NAPA'S GREENHOUSE GAS CALCULATOR v5
User Guide
April 2021

1. INTRODUCTION

NAPA's Greenhouse Gas (GHG) Calculator allows users to evaluate GHG emissions related to asphalt mixture manufacturing in a gate-to-gate analysis. The user-friendly interface has data entry fields for typical fuels that are linked to the Climate Change Registry of CO_2-equivalent (CO_2e) emission factors, the universal measure of greenhouse gases. CO_2e emission factors express all relevant GHG compounds, such as CH_4 and N_2O, into equivalent units of CO_2.

The GHG Calculator allows users to input any combination of fuels used by the rotary dryer plus additional fuels used inside the gate by equipment and vehicles. A final category addresses CO_2e released during grid power generation with unique factors based on the plant location. Fuel used for onsite power generation should be added to the Equipment and Vehicles category. Fuel used for transporting materials (e.g., asphalt mix, aggregates, asphalt binder, etc.) either to or from the facility should not be included since these activities do not fall within the gate-to-gate scope of the GHG Calculator. Generally, the more fuel burned and the higher the carbon content, the more CO_2e emissions are generated by asphalt mixture production.

The GHG Calculator also includes emission offset "credits" for the use of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) to recognize the avoided upstream GHG emissions by using these recycled materials rather than virgin materials. It also provides a summary of the avoided fuel consumption and emissions from production of warm-mix asphalt (WMA). The GHG Calculator does not include an offset credit for use of waste-derived recycled oil (RO).

The GHG Calculator uses a different set of system boundaries, assumptions, and emission factors than the Emerald Eco-Label environmental product declaration (EPD) tool, so the results from the two tools are not directly comparable. The Emerald Eco-Label EPD tool is based on an externally verified life cycle assessment (LCA) that conforms to the requirements in ISO 14040/14044 and provides a more robust product-specific cradle-to-gate analysis of asphalt mixture production. The Emerald Eco-Label EPD tool is also verified to conform to the Product Category Rules (PCR) for Asphalt Mixtures as well as ISO 21930, making it suitable for communicating the potential environmental impacts of asphalt mixture production to external customers and other stakeholders. NAPA's GHG Calculator has not been independently verified. As such, the results are suitable for internal analysis and benchmarking, but may not be suitable for external communications with customers or other stakeholders.

NAPA's GHG Calculator was originally developed under the leadership of NAPA's Environmental Committee and is now managed under the Sustainability Committee. Refinements and enhancements will be made as need arises based on user feedback. If you have suggestions for enhancements, or questions regarding underlying algorithms, contact Joseph Shacat, NAPA Director of Sustainable Pavements.

2. EMISSION FACTORS

Emission factors used to calculate CO_2e are taken from tables provided by The Climate Registry (TCR) 2008 General Reporting Protocol. It should be noted that TCR emission factors are not equivalent to the

U.S. EPA's AP-42 emissions factors for asphalt mixture manufacturing. AP-42 emission factors were developed using directly measured emissions from stack test data whereas TCR uses the average carbon content of each fuel to calculate GHG emissions on a mass balance basis. Because emissions from the use of waste-derived fuels such as RO are not included in TCR due to variations in carbon content, NAPA's GHG Calculator assumes that CO_2e emissions for RO are equivalent to emissions for No. 2 fuel oil.

Recycled materials generate significant upstream GHG benefits due to avoided emissions from the mining, processing, and transportation of virgin materials. Factors for avoided emissions are taken from the COLAS Materials Life Cycle Analysis report entitled The Environmental Road of the Future; 10 kg CO_2e/tonne crushed stone and 285 kg CO_2e/tonne asphalt binder. NAPA's GHG Calculator provides offset credits for use of raw materials such as RAP and RAS, but these credits can be misleading since the GHG Calculator does not account for transportation of raw materials. If a more complete analysis of upstream GHG emissions that includes transportation of raw materials is desired, NAPA recommends using the Emerald Eco-Label EPD tool.

3. INPUTS

Plant Information

The **Plant Information** data fields populate the title section of the output report. The **Mix Produced Per Year** field is used to normalize GHG emissions on a per-ton basis.

Line Power

Enter the total number of kilowatt-hour (kWh) of electricity consumed by the plant during the period of analysis. Select the power region that corresponds to your plant's location. A link to a U.S. map with all available power regions is provided. If your plant's electricity is supplied by an on-site generator, the generator fuel consumption should be included in the Equipment & Vehicles section (see below).

Plant Combustion

Enter the quantity of each fuel type consumed by the burner(s). Since some plants do not submeter their burner fuel consumption and hot oil heater fuel consumption, NAPA recommends including hot oil heater fuel consumption in this section as well.

Equipment & Vehicles

Enter the quantity of each fuel type consumed by on-site equipment and vehicles, such as loaders, generators, compressors, etc. For biodiesel, use the field that most closely corresponds to the biodiesel blend that your equipment consumes (e.g., Biodiesel 20 corresponds to a B20 blend that contains 20% biodiesel).

GHG Credits

For WMA Mix Temperature, enter the target mix production temperature when the plant produces WMA. Enter the number of tons of WMA produced in the WMA field. NCHRP Report 779 determined that energy savings from reduced mix temperatures average 1,100 Btu/ton/°F. For this tool, NAPA uses a slightly more conservative factor of 1,000 Btu/ton/°F. The 1,000 Btu factor is used to calculate energy savings from producing WMA at a user defined average mix temperature assuming 310 °F temperature

for conventional mix. Reductions in GHG emissions and fuel consumption are calculated for each fuel type entered in the **Plant Combustion** data fields.

For the RAP Percent Binder and RAS Percent Binder fields, enter the average binder content of the RAP and RAS used at the plant, respectively. Enter the total tonnage of RAP and RAS in the Amount Used data fields. Producing asphalt binder is energy intensive. Consequently, credits are sensitive to quantity of binder provided by recycled materials. Typical asphalt binder content of RAP and RAS stockpiles are pre-loaded in the tool, but users should enter their plant-specific values to produce the most accurate results.

4. RESULTS

The results can be easily printed or converted to an Adobe pdf by clicking on the **Print Results** button.

Emissions by Fuel Type

This section of the report shows the GHG emissions for each type of fuel or energy source in a horizontal bar chart.

Emissions by Source

The data table in this section lists the total emissions (tons CO_2e), emissions intensity (lbs. CO_2e/ton mix) for each of the GHG emission sources (Plant Combustion, Equipment & Vehicles, and Electric), along with the percent contribution of each. Credits for the use of RAP and RAS are also included in this table. Emissions by Source are also displayed in a horizontal bar chart.

Warm Mix Asphalt Savings

This section of the report shows the estimated fuel saved and avoided emissions from production of WMA for each type of fuel consumed.

Actual vs. Expected Energy Use

The horizontal bar chart shows the plant's actual energy use (MMBtu/ton), along with the expected energy use. The expected energy use is a general benchmark that can be used as a "data check" to ensure your inputs are reasonable. Large differences between the actual and expected energy use indicate the possibility of incorrect data inputs.

5. CHANGELOG

March 17, 2021

- Corrected an error in the Emissions by Source table. The Efficiency Values were incorrectly reporting emissions in units of tons CO_2/short ton mix instead of kg CO_2/short ton mix.
- Added a reference to the Inputs table for WMA to indicate that the tool assumes a baseline HMA mix temperature of 310 F.

August 18, 2020

- Version 5 of the GHG Calculator went live at https://asphaltepd.org/ghg/.