NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Blended Conventional and F-T Jet Fuel, Acquisition, Transport, Conversion, Delivery and Use: 10% Chipped Biomass Separate Gasifiers

Reference Flow: 1 MJ of Blended Conventional and F-T Jet Fuel, Combusted

Brief Description: This process includes all inputs for the raw material acquisition, raw material transportation, energy conversion, product transport, and end use for 1 MJ of combusted blended conventional and F-T jet fuel.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A

Year Data Best Represents: 2011

Process Type: Energy Conversion (EC)

Process Scope: Cradle-to-Gate Process (CG)

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:

Coal_mine_methane	*Amount of methane released from the mining and coal cleaning process*
Biomass_yield	*Southern pine biomass yield*

Coal_distance	*Transport distance for coal from the mine to the CBTL facility*
Biomass_dist	*Transport distance for biomass from the field to the CBTL facility*
Biomass_treat	*Binary switch to select biomass treatment scenario: 0 = Chipped Biomass; 1 = Torrefied Biomass*
CO2_pipe_length	*CO_2 pipeline length from the CBTL facility to the EOR site*
CO2_pipe_loss	*Loss of CO_2 per km of pipeline distance*
Jet_pipe_length	*Jet fuel pipeline length from the CBTL facility to the user*
Jet_trans_scen	*Binary switch to select blended jet fuel transport scenario: 1 = Pipeline; 0 = Pipeline (60%) and Truck (40%)*

Tracked Input Flows:

Montana Rosebud Coal	*Mass of Montana Rosebud sub-bituminous coal required per reference flow*
Southern Pine Biomass	*Mass of Southern pine biomass required per reference flow*
Conventional Jet Fuel	*Conventional jet fuel required per reference flow*
Water	*Water required per reference flow*
Energy Resources	*Energy Requirements per reference flow*

Tracked Output Flows:

Blended Conventional and F-T Jet Fuel, Combusted [Valuable Substance]	*Reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_CTG_CCAT_Conv_and_FTjet_10_Percent_Microchipped_Biom_SeparateGasifiers_2012.01.xlsx*, 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 acquisition and transport of coal and biomass to a coal and biomass-to-liquids (CBTL) facility for conversion to Fischer Tropsch (F-T) jet fuel. The unit process also accounts for the blending of the finished F-T jet fuel product with conventional jet fuel, transport to the user, and combustion in an aircraft. This particular unit process examines a scenario in which there is 10% microchipped biomass and 90% coal converted to F-T jet fuel at the CBTL facility in separate gasifiers. Available adjustable parameters and their default values are provided in Section I. The reference flow of this unit process is: 1 MJ of Blended Conventional and F-T Jet Fuel, Combusted

Boundary and Description

LC stage #1, raw material acquisition (RMA) of southern pine, includes land preparation for the southern pine production, cultivation of southern pine, and the harvesting and storing of the southern pine. Most of the data used in the formation of the operation processes are from states in the US Midwest.

The RMA of southern pine includes the construction of the machinery needed for RMA operation processes. Within the machinery construction, upstream processes (for example, steel or rubber) are included.

The biomass processes are set up slightly differently than some of the other feedstocks. Unlike other RMA pathways, biomass has a set order of operations for its production. The product from one process is the input to another process which lends itself to assembly of the model in series. Each of the operations use a distinct set of machinery, and each piece is constructed as many times as needed during the study period. For the operation processes, each requires diesel fuel and calculates the emissions based on the diesel consumed. The cultivation process also includes the production and application of different fertilizers (potassium, nitrogen and phosphorus).

The construction processes for machinery contain all of the machinery needed for the initial clearing of the site, cultivation, and harvesting of the southern pine. The machinery includes:

- Tiller

  (DS/DF_Stage1_C_Tiller_5015_lbs_TractorPropelled_2009.01.doc)

- Tractor
  (DS/DF_Stage1_C_Diesel_Tractor_165_HP_2009.01.doc)
- Tree Planter
  (DS/DF_Stage1_C_Treeplanter_4500_lbs_TractorPropelled_2009.01.doc)
- Tree Harvester
  (DS/ DF_Stage1_C_Tree_Harvester_Chipper_440_HP_2010.01.doc)
- Pushoff Trailer
  (DS/ DF_Stage1_C_Pushoff_Trailer_60m3_Tractor_Propelled.01.doc)

Each piece of equipment is scaled to the production of one kilogram of southern pine accounting for the lifetime of each piece of equipment, as relevant.

LC stage #1, RMA for subbituminous coal, includes the construction of an aboveground Powder River Basin – Montana Rosebud coal mine and required operation equipment, the operation of the coal mine, and the commissioning and decommissioning of the mine. The mine was modeled based on a compilation of surface mines in Wyoming and Montana, producing Montana Rosebud Coal.

Each of the processes included in RMA for Montana Rosebud coal include upstream processes (for example, diesel fuel or steel). Coal mine construction and operation include individual construction unit processes for key equipment, which are aggregated within the model as described below.

Coal mine commissioning and decommissioning integrates diesel and gasoline use during commissioning and decommissioning of the Montana Rosebud mine. Due to lack of available data, coal mine decommissioning was assumed to require 10% of the commissioning inputs. The coal mine operation includes energy from the power grid and diesel use for the operation of the mine and mine equipment. Coal mine methane emissions are included as an adjustable parameter in this process.

The construction process contains key machinery needed for the initial clearing of the site and the extraction of the coal. The machinery includes:

- Blasthole Drill
  (DS/DF_Stage1_C_Blasthole_Drill_250000lb_2010.01.doc)
- Coal Loading Silo
  (DS/DF_Stage1_C_Coal_Loading_Silo_PRB_2010.01.doc)
- Conveyor System
  (DS/ DF_Stage1_C_Conveyor_System_48_Inch_2010.01.doc)
- Dragline
  (DS/ DF_Stage1_C_Dragline_8200ton_2010.01.doc)
- Coal Loader
  (DS/ DF_Stage1_C_Track_Loader_239_HP_2010.01.doc)
- Mining Truck
  (DS/ DF_Stage1_C_Mining_Truck_623690kg_2010.01.doc)

- Electric Shovel
  (DS/ DF_Stage1_C_Electric_Shovel_120_Tons_Payload_2010.01.doc)
- Coal Crusher
  (DS/ DF_Stage1_C_Coal_Crusher_254000lb_2010.01.doc)

Each piece of equipment is scaled to coal mine production, accounting for the lifetime of each piece of equipment, as relevant.

