NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Mountain Pass CHP

Reference Flow: 1 MJ of electricity or heat

Brief Description: This unit process provides the natural gas usage for 1 MJ of electricity or heat

Section I: Meta Data

Geographical Coverage: USA **Region:** California

Year Data Best Represents: 2012

Process Type: Energy Conversion (EC)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: Yes

Completeness: Individual Relevant Flows Captured

Flows Aggregated in Data Set:

☐ Process ☑ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☐ Criteria Air	☐ Other
Releases to Water:	☐ Inorganic	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☑ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

func_unit	*[binary] 0 - electricity, 1 - heat*

Tracked Input Flows:

natural gas, combusted in turbine	*[Technosphere] Natural gas combusted in a turbine with SCR*
natural gas, combusted in duct burners	*[Technosphere] Natural gas combusted in duct burners*

Tracked Output Flows:

Electricity [Electric Power]	*Reference flow*
Heat, from Mountain Pass CHP	*Emission to air*
Water [Water]	*Water discharged*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Mountain_Pass_CHP_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

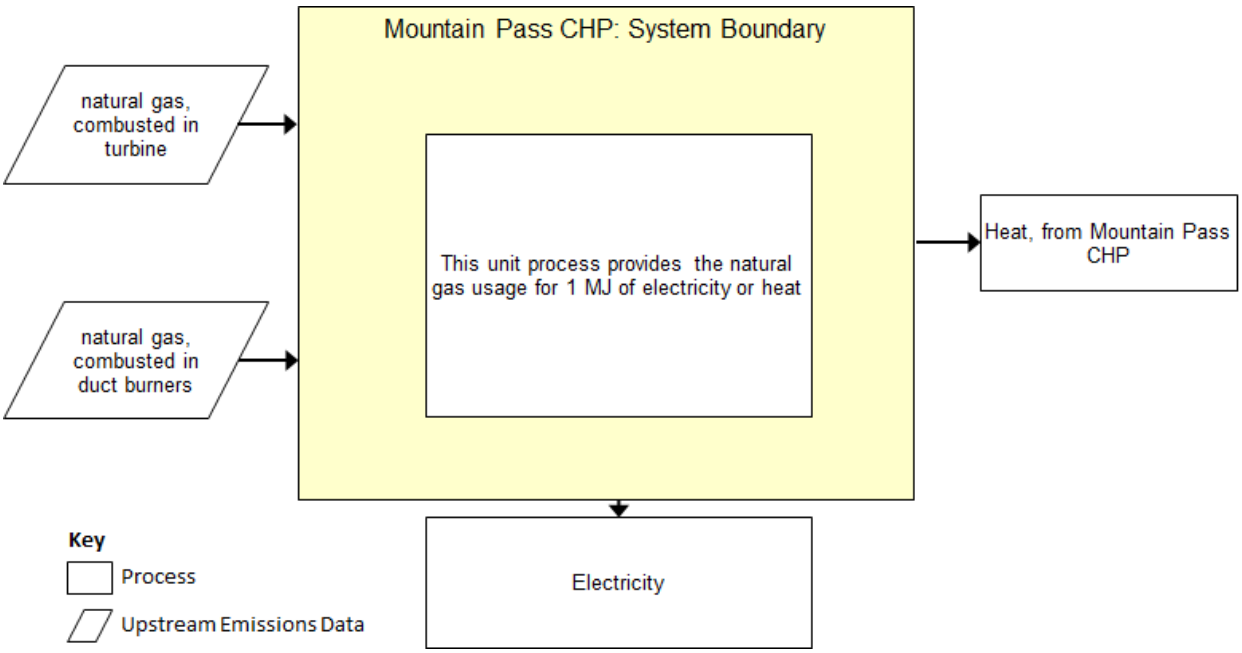
Goal and Scope

This unit process provides natural gas and water usage to operate the combined heat and power plant at the Mountain Pass rare earths mine and processing facility. Natural gas that is used in both the turbines and heat recovery steam generators (HRSGs) is allocated according to calculation efficiencies. The process also includes natural gas input for duct burners that increase the heat available to the HRSGs. The reference flow of this unit process is: 1 MJ of electricity or heat.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, the upstream emissions from natural or associated gas and water are calculated in another unit process. The methods for calculating these operating activities are described below.

