CASE STUDY #3: ENERGY SECTOR – COAL PRODUCTION AND USE

Part 1: Goal

The objective of this case study is to learn how to characterize, estimate, and report emissions for a point source category. The specific goals to be achieved by this case study are:

- To estimate emissions from coal production and use for energy generation;
- To use emission factors and activity data for estimating emissions of key pollutants for this source;
- To document the inventory process so that the results can be duplicated.

Part 2: Problem Description

Coal dominates South Africa's energy supply sources. An emission factor-based approach is needed to estimate key air quality pollutant emissions for a large electric utility plant. Pulverized coal furnaces are used in the utility boilers, and the primary coal type is bituminous. In a pulverized coal system, the coal is pulverized in a mill to the consistency of talcum powder. The pulverized coal is then entrained in primary air before being fed through the burners to the combustion chamber of the boiler, where it burns in suspension. The key pollutants of concern for this inventory are sulfur oxides, nitrogen oxides, carbon monoxide, and particulate matter.

In addition to the burning of the coal at the plant, emissions related to the surface mining of the coal utilized in the plant are of interest. The emission of concern at the mining location is particulate matter, which results from blasting, bulldozing, draglines, grading, and storage piles.

Note to Student: All of the activity data and case study characteristics provided in this example are fictitious and made up for the sole purpose of demonstrating inventory methodologies. However, the emission factors used in the examples are actual factors taken from available reference sources as cited in the case study.

Surface Mining Operation

The mining consists of strip mining with overburden removal/replacement and loading of the coal on site prior to transport to the utility. Not all of the coal leaving the mine goes to the utility boiler being inventoried. Only the quantity of coal that is burned in the utility boiler (2.3 million Mg of coal/year) is used to estimate emissions for the boiler component of this case study; however, the surface mining component of this case study includes all coal produced at the mine for the inventory year. The overall production at this mine is reported to be 9.07 million Mg of coal per year.

The following activities occur at the surface mining operation:

- Blasting of overburden and coal;
- Truck loading of coal;
- Shoveling/dumping coal and overburden;
- Dragline for overburden;
- Active coal storage piles prior to loading for transport.

Blasting occurs once a day for 330 days per year, shoveling and dumping operations 6 hours/day for 360 days per year, and 11.5 million cubic meters of overburden are moved per year. The active coal storage piles cover 2 hectares in total and are present all year.

For each of the activities listed above, emissions can be calculated by multiplying an appropriate emission factor times the associated activity levels for each. Emissions can be calculated using the following general equation.

$$\mathbf{E = A \times EF}$$

Where:
E = emissions (kg/year);
A = activity level (activity units/year); and
EF = emission factor (kg/activity unit).

Emission factors for surface coal mining for the above listed activities are available based on testing at surface mining operations in the western United States and contained in the U.S. EPA’s AP-42 guidance. If available, region-specific factors should be utilized. However, in the absence of regional factors, and since operations and general coal types (bituminous) on which the AP-42 factors are based are similar, an initial estimation could be made with AP-42 factors listed below:

Mining Activity	**PM ≤ 30 µm Emission factor**	**PM ≤ 2.5 µm Emission factor**	**Units for emission factors**
Blasting	13.9482	0.4184	kg/blast
Truck Loading	0.0183	0.0003	kg/Mg coal
Bulldozing			
Coal	22.4236	0.6727	kg/hr
Overburden	1.6377	0.0278	kg/hr
Dragline	0.0346	0.0011	kg/m^3
Coal Storage Pile	5.94	no data	kg/(hectare/hr)

Emission factor source: Compiled from US EPA, AP-42, Fifth Edition, Volume I, Chapter 11 *Mineral Products Industry*, Chapter 11.9 *Western Surface Coal Mining, Supplement E*, Oct. 1998.

Utility Boilers

A utility boiler burns bituminous coal with characteristics of 45% ash content, and 1.2% sulfur content. The boiler type is a pulverized coal, dry bottom, wall-fired configuration with electrostatic precipitation (ESP) control technology installed to reduce particulate matter emissions. Plant records indicate the boiler burns 2.3 million Mg of coal per year.

The following emission factors (in units of kg pollutant per Mg coal burned) are available for the above firing configuration:

Boiler configuration	**SO_x factor (kg/Mg)**	**NO_x factor (kg/Mg)**	**CO factor (kg/Mg)**	**PM-10 (kg/Mg)**	**PM-2.5 (kg/Mg)**
Pulverized coal, dry bottom, wall-fired with ESP	19 × (S)	11	0.25	0.027 × (A)	0.012 ×(A)

Note: S= sulfur content (%); A= ash content (%) of coal
Emission factors source: US EPA, AP-42, Fifth Edition, Volume I, Chapter 1.1 *Bituminous and Subbituminous Coal Combustion.*

Part 3: Planning

A brief IPP/QAP for the coal mining and combustion inventory should be prepared. The contents of the IPP/QAP are outlined as follows:

- Inventory area status;
- Inventory scope (area/facility, pollutants of concern, base year, temporal resolution);
- Data quality objectives;
- Background and purpose of the inventory;
- Inventory resources;
- Emissions estimation methodologies; and
- QA/QC procedures
  - Internal QC procedures;
  - External QA/QC procedures (to be conducted in Step 6 by exchanging solutions with another group, and completing the QA Checklist).