### 6.1.3 Electric Vehicles

###### Description

The measure is for the purchase of electric passenger vehicles. As such, the measure proposed here reflects the electric passenger vehicle measure as a traditional energy efficiency investment by converting the displaced fossil fuel energy to the equivalent of electric energy using the heat rate of electric generation. This conversion causes energy savings to be accounted for as kilowatt hour equivalence (kWhe).

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

###### Definition of Efficient Equipment

A newly purchased battery-powered passenger vehicle or ‘Battery Electric Vehicle’ (BEV) that is powered solely by electricity that can be recharged from an external source.

###### Definition of Baseline Equipment

A newly purchased internal combustion engine vehicle that relies on fossil fuel for operation.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 13 years.[[1]](#footnote-1) An adjustment should be applied to account for the proportion of BEV vehicles that move out of state.

###### Deemed Measure Cost

The incremental capital cost for this measure is assumed to be $4,496 based on the sales weighted average manufacturer suggested retail price of a newly purchased electric vehicle compared to a newly purchased baseline internal combustion vehicle.[[2]](#footnote-2)

###### Loadshape

###### Coincidence Factor

Coincidence factor is embedded in deemed demand reduction savings estimate so the coincidence factor is assumed to be 1.

Algorithm

###### Calculation of Energy Savings

###### Electric Energy Savings

ΔkWh = (((VMT \* %InState) / MPG\_ice \* 120,429) / 3413) - ((VMT \* %InState) \* EV\_ee / 100)

Where:

 VMT = Annual vehicle miles traveled of the vehicle measure.

= 10,690 [[3]](#footnote-3)

 %Instate = Percentage of refueling (gasoline or electric charging) that occurs in Illinois

 = Actual if determined by evaluation, else assume 93% [[4]](#footnote-4)

 MPG\_ice = Baseline fuel economy for the internal combustion engine vehicle expressed in miles per gallon.

 = 28 MPG [[5]](#footnote-5)

 120,286 = Conversion factor for BTU per Gallon of Gasoline.[[6]](#footnote-6)

 3413 = converts BTU to kWh

 EV\_ee = Actual nameplate operation efficiency for electric vehicle expressed in kWh per 100 miles.

 = Actual. If unknown assume 30 kWh per 100 miles.[[7]](#footnote-9)

 ∆kWh per Electric Vehicle = (((10,690 \* 0.93)/28 \* 120,286)/3413) – (10,690 \* 0.93 \* 30/100)

 = 9,531 kWh

###### Summer Coincident Peak Demand Savings

ΔkW = - kW\_vehicle \* CF

Where:

kW\_vehicle = Summer peak electric demand of the electric vehicle.

= 0.28 kW[[8]](#footnote-10)

CF = Summer peak coincidence factor

= 1[[9]](#footnote-11)

###### Natural Gas Savings

N/A

###### Water and Other Non-Energy Impact Descriptions and Calculation

N/A

###### Deemed O&M Cost Adjustment Calculation

Avoided Annual O&M cost = VMT \* (O&M\_ice - O&M\_ee) / 100

Where:

O&M\_ice = Baseline O&M cost for the internal combustion engine vehicle expressed in cents per mile.

 = 5.38 [[10]](#footnote-12)

O&M\_ee = Efficient O&M cost for the electric vehicle expressed in cents per mile.

 = 4.10 [[11]](#footnote-13)

100 = Conversion factor for cents per dollar

###### Cost-Effectiveness Screening

For the purposes of screening an EV measure application for cost-effectiveness, the displaced fossil fuel consumption from the internal combustion engine vehicle and the electricity consumption of the EV should be accounted for separately. In general, the benefit and cost components used in evaluating the cost-effectiveness of an EV measure would include at least the following terms:

Benefits: ICE\_gal + O&M\_costs

Costs: kWh\_ev + ΔkW + EV\_cost

Where:

ICE\_gal = Displaced fossil fuel consumption of internal combustion engine.

= (VMT \* %InState) / MPG\_ice

O&M\_costs = Avoided operations and maintenance costs as defined in the “Deemed O&M Cost Adjustment Calculation” section.

kWh\_ev = Electricity consumption of the electric vehicle.

= (VMT \* %InState \* EV\_ee) / 100

EV\_cost = Incremental cost of the electric vehicle as defined in the “Deemed Measure Cost” section.