Figure 1: Unit Process Scope and Boundary



According to Molycorp, the rare earth mine in Mountain Pass, CA now includes a natural-gas fired combined-cycle, combined heat and power (CHP) plant, replacing natural gas fired boilers (Molycorp, 2011). The average operating conditions for CHP electricity generation and steam production are defined within the presentation – 48 MW and 320,000 lb/hr (145,150 kg/hr) of steam. A heat rate of 12,326 BTU/kWh lower heating value (LHV) is also provided. The heat rate is used to calculate a natural gas demand of 3.07 kg/s, assuming a higher heating value (HHV) of 52.58 MJ/kg and an LHV of 47.45 MJ/kg, resulting in an efficiency of 30% HHV. A steam efficiency of 1000 BTU/lb-steam@300 psi is also provided, noting that duct burners are used to increase efficiency which represents more natural gas usage. It is assumed that the steam enthalpy increases from 60 ºF at atmospheric pressure to saturation temperature at 300 psig, representing 110 MW of steam energy. The provided heat rate is used to calculate an additional natural gas demand of 0.68 kg/s.

In order to provide a process that can be used for either electricity or steam (since it is unlikely that any process would use the precise ratio of electricity and steam energy generated by the process), the natural gas demand must be allocated to one or the other. The method of allocation is that recommended by the World Resources Institute Greenhouse Gas Protocol (WRI & WBSCD, 2006). This method uses the ratio of either electricity or steam heat output to the total heat input to calculate allocation factors, as shown in **Equation [1]**. However, the steam generation heat input is not straight forward because the gas turbine waste heat is partially used to generate the steam. To account for this heat, operating data for a natural gas combined cycle (NGCC) plant was

used to calculate the waste heat provided per MW of electricity generated (NETL, 2010). This waste heat was combined with the duct burner natural gas heat input to calculate the heat recovery steam generator (HRSG) efficiency – 76% HHV. The allocation factors are calculated as 0.53 for electricity and 0.47 for steam.

$$F_{steam} = \frac{\frac{P_{steam}}{\eta_{steam}}}{\frac{P_{steam}}{\eta_{steam}} + \frac{P_{elec}}{\eta_{elec}}} \quad [1]$$

Where,

F_{steam} is the allocation factor for stream production

P_{steam} is the steam power produced by the steam generators

η_{steam} is the efficiency of steam generation

P_{elec} is the electricity generated

η_{elec} is the efficiency of electricity production

Water demand and discharge were also taken from the NGCC report and the allocation factors applied to provide separate water use for electricity and steam generation (NETL, 2010).

Table 2: Unit Process Input and Output Flows

Flow Name	Electricity	Heat	Units (Per Reference Flow)
Inputs			
natural gas, combusted in turbine	3.50E-02	1.32E-02	kg
natural gas, combusted in duct burners	0.00E+00	6.18E-03	kg
Water [Water]	1.47E-01	5.54E-02	kg
Outputs			
Electricity [Electric Power]	1.00E+00	0.00E+00	MJ
Heat, from Mountain Pass CHP	0.00E+00	1.00E+00	MJ
Water [Water]	3.29E-02	1.24E-02	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

Molycorp (2011). Industrial Boiler Replacement with CHP. Paper presented at the CHPP National Meeting: Panel on CHP and Industrial Efficiency. Retrieved December 17, 2013 from http://www.epa.gov/chp/documents/meeting_100511_coleman.pdf

WRI, & WBSCD. (2006). Allocation of GHG Emissions from a Combined Heat and Power (CHP) Plant. Retrieved December 17, 2013 from http://www.ghgprotocol.org/files/ghgp/tools/CHP_guidance_v1.0.pdf

NETL. (2010). Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity Report. (DOE/NETL-2010/1397). Pittsburgh, PA: National Energy Technology Laboratory Retrieved June 5, 2012, from http://www.netl.doe.gov/energy-analyses/pubs/BitBase_FinRep_Rev2.pdf

Section III: Document Control Information

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