NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Operation of Existing Pulverized Coal Power Plant

Reference Flow: 1 MWh of Electricity

Brief Description: The operations of an existing pulverized coal (EXPC) power plant with or without carbon capture and sequestration (CCS) on the basis of 1MWh electricity output.

Section I: Meta Data

Geographical Coverage: USA **Region:** Midwest

Year Data Best Represents: 2005

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:

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.*

Tracked Input Flows:

CCS addition [Construction]	*[Technosphere] CCS addition to an existing plant*
Hard Coal (Illinois No 6) [Hard coal (resource)]	*[Technosphere] Coal for combustion*
Power (from grid mix) [System-dependent]	*[Technosphere] Electric power from grid to offset power diverted to CCS*

Tracked Output Flows:

Power [Electric Power]	*Reference flow*
Carbon dioxide [Inorganic intermediate products]	*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-EXPC_Power_Plant_baseline.xls*, which provides additional details regarding relevant calculations, data quality, and references.

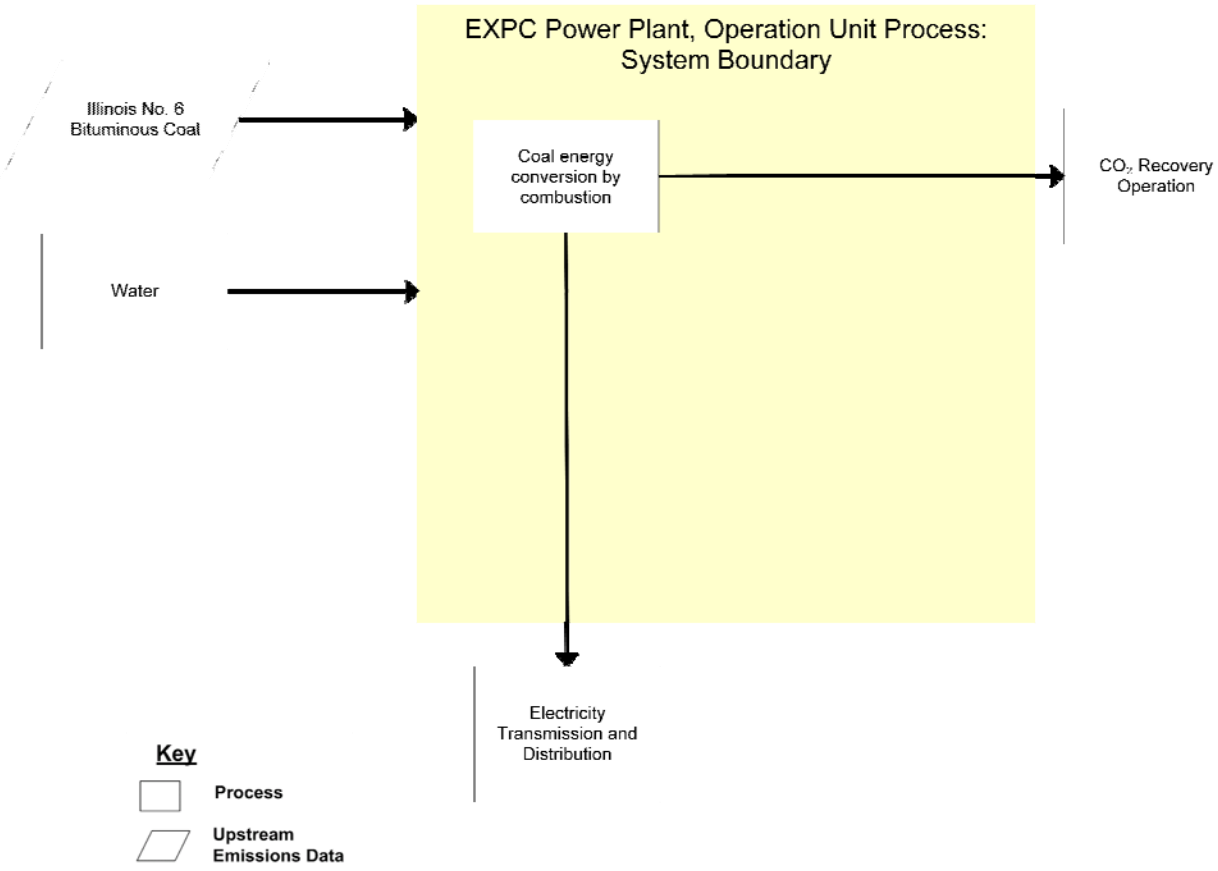
Goal and Scope

This unit process provides a summary of relevant input and output flows associated with the production of electricity by the combustion of coal in an existing, subcritical pulverized coal power plant. 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. 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 EXPC plant is based on an operating power plant, Conesville Unit 5. The Conesville power plant was the subject of a previous CCS retrofit study for coal-fired power plants (NETL, 2007a). Emissions data for the Conesville plant was obtained from two EPA databases and converted to a per MWh produced (i.e., net generation) basis as necessary to represent an EXPC plant without CCS (EPA, 2009a, 2009b). The non-CCS emissions factors were then scaled by the ratio of the net powers of the EXPC plant without and with CCS (433.778 MW / 303.317 MW). These scaled emissions factors represent an EXPC plant with CCS.

