



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Operation of NETL Baseline SCPC Power Plant
Reference Flow: 1 MWh of Electricity
Brief Description: The operations of the NETL baseline Supercritical Pulverized Coal (SCPC) power plants 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: 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:

CF *[dimensionless] Capacity Factor of SCPC 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	<i>[Dimensionless] Fraction of downtime that auxiliary boiler operates</i>
AuxB_opt_factor	<i>[Dimensionless] Fraction of total time that auxiliary boiler operates</i>

Tracked Input Flows:

SCPC power plant [Construction]	<i>[Technosphere] SCPC power plant</i>
Hard Coal (Illinois No 6) [Hard coal (resource)]	<i>[Technosphere] Coal for combustion</i>
Natural gas combustion in auxiliary boiler	<i>[Technosphere] Natural gas combusted in auxiliary boiler</i>
Water (ground water) [Water]	<i>[Resource] Ground water withdrawal</i>
Water (surface water) [Water]	<i>[Resource] Surface water withdrawal</i>

Tracked Output Flows:

Power [Electric Power]	<i>Reference flow</i>
Carbon dioxide [Inorganic intermediate products]	<i>CO₂ captured for CCS</i>

Section II: Process Description

Associated Documentation

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

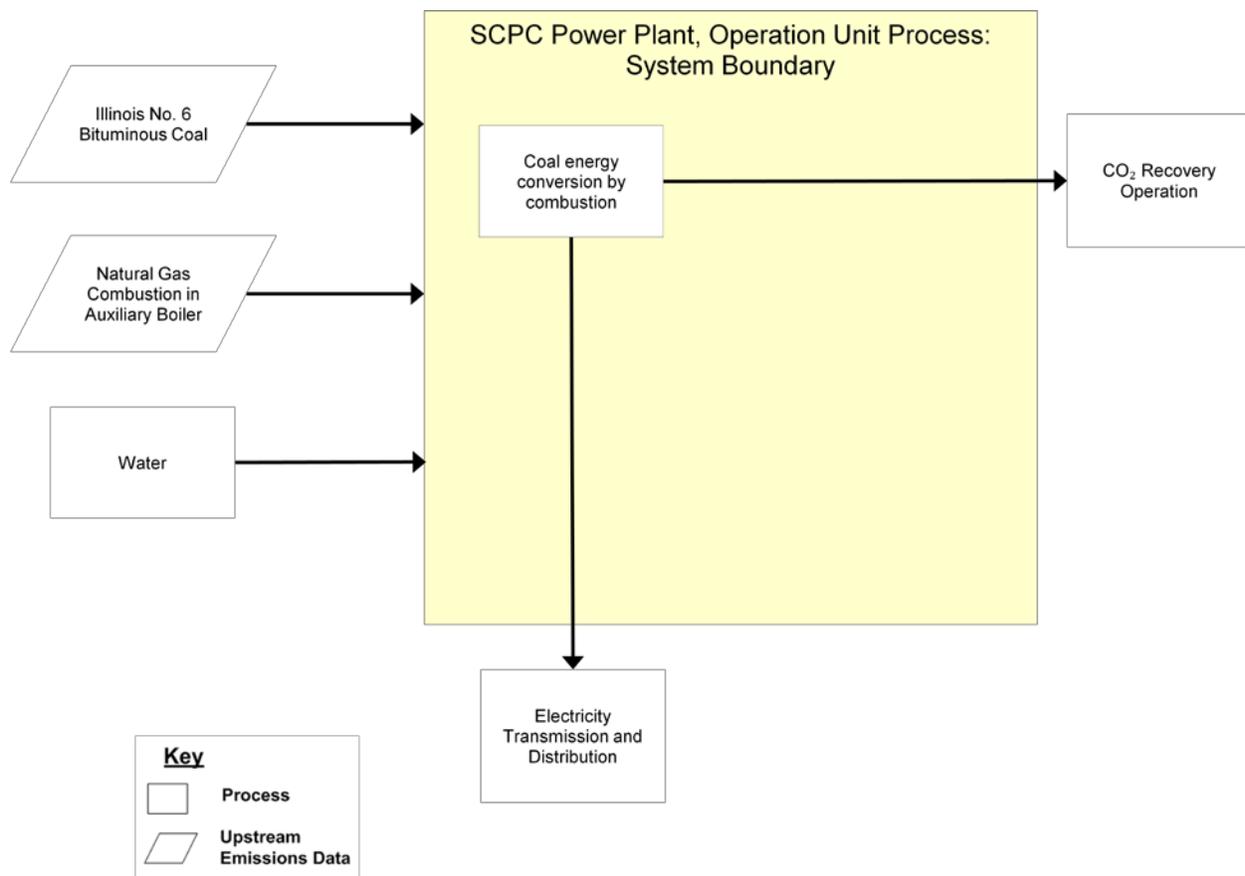
Goal and Scope

This unit process provides a summary of relevant input and output flows associated with the production of electricity by the combustion of coal in the supercritical pulverized coal power plants defined in the NETL baseline studies. This process can be used for scenarios with and without CCS. Key inputs include Illinois No. 6 coal 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.

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 SCPC plant is based on the NETL baseline of SCPC power (NETL, 2010). Refer to the baseline studies for details regarding plant designs with and without CCS. The SCPC process inputs, water usage, and emissions, with the exceptions of ammonia and lead, are calculated on a per unit basis using the results of the NETL baseline SCPC plants, Cases 11 and 12.

The ammonia emissions resulting from the combustion of natural gas are negligible, but the NETL baseline SCPC 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 2 ppmv slip rate at the end of the useful life of the catalyst. The unit process converts the 2 ppmv slip rate into a kg/MWh emission factor using flue gas data from the baseline report.

