NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Operation of NETL baseline IGCC plant

Reference Flow: 1 MWh of Electricity Output

Brief Description: The operations of the Integrated Gasification Combined Cycle (IGCC) 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

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 IGCC plant*
CCS	*[binary] If CO2 in flue gas is routed to CO2 recovery, value = 1. If CO2 in flue gas is released to atmosphere, value = 0.*

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

Tracked Input Flows:

IGCC power plant [Construction]	*[Technosphere] IGCC power plant*
Coal [Natural gas (resource)]	*[Technosphere] Coal for gasification*
Natural gas combustion in auxiliary boiler	*[Technosphere] Natural gas combusted in auxiliary boiler*
Water (ground water) [Water]	*[Resource] Ground water withdrawal*
Water (surface water) [Water]	*[Resource] Surface water withdrawal*

Tracked Output Flows:

Electricity Output	*Reference flow*
Carbon dioxide [Co-product]	*CO_2 captured for CCS*
Carbon dioxide [Inorganic emissions to air]	*Emission to air*
Nitrogen oxides [Inorganic emissions to air]	*Emission to air*
Sulphur dioxide [Inorganic emissions to air]	*Emission to air*
Dust (unspecified) [Particles to air]	*Emission to air*
Mercury (+II) [Heavy metals to air]	*Emission to air*
Water (wastewater) [Water]	*Renewable resources*

Section II: Process Description

Associated Documentation

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

Goal and Scope

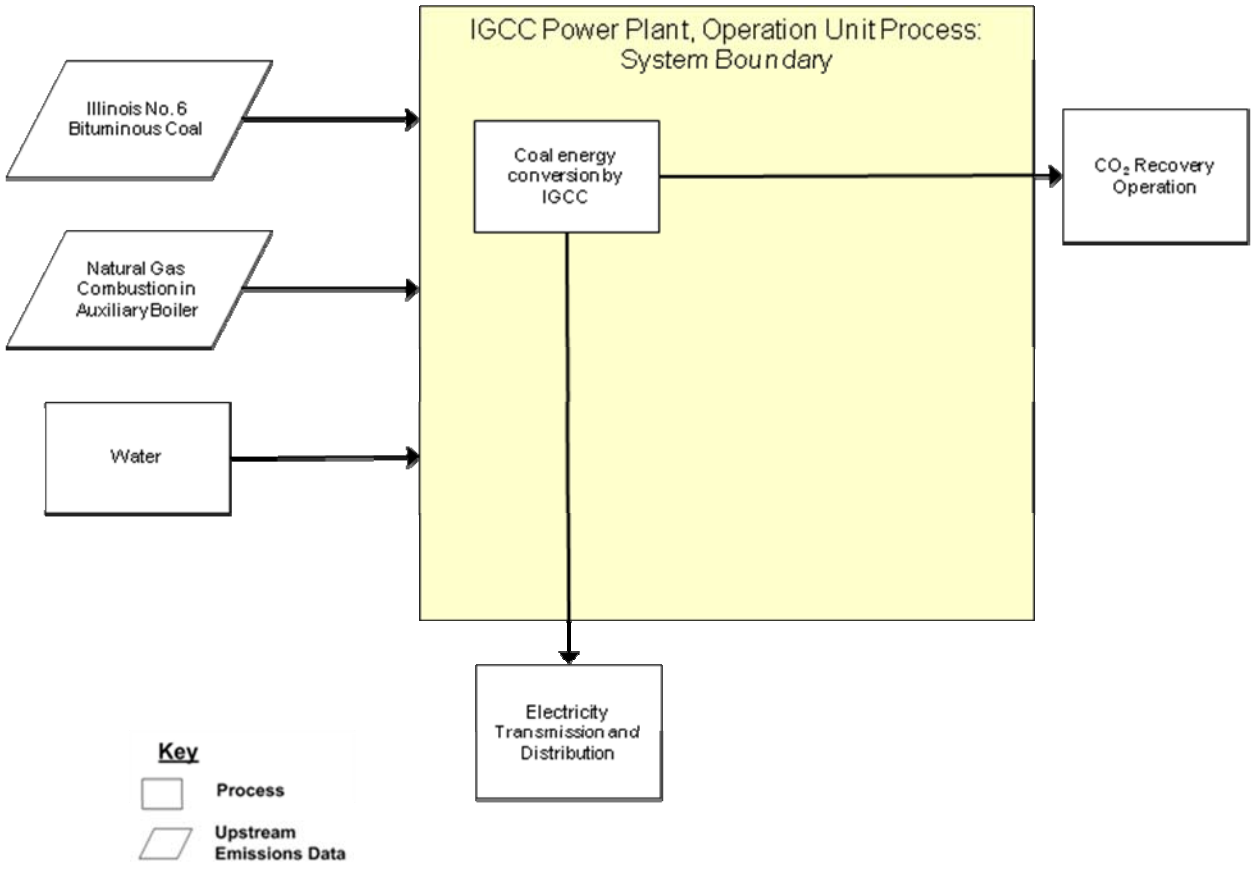
This unit process provides a summary of relevant input and output flows associated with the production of electricity by the combustion of natural gas in the integrated gasification combined cycle (NGCC) power plants defined in the NETL baseline studies (NETL, 2010). This process can be used for scenarios 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 IGCC plant was based on the NETL baseline of IGCC power using a General Electric Energy gasifier without CCS (NETL, 2010). The IGCC process inputs, water usage, and emissions, with the exception of lead, are calculated on a per unit basis using the results of the NETL baseline IGCC plant Case 1. The lead air emissions factor for the

IGCC plant was calculated using measured data from an operating IGCC plant (Ratafia-Brown et al., 2002).

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 for 10% 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 10% and then divided by 80% of the plant power output. The emissions from the auxiliary boiler are calculated by a separate unit process.

The total emissions for this unit process are the sum of IGCC plant and auxiliary boiler emissions. **Table 1** provides the input and output flows for this unit process.

Table 1: Unit Process Input and Output Flows

Flow Name	IGCC without CCS	IGCC with CCS	Units (Per Reference Flow)
Inputs			
IGCC power plant [Construction]	7.64E-09	8.75E-09	pce
Illinois No 6 Coal [Hard coal (resource)]	340.46	406.63	kg
Natural gas combustion in auxiliary boiler	0.20	0.23	kg
Water (ground water) [Water]	863.26	1215.38	L
Water (surface water) [Water]	863.26	1215.38	L
Outputs			
Electricity Output	1.00	1	MWh
Carbon dioxide [Co-product]	0	840.96	kg
Carbon dioxide [Inorganic emissions to air]	781.54	93.44	kg
Nitrogen oxides [Inorganic emissions to air]	2.34E-01	2.30E-01	kg
Sulfur dioxide [Inorganic emissions to air]	4.91E-03	1.02E-02	kg
Dust (unspecified) [Particles to air]	2.84E-02	4.35E-03	kg
Mercury (+II) [Heavy metals to air]	2.27E-06	2.71E-06	kg
Lead (+II) [Heavy metals to air]	1.15E-06	1.38E-05	Kg
Water (wastewater) [Water]	363.49	454.35	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

Ratafia-Brown, J. A., Manfredo, L. M., Hoffman, J. W., Ramezan, M., & Stiegel, G. J. (2002). *An Environmental Assessment of IGCC Power Systems*. Paper presented at the Nineteenth Annual Pittsburgh Coal Conference, Pittsburgh, PA.

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

Date Created: September 20, 2012

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

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

NETL (2012). NETL Life Cycle Inventory Data – Unit Process: Operation of NETL baseline IGCC plant. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: September 2012 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.