Coal feed rates for the EXPC plant had to be calculated using EPA data, which provided heat input in MMBTU for the year, and higher heating values provided in the retrofit study (NETL, 2007a) and the NETL bituminous baseline study (NETL, 2010). Again, the non-CCS value was scaled to provide a with CCS value.

Water usage for the EXPC plant was estimated from the Power Plant Water Usage and Loss Study (NETL, 2007b) henceforth referred to as the water report. For Subcritical PC Boiler Raw Water Usage, the water report lists a value of 663.8 gal/MWh which is used

for the plant water input value. Additionally, the CO_2 capture study (NETL, 2007a) lists additional CCS requirements of 84.5 gal/MWh for makeup to the amine plant and 413.6 gal/MWh for cooling tower makeup for a total of 1161.9 gal/MWh. This input is only for water withdrawn from a municipal or other source and does not include moisture in the coal or humidity in the combustion air for example. The UP assumes that the water input is divided 50/50 by ground and surface water sources. Water that is discharged from the plant as a waste is listed under Subcritical PC Boiler Water Loss by Function as cooling tower blowdown in the water report at a rate of 149.5 gallons per megawatt hour. This value is used for the non-CCS plant. The CCS plant discharge water is scaled by the ratio of the non-CCS and with-CCS makeup water requirements, about 1.75. This is supported by the bituminous baseline study (NETL, 2010), which shows that water discharge rates for a modeled pulverized coal power plant with CCS were roughly double that of the non-CCS plant.

An auxiliary boiler is not identified in the Conesville report (NETL, 2007a), nor are emissions from an auxiliary boiler at the Conesville plant identified in either of the emissions sources used for modeling (EPA, 2009a, 2009b). And while it is likely that one exists, it is the modeler's opinion that an auxiliary boiler would not be operated for a significant period of time as the EXPC plant is modeled after Conesville Unit 5 which is one coal-fired steam unit of four listed as active at the site. Therefore, rather than risk the introduction of additional emissions which may be double counted, a decision was made that emissions from an auxiliary boiler would not be modeled.

Table 1: Unit Process Input and Output Flows

Flow Name	Value w/o CCS	Value w/ CCS	Units (Per Reference Flow)
Inputs			
CCS addition [Construction]	0	1.47E-08	pce
Hard Coal (Illinois No 6) [Hard coal (resource)]	393.11	562.19	kg
Power (from grid mix) [System-dependent]	0.00	0.43	MWh
Water (ground water) [Water]	87.68	153.47	L
Water (surface water) [Water]	87.68	153.47	L
Outputs			
Power [Electric Power]	1.00	1.00	MWh
Carbon dioxide [Inorganic intermediate products]	0.00	1,211.23	kg
Carbon dioxide [Inorganic emissions to air]	941.05	134.58	kg
Methane [Organic emissions to air (group VOC)]	0.01	0.02	kg
Nitrogen oxides [Inorganic emissions to air]	1.88	2.68	kg
Sulphur dioxide [Inorganic emissions to air]	2.22	3.17	kg
Carbon monoxide [Inorganic emissions to air]	0.10	0.14	kg
NMVOC (unspecified) [Group NMVOC to air]	0.01	0.02	kg
Dust (PM10) [Particles to air]	0.63	0.90	kg
Dust (PM2.5) [Particles to air]	0.59	0.84	kg
Lead (+II) [Heavy metals to air]	5.88E-06	8.41E-06	kg
Mercury (+II) [Heavy metals to air]	4.84E-05	6.92E-05	kg
Ammonia [Inorganic emissions to air]	2.04E-04	2.92E-04	kg
Water (wastewater) [Water]	39.49	69.13	L

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

Embedded Unit Processes

None.

References

EPA. (2009a). Emissions & Generation Resource Integrated Database. Retrieved October 30, 2009, from United States Environmental Protection Agency http://www.epa.gov/cleanenergy/energy-resources/egrid/

EPA. (2009b). U.S. Environmental Protection Agency: 2005 National Emissions Inventory Data & Documentation, NAICS Summaries Retrieved July 18, 2010, from http://www.epa.gov/ttnchie1/net/2005inventory.html

NETL. (2007a). *Carbon Dioxide Capture from Existing Coal-Fired Power Plants*. (DOE/NETL-401/110907). National Energy Technology Laboratory, from http://www.netl.doe.gov/energy-

analyses/pubs/CO2%20Retrofit%20From%20Existing%20Plants%20Revised%20November%202007.pdf

NETL. (2007b). *Power Plant Water Usage and Loss Study*. Pittsburgh, PA: National Energy Technology Laboratory, from http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/WaterReport_Revised%20May2007.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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