LC Stage #2, raw material transport (RMT), includes the transport of the southern pine from the farm to the energy conversion facility (LC Stage #3). The construction of equipment used to transport southern pine and the operation of that equipment are the two processes within RMT. Southern pine transport takes place via a chip truck, which is suitable for the transport of southern pine, and which is powered by diesel. The transport distance is an adjustable parameter for RMT.

Construction of the truck for RMT includes the materials required to construct the following piece of equipment for transport:

- Container/Chip Truck
  (DS/ DF DF_Stage2_C_Chip_Truck_Biomass_Transport_2010.01.doc)

LC Stage #2 (RMT) includes the transport of the mined and processed Montana Rosebud subbituminous coal from the aboveground coal mine site to the energy conversion facility (LC Stage #3). The construction of equipment used to transport mined coal and the operation of that equipment are considered within RMT. Coal transport takes place via a diesel powered train/locomotive, which is suitable for the transport of coal. The transport distance is an adjustable parameter for RMT.

Construction of the train for RMT includes the materials required to construct the following piece of equipment for transport:

- Coal railcar
  (DS/DF_Stage2_C_Railcar_244000_lbs_Net_Capacity_2009.01)
- Diesel locomotive
  (4,400 horsepower) (DS/DF_Stage2_C_Locomotive_2009.01)
- Coal unit train (100 railcars and the required number of locomotives)
  (DS/DF_Stage2_C_Assembly_Coal_Unit_Train_100_Cars_2010.01)

LC Stage #3, energy conversions facility (ECF), includes grinding and drying of southern pine biomass prior to the combination with the Montana Rosebud coal for reaction in the CBTL facility in separate gasifiers. The CBTL process creates the following products: F-T Jet Fuel, F-T Diesel Fuel, F-T Naphtha, F-T Liquefied Petroleum Gas (LPG), and Electricity. The main product of interest in this study is F-T jet fuel. All co-products are allocated by means of system expansion, meaning displacement of conventional production methods for those products. Because no existing commercial scale CBTL energy conversion facilities have been produced, there are no real world data sources for construction requirements of the modeled CBTL facility. Therefore, the analysis

provided here relies on proxy data to estimate the total construction materials required for the construction of the CBTL facility. Specifically, construction requirements for concrete, steel, pipe, iron, and aluminum were quantified based on prior estimates for a hypothetical CBTL facility, as previously estimated by NETL for a separate modeling effort

The CBTL facility includes a carbon capture system which sends the captured stream to be used for Enhanced Oil Recovery (EOR). ECF includes the construction of the EOR facility as well as any emissions from the operations of that facility. The products of EOR include crude oil and natural gas liquids. Similar to the handling of the co-products at the CBTL facility, the crude oil and natural gas liquids produced from EOR displace conventional production methods.

LC Stage #4, product transport (PT), includes pipeline transport of F-T jet fuel from the CBTL facility to a blending station. At the blending facility, the F-T jet fuel is blended with conventional, petroleum-based jet fuel. The pipeline used for transporting the F-T jet fuel to the refinery/blending station is assumed to be a pre-existing pipeline used to transport petroleum products. However, it is assumed that an approximately 20 mile length of pipeline will need to be constructed to connect the CBTL facility to the existing portion of the petroleum pipeline. Construction related materials and emissions are included for this 20-mile pipeline segment. Total distance from the CBTL facility to the refinery/blending station was assumed to be 225 miles. F-T jet fuel is blended with conventional jet fuel on a 1:1 basis (by volume). Blended jet fuel, which is the resulting fuel following blending, is tracked through the remainder of the life cycle model. Blended fuels transport is modeled according to two separate options. The first option includes exclusive pipeline delivery of the blended jet fuel to a single large airport, while the second includes pipeline delivery to a single large airport, plus tanker truck delivery to additional smaller regional airports.

LC Stage #5, end use, includes the combustion of the blended jet fuel stream in an aircraft. End use also accounts for the construction of the aircraft.

A visual schematic of the life cycle model is shown in **Figure 1**. The profiles and processes included in the five stages of the life cycle model are provided in **Table 2**. Those shown in bold face were developed by NETL.

