



NETL Life Cycle Inventory Data

Process Documentation File

Hard Coal (Illinois No. 6) [Hard Coal Products] *Coal mine production flow for Illinois No. 6 bituminous coal*

Section II: Process Description

Associated Documentation

This unit process is comprised of this document, as well as the data sheet (DS) *DS_Stage1_O_Underground_Coal_Mine_I6_2009.02.xls*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

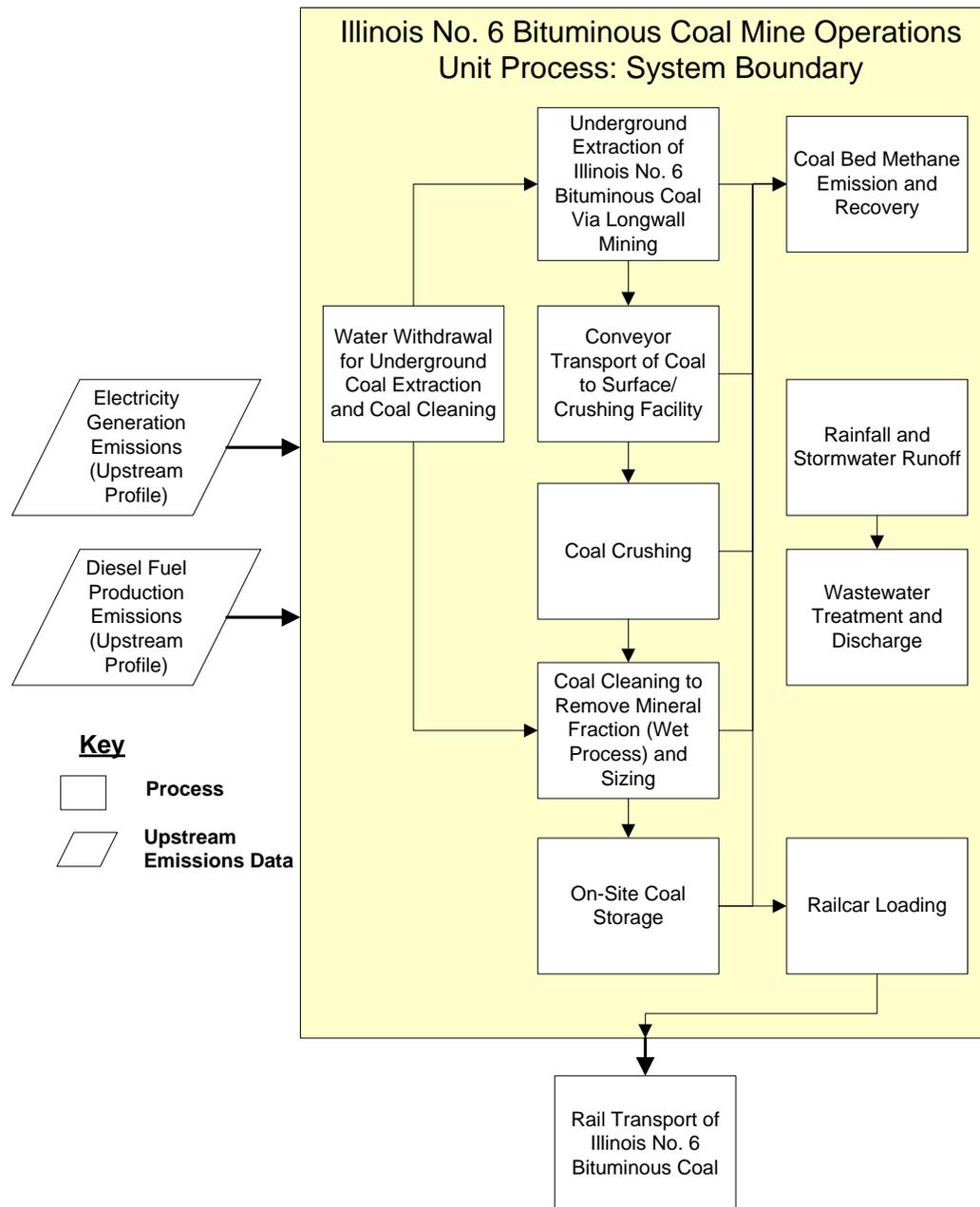
The scope of this process covers the production of coal during operation of an underground coal mine, from resource extraction to the boundary for LC Stage #2 (e.g., transport of coal). The process is based on the reference flow of 1 kg of cleaned, crushed (to approximately 3 inches) Illinois No. 6 bituminous coal, as described below, and in **Figure 1**. Considered are the consumption of electricity, consumption of diesel, emissions of methane associated with off-gassing from the coal/coal mine, particulate matter emissions associated with fugitive coal dust, water input flows required for mining and cleaning operations, wastewater flows including stormwater, emissions of criteria air pollutants, and air emissions of mercury and ammonia.

