

Spot vs. Long-term - Natural Gas		
Category	Percent of Total	Discount from Base Residential
Long-term	0%	5%
Spot Purchase	100%	0%
Total	100%	N/A

Adjusted Residential Fuel Oil Prices Based on Pre-Buy Forecast		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Base Distillate Fuel Oil		19.63	15.39	18.48	20.35	21.43	21.91	22.29	22.56	22.90	23.22	23.70	24.07	24.26	24.31	24.52	24.98	25.39
Base Distillate Fuel Oil - Convert $ / MMBTU to $ / Gallon		1.79	1.41	1.69	1.86	1.96	2.00	2.04	2.06	2.09	2.12	2.16	2.20	2.22	2.22	2.24	2.28	2.32
Distillate Fuel Oil - Apply Pre-buy Discount		1.78	1.39	1.67	1.84	1.94	1.98	2.02	2.04	2.07	2.10	2.14	2.18	2.19	2.20	2.22	2.26	2.30
	Pre-buy discount	10%																
Distillate Fuel Oil - Convert $ / Gallon to $ / MMBTU		19.44	15.24	18.30	20.15	21.22	21.69	22.07	22.34	22.67	22.99	23.46	23.83	24.02	24.06	24.28	24.73	25.14

Adjusted Residential Natural Gas Prices Based on Pre-Buy Forecast		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Base Natural Gas ($ / MMBTU)		13.00	12.50	12.56	12.73	12.86	13.04	13.25	13.45	13.60	13.72	13.81	13.87	14.00	14.19	14.39	14.52	14.58
Natural Gas - Apply Price Protection Discount		12.96735536	12.46867619	12.52818404	12.69857799	12.83129038	13.00582994	13.21571192	13.41340943	13.56440101	13.68485811	13.77560069	13.83404421	13.96238755	14.15076941	14.35217464	14.48803813	14.54812653
	Assume pre-buy discount is 5%, with 5% of customers using																	

Propane 2016 $/MMBtu		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Base Propane 2016 $/MMBtu		20.06	18.99	19.16	20.39	20.43	20.37	20.38	20.82	21.10	21.19	21.15	21.19	21.39	21.45	21.47	21.64	22.07
Propane - Apply Price Discount		20.06	18.99	19.16	20.39	20.43	20.37	20.38	20.82	21.10	21.19	21.15	21.19	21.39	21.45	21.47	21.64	22.07
	Assume pre-buy discount is zero																	

###
General assumptions applied to investment categories

Inputs - General

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General Assumptions

Assumption
Line Losses
Wholesale Risk Premium (WRP)
Distribution Losses
Real Discount Rate
Percent of Capacity Bid into FCM (%Bid)
After-tax WACC
Inflation Rate

Emissions Assumptions

Assumption
CO2 Grid Emissions Factors
SO2 Grid Emissions Factor
NOX Grid Emissions Factor
NE-ISO Off-Peak LMU Marginal CO2 Emission rate
NE-ISO On-Peak LMU Marginal CO2 Emission rate

Unit Conversions

Assumption
Pounds to Tons conversion
kg to pounds conversion
kWh to MWh conversion

Time Assumptions

Assumption	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
CO2 Abatement Cost	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Embedded Cost in Electric Energy Market Prices	20.12	20.13	20.14	20.15	20.16	20.17	20.18	20.19	20.20	20.21	20.22	20.23	20.24	20.25	20.26	20.27
Non-embedded CO2 Costs (pre-inflation)	79.88	79.87	79.86	79.85	79.84	79.83	79.82	79.81	79.80	79.79	79.78	79.77	79.76	79.75	79.74	79.73
Non-embedded CO2 Costs (post-inflation)	107.51	109.64	111.82	114.04	116.31	118.62	120.98	123.38	125.84	128.34	130.89	133.49	136.14	138.85	141.61	144.42
Non-embedded CO2 Costs (pre-inflation)	41.10	41.09	41.09	41.08	41.08	41.07	41.07	41.06	41.06	41.05	41.05	41.04	41.04	41.03	41.03	41.02
Non-embedded CO2 Costs (post-inflation)	55.31	56.41	57.53	58.68	59.84	61.03	62.24	63.48	64.74	66.03	67.34	68.68	70.05	71.44	72.86	74.30

