NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Operation of NETL Baseline NGCC plant

Reference Flow: 1 MWh of Electricity Output

Brief Description: The operations of the Natural Gas Combined Cycle (NGCC) with or without carbon capture and sequestration (CCS) on the basis of 1 MWh electricity output.

Section I: Meta Data

Geographical Coverage: USA **Region:** Midwest

Year Data Best Represents: 2010 (baseline report)

Process Type: Energy Conversion (EC)

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

Allocation Applied: No

Completeness: All 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:

CF	*[dimensionless] Capacity Factor of NGCC plant*
CCS	*[binary] If CO2 in flue gas is routed to CO2 recover, value = 1. If CO2 in flue gas is released to atmosphere, value = 0.*

CF_AuxB	*[Dimensionless] Fraction of downtime that auxliary boiler operates*

Tracked Input Flows:

NGCC power plant [Construction]	*[Technosphere] NGCC power plant*
Natural gas USA [Natural gas (resource)]	*[Technosphere] Natural gas combusted for power generation*
Natural gas combustion in auxiliary boiler	*[Technosphere] Natural gas combusted in auxiliary boiler*

Tracked Output Flows:

Electricity Output	*Reference flow*
Carbon dioxide [Co-product]	*CO_2 captured for CCS*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *Stage - 3 - O - NGCC baseline.xls*, which provides additional details regarding relevant calculations, data quality, and references.

