



Create Your Own LCA (1 of 2)

THE NATIONAL RENEWABLE ENERGY LABORATORY (NREL) DATABASE for life cycle assessment (LCA) calculations is open to anyone, which means that you can perform your own life cycle assessment using the same data that scientists use. Data for utilities, transportation, and basic mining and forestry materials are all included in this database. To use the database, you will need to know a few terms. LCA involves calculating the resources (or input streams) required for a process or product as well as the output streams that result from that process or product. A full life cycle assessment involves a cradle-to-grave calculation. This means accounting for all the inputs and outputs for a product involved at each step of production starting from raw materials, during the use of the product, and for disposal of the product. Product life cycles are generally split up into unit processes. A unit process is one specific step in the product’s life cycle.

The NREL database provides data sets for specific unit processes, which you can combine to analyze larger processes. Each unit process has its own set of data regarding necessary inputs from nature and from the manufactured inputs, as well as outputs to nature in the form of solid, liquid, and gas emissions and co-products of the process. These spreadsheets can be combined to create analyses of more complex processes.

To begin, go to <https://www.lcacommons.gov/nrel/search>. Notice the data categories listed down the left side of the page. You can navigate through these to find processes on which you would like to focus. For example, if you want to know how much electricity a particular process uses and you know that the electricity is produced using bituminous coal. You can use the NREL database to calculate the greenhouse gas emissions associated with that electricity consumption.

To do this, expand the “Utilities” category on the left side of the page and select “Fossil Fuel Electric Power Generation.” This will change the list of datasets on the right side of the page. In that new list,

find “Electricity, bituminous coal at power plant” and click on that selection. Go to the “Exchanges” tab of this new page to see the emissions associated with producing electricity using bituminous coal.

You can find data for the inputs and outputs associated with this process (figure 1). The numbers are all based on one unit of product. Since we are looking at power production, these numbers are based on one kilowatt-hour of electricity. Let’s focus first on the outputs. We can see quite a long list of outputs, but we are interested only in the most significant greenhouse gases, which include carbon dioxide, methane, and dinitrogen monoxide (also known as nitrous oxide). Scanning down the list of outputs, we can see that producing one kilowatt-hour of electricity also produces 9.94e-01 kg of carbon dioxide, 2.42e-05kg of dinitrogen monoxide, and 8.31e-06 kg of methane.

Flow	Type	Amount	Comment
Inputs			
Bituminous coal, at mine	Mining (except Oil and Gas)/Coal Mining	ProductFlow kg	4.42e-01
Dummy_Disposal, ash and flue gas desulfurization sludge, to unspecified reuse	root/Flows	ProductFlow kg	1.41e-02
Dummy_Disposal, solid waste, unspecified, to unspecified treatment	root/Flows	ProductFlow kg	4.38e-02
Dummy_Transport, pipeline, coal slurry	root/Flows	ProductFlow t*km	2.22e-03
Transport, barge, average fuel mix	Water Transportation/Inland Water Freight Transportation	ProductFlow t*km	5.59e-02
Transport, combination truck, diesel powered	Truck Transportation/General Freight Trucking	ProductFlow t*km	2.99e-03
Transport, train, diesel powered	Rail Transportation/Rail Transportation	ProductFlow t*km	4.61e-01
Outputs			
Acenaphthene	air/unspecified	ElementaryFlow kg	1.13e-10
Acenaphthylene	air/unspecified	ElementaryFlow kg	5.52e-11
Acrolein	air/unspecified	ElementaryFlow kg	6.41e-08
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Cadmium	air/unspecified	ElementaryFlow kg	1.13e-08
Carbon dioxide, fossil	air/unspecified	ElementaryFlow kg	9.94e-01
Carbon monoxide, fossil	air/unspecified	ElementaryFlow kg	1.10e-04
Chromium	air/unspecified	ElementaryFlow kg	5.74e-08
Chromium VI	air/unspecified	ElementaryFlow kg	1.75e-08
Chrysene	air/unspecified	ElementaryFlow kg	2.21e-11
Chrysene, 5-methyl-	air/unspecified	ElementaryFlow kg	4.86e-12
Cobalt	air/unspecified	ElementaryFlow kg	2.21e-08
Dinitrogen monoxide	air/unspecified	ElementaryFlow kg	2.42e-05
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Methane, dichloro-, HCC-30	air/unspecified	ElementaryFlow kg	6.41e-08

Figure 1: NREL data for “Electricity, Bituminous, coal, at power plant”

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These are the greenhouse emissions associated with burning the coal at the power plant. However, to find ALL the emissions associated with coal-fired electricity, we must find the emissions associated with producing each of these inputs.