###### Measure Code: CC-TRS-BEVS-V01-210101

###### Review Deadline: 1/1/2022

### 6.1.4 Electric Vehicles with Charger

###### Description

The measure is for the purchase of electric passenger vehicles bundled with the purchase of an efficient level 2 electric vehicle charger. As such, the measure proposed here reflects the electric passenger vehicle measure as a traditional energy efficiency investment by converting the displaced fossil fuel energy to the equivalent of electric energy using the heat rate of electric generation. This conversion causes energy savings to be accounted for as kilowatt hour equivalence (kWhe). Energy savings associated with the charger are also included. The EV charger component is designed to be consistent with the ENERGY STAR specification for Electric Vehicle Supply Equipment (EVSE) installed for residential household use. Networked chargers enable access to online energy management tools through an EVSE network. Non-networked chargers are standalone units that are not connected to other units through an EVSE network.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

###### Definition of Efficient Equipment

A newly purchased battery-powered passenger vehicle or ‘Battery Electric Vehicle’ (BEV) that is powered solely by electricity paired with an efficient level 2 electric vehicle charger.

###### Definition of Baseline Equipment

A newly purchased internal combustion engine vehicle that relies on fossil fuel for operation with no EVSE installed.

###### Deemed Lifetime of Efficient Equipment

The expected measure life for the vehicle is assumed to be 13 years.[[12]](#footnote-14) An adjustment should be applied to account for the proportion of BEV vehicles that move out of state.

The expected measure life for the EV charger is assumed to be 10 years.[[13]](#footnote-15)

###### Deemed Measure Cost

The incremental capital cost for the EV is assumed to be $4,496 based on the sales weighted manufacturer suggested retail price of a newly purchased electric vehicle compared to a newly purchased baseline internal combustion vehicle. [[14]](#footnote-16)

The incremental cost for the EV charger is assumed to be $593 for a non-networked charger and $817 for a networked charger.[[15]](#footnote-18)

###### Loadshape

###### Coincidence Factor

Coincidence factor is embedded in deemed demand reduction savings estimate so the coincidence factor is assumed to be 1.

Algorithm

###### Calculation of Energy Savings

###### Electric Energy Savings

ΔkWh = (((VMT \* %InState) / MPG\_ice \* 120,429) / 3413) - (VMT \* %InState \* EV\_ee / 100) + (((Hours\_PS + Hours\_US) \* SP\_base) - (Hours\_PS \* SP\_EEp + Hours\_US \* SP\_EEu))/ 1000)

Where:

 VMT = Annual vehicle miles traveled of the vehicle measure.

= 10,690 [[16]](#footnote-19)

 %Instate = Percentage of refueling (gasoline or electric charging) that occurs in Illinois

 = Actual if determined by evaluation, else assume 93% [[17]](#footnote-21)

 MPG\_ice = Baseline fuel economy for the internal combustion engine vehicle expressed in miles per gallon.

 = 28 MPG [[18]](#footnote-22)

 120,286 = Conversion factor for BTU per Gallon of Gasoline [[19]](#footnote-23)

 3413 = Converts BTU to kWh

 EV\_ee = Actual nameplate operation efficiency for electric vehicle expressed in kWh per 100 miles.

 = 30 kWh per 100 miles[[20]](#footnote-26)

 EV\_kWh = Annual Driving Energy Consumed at Home (kWh)

 = VMT \* EV\_ee / 100 \* %Home\_Charging

 %Home\_Charging = Percent of charging that is done at home

 = 86% [[21]](#footnote-27)

 = 2,967 kWh

 Hours\_C = Annual Active Charging Hours

 = EV\_kWh / Steady State Charger Output Capacity (kW)

 = EV\_kWh / 8.2 [[22]](#footnote-28)

 = 362 hours

 Hours\_P = Total Annual Hours Plugged In

 = Annual # of Charging Sessions \* Average EV Plug in Time per Charging Session (Hrs)

 = (EV\_kWh / 7.4 [[23]](#footnote-29)) \* 14.7 [[24]](#footnote-30)

 = 5,894 hours

 Hours\_PS = Annual Standby Hours Plugged In

 = Hours\_P - Hours\_C

 = 5,532 hours

 Hours\_US = Annual Standby Hours Unplugged

 = 8760 - Hours\_P

 = 2,866 hours

 SP\_base = Baseline Average Standby Power (W)

 = 3.7 for non-networked, 9.9 for networked[[25]](#footnote-31)

 SP\_EEp = Efficient Average Standby Power (W) with vehicle plugged in

 = 4.3 for non-networked, 6.4 for networked[[26]](#footnote-32)

 SP\_EEu = Efficient Average Standby Power (W) in no vehicle mode

 = 2.1 for non-networked, 3.2 for networked[[27]](#footnote-33)

 ∆kWh per Electric Vehicle with non-networked charger = (((10,690 \* 0.93)/28 \* 120,286)/3413) – (10,690 \* 0.93 \* 30/100) + (((5,532 + 2,866) \* 3.7) - (5,532 \* 4.3 + 2,866 \* 2.1))/ 1000)