Figure 1: Unit Process Scope and Boundary

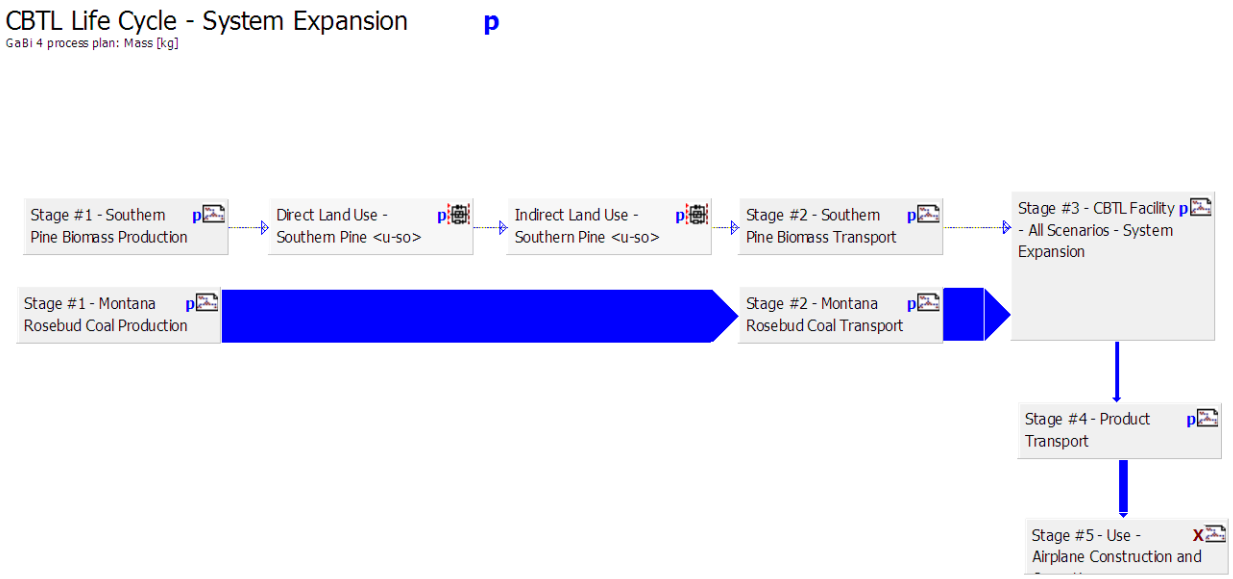

Table 1: Profiles and Processes Included in the CTG Model for CBTL Jet Fuel

CBTL Life Cycle - All Scenarios - System Expansion
- Stage #1 - Montana Rosebud Coal Production
  - RMA - Rosebud Coal Mining, Commissioning/Decommissioning
    - Diesel - NETL Baseline <u-so>
    - **US: Commissioning and Decommissioning of Rosebud Coal Mine NETL <u-so>**
  - RMA - Rosebud Coal Mining, Construction
    - Blasthole Drill Construction
      - **US: Blasthole Drill, 250,000 lbs, Construction NETL <u-so>**
      - WOR: Steel Plate, BF, Manufacture NETL <u-so>
    - Coal Crusher Construction
      - DE: Steel cold rolled PE
      - **US: Coal Crusher, 254,000 lbs, Construction NETL <u-so>**
    - Conveyor Construction
      - **BF: Hot-dip Galvanized NETL**
      - DE: Steel cold rolled PE
      - DE: Styrene-butadiene rubber mix (SBR) PE
      - **US: Steel-Cord Conveyor System, 72", Construction NETL <u-so>**
    - Dragline Construction
      - **US: Dragline, 8,200 ton, Construction NETL <u-so>**
      - WOR: Steel Plate, BF, Manufacture NETL <u-so>
    - Electric Shovel Construction
      - **US: Electric Shovel, 120 tons payload, Construction NETL <u-so>**
      - WOR: Steel Plate, BF, Manufacture NETL <u-so>
    - Mining Truck Construction

DE: Styrene-butadiene rubber mix (SBR) PE
US: Mining Truck for Surface Mine, 623,690 kg, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Silo Construction
US National Average Electricity Mix, 2007
US: Coal-Loading Silo, 12,000 Tons, Rosebud, Construction NETL <u-so>
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Track Loader Construction
US: Track Loader, 239 Horsepower (HP), Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
US: Rosebud Surface Mine Assembly, Construction NETL <u-so>
RMA - Rosebud Coal Mining, Operation
US National Average Electricity Mix, 2007
Diesel - NETL Baseline <u-so>
RER: Ammonium nitrate PE
US: Fuel oil light at refinery PE
US: Rosebud Surface Subbituminous Coal Mine, Operations NETL <u-so>
US: STAGE#1: COAL MINE CONSTRUCTION & OPERATION NETL
Stage #1 - Southern Pine Biomass Production
RMA - Southern Pine Cultivation, Construction
Tiller, Construction
US: Tiller, 5015 lbs, Tractor-Propelled, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Tractor, Construction
US: Diesel Tractor, 165 Horsepower, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Tree Planter (SRWC), Construction
US: Treeplanter, 4500 lbs, Tractor-Propelled, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
US: Southern Pine Cultivation Assembly, Construction NETL <u-so>
RMA - Southern Pine Cultivation, Operation
Direct Land Use - Southern Pine <u-so>
Indirect Land Use - Southern Pine <u-so>
Average K Fertilizer
US National Average Electricity Mix, 2007
EU-15: Average K Fertilizer NETL
Average N Fertilizer
US National Average Electricity Mix, 2007
DE: Ammonia (NH3) PE
DE: Nitric acid (98%) PE
EU-15: Average N Fertilizer NETL
Average P Fertilizer

US National Average Electricity Mix, 2007
DE: Sulphuric acid (96%) PE
EU-15: Average P Fertilizer NETL
US: Phosphate NETL
US National Average Electricity Mix, 2007
Diesel - NETL Baseline <u-so>
US: Southern Pine Biomass Cultivation, Operation NETL <u-so>
RMA - Southern Pine Harvesting, Construction
Disc Wood Micro-chipper Construction
US: Disc Micro-Chipper for Wood, 765 HP NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Skidder Construction
US: Grapple Skidder 172 HP, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Standard Drum Chipper Construction
US: Standard Drum Wood Chipper, 630 HP, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Tree Harvester Construction
US: Tree Harvester, 241 HP, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
US: Southern Pine Harvesting Assembly, Construction NETL <u-so>
RMA - Southern Pine Harvesting, Operation
Diesel - NETL Baseline <u-so>
US: Southern Pine Harvesting & Storage, Operation NETL <u-so>
RMA - Southern Pine Land Preparation, Operation
Diesel - NETL Baseline <u-so>
US: SRWC Southern Pine Land Preparation, Operation NETL <u-so>
Stage #2 - Montana Rosebud Coal Transport
Coal Train Construction
RER: Aluminum sheet mix PE
US: Coal Railcar, 244000 lbs Net Capacity, Construction NETL <u-so>
US: Coal Unit Train Assembly, 100 Railcars, Construction NETL <u-so>
US: Diesel Locomotive, 4400 Horsepower, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
WOR: Steel, Stainless, 316 2B, 80% Recycled NETL <u-so>
Transport of Coal via Train, Operation
Diesel - NETL Baseline <u-so>
US: Coal, Train Transport NETL <u-so>
US: Assembly: Coal Rail Transport (Construction & Operation) NETL
Stage #2 - Southern Pine Biomass Transport
Biomass Truck & Container Trailer, Construction
DE: Lead (99,995%) PE
DE: Styrene-butadiene rubber mix (SBR) PE

RER: Aluminum sheet mix PE
RER: Nylon 6.6 granulate (PA 6.6) ELCD/PlasticsEurope <p-agg>
RER: Polyurethane flexible foam (PU) PlasticsEurope
US: Chip Truck, Biomass Transport, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
Diesel - NETL Baseline <u-so>
US: Tractor Trailer Biomass Transport, Class 8B, Operation NETL <u-so>
Stage #3 - CBTL Facility - All Scenarios - System Expansion
Biomass Drying
Natural Gas RMA/RMT 2009 Mix 02022012 <u-so>
US: Biomass Drying for Coal-Biomass Cofiring NETL <u-so>
CBTL Facility Construction
DE: Aluminum sheet mix PE
DE: Cast iron part PE <p-agg>
US: CBTL Facility Construction NETL
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>
US: US National Average Electricity Mix, 2007 080811 NETL
US: Thermal energy from heavy fuel oil PE
WOR: Steel Pipe, Welded, BF, Manufacture NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
CO2 Management
CO2 Pipeline Operation and Construction
US: Carbon Dioxide (CO2) Pipeline, Construction NETL <u-so>
US: CO2 Pipeline Operation NETL <u-so>
WOR: Steel Pipe, Welded, BF, Manufacture NETL <u-so>
CO2 Sequestration Operation and Construction
US National Average Electricity Mix, 2007
US: Carbon Dioxide (CO2) Sequestration Pipeline & Injection Well, Construction NETL <u-so>
US: CO2 Saline Sequestration Operation NETL <u-so>
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>
WOR: Steel Pipe, Welded, BF, Manufacture NETL <u-so>
Enhanced Oil Recovery
Conventional Crude Oil - National Average, 2010
Enhanced Oil Recovery Construction
US National Average Electricity Mix, 2007
Diesel - NETL Baseline <u-so>
Enhanced Oil Recovery Operations <u-so>
Natural Gas RMA/RMT 2009 Mix 02022012 <u-so>
US: Liquid gas LPG (70% propane; 30% butane) PE
US: System expansion (Crude Oil) NETL
US: System expansion (NGL) NETL
US National Average Electricity Mix, 2007 Busbar