Boundary and Description

Operations of the coal mine are based on operation of the Galatia Mine, an underground, bituminous Illinois No. 6 coal mine, having an average production rate of approximately 6.6 million short tons per year. The Galatia Mine is operated by the American Coal Company and is located in Saline County, IL. Sources reviewed in assessing coal mine operations include Galatia mine facilities and equipment, production rates, electricity usage, particulate air emissions, methane emissions, wastewater discharge permit monitoring reports, and communications with Galatia mine staff. When data from the Galatia mine were not available, surrogate data were taken from other underground mines, as relevant.

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, upstream emissions associated with the production and delivery of electricity and diesel fuel are accounted for outside of the boundary of this unit process.

Figure 1: Unit Process Scope and Boundary



Coal is extracted from the underground Illinois No. 6 coal seam with wet-head longwall and continuous miners using a longwall mining process. Coal is then loaded onto a conveyor for transport to the surface. At the surface, the coal continues along a conveyor to the crushing facility, where the coal is crushed to approximately 3 inch sizing. Coal then continues to the cleaning facility, where the mineral fraction (approximately 45% of total coal mass) of the run-of-the-mine coal is removed via a water-based cleaning and sorting process. The coal is then temporarily stored, until it is eventually loaded onto a railcar for rail transport. Stormwater, which generates on-site runoff from coal stockpiles and other facilities, is treated at a wastewater treatment

plant, which discharges to a river. The wastewater treatment plant does not treat mining or coal cleaning process water. These systems are closed-loop in terms of water use, and generate no wastewater discharge.

Coalbed methane emissions from the coal mine, and from the extracted coal during processing and storage, were estimated based on U.S. EPA estimates of methane release for coal mines (U.S. EPA 2008). A 40% methane capture rate was used based on data for existing and potential recovery rates (U.S. EPA 2008), which resulted in a coalbed methane emission factor of 216 standard cubic feet per short ton of coal. For the sensitivity analysis, assuming that no coalbed methane capture method was employed, it was assumed that all emitted methane was released to the atmosphere, for a sensitivity value for coalbed methane emissions of 360 standard cubic feet per short ton.

Electricity use was estimated based on previous estimates made by U.S. EPA for electricity use for underground mining and coal cleaning at the Galatia Mine (U.S. EPA 2008). Diesel use was estimated for the Galatia mine from 2002 U.S. Census data for bituminous coal underground mining operations and associated cleaning operations (U.S. Census Bureau 2004).

Emissions of criteria pollutants were based on emissions associated with the use of diesel. U.S. EPA Tier 4 diesel standards for non-road diesel engines were used, since these standards would go into effect within a couple years of commissioning of the mine for this study (U.S. EPA 2004). Diesel is assumed to be ULSD (15 ppm sulfur). Emissions of particulate matter included those due to the combustion of diesel, as well as fugitive coal dust from the mining process. Total coal dust emissions from the Galatia Mine were used based on data for the mine (U.S. EPA 2005), and were normalized to the reference flow.