Lead emissions were not included in the NETL baseline SCPC plants but are included in this unit process. A lead emission factor was calculated based on emissions data available in the EPA Toxics Release Inventory database (EPA, 2011). Lead air emissions as measured from flue gas were averaged for the past 6 years for ten supercritical coal power plants located in the Midwest. These averages were converted to an emission factor on a per MWh basis, using an average of the actual power produced over three years (EPA, 2012). For the case without CCS, the lead emission factor is the average of all ten calculated emission factors. To scale the emission factor for use with CCS, the without CCS emission factor was scaled by the ratio of the gross power outputs of NETL baseline SCPC power plant with and without CCS (662.8 MW / 580.4 MW).

This process also includes a tracked input of natural gas used for auxiliary boiler operations. The auxiliary boiler operating time is assumed to be half of the SCPC plant downtime, which is derived from the SCPC plant capacity factor. The result is that the auxiliary boiler operates 7.5% of the plant life. To place 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: Unit Process Input and Output Flows

Flow Name	Value w/o CCS	Value w/ CCS	Units (Per Reference Flow)
Inputs			
SCPC power plant [Construction]	8.13E-09	8.13E-09	pce
Hard Coal (Illinois No 6) [Hard coal (resource)]	337.75	466.66	kg
Natural gas combustion in auxiliary boiler	0.16	0.16	kg
Water (ground water) [Water]	1,101.79	2078.64	L
Water (surface water) [Water]	1,101.79	2078.64	L
Outputs			
Power [Electric Power]	1.00	1.00	
Carbon dioxide [Inorganic intermediate products]	0.00E+00	996.09	kg
Carbon dioxide [Inorganic emissions to air]	801.95	110.68	kg
Nitrogen oxides [Inorganic emissions to air]	0.28	0.38	kg
Sulphur dioxide [Inorganic emissions to air]	0.34	0.01	kg
Dust (unspecified) [Particles to air]	0.05	0.07	kg
Lead (+II) [Heavy metals to air]	6.18E-05	7.05E-05	kg
Mercury (+II) [Heavy metals to air]	4.50E-06	6.23E-06	kg
Ammonia [Inorganic emissions to air]	1.95E-03	2.70E-03	kg
Water (wastewater) [Water]	454.35	976.85	L

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

Embedded Unit Processes

None.

References

- EPA. (2011). Toxics Release Inventory. Available from EPA Toxics Release Inventory Retrieved August 14, 2012, from EPA <http://www.epa.gov/enviro/facts/tri/search.html>
- EPA. (2012). The Emissions and Generation Resource Integrated Database (eGRID). EPA, from <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>
- 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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Original/no revisions

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