Biomass to CBTL Pretreatment <u-so>
Diesel - NETL Baseline <u-so>
US: FT Jet Fuel from CBTL - Generic Scenario NETL <u-so>
US: Liquid gas LPG (70% propane; 30% butane) PE
US: Naphtha at refinery PE
US: Sulphur at refinery PE
US: System expansion (Diesel) NETL
US: System expansion (Electricity) NETL
US: System expansion (LPG) NETL
US: System expansion (Naphtha) NETL
US: System expansion (Sulphur) NETL

Stage #4 - Product Transport

Blended Fuels Transport

Blended Fuels Transport Construction

Fuel Transport Pipeline Construction
Fuels Tanker Trailer Construction
US: Assembly of fuel transport construction and installation/deinstallation NETL <u-so>

US National Average Electricity Mix, 2007
Diesel - NETL Baseline <u-so>
Finished Jet Fuels Transportation Mixer <u-so>
US: Blended Jet Fuel Transport to Aircraft, Operation NETL <u-so>
US: Tractor-Trailer Liquid Fuels Transport, Class 8B, Operation NETL <u-so>

Finished Fuels Blending

US National Average Electricity Mix, 2007
Jet - NETL Baseline Updated to 2010 <u-so>
US: Fischer-Tropsch and Conventional Jet Fuel Blending NETL <u-so>

F-T Finished Fuels Transport

Fuel Transport Pipeline Construction

Diesel - NETL Baseline <u-so>
US: Fuel Transport Pipeline, Construction NETL <u-so>
WOR: Steel Pipe, Welded, BF, Manufacture NETL <u-so>

US National Average Electricity Mix, 2007
US: Pipeline Transport and Blending Energy Requirements for F-T Jet Fuel NETL <u-so>

Stage #5 - Use - Airplane Construction and Operations

RER: Aluminum sheet mix PE
US: Airplane Combustion of Blended F-T/Conventional Jet Fuel Updated NETL <u-so>
US: Jet Aircraft, 46 Short Tons, Construction NETL <u-so>

Parameters and Balances

The parameters for the highest level modeling plans for the CBTL jet fuel model are shown in **Table 2**. These parameters may or may not include the adjustable parameters shown previously depending on how the model was created. **Table 3** presents a summary level review of the input and output balances for resources and emissions of interest for the cradle-to-gate plan. **Table 4** shows the full suite of results for the input and output balances.

Table 2: Adjustable Parameters included in the in the CTG Model for CBTL Jet Fuel

Plan	Parameter	Value	Comment
LC Stage #1: Raw Material Acquisition			
Stage #1 - Montana Rosebud Coal Production	Coal_mine_methane	40	[scf/ton] Amount of methane released from the mining and coal cleaning process
Stage #1 - Southern Pine Biomass Production	Biomass_yield	6,350	[kg/acre-yr] Southern pine biomass yield
LC Stage #2: Raw Material Transport			
Stage #2 - Montana Rosebud Coal Transport	Coal_distance	1,600	[miles] Transport distance for coal from the mine to the CBTL facility
Stage #2 - Southern Pine Biomass Transport	Biomass_dist	40	[miles] Transport distance for biomass from the field to the CBTL facility
LC Stage #3: Energy Conversion Facility			
Stage #3 - CBTL Facility	Biomass_treat	0	[dimensionless] 0 = Chipped Biomass; 1 = Torrefied Biomass
CO2 Pipeline Operation and Construction	CO2_pipe_length	775	[miles] CO2 pipeline length from the CBTL facility to the EOR site
CO2 Pipeline Operation and Construction	CO2_pipe_loss	2.6E-07	[%/km] Loss of CO2 per km of pipeline distance
LC Stage #4: Product Transport			
F-T Finished Fuels Transport	Jet_pipe_length	225	[miles] Jet fuel pipeline length from the CBTL facility to the user
F-T Finished Fuels Transport	Jet_trans_scen	1	[dimensionless] 1 = Pipeline; 0 = Pipeline (60%) and Truck (40%)

Table 3: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Montana Rosebud Coal	9.742E-02	kg
Southern Pine Biomass	1.791E-02	kg
Conventional Jet Fuel	1.182E-02	kg
Water	7.968E+00	kg
Energy Resources	-4.103E-02	kg
Outputs		
Blended Conventional and F-T Jet Fuel, Combusted [Valuable Substance]	1	MJ
Carbon dioxide	1.013E-01	kg
Methane	1.637E-05	kg
Nitrous oxide (laughing gas)	4.489E-06	kg
Nitrogen oxides	2.681E-04	kg
Sulphur dioxide	-3.703E-05	kg
Carbon monoxide	1.794E-04	kg
Dust (unspecified)	1.543E-05	kg
Lead (+II)	-1.444E-10	kg
Mercury (+II)	1.481E-09	kg
Ammonia	1.493E-06	kg
Radioactive emissions to air	-1.461E-12	kg
Group NMVOC to air	1.745E-04	kg
Heavy metals to industrial soil	-3.595E-05	kg
Waste (solid)	1.405E-04	kg
Aluminum (+III)	5.581E-06	kg
Ammonium / ammonia	2.342E-06	kg
Heavy metals to fresh water	2.805E-05	kg
Nitrate	1.733E-07	kg
Nitrogen	9.385E-06	kg
Phosphate	-8.446E-09	kg
Phosphorus	6.150E-06	kg
Water (output)	2.039E-01	kg

Table 1: Inputs and Output Balances for Cradle-to-Gate and Life Cycle Stages for CBTL Jet Fuel (kg/MJ combusted)

Process or Category	CTG
Inputs	
Flows	7.933E+00
Resources	7.933E+00
Energy resources	-4.103E-02
Non renewable energy resources	-4.103E-02
Crude oil (resource)	-4.151E-02
Hard coal (resource)	-6.572E-04
Lignite (resource)	-1.554E-05
Natural gas (resource)	1.151E-03
Uranium (resource)	-1.360E-10
Renewable energy resources	-4.736E-08
Unspecified	0.000E+00
Energy unspecified (APME)	0.000E+00
Land use	0.000E+00
Hemerobie ecoinvent	0.000E+00
Transformation, from unknown	0.000E+00
Transformation, to mineral extraction site	0.000E+00
Occupation	0.000E+00
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Transformation	0.000E+00
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Material resources	7.956E+00
Non renewable elements	2.442E-05
Aluminum	-4.571E-11
Chromium	4.341E-13
Copper	7.133E-14
Iron	2.429E-05