For example, looking at the list of inputs, we can see that 4.42e-01 kg of “Bituminous coal, at mine” are necessary to produce one kilowatt-hour of electricity. Returning to the categories list, we can expand the “Mining” category to find the link to the dataset for “Bituminous coal, at mine” and again go to the “Exchanges” tab to see the data. Again, we can see a list of outputs associated with this unit process along with the inputs necessary to produce one kilogram of bituminous coal (figure 2). To find all the emissions associated with the production of electricity, we must follow each of these inputs back. The NREL data can be pieced together to construct a comprehensive view of the inputs and outputs associated with each unit process.

Flow	Type	Amount	Comment
Inputs			
Bituminous coal, combusted in industrial boiler	Utilities/Steam and Air-Conditioning Supply	ProductFlow kg	4.31e-04
Coal, bituminous, 24.8 MJ per kg	resource/ground-	ElementaryFlow kg	1.24e+00
Diesel, combusted in industrial boiler	Utilities/Steam and Air-Conditioning Supply	ProductFlow l	8.80e-03
Dummy, Disposal, solid waste, unspecified, to underground deposit	root/Flows	ProductFlow kg	2.35e-01
Electricity, at grid, US, 2000	Utilities/Electric Power Distribution	ProductFlow kWh	3.87e-02
Gasoline, combusted in equipment	Utilities/Steam and Air-Conditioning Supply	ProductFlow l	8.36e-04
Natural gas, combusted in industrial boiler	Utilities/Steam and Air-Conditioning Supply	ProductFlow m3	1.62e-04
Residual fuel oil, combusted in industrial boiler	Utilities/Steam and Air-Conditioning Supply	ProductFlow l	8.70e-04
Outputs			
Bituminous coal, at mine	Mining (except Oil and Gas)/Coal Mining	ProductFlow kg	1.00e+00
Iron	water/unspecified	ElementaryFlow kg	8.64e-06
Manganese	water/unspecified	ElementaryFlow kg	5.76e-06
Methane	air/unspecified	ElementaryFlow kg	3.99e-03
Particulates, unspecified	air/unspecified	ElementaryFlow kg	1.63e-03
Suspended solids, unspecified	water/unspecified	ElementaryFlow kg	1.00e-04
VOC, volatile organic compounds	air/unspecified	ElementaryFlow kg	2.57e-05

Figure 2: NREL data for “Bituminous coal, at mine”

Figure 3 shows the unit processes we have identified so far. To complete this analysis, we would have to trace the other unit process in the same way that we have traced “Bituminous coal, at mine” and “Bituminous coal, combusted in industrial boiler.” Microsoft Excel® can be used to build an account of emissions that incorporates all of the unit processes involved manufacturing a specific item. To simplify calculations for a class project, we recom-

mend not including the inputs that are associated with the transportation unit processes. For these processes, include only the emissions that are listed in the outputs. This will give a slightly lower estimate of emissions, but the difference will be minor.

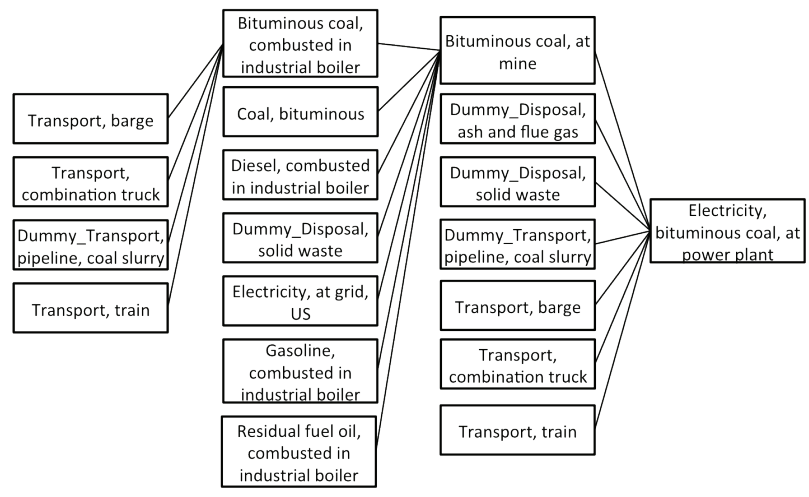


Figure 3: Partial map of unit processes associated with “Electricity, bituminous coal at power plant”