Addition of Combined Heat and Power Electricity Plants to the GREET® Model

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ACRONYMS

CHP	combined heat and power
EIA	US Energy Information Administration
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Transportation
HHV	higher heating value
LHV	lower heating value

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1 INTRODUCTION

This document describes additions of several combined heat and power (CHP) electrical generating plants to the GREET® (**G**reenhouse gases, **R**egulated **E**missions, and **E**nergy use in **T**ransportation) model. The GREET model was originally developed to evaluate fuel-cycle (or well-to-wheels) energy use and emissions of various transportation technologies (Wang 1999). Numerous electricity generating technology and fuel pathways exist within GREET and this update describes how CHP data was obtained and integrated within 2017 GREET.

2 POWER PLANT UPDATES

This study uses Energy Information Agency (EIA) power plant data from Form 923 (2015 data files) to understand the efficiency of several different natural gas and coal CHP technologies (U.S. Energy Information Administration 2017). The Form 923 Generation and Fuel data were filtered to exclude all non-CHP plants. Then data were partitioned into natural gas (NG) and coal plants based on reported fuel codes. We further filtered those plants to identify those that were either steam turbine, gas turbine, or combined cycle facilities for NG, or just steam turbine facilities for coal. In addition, we set practical bounds on the minimum and maximum ratio of fuel used for electricity production to the total fuel consumed within the plant. The minimum and maximum ratios were investigated using a sensitivity analysis using, and the resultant ratios of 10% minimum and 70% maximum were selected as representative.

A production weighted average of all plants available within each set of selection criteria were used to determine characteristic plant efficiencies for the three types of NG plants and the one type of coal plants. In addition, a weighted average of the different NG plants was also determined. Table 1 presents the results of that analysis. Note that within this work the reported higher heating values (HHV) were converted to lower heating values (LHV) to be consistent with GREET assumptions. Further, the NG combined cycle plants within Form 923 are partitioned into “turbine” and “steam” parts. It was necessary to combine those “parts”, by summing their various inputs and outputs.

Table 1 Combined Heat and Power Plant Thermal Electric and Overall Efficiencies

Plant Type	Equivalent Electric Efficiency Using Fuel Allocated to Power Generation	Overall Plant Energy Conversion Efficiency
Natural Gas Steam Turbine	52.8%	80.6%
Natural Gas Combustion Turbine	65.8%	79.4%
Natural Gas Combined Cycle	68.1%	77.9%
Natural Gas, weighted average	*65.6%*	*79.0%*
Coal Steam Turbine	46.9%	65.8%

The four CHP plants were integrated within GREET’s .Net and Excel platforms for the 2017 release.

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