Process or Category	CTG
Lead	4.284E-13
Magnesium	5.139E-16
Mercury	1.298E-13
Nickel	1.597E-15
Phosphorus	5.136E-11
Sulphur	1.212E-09
Zinc	1.352E-07
Non renewable resources	-9.019E-03
Barium sulphate	-1.108E-16
Basalt	-7.989E-07
Bauxite	5.555E-05
Bentonite	-1.753E-04
Calcium carbonate (CaCO3)	2.745E-05
Calcium chloride	-1.135E-14
Chalk (Calciumcarbonate)	8.162E-40
Chromium ore (39%)	1.082E-06
Clay	-1.143E-05
Colemanite ore	-1.403E-09
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	-1.443E-07
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	-8.788E-08
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	-4.960E-08
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	-1.737E-08
Copper ore (0.14%)	-3.474E-07
Copper ore (1.2%)	-1.496E-08
Copper ore (4%)	-6.414E-17
Copper ore (sulphidic, 1.1%)	-2.040E-08
Dolomite	2.183E-06
Feldspar (aluminum silicates)	3.622E-11
Ferro manganese	1.065E-13
Fluorspar (calcium fluoride; fluorite)	4.188E-07
Granite	1.136E-20
Gravel	-6.434E-07
Gypsum (natural gypsum)	-6.313E-06
Heavy spar (BaSO4)	-4.240E-04
Ilmenite (titanium ore)	-3.035E-12
Inert rock	-8.370E-03

Process or Category	CTG
Iron ore (56,86%)	-1.096E-04
Iron ore (65%)	-4.136E-09
Kaolin ore	-2.474E-09
Lead - zinc ore (4.6%-0.6%)	-3.388E-05
Limestone (calcium carbonate)	-2.916E-04
Magnesit (Magnesium carbonate)	-1.245E-10
Magnesium chloride leach (40%)	-2.614E-06
Manganese ore	2.593E-07
Manganese ore (R.O.M.)	-1.336E-06
Molybdenite (Mo 0,24%)	-1.065E-08
Molybdenum ore (0.1%)	3.751E-07
Natural Aggregate	-2.273E-05
Nickel ore (1,5%)	2.659E-07
Nickel ore (1.6%)	-4.717E-06
Olivine	1.108E-12
Peat	-1.300E-07
Phosphate ore	1.285E-05
Phosphorus minerals	1.464E-07
Phosphorus ore (29% P2O5)	9.975E-14
Potassium chloride	3.582E-04
Precious metal ore (R.O.M)	-5.372E-10
Quartz sand (silica sand; silicon dioxide)	-4.848E-06
Raw pumice	-2.945E-10
Rutile (titanium ore)	5.870E-11
sand	1.314E-10
Slate	2.654E-12
Sodium chloride (rock salt)	1.125E-06
Sodium nitrate	2.198E-20
Sodium sulphate	4.689E-11
Soil	-9.467E-06
Sulphur (bonded)	-4.436E-13
Talc	-1.018E-10
Tin ore	-9.613E-18
Titanium ore	-4.396E-07
Zinc - copper ore (4.07%-2.59%)	-5.740E-06
Zinc - lead - copper ore (12%-3%-2%)	-2.360E-06
Zinc - lead ore (4.21%-4.96%)	-2.190E-17

Process or Category	CTG
Zinc ore (4%)	-1.098E-07
Zinc ore (sulphidic, 4%)	-1.098E-16
Renewable resources	7.965E+00
Water	7.968E+00
Water	1.756E-02
Water (feed water)	7.313E-06
Water (ground water)	8.613E-01
Water (lake water)	-1.497E-06
Water (municipal)	-1.334E-06
Water (river water)	1.787E-01
Water (sea water)	-4.133E-04
Water (storm)	6.235E+00
Water (surface water)	6.721E-01
Water (well water)	3.647E-07
Water (well-produced water)	3.718E-03
Water (with river silt)	7.629E-17
Water,turbine use, unspecified natural origin	0.000E+00
Air	-3.019E-03
Carbon dioxide	-2.036E-05
Nitrogen	2.045E-08
Oxygen	0.000E+00
Unspecified	-1.312E-08
Unspecified minerals	-2.984E-09
Unspecified resources	-1.013E-08
Area of Production Land	0.000E+00
Rosebud Subbituminous Coal	0.000E+00
SRWC Biomass	1.791E-02
Watertube or Firetube Industrial Boiler, 150,000 lbs/hr Capacity	0.000E+00
Output	
Flows	3.169E-01
Resources	2.039E-01
Energy resources	0.000E+00
Non renewable energy resources	0.000E+00
Crude oil (resource)	0.000E+00
Crude oil Ecuador	0.000E+00
Crude oil Iraq	0.000E+00
Crude oil USA	0.000E+00

Process or Category	CTG
Hard coal (resource)	0.000E+00
Hard Coal (Illinois No 6)	0.000E+00
Powder River Basin Subbituminous Coal	0.000E+00
Non Renewable Energy	0.000E+00
Renewable energy resources	0.000E+00
Feedstock Energy	0.000E+00
Renewable Energy	0.000E+00
Total Primary Energy	0.000E+00
Land use	0.000E+00
Hemeroby	0.000E+00
Occup. as Forest land	0.000E+00
Material resources	2.039E-01
Renewable resources	2.039E-01
Water	2.039E-01
Water	0.000E+00
Water (feed water)	0.000E+00
Water (ground water)	0.000E+00
Water (river water)	0.000E+00
Water (sea water)	0.000E+00
Water (storm runoff)	1.983E-01
Water (wastewater)	8.492E-03
Water (wastewater)	-2.938E-03
Nitrogen	0.000E+00
Oxygen	9.660E-07
Land Area Required	0.000E+00
Rosebud Subbituminous Coal	0.000E+00
Ecoinvent	-1.379E-06
Long-term emission	-1.379E-06
Fresh water	-1.379E-06
Chloride	-1.379E-06
Dissolved organic carbon, DOC (Ecoinvent)	-5.420E-13
Total organic carbon, TOC (Ecoinvent)	0.000E+00
Emissions to air	1.011E-01
Heavy metals to air	-6.540E-08
Antimony	-3.289E-12
Arsenic (+V)	-4.347E-11
Arsenic trioxide	-2.353E-14

