

Huntsville Utilities Climate Pollution Reduction Grants- Implementation Grants

Application: Technical Appendix

Measure 1:

GHG emissions reductions for Measure 1, Huntsville Utilities fleet electrification, were calculated using several sources. First, the operating costs of gas-powered vehicles versus electric vehicles were compared using the DOE Alternative Fuels Data Center Vehicle Cost Calculator.ⁱ This calculator shows the annual fuel use, annual electricity use, annual fuel or electricity cost, annual overall operating cost, cost per mile, and the annual emissions in pounds of CO₂ (see Figure 1 below).







Vehicle	Annual Fuel Use 	Annual Electricity Use 	Annual Fuel/Elec Cost 	Annual Operating Cost 	Cost Per Mile 	Annual Emissions (lbs CO ₂) 
2023 Ford F-150 Lightning 4WD Extended Range EV	0 gal	7,543 kWh	\$987	\$3,279	\$0.20	7,562
2023 Ford F150 Pickup 4WD FFV	884 gal	0 kWh	\$2,704	\$5,208	\$0.32	21,211

Figure 1 – Screenshot from the Vehicle Cost Calculator

The difference in annual emissions between the EV and gas-powered vehicle was then calculated, as this is the amount of emissions that will be reduced for each gas-powered vehicle being replaced by an EV. Since the Vehicle Cost Calculator produced the CO₂ emissions in pounds, the metric of pounds of CO₂ was then converted to metric tons of CO₂ to comply with the CPRG FOA value requirements. Once the metric tons equivalent for emission reductions was calculated for each EV model, it was then multiplied by the number of those models the measure calls for in total each year, as the measure calls for a staged rollout and commissioning of the EVs. So, instead of all EVs being purchased in one year, years one and two will each see the purchase of 4 EV trucks and one passenger EV purchased and commissioned, and year three will see the purchase and commissioning of 4 EV trucks. To calculate the GHG emissions reduction per year, the number of EVs purchased for each model would be multiplied by their corresponding emissions reductions. For instance, the Ford F-150 Lightning 4WD Extended Range EV has an annual emission reduction of CO₂ in metric tons of 6.19. To determine the total amount of emissions reductions for the trucks to be purchased in year one, this metric of 6.19 metric tons of carbon was multiplied by 4, as 4 EV trucks will be purchased in year one, which equates to 24.76 metric tons of CO₂ reduced in year one just for the EV trucks purchased. This same calculation was then done for the EV passenger vehicle to be purchased in year one. For years two and three, the same calculations were run with the number of each EV model to be purchased in that year.

Using the above calculations, it was found that the GHG emissions reductions for the periods of 2025-2030 and 2025-2050 are as follows:

- 2025-2030: 429 metric tons of CO₂; and
- 2025-2050: 1,769 metric tons of CO₂.

Measure 2:

GHG Reduction Estimate Method

The method used can be divided into two steps:

The first step was to come up with the kWh equivalent that will be generated using the battery as a source of generation instead of the fossil fuel energy dispatched from TVA during peak demand scenarios. The annual values over the 25-year period are shown in Table 1a.

The second step was to estimate the greenhouse gas equivalent of the kWh using the “Greenhouse Gas Equivalencies Calculator” to calculate the GHG emission reduction estimate. There are different versions of this calculator. The calculator version referenced as source 6 in the Workplan is used throughout the workplan document. The URL for source 6, hereinafter referred to as “Link 1” in this Technical Appendix is below:

Link 1: <https://19january2021snapshot.epa.gov/sites/static/files/widgets/ghg-calc/calculator.html#results>

Models/Tools Used

The Greenhouse Gas Equivalencies Calculator was then used to calculate the GHG emission reduction estimate after establishing an estimate of the kWh that will be generated by the battery source. Another version of this calculator is located on EPA’s website at the following URL, which is hereinafter referenced as “Link 2”:

Link 2: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>

Link 2 was updated on ‘January 2024’ and generates slightly lower GHG CO₂ emissions than what Link 1 generates. The last column of Table 1a shows the percentage decrease in the calculations using Link 2 instead of Link 1 in the calculations. Due to this discrepancy, Link 1 was used for all equivalence conversions in the Workplan.

Measure Implementation Assumptions

A 25-year lifecycle is assumed for the two battery storage units. A .8 factor (20% degradation rate) is assumed in the first 10 years, this number is then further increased to a .75 factor (25% degradation rate) in years 11-20, and is finally increased to 50% in the last five years of the asset’s lifetime. Other assumptions include a daily discharge and charging cycle during the asset’s lifetime and a 5% reduction in I²R losses that would have been attributed to transmission and transformer loss if the kWh generated from the battery had been generated from one of TVA’s fossil generation sources.

