

Appendix C

In calculating and developing the scenario, EPA calculators were used whenever possible alongside the most recent relevant statistical averages.

Baseline Assumptions:

That Parrish's residential population is similar enough to the most recent data and statistical averages that its mt CO₂e/year can be estimated using them.

That the renovation or construction of ecologically conscious buildings can energize and solidify an ecologically conscious culture.

That solar rooftops will not be replaced by traditional equivalents.

Yearly mt CO₂e calculations:

Buildings:

Due to a recent reordering of The Town of Parrish's workflow, only the month of January 2024 was both available and directly comparable to future energy consumption of the Town of Parrish. The yearly kWh for the Town of Parrish's buildings was extrapolated from that month's energy usage. This is a high estimate, but as any excess power would be sold to the grid the reduction in emissions would remain constant. The emissions were estimated using the EPA Simplified GHG Emissions Calculator. The location-based emissions result was used to generate a general mt CO₂e/MWh factor for utility power which was used where necessary within the rest of the model. A licensed architect's professional estimate of post-renovation efficiency gain was used to derive the post-renovation energy usage of the town's structures. Q4 of 2026 and every subsequent year was assumed to use this post-renovation kWh. The post-renovation mt CO₂e/year was calculated from the mt CO₂e/MWh of solar power production. The emissions reduction from the 20% safety margin was not considered in GHG reduction calculations.

The residential electrical emissions of the town were derived from the average south kWh/year per household multiplied by the number of households per the 2022 American Community Survey to estimate the kWh/year used by the town as a whole. This kWh/year figure was imputed into the EPA Simplified Calculator, giving the residential mt CO₂e/year. The mt CO₂e/year figure under 100% residential solar penetration was calculated from the same kWh/year figure converted into MWh and multiplied by the mt CO₂e/MWh of solar power.¹

EVs/EV Chargers:

Town of Parrish:

The g CO₂e/mile for each of the Town of Parrish's trucks and the employee's sedans was computed from "The Calculator". The EPA kWh per 100 miles and the location based mt CO₂e/MWh derived from the calculator were used to calculate the motive and non-motive proportions of the EPA g CO₂e/mile figure. These were used to calculate the solar-powered g CO₂e/mile, on the assumption that the Town's cars will mostly be charged at Town-owned chargers. Any excess solar power will be exported to the grid, resulting in an equal emissions reduction. The potential emissions reduction from the safety margin solar power for the primarily government-use level 2 EV chargers is not considered. In this model potential non-governmental use of EV chargers is not modeled as a reduction, since it

would either be utility charging, double counting solar governmental charging, or solar charging allowed by excess solar or solar expansion beyond the scope of this project.

The mileage for the vehicles was not available and the average Alabama millage/driver was substituted. This mileage/driver was derived from Federal Department of Transportation estimates. This was used with the various g/mile figures to calculate the mt CO₂e/year of the Town of Parrish's vehicles. The transition to electric vehicles is assumed to occur at the start of Q1 2025 and the transition to solar power is assumed to occur at the start of Q4 2026.

The makeup of the population's vehicles is currently unknown except for the knowledge that there are no electric cars currently in use. The g CO₂e/mile of an "average new car" according to FuelEconomy.gov was used as a stand in for the town's conventional vehicles. The comparison electric vehicle was the 2023 F-150 Lightning due to the popularity of truck-chassis vehicles in the area and the direction of the market as a whole. No efficiency improvements were assumed for this calculation.

The ACS 2022 survey estimate of inhabitants and the Alabama average of drivers per 1000 residents was used to calculate the number of total drivers in Parish.

EV chargers:

The peak daily usage of municipal level 3 chargers was used to calculate the amount of solar required to power them with a 20% safety margin and the yearly emissions reduction from using solar over grid power for those charges. The excess power from the 20% safety margin was not included in the GHG reduction calculation.