Process or Category	CTG
Cadmium (+II)	-2.276E-13
Chromium (+III)	-4.910E-12
Chromium (+VI)	8.416E-13
Chromium (unspecified)	1.461E-09
Cobalt	-1.975E-11
Copper (+II)	-6.137E-11
Heavy metals to air (unspecified)	-8.588E-13
Hydrogen arsenic (arsine)	-1.953E-12
Iron	-1.678E-09
Lanthanides	-5.999E-15
Lead (+II)	-1.444E-10
Manganese (+II)	-1.301E-10
Mercury (+II)	1.481E-09
Molybdenum	5.471E-11
Nickel (+II)	-6.104E-10
Palladium	-3.141E-19
Rhodium	-3.032E-19
Selenium	-4.448E-11
Silver	2.748E-19
Tellurium	-6.547E-13
Thallium	-4.802E-12
Tin (+IV)	-1.201E-11
Titanium	-3.482E-13
Vanadium (+III)	-6.250E-08
Zinc (+II)	-3.141E-09
Inorganic emissions to air	1.014E-01
Ammonia	1.493E-06
Ammonium	-4.580E-14
Ammonium nitrate	-2.607E-15
Argon	-9.017E-13
Barium	-2.670E-07
Beryllium	-2.413E-12
Boron compounds (unspecified)	-2.626E-10
Bromine	-1.367E-10
Carbon dioxide	1.189E-01
Carbon dioxide (biotic)	6.721E-08
Carbon dioxide (biotic)	-1.767E-02

Process or Category	CTG
Carbon disulphide	1.022E-13
Carbon monoxide	1.794E-04
Carbon monoxide (biotic)	-1.526E-13
Chloride (unspecified)	-9.992E-09
Chlorine	2.387E-11
Cyanide (unspecified)	-1.041E-09
Fluoride	7.947E-09
Fluorides	-9.953E-10
Fluorine	-2.470E-13
Helium	-9.236E-11
Hydrogen	-1.957E-08
Hydrogen bromine (hydrobromic acid)	-5.398E-12
Hydrogen chloride	-2.557E-08
Hydrogen cyanide (prussic acid)	-7.810E-13
Hydrogen fluoride	3.960E-09
Hydrogen iodide	-7.969E-16
Hydrogen phosphorous	2.606E-13
Hydrogen sulphide	-2.498E-07
Lead dioxide	-6.653E-13
Nitrogen (atmospheric nitrogen)	-1.725E-06
Nitrogen (N-compounds)	-1.764E-13
Nitrogen dioxide	3.763E-06
Nitrogen monoxide	3.996E-11
Nitrogen oxides	2.681E-04
Nitrous oxide (laughing gas)	4.489E-06
Oxygen	-1.640E-05
Scandium	-3.015E-15
Steam	-2.968E-04
Strontium	-1.152E-13
Sulphur dioxide	-3.703E-05
Sulphur hexafluoride	1.320E-09
sulphur oxide	8.880E-06
Sulphuric acid	-1.240E-10
Tin oxide	-9.915E-17
Unspecified Particles	-2.443E-08
Zinc oxide	-1.983E-16
Zinc sulphate	-4.920E-11

Process or Category	CTG
Organic emissions to air (group VOC)	1.931E-04
Group NMVOC to air	1.745E-04
Group PAH to air	-8.677E-09
Anthracene	-6.279E-12
Benzo{a}anthracene	-3.159E-12
Benzo{a}pyrene	-5.519E-11
Benzo{ghi}perylene	-2.818E-12
Benzofluoranthene	-5.637E-12
Chrysene	-7.761E-12
Dibenz(a)anthracene	-1.757E-12
Indeno[1,2,3-cd]pyrene	-2.098E-12
Naphthalene	-6.594E-10
Phenanthrene	-2.071E-10
Polycyclic aromatic hydrocarbons (PAH)	-7.725E-09
Halogenated organic emissions to air	1.878E-09
Dichloroethane (ethylene dichloride)	-1.835E-14
Dichloromethane (methylene chloride)	5.457E-15
Dioxins (unspec.)	-1.226E-15
Halogenated hydrocarbons (unspecified)	6.600E-13
Halon (1301)	0.000E+00
Polychlorinated biphenyls (PCB unspecified)	-4.291E-12
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	-5.621E-17
R 11 (trichlorofluoromethane)	-1.838E-14
R 114 (dichlorotetrafluoroethane)	-1.906E-14
R 116 (hexafluoroethane)	1.950E-10
R 12 (dichlorodifluoromethane)	-4.078E-15
R 13 (chlorotrifluoromethane)	-2.489E-15
R 22 (chlorodifluoromethane)	-4.207E-15
Tetrafluoromethane	1.751E-09
Vinyl chloride (VCM; chloroethene)	-6.463E-11
Acetaldehyde (Ethanal)	-7.636E-10
Acetic acid	-3.484E-11
Acetone (dimethylcetone)	-6.713E-10
Acrolein	-4.431E-11
Aldehyde (unspecified)	-5.197E-11
Alkane (unspecified)	-5.836E-10
Alkene (unspecified)	-5.709E-10

Process or Category	CTG
Aromatic hydrocarbons (unspecified)	5.381E-12
Benzene	-1.567E-08
Butadiene	-4.034E-14
Butane	-3.174E-06
Butane (n-butane)	-2.222E-10
Caprolactam	1.550E-17
Cumene (isopropylbenzene)	-1.174E-20
Cyclohexane (hexahydro benzene)	3.041E-13
Diethylamine	-1.028E-18
Ethane	-8.415E-06
Ethanol	-7.002E-12
Ethene (ethylene)	-2.141E-10
Ethyl benzene	-6.935E-10
Fluoranthene	-2.045E-11
Fluorene	-6.489E-11
Formaldehyde (methanal)	1.664E-04
Heptane (isomers)	-1.129E-07
Hexamethylene diamine (HMDA)	-2.373E-15
Hexane (isomers)	-1.671E-07
Mercaptan (unspecified)	-8.570E-10
Methanethiol	-6.211E-10
Methanol	-6.606E-12
NMVOC (unspecified)	3.719E-05
Octane	-6.211E-08
Pentane (n-pentane)	-1.058E-06
Phenol (hydroxy benzene)	-3.964E-14
Propane	-1.605E-05
Propene (propylene)	-5.160E-11
Propionic acid (propane acid)	-5.518E-15
Styrene	5.780E-15
Toluene (methyl benzene)	-1.991E-09
Trimethylbenzene	-9.658E-16
Xylene (dimethyl benzene)	-3.618E-09
Hydrocarbons (unspecified)	-1.826E-09
Methane	1.637E-05
Methane (biotic)	2.594E-09
Organic chlorine compounds	8.233E-13