 = 9,531 + 1.3

 = 9,532.3 kWh

 ∆kWh per Electric Vehicle with networked charger = ((10,690/28 \* 120,286)/3413) – (10,690 \* 30/100) + (((5,532 + 2,866) \* 9.9) - (5,532 \* 6.4 + 2,866 \* 3.2))/ 1000)

 = 9,531 + 38.6

 = 9,569.6 kWh

###### Summer Coincident Peak Demand Savings

ΔkW = - kW\_vehicle \* CF

Where:

kW\_vehicle = Summer peak electric demand of the electric vehicle.

= 0.28 kW[[28]](#footnote-34)

CF = Summer peak coincidence factor

= 1[[29]](#footnote-35)

###### Natural Gas Savings

N/A

###### Water and Other Non-Energy Impact Descriptions and Calculation

N/A

###### Deemed O&M Cost Adjustment Calculation

Avoided Annual O&M cost = VMT \* (O&M\_ice - O&M\_ee) / 100

Where:

O&M\_ice = Baseline O&M cost for the internal combustion engine vehicle expressed in cents per mile.

 = 5.38 [[30]](#footnote-36)

O&M\_ee = Efficient O&M cost for the electric vehicle expressed in cents per mile.

 = 4.10 [[31]](#footnote-37)

100 = Conversion factor for cents per dollar

###### Cost-Effectiveness Screening

For the purposes of screening an EV measure application for cost-effectiveness, the displaced fossil fuel consumption from the internal combustion engine vehicle and the electricity consumption of the EV should be accounted for separately. In general, the benefit and cost components used in evaluating the cost-effectiveness of an EV measure would include at least the following terms:

Benefits: ICE\_gal + O&M\_costs

Costs: kWh\_ev + ΔkW + EV\_cost

Where:

ICE\_gal = Displaced fossil fuel consumption of internal combustion engine.

= (VMT \* %InState) / MPG\_ice

O&M\_costs = Avoided operations and maintenance costs as defined in the “Deemed O&M Cost Adjustment Calculation” section.

kWh\_ev = Electricity consumption of the electric vehicle.

= (VMT \* %InState \* EV\_ee) / 100

EV\_cost = Incremental cost of the electric vehicle as defined in the “Deemed Measure Cost” section.