GHG Reduction Estimate Assumptions

The estimated output of the Greenhouse Gas Equivalencies Calculator is based on an annual usage of the energy sourced from the batteries. The level sourced from the battery is reduced periodically to reflect

battery degradation. There are slight differences in the results based on the version of the calculator used. Table 1a shows the difference between the values from the two links as 124 Metric tons for year 1.

Reference Case Scenario (GHG Emissions or Activity Level):

A reference case scenario for year 2025 in the absence of a GHG emission reduction measure is illustrated below. Equation 1, seen below, was used to estimate the total kWh output from the battery yearly.

Equation 1:

$$\text{Degradation factor} * \text{kWh sourced from TVA} * \text{Days in a year} * \text{Number of years} * 2$$

The multiplying factor '2' in Equation 1, has been applied for the potential to handle both morning and evening peaks during the 4-hour discharge cycle.

For year 25 in Table 1a, the numbers involved are:

$((0.8 * 16000 * 365) + (0.8 * 8000 * 365)) * 2$, hereinafter known as Factor 1, kWh from the two storage units plus $0.05 * (\text{Factor 1})$, which is hereinafter known as Factor 2. These equations calculate the equivalent upstream losses in kWh, due to the losses in the transmission system and power transformers.

Factors 1 and 2 sum to **14,716,800 kWh**.

14,716,800 kWh is the estimated kWh amount that the batteries will output for the first 10 years.

The same calculations were utilized for years 11 through 20 of the system's life, with a degradation factor of 0.75 instead of 0.8. In the last five years, years 21 through 25 of the system's life, the degradation factor is reduced further to 0.5.

The calculations give kWh values of **14,716,800** and **11,497,500** in the first ten years and second ten years, respectively, and **9,198,000 kWh** in the last five years.

Each of the kWh values in **bold** gives the equivalent annual CO₂ emission reduction values shown in Table 1a with the calculator in Link 1. The annual values give a cumulative sum of **217,855** metric tons. The GHG equivalencies calculator gives the equivalent of **217,862** metric tons of CO₂ emissions when the annual kWh values are summed up before converting to the CO₂ equivalent. The total kWh for the 25-year period sums to 308,133,000 kWh. The equivalent of **217,862 metric tons of CO₂** has been recorded in the Workplan. The slight difference in the numbers may be attributed to rounding errors in the equivalency calculator.

Measure-Specific Activity Data

For each of the identified circuits, at the various substations (Stringfield, Gurley and Wheeler), it is estimated that the kWh in Table 1a will be taken off the peak annually.

GHG Emissions Reduced

Using the calculations shown in the “**Reference Case Scenario**” section in Table 1a, the annual and cumulative GHG emission reductions for the years 2025 through 2030 and 2025 through 2050 is documented.

Table 1a: Estimated reduction in GHG Emissions to be gained from Measure 1

Project year	Actual Year	KWh sourced from batteries and I ² R losses	CO2 emission reduction referenced (in metric tons)	Cumulative CO2 emission (in metric tons)	CO2 emission reduction using link 2 (in metric tons)	Percentage difference
1	2025	14,716,800	10,405	10,405	10,281	0.0119
2	2026	14,716,800	10,405	20,810		
3	2027	14,716,800	10,405	31,215		
4	2028	14,716,800	10,405	41,620		
5	2029	14,716,800	10,405	52,025		
6	2030	14,716,800	10,405	62,430		
7	2031	14,716,800	10,405	72,835		
8	2032	14,716,800	10,405	83,240		
9	2033	14,716,800	10,405	93,645		
10	2034	14,716,800	10,405	104,050		
11	2035	11,497,500	8,129	112,179	8,032	0.0119
12	2036	11,497,500	8,129	120,308		
13	2037	11,497,500	8,129	128,437		
14	2038	11,497,500	8,129	136,566		
15	2039	11,497,500	8,129	144,695		
16	2040	11,497,500	8,129	152,824		
17	2041	11,497,500	8,129	160,953		

18	2042	11,497,500	8,129	169,082		
19	2043	11,497,500	8,129	177,211		
20	2044	11,497,500	8,129	185,340		
21	2045	9,198,000	6,503	191,843		
22	2046	9,198,000	6,503	198,346		
23	2047	9,198,000	6,503	204,849		
24	2048	9,198,000	6,503	211,352		
25	2049	9,198,000	6,503	217,855		
26	2050		6,503	224,358		
Total		308,133,000	217,855			

ⁱ "Vehicle Cost Calculator." U.S. DOE Alternative Fuels Data Center. U.S. Department of Energy.
<https://afdc.energy.gov/calc/>.