SO2 & NOx Emissions Factors - non-electric fuels

Fuel
Natural Gas
Propane
Fuel Oil

SO2 and NOX - AESC 2015 Update

Source:

Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
2015	13.45868338	13.72785705	14.00241419	14.28246248	14.56811173	14.85947396	15.15666344	15.45979671	15.76899264	16.08437249	16.40605994	16.73418114	17.06886477	17.41024206	17.7584469	18.11361584	18.47588816	18.8454059
2016	1.493913856	1.523792133	1.554267975	1.585353335	1.617060402	1.64940161	1.682389642	1.716037435	1.750358183	1.785365347	1.821072654	1.857494107	1.894643989	1.932536869	1.971187606	2.010611358	2.050823586	2.09184006
2017																		
2018																		
2019	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
2020	17.41024206	18.11361584	18.84540592	19.60676032	20.39887344	21.22298792	22.08039664	22.97244466	23.90053142	24.86611289	25.87070385	26.91588029	28.00328185	29.13461444	30.31165286	31.53624364	32.81030788	34.1358443
2021	1.932536869	2.010611358	2.091840057	2.176350396	2.264274952	2.35575166	2.450924027	2.549941357	2.652958988	2.760138531	2.871648128	2.987662712	3.108364286	3.233942203	3.364593468	3.500523044	3.641944175	3.78907872
2022																		
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2047																		

Avoided Unit Cost of Electric Capacity

Source / Period	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
2018	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55	233.55
2019																
2020																
2021																
2022																
2023																
2024	$116,246	$112,918	$113,255	$123,361	$127,971	$132,715	$137,599	361,070.12	368,291.52	375,657.35	383,170.50	390,833.91	398,650.59	406,623.60	414,756.07	423,051.19
2025																
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Avoided Unit Cost of Energy

Source / Period
2018
2019
2020
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Avoided Energy Costs Electric Heat and Electric Vehicles Weighted A

Seasonal Avoided Energy Costs (pre-inflation)

Period	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Winter On-Peak	0.0773971	0.078714442	0.080054206	0.081416773	0.082802531	0.084211876	0.085645209	0.087102938	0.088585479	0.090093253	0.09162669	0.093186227
Winter Off-Peak	0.071145603	0.072789251	0.074470871	0.076191341	0.077951558	0.079752441	0.081594929	0.083479983	0.085408586	0.087381746	0.08940049	0.091465873
Summer On-Peak	0.091200854	0.095274126	0.099529321	0.103974564	0.108618344	0.113469527	0.118537377	0.12383157	0.129362216	0.135139876	0.141175581	0.147480857
Summer Off-Peak	0.061723783	0.063596846	0.065526748	0.067515215	0.069564024	0.071675006	0.073850047	0.076091092	0.078400143	0.080779265	0.083230583	0.085756288

Seasonal and Peak Segmentation

Winter months / year
Summer months / year
Hours / year
On-peak hours / day
Off-peak hours / day

Season
Winter
Summer

Electric Heat & EV Seasonal Load Segmentation

Season
Summer Off-Peak
Summer On-Peak
Winter Off-Peak
Winter On-Peak

Weighted Average Annual Price (pre-inflation & WRP)

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Hourly Wght. Avg. YOY	0.0773	0.0794	0.0815	0.0837	0.0860	0.0883	0.0907	0.0932	0.0958	0.0985	0.1012	0.1040

Add MRP & Inflation

MRP

Inflation

Weighted Average Annual Price (pre-inflation & WRP)

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Hourly Wght. Avg. YOY	0.1228	0.1286	0.1347	0.1411	0.1478	0.1549	0.1623	0.1701	0.1783	0.1869	0.1959	0.2054

Avoided REC Cost

Source

Period	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
2018	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
2019																
2020																
2021																
2022																
2023																
2024																
2025																
2026	6.24	6.36	6.49	6.62	6.75	6.89	7.03	7.17	7.31	7.46	7.61	7.76	7.91	8.07	8.23	8.40
2027																
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DRIPE

Source

Energy

Period
2018
2019
2020

Capacity

Period
2018
2019
2020
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Electric Heat and Electric Vehicles - DRIPE (pre-inflation)