###### Measure Code: CC-TRS-BVCH-V01-210101

###### Review Deadline: 1/1/2022

1. Average age of household vehicles in operation for 2017 from Table 1-26. National Transportation Statistics. Bureau of Transportation Statistics, US Department of Transportation. [↑](#footnote-ref-1)
2. Gasoline car costs based on average new vehicle MSRPs from Annual Energy Outlook 2019. U.S. Energy Information Administration, and EV costs based on 2019 sales weighted MSRP from evadoption.com. See “Electric Vehicle Incremental Cost Workpaper.xls for details. [↑](#footnote-ref-2)
3. Average annual vehicle miles traveled estimated based on Statewide average of data from the 2017 National Household Transportation survey, accessed 07/2020. See “20200622 2017 NHTS IL VMT.xlsx” for details. [↑](#footnote-ref-3)
4. It is estimated that half of charging that occurs away from home is out of state. The estimate of home charging is 86% from the RTF characterization based on 2014 Idaho National Laboratory study. [↑](#footnote-ref-4)
5. Estimated using the 2019 US Fuel Economy Guide fleetwide average for gasoline cars. Baseline MPG includes an efficiency adder of 4.2 MPG since gasoline vehicles replaced by EVs are more efficient than the fleet-wide average, according to NBER Working Paper No. 25771. “What Does an Electric Vehicle Replace?” by Jianwei Xing, Benjamin Leard, Shanjun Li. Issued in April 2019. [↑](#footnote-ref-5)
6. US Energy Information Administration. [↑](#footnote-ref-6)
7. Average electric vehicle efficiency based on light-duty vehicle miles per gallon from Annual Energy Outlook 2019. U.S. Energy Information Administration. [↑](#footnote-ref-9)
8. Summer peak demand impacts are a deemed value based on EV Charging Station Pilot Evaluation Report. Xcel CO. May 2015. Page 5. [↑](#footnote-ref-10)
9. kW\_Vehicle accounts for the estimated average kW draw during the system peak. [↑](#footnote-ref-11)
10. According to the American Automobile Association (AAA) publication, "Your Driving Costs," 2010 Edition average vehicle maintenance costs are 5.38 cents per mile. [↑](#footnote-ref-12)
11. Maintenance for EVs is reduced by 28% based on DeLuchi, Mark and Lipman, Timothy, An Analysis of the Retail and Life Cycle Cost of Battery-Powered Electric Vehicles; UC-Davis Institute of Transportation Studies. http://escholarship.org/uc/item/50q9060k [↑](#footnote-ref-13)
12. Average age of household vehicles in operation for 2017 from Table 1-26. National Transportation Statistics. Bureau of Transportation Statistics, US Department of Transportation. [↑](#footnote-ref-14)
13. Based on Northwest Power and Conservation Council, Regional Technical Forum workbook for Level 2 Electric Vehicle Charger version 1.1. approved May 2019. https://rtf.nwcouncil.org/measure/level-2-electric-vehicle-charger [↑](#footnote-ref-15)
14. Gasoline car costs based on average new vehicle MSRPs from Annual Energy Outlook 2019. U.S. Energy Information Administration, and EV costs based on 2019 sales weighted MSRP from evadoption.com. See “Electric Vehicle Incremental Cost Workpaper.xls for details. [↑](#footnote-ref-16)
15. Based on Northwest Power and Conservation Council, Regional Technical Forum workbook for Level 2 Electric Vehicle Charger version 1.1. approved May 2019. https://rtf.nwcouncil.org/measure/level-2-electric-vehicle-charger. [↑](#footnote-ref-18)
16. Average annual vehicle miles traveled estimated based on Stateside average of data from the 2017 National Household Transportation survey, accessed 07/2020. [↑](#footnote-ref-19)
17. It is estimated that half of charging that occurs away from home is out of state. The estimate of home charging is 86% from the RTF characterization based on 2014 Idaho National Laboratory study. [↑](#footnote-ref-21)
18. Estimated using the 2019 US Fuel Economy Guide fleetwide average for gasoline cars. Baseline MPG includes an efficiency adder of 4.2 MPG since gasoline vehicles replaced by EVs are more efficient than the fleet-wide average, according to NBER Working Paper No. 25771. “What Does an Electric Vehicle Replace?” by Jianwei Xing, Benjamin Leard, Shanjun Li. Issued in April 2019. [↑](#footnote-ref-22)
19. US Energy Information Administration. [↑](#footnote-ref-23)
20. Average electric vehicle efficiency based on light-duty vehicle miles per gallon from Annual Energy Outlook 2019. U.S. Energy Information Administration. [↑](#footnote-ref-26)
21. Assumption consistent with RTF characterization based on 2014 Idaho National Laboratory study. [↑](#footnote-ref-27)
22. Analysis of WA and OR Cumulative EV Registrations through 2018 paired with Vehicle Maximum Power Acceptance (kW) data from Chargehub https://chargehub.com/en/find-the-right-charging-station-power.html [↑](#footnote-ref-28)
23. Avista Docket No. UE-160082 – Avista Utilities Semi-Annual Report on Electric Vehicle Supply Equipment Pilot Program (November 2018) Table 13 Avg. kWh Consumed per Session [↑](#footnote-ref-29)
24. Based on data provided by Avista. Total hours EV is plugged into charging station including both charge and standby time. [↑](#footnote-ref-30)
25. INL charger testing https://avt.inl.gov/evse-type/ac-level-2 and ENERGY STAR Market and Industry Scoping Report Electric Vehicle Supply Equipment (EVSE) September 2013 (source data is from INL). [↑](#footnote-ref-31)
26. 2019 ENERGY STAR QPL of Residential EVSE. No Residential units, used commercial as a proxy. Averaged Partial On Mode Input Power (W) and Idle Mode Input Power (W) [↑](#footnote-ref-32)
27. 2019 ENERGY STAR QPL of Residential EVSE. No Residential units, used commercial as a proxy. Averaged Partial On Mode Input Power (W) and Idle Mode Input Power (W). [↑](#footnote-ref-33)
28. Summer peak demand impacts are a deemed value based on EV Charging Station Pilot Evaluation Report. Xcel CO. May 2015. Page 5. [↑](#footnote-ref-34)
29. kW\_Vehicle accounts for the estimated average kW draw during the system peak. [↑](#footnote-ref-35)
30. According to the American Automobile Association (AAA) publication, "Your Driving Costs," 2010 Edition average vehicle maintenance costs are 5.38 cents per mile. [↑](#footnote-ref-36)
31. Maintenance for EVs is reduced by 28% based on DeLuchi, Mark and Lipman, Timothy, An Analysis of the Retail and Life Cycle Cost of Battery-Powered Electric Vehicles; UC-Davis Institute of Transportation Studies. http://escholarship.org/uc/item/50q9060k [↑](#footnote-ref-37)