Process or Category	CTG
Unspecified Organic Compounds	-1.698E-14
VOC (unspecified)	2.177E-06
Other emissions to air	-4.674E-04
Aldehydes, unspecified	-8.488E-15
Carbonyl sulfide (US LCI)	8.740E-15
Exhaust	-1.532E-03
non used primary energy from wind power	0.000E+00
Particulate Matter, unspecified	6.847E-05
Sand (Silica) (SiO2)	-1.618E-10
Unused primary energy from solar energy	0.000E+00
Used air	9.961E-04
Waste heat	0.000E+00
Particles to air	1.680E-05
Dust (PM10)	-3.726E-07
Dust (PM2,5 - PM10)	5.619E-07
Dust (PM2.5)	-4.261E-07
Dust (Portland cement kiln)	1.608E-06
Dust (unspecified)	1.543E-05
Metals (unspecified)	7.196E-13
Unspecified Organic Chlorine Compounds	-1.120E-13
Wood (dust)	-3.660E-14
Radioactive emissions to air	-1.461E-12
Antimony (Sb124)	0.000E+00
Argon (Ar41)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00
Iodine (I131)	0.000E+00
Krypton (Kr85)	0.000E+00
Krypton (Kr85m)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
radionuclides	0.000E+00
Radon (Rn222)	0.000E+00

Process or Category	CTG
Uranium (total)	-1.461E-12
Uranium (U234)	0.000E+00
Uranium (U235)	0.000E+00
Uranium (U238)	0.000E+00
Xenon (Xe131m)	0.000E+00
Xenon (Xe133)	0.000E+00
Xenon (Xe133m)	0.000E+00
Xenon (Xe135)	0.000E+00
Xenon (Xe135m)	0.000E+00
Xenon (Xe137)	0.000E+00
Xenon (Xe138)	0.000E+00
Unspecified Heavy Metals	-8.747E-18
Emissions to fresh water	1.279E-02
Analytical measures to fresh water	-1.691E-05
Adsorbable organic halogen compounds (AOX)	-8.773E-09
Biological oxygen demand (BOD)	2.211E-07
Chemical oxygen demand (COD)	-2.737E-06
Nitrogenous Matter (unspecified, as N)	5.491E-09
Solids (dissolved)	-3.886E-05
Total Biochemical Oxygen Demand	0.000E+00
Total dissolved organic bounded carbon	2.610E-07
Total Dissolved Solids	2.441E-05
Total organic bounded carbon	-2.004E-07
Total Suspended Solids	0.000E+00
Heavy metals to fresh water	2.805E-05
Aluminium	2.422E-07
Antimony	4.952E-08
Arsenic (+V)	1.596E-07
Cadmium (+II)	1.143E-08
Chromium (+III)	-1.006E-11
Chromium (+VI)	1.443E-10
Chromium (unspecified)	2.639E-07
Cobalt	-2.215E-11
Copper (+II)	2.185E-07
Heavy metals to water (unspecified)	-2.744E-10
Iron	1.529E-05
Lead (+II)	5.381E-07

Process or Category	CTG
Manganese (+II)	1.227E-06
Mercury (+II)	4.167E-09
Molybdenum	2.207E-11
Nickel (+II)	3.913E-06
Selenium	1.077E-08
Silver	4.823E-08
Strontium	-7.177E-08
Thallium	-8.248E-13
Tin (+IV)	-7.110E-11
Titanium	-1.836E-11
Unspecified Substance	-7.566E-14
Uranium	-1.127E-06
Vanadium (+III)	-6.071E-10
Zinc (+II)	7.268E-06
Inorganic emissions to fresh water	1.268E-02
Acid (calculated as H+)	1.205E-08
Acidity	0.000E+00
Aluminum (+III)	5.581E-06
Ammonia	6.048E-05
Ammonia, as N	7.038E-12
Ammonium (total N)	4.034E-09
Ammonium / ammonia	2.342E-06
Barium	9.826E-07
Beryllium	-3.251E-15
Boron	-2.143E-09
Bromate	7.299E-15
Bromine	-2.817E-12
Calcium (+II)	4.883E-05
Carbonate	7.847E-05
Chlorate	7.393E-12
Chloride	-1.501E-04
Chlorine (dissolved)	-2.163E-08
Copper ion (+II/+III)	3.382E-12
Cyanide	4.494E-07
Fluoride	2.656E-06
Fluorine	-2.590E-10
Hydrogen chloride	-4.962E-12

Process or Category	CTG
Hydrogen fluoride (hydrofluoric acid)	-2.716E-12
Hydrogen Ions (H+)	-1.689E-11
Hydroxide	3.404E-08
Inorganic salts and acids (unspecified)	6.453E-20
Iron ion (+II/+III)	1.570E-09
Magnesium (+III)	-4.426E-08
Magnesium chloride	-8.545E-14
Metal ions (unspecific)	5.064E-10
Neutral salts	1.581E-13
Nickel ion (+III)	9.788E-11
Nitrate	1.733E-07
Nitrate (as total N)	-2.713E-13
Nitrogen	9.385E-06
Nitrogen (as total N)	1.909E-08
Nitrogen organic bounded	-9.950E-08
Phosphate	-8.446E-09
Phosphorus	6.150E-06
Potassium	-1.168E-09
Silicate particles	1.164E-09
Sodium (+I)	-1.713E-07
Sodium chloride (rock salt)	2.012E-05
Sodium hypochlorite	5.455E-13
Sulfates	4.094E-03
Sulphate	-2.365E-05
Sulphide	-3.494E-07
Sulphite	-4.070E-11
Sulphur	-2.139E-09
Sulphur dioxide	0.000E+00
Sulphuric acid	-6.397E-10
Total Dissolved Solids	8.526E-03
Unspecified Iron Oxides	-1.938E-13
Unspecified Oil	-6.865E-13
Unspecified Organic Chlorine compounds	-1.556E-15
Unspecified Salt	-6.224E-12
Unspecified Solids (Suspended)	-2.416E-11
Organic emissions to fresh water	-1.734E-06
Halogenated organic emissions to fresh water	-3.629E-12