Water use was estimated by dividing USGS 2005 county-level water use (U.S. Geological Survey, 2005) by the 2005 Galatia Mine coal production (EIA 2013), which correlates well with an estimate provided by Galatia Mine staff (Personal Communication 2009). Water use for other counties with coal mines is provided to provide a bound for uncertainty. Water emissions data, including flows and concentrations of relevant inorganic constituents and biological oxygen demand, were taken from available National Pollutant Discharge Elimination System permit reporting documentation for Galatia Mine from 2009-2011 (EPA 2013).

Properties of Illinois No. 6 coal relevant to this unit process are indicated in **Table 1**. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS sheet.

Table 1: Properties of Illinois No. 6 Coal (NETL 2007)

Rank	Bituminous	
Seam	Illinois No. 6 (Herrin)	
Source	Old Ben Mine	
Proximate Analysis (weight %) (Note A)		
	As Received	Dry
Moisture	11.12	0.00
Ash	9.70	10.91
Volatile Matter	34.99	39.37
Fixed Carbon	44.19	49.72
Total	100.00	100.00
Sulfur	2.51	2.82
HHV, kJ/kg	27,113	30,506
HHV, Btu/lb	11,666	13,126
LHV, kJ/kg	26,151	29,544
LHV, Btu/lb	11,252	12,712
Ultimate Analysis (weight %)		
	As Received	Dry
Moisture	11.12	0.00
Carbon	63.75	71.72
Hydrogen	4.50	5.06
Nitrogen	1.25	1.41
Chlorine	0.29	0.33
Sulfur	2.51	2.82
Ash	9.70	10.91
Oxygen (Note B)	6.88	7.75
Total	100.00	100.00

Notes: (A) the proximate analysis assumes sulfur as volatile matter; (B) by difference.

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Power [Electric power]	3.31E-02	kWh
Hard Coal (Illinois No. 6) [Hard coal (resource)]	1.01E+00	kg
Diesel [Crude oil products]	3.10E-04	L
Water (ground water, fresh) [Water]	1.34E-01	L
Water (ground water, saline) [Water]	5.17E-02	L
Water (surface water, fresh) [Water]	1.18E-01	L
Outputs		
Hard Coal (Illinois No. 6) [Hard Coal Products]	1.00E+00	kg
Carbon dioxide [Inorganic emissions to air]	8.29E-04	kg
VOC (unspecified) [Organic emissions to air (group VOC)]	2.38E-07	kg
Methane [Organic emissions to air (group VOC)]	7.56E-03	kg
Nitrogen oxides [Inorganic emissions to air]	5.10E-07	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	2.13E-08	kg
Sulphur oxide [Inorganic emissions to air]	7.82E-09	kg
Particulate Matter, unspecified [Other emissions to air]	1.25E-06	kg
Carbon monoxide [Inorganic emissions to air]	4.44E-06	kg
Mercury (+II) [Heavy metals to air]	4.08E-14	kg
Ammonia [Inorganic emissions to air]	3.41E-08	kg
Water (storm runoff) [Water]	3.78E-01	L
Total suspended solids [Particles to fresh water]	5.32E-06	kg
Iron [Heavy metals to fresh water]	9.22E-08	kg
Alkalinity [Inorganic emissions to fresh water]	6.10E-05	kg
Acidity [Inorganic emissions to fresh water]	-2.97E-05	kg
Chloride [Fresh water]	2.44E-03	kg
Sulphate [Inorganic emissions to fresh water]	3.80E-04	kg
Biological oxygen demand (BOD) [Analytical measures to fresh water]	7.49E-06	kg
Ammonia, as N [Inorganic emissions to fresh water]	1.88E-06	kg

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

Embedded Unit Processes

None.

References

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Section III: Document Control Information

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4/1/2013 Water use and emissions updated to newer data

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www.netl.doe.gov/energy-analyses (<http://www.netl.doe.gov/energy-analyses>)

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