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Energy												
Capacity	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548
Total DRIPE	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548	0.000166548

Inflation

Conversion to MW

Electric Heat DRIPE (post inflation)

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Total DRIPE	0.242628424	0.247480993	0.252430613	0.257479225	0.262628809	0.267881385	0.273239013	0.278703793	0.284277869	0.289963427	0.295762695	0.301677949

Solar DRIPE

Solar DRIPE (pre-inflation)	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Energy												
Capacity	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135
Total DRIPE	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135	0.000168135

Inflation
Conversion to MW

Solar DRIPE (post-inflation)

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Total DRIPE	0.24494148	0.249840309	0.254837116	0.259933858	0.265132535	0.270435186	0.275843889	0.281360767	0.286987983	0.292727742	0.298582297	0.304553943

Solar - Seasonal Demand by System Type

Season
Summer Off-Peak
Summer On-Peak
Winter Off-Peak
Winter On-Peak
Total

Energy Storage DRIPE (pre-inflation)

Energy Storage DRIPE (pre-inflation)	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Energy	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341
Total DRIPE	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341	0.000169341

Inflation
Convert to MWh

Energy Storage DRIPE (post-inflation)	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Total	0.24669799	0.25163195	0.256664589	0.261797881	0.267033838	0.272374515	0.277822006	0.283378446	0.289046015	0.294826935	0.300723474	0.306737943

New England Residential Energy Prices

Energy Prices Residential (Case Reference case Region New England)
https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO20178
09:51:48 GMT-0400 (Eastern Daylight Time)
Source: U.S. Energy Information Administration

New England Residential Energy Prices

Year
2015
2016
2017
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Spot vs. Long-term Fuel Purchases

Category
Long-term
Spot Purchase
Total
Source
Assumptions

Spot vs. Long-term - Natural Gas

Category
Long-term
Spot Purchase
Total

Spot vs. Long-term - Natural Gas

Category
Long-term
Spot Purchase
Total

Adjusted Residential Fuel Oil Prices Based on Pre-Buy Forecast

	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Base Distillate Fuel Oil	25.89	25.81	26.12	26.33	26.86	26.94	27.10	27.48	27.67	27.72	27.77	27.83	27.93	28.02	28.19	28.54	28.56	28.74	29.02
Base Distillate Fuel Oil - Convert $ / MMBTU to $ / Gallon	2.36	2.36	2.39	2.40	2.45	2.46	2.48	2.51	2.53	2.53	2.54	2.54	2.55	2.56	2.57	2.61	2.61	2.63	2.65
Distillate Fuel Oil - Apply Pre-buy Discount	2.34	2.33	2.36	2.38	2.43	2.44	2.45	2.48	2.50	2.51	2.51	2.52	2.53	2.53	2.55	2.58	2.58	2.60	2.62
Distillate Fuel Oil - Convert $ / Gallon to $ / MMBTU	25.63	25.55	25.85	26.07	26.59	26.67	26.83	27.20	27.40	27.44	27.49	27.55	27.65	27.74	27.91	28.25	28.27	28.46	28.73

Adjusted Residential Natural Gas Prices Based on Pre-Buy Forecast

	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Base Natural Gas ($ / MMBTU)	14.68	14.75	14.94	15.18	15.33	15.50	15.62	15.74	15.79	15.92	16.05	16.21	16.40	16.60	16.79	16.93	17.09	17.23	17.21
Natural Gas - Apply Price Protection Discount	14.6463733	14.7142811	14.89895626	15.14364401	15.29371788	15.45727696	15.57939989	15.70160361	15.75109956	15.87667085	16.00709098	16.1691169	16.36202841	16.56036832	16.74456368	16.89005304	17.05145852	17.1897519	17.16468

Propane 2016 $/MMBtu

	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Base Propane 2016 $/MMBtu	22.39	22.45	22.69	22.80	23.14	23.30	23.61	24.05	24.21	24.47	24.61	24.81	24.99	25.07	25.26	25.46	25.69	25.81	26.04
Propane - Apply Price Discount	22.39	22.45	22.69	22.80	23.14	23.30	23.61	24.05	24.21	24.47	24.61	24.81	24.99	25.07	25.26	25.46	25.69	25.81	26.04