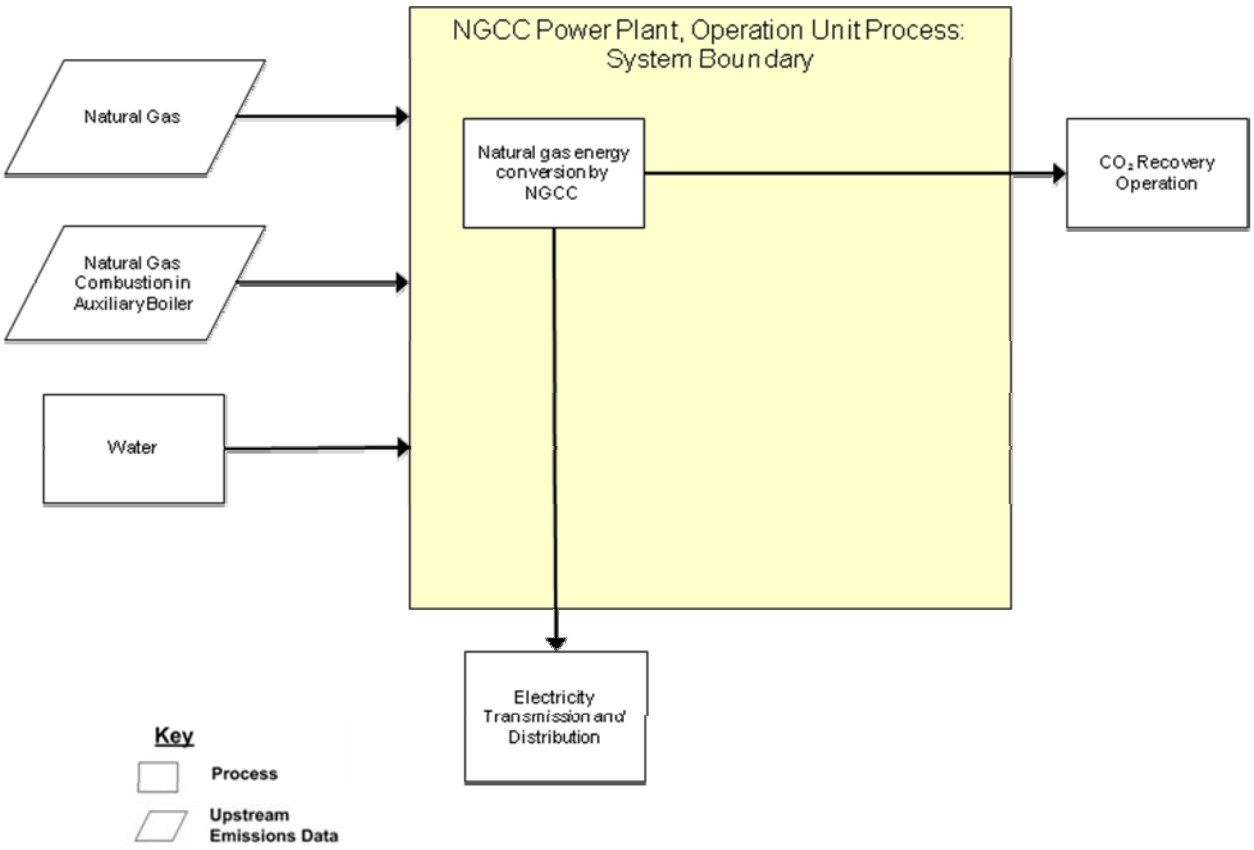
Goal and Scope

This unit process provides a summary of relevant input and output flows associated with the production of electricity by the combustion of natural gas in the natural gas combined cycle (NGCC) power plants defined in the NETL baseline studies (NETL, 2010). This process can be used for scenarios with and without CCS. Key inputs include natural gas and water from surface and ground sources and combustion of natural gas in an auxiliary boiler. Key outputs include electricity, greenhouse gas emissions to air, and waste water. The reference flow of this unit process is: 1 MWh of Electricity Output.

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 the mining and transportation of coal are calculated in another unit process which should be added to this to provide an accurate inventory value. Water is assumed to enter the boundary of the unit process with no upstream resources or emissions. The methods for calculating these operating activities are described below.

Figure 1: Unit Process Scope and Boundary



The NGCC plant is based on the NETL baseline of NGCC power (NETL, 2010). Refer to the baseline studies for details regarding plant designs with and without CCS. The NGCC process inputs, water usage, and emissions, with the exception of ammonia, are calculated on a per unit basis using the results of the NETL baseline NGCC plants, Cases 13 and 14.

The ammonia emissions resulting from the combustion of natural gas are negligible, but the NETL baseline NGCC plants use a selective catalytic reduction (SCR) system to reduce NO_x emissions. As the SCR catalyst strength reduces, ammonia is exhausted to the flue gas, known as ammonia slip. The NETL baseline report assumed a 10 ppmv slip rate at the end of the useful life of the catalyst. The unit process converts the 10 ppmv slip rate into a kg/MWh emission factor using flue gas data from the baseline report.

This process also includes a tracked input of natural gas used for auxiliary boiler operations (Wabash, 2008). The auxiliary boiler operating time is assumed to be half of the NGCC plant downtime, which is derived from the NGCC plant capacity factor. The result is that the auxiliary boiler operates 7.5% of the plant life. To get the auxiliary boiler natural gas consumption on a MWh basis, the auxiliary boiler natural gas consumption is scaled down to 7.5% and then divided by the plant power output which

operates only 85% of the time. The emissions from the auxiliary boiler are calculated by a separate unit process.

Table 1 provides the relevant input and output flows for this unit process. Results are provided for NGCC plant operation with and without CCS.

Table 1: Unit Process Input and Output Flows

Flow Name	NGCC without CCS	NGCC with CCS	Units (Per Reference Flow)
Inputs			
NGCC power plant [Construction]	8.06E-09	9.45E-09	pce
Natural gas USA [Natural gas (resource)]	1.37E+02	1.60E+02	kg
Natural gas combustion in auxiliary boiler	1.61E-01	1.88E-01	kg
Water (ground water) [Water]	4.88E+02	9.54E+02	L
Water (surface water) [Water]	4.88E+02	9.54E+02	L
Outputs			
Electricity Output	1.00	1.00	MWh
Carbon dioxide [Co-product]	0.00E+00	3.84E+02	kg
Carbon dioxide [Inorganic emissions to air]	3.65E+02	4.26E+01	kg
Nitrogen oxides [Inorganic emissions to air]	2.77E-02	2.99E-02	kg
Ammonia [Inorganic emissions to air]	1.78E-02	2.12E-02	kg
Water (wastewater) [Water]	2.27E+02	4.77E+02	L

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

Embedded Unit Processes

None.

References

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

Wabash. (2008). 40000 PPH Nebraska, Watertube, trailer mounted, 350 psi, gas/oil (3). Wabash Power Equipment Company Retrieved October 2008

Section III: Document Control Information

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Revision History:

1. (09/20/2012) Updated to new DS/DF documentation format and to Rev. 2 of the Bituminous Baseline
2. (03/26/2014) Replaced incorrect values for NOx emissions in the DS 'Baseline' tab with correct values from Rev.2 of the Bituminous Baseline. Updated related output values in Table 1 of the DF.

How to Cite This Document: This document should be cited as:

NETL (2012). NETL Life Cycle Inventory Data – Unit Process: Operation of NETL Baseline NGCC plant. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: March 2014 (version 03). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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