Calculations for each year 2025-2050

Town of Parrish:

The Town of Parrish calculation for each year was derived by assuming that the implementation schedule is followed. Namely; the town EVs will be put to use by the beginning of Q1 2025, the level 3 EV chargers will be operational at the beginning of Q2 2025, and the renovations will be completed by the beginning of Q4 2026. At that point, the Town of Parrish's emissions remain static through 2050 with the exception of EVs. The primary scenario assumes that the town's electric vehicles are replaced every 7 years after 2025 with vehicles 10% more efficient in g CO₂e/mile terms. Replacement of buildings and solar panels is not expected before 2050.

Parrish Residential Population:

Electric Vehicles:

To translate the 0% and 100% EV adoption rates into a GHG emissions model, a growth and stock model were created.

For the growth model the average EV market growth 2011-2023 (G) was calculated from Department of Energy Fact of the Week #1327.^{2 3} Outlier years with growth rates above 50% were excluded. The equation $Year\ EV\ New\ Sales\ Percentage(S(n)) = S(n-1) * (1 + (1 - S(n-1) * G))$ was used to calculate each successive year 2024-2050. This results in a smooth decline in growth rate as the EV new vehicle

market share increases. Year EV New Sales Percentage($S(n)$)= $S(n-1) * (1 + ((1 - S(n-1)) * G))$

The initial EV new sales percentage were taken from “Transportation Electrification in the Southeast” and “Get Connected Electric Vehicle Quarterly Report.”⁴⁵

For the stock model the national average percentage of new personal vehicle sales per personal vehicle registered was used as the entry rate (E) for new personal vehicles into the market. The equation: *Current EV Market Share* ($M(n)$)= $(M(n-1) * (1 - G)) + (S(n) * (G))$ was used to calculate the market share for each year. The resident vehicle emissions were calculated from the proportion of EVs and traditional vehicles.

Residential Solar:

In the maximum case, residential solar conversions are expected to start at 5 households in 2025 and increase at a rate of 40% per year until 2030, 25% per year 2031-2033 before plateauing at 48 conversions per year. The initial 5 are local organizers who have expressed significant interest and have the funds to install sufficient solar. The growth figures are based on community consultations and are principally based on a desire to move away from their current utility. 40 conversions per year is considered to be the maximum sustainable rate for the town.

The stock equation:

$$\text{Current Percent Stock } s(n) = s(n-1) + ((s(n-1) - s(n-2)) * (1 + R))$$

Where R is the percent increase in rate of conversion. Upon reaching 40 conversion per year the equation becomes:

$$\text{Current Percent Stock } s(n) = s(n-1) + C$$

Where C is the constant $\frac{1}{12}$

The emissions are then calculated from the proportions of solar vs utility powered homes in Parrish.

Conversion into 2025-2030, 2025-2035, and 2025-2050 Total Emissions reductions

Each category was totaled annually, subtracted from the comparison year, and summed.

¹National Renewable Energy Laboratory, National Renewable Energy Laboratory,
<https://www.nrel.gov/docs/fy13osti/56487.pdf>.

² “FOTW #1327, January 29, 2024: Annual New Light-Duty EV Sales Topped 1 Million for the First Time in 2023.” U.S. Department of Energy, U.S. Department of Energy, 29 Jan. 2024, <https://www.energy.gov/eere/vehicles/articles/fotw-1327-january-29-2024-annual-new-light-duty-ev-sales-topped-1-million>.

³ “Light Duty Electric Drive Vehicles Monthly Sales Updates | Argonne National Laboratory.” Argonne National Laboratory, Argonne National Laboratory, 1 Nov. 2019, <https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates>

⁴SACE, SACE, <https://www.cleanenergy.org/wp-content/uploads/Transportation-Electrification-in-the-Southeast-2023-Report.pdf>

⁵ <https://www.autosinnovate.org/posts/papers-reports/Get%20Connected%20EV%20Quarterly%20Report%202023%20Q3.pdf>