Process or Category	CTG
1,2-Dibromoethane	7.144E-17
Chlorinated hydrocarbons (unspecified)	-9.451E-14
Chloromethane (methyl chloride)	-3.530E-12
Dichloroethane (ethylene dichloride)	-7.747E-16
Dichloropropane	-1.905E-18
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	-2.498E-18
Vinyl chloride (VCM; chloroethene)	-4.275E-15
Hydrocarbons to fresh water	-1.200E-06
Acenaphthene	-5.402E-12
Acenaphthylene	-2.284E-12
Acetic acid	-5.684E-11
Acrylonitrile	-1.393E-13
Anthracene	-8.823E-12
Aromatic hydrocarbons (unspecified)	-2.530E-09
Benzene	-1.157E-08
Benzo{a}anthracene	-7.063E-13
Benzofluoranthene	-2.617E-13
Chrysene	-2.941E-12
Cresol (methyl phenol)	-5.539E-11
Ethyl benzene	-6.024E-10
Fluoranthene	-8.057E-13
Hexane (isomers)	-6.048E-12
Hydrocarbons (unspecified)	2.887E-08
Methanol	1.935E-07
Oil (unspecified)	-1.386E-06
Phenol (hydroxy benzene)	-1.131E-08
Polycyclic aromatic hydrocarbons (PAH, unspec.)	-3.521E-10
Toluene (methyl benzene)	-7.244E-09
Xylene (isomers; dimethyl benzene)	-2.504E-09
Carbon, organically bound	-5.338E-07
Naphthalene	-3.667E-10
N-unspecified (N)	-5.372E-13
Organic chlorine compounds (unspecified)	1.473E-13
Organic compounds (dissolved)	1.677E-10
Organic compounds (unspecified)	1.489E-11
Unspecified wastewater	-4.062E-10
Other emissions to fresh water	0.000E+00

Process or Category	CTG
Detergent (unspecified)	0.000E+00
non used primary energy from water power	0.000E+00
Unused primary energy from geothermal	0.000E+00
Waste heat	0.000E+00
Waste water	0.000E+00
Particles to fresh water	1.010E-04
Metals (unspecified)	3.126E-12
Silicon dioxide (silica)	5.188E-09
Soil loss by erosion into water	-4.913E-11
Solids (suspended)	-1.491E-04
Suspended solids, unspecified	3.998E-09
Total suspended solids	2.501E-04
Unspecified Oxides	-1.611E-13
Radioactive emissions to fresh water	0.000E+00
Americium (Am241)	0.000E+00
Antimony (Sb124)	0.000E+00
Antimony (Sb125)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00
Curium (Cm alpha)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00
Iodine (I131)	0.000E+00
Manganese (Mn54)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
Radionuclides	0.000E+00
Radium (Ra226)	0.000E+00
Ruthenium (Ru106)	0.000E+00
Silver (Ag110m)	0.000E+00
Strontium (Sr90)	0.000E+00
Thorium (Th234)	0.000E+00
Uranium	0.000E+00
Bromide	0.000E+00
Radionuclide	0.000E+00

Process or Category	CTG
Sulfite	0.000E+00
Unspecified Solids (Dissolved)	-4.657E-11
Uranium (total)	-1.047E-13
Emissions to sea water	-8.049E-04
Analytical measures to sea water	-4.717E-06
Adsorbable organic halogen compounds (AOX)	-3.210E-13
Biological oxygen demand (BOD)	-3.541E-07
Chemical oxygen demand (COD)	-4.008E-06
Total organic bounded carbon	-3.541E-07
Heavy metals to sea water	-1.109E-06
Arsenic (+V)	-5.917E-09
Cadmium (+II)	-3.017E-09
Chromium (unspecified)	-9.068E-09
Cobalt	-7.145E-10
Copper (+II)	-2.805E-08
Iron	-6.060E-08
Lead (+II)	-8.247E-09
Manganese (+II)	-6.012E-09
Mercury (+II)	-1.180E-10
Molybdenum	-4.735E-10
Nickel (+II)	-8.561E-09
Silver	-1.195E-09
Strontium	-9.630E-07
Tin (+IV)	-1.432E-09
Titanium	-1.458E-10
Vanadium (+III)	-6.723E-10
Zinc (+II)	-1.171E-08
Inorganic emissions to sea water	-5.169E-04
Aluminum (+III)	-4.695E-09
Ammonia	-1.395E-07
Barium	-9.678E-08
Beryllium	-1.857E-11
Boron	-7.592E-08
Calcium (+II)	-8.291E-06
Carbonate	-6.088E-06
Chloride	-4.893E-04
Magnesium	-2.063E-06

Process or Category	CTG
Nitrate	-7.891E-09
Sodium (+I)	-7.072E-06
Sulphate	-2.573E-06
Sulphide	-1.108E-06
Sulphur	-4.062E-08
Sulphur dioxide	0.000E+00
Organic emissions to sea water	-3.157E-07
Hydrocarbons to sea water	-3.141E-07
Acenaphthene	-3.672E-11
Acenaphthylene	-1.434E-11
Acetic acid	-3.253E-12
Anthracene	-2.067E-11
Aromatic hydrocarbons (unspecified)	-3.541E-09
Benzene	-3.673E-08
Benzo{a}anthracene	-7.482E-12
Benzofluoranthene	-7.522E-12
Chrysene	-4.071E-11
Cresol (methyl phenol)	-1.052E-09
Ethyl benzene	-1.557E-09
Fluoranthene	-8.685E-12
Hexane (isomers)	-1.149E-10
Oil (unspecified)	-2.130E-07
Phenol (hydroxy benzene)	-2.583E-08
Toluene (methyl benzene)	-2.603E-08
Xylene (isomers; dimethyl benzene)	-6.032E-09
Naphthalene	-1.633E-09
Particles to sea water	-2.818E-04
Solids (suspended)	-2.818E-04
Emissions to agricultural soil	1.327E-07
Heavy metals to agricultural soil	1.327E-07
Cadmium (+II)	2.089E-09
Chromium (unspecified)	1.013E-07
Copper (+II)	4.414E-09
Lead (+II)	6.826E-10
Mercury (+II)	9.080E-12
Nickel (+II)	2.422E-09
Zinc (+II)	2.179E-08

Process or Category	CTG
Emissions to industrial soil	-3.716E-05
Heavy metals to industrial soil	-3.595E-05
Antimony	-1.620E-20
Arsenic (+V)	-1.969E-08
Cadmium (+II)	-4.789E-12
Chromium (+III)	5.390E-13
Chromium (+VI)	-5.870E-20
Chromium (unspecified)	-1.132E-09
Cobalt	-2.018E-11
Copper (+II)	-1.034E-11
Iron	-3.524E-05
Lead (+II)	-1.408E-07
Manganese (+II)	-2.383E-10
Mercury (+II)	-3.642E-10
Nickel (+II)	-3.216E-10
Selenium	-2.339E-09
Strontium	-4.236E-07
Thallium	-1.703E-08
Vanadium (+III)	-1.075E-07
Zinc (+II)	-1.183E-10
Inorganic emissions to industrial soil	-1.206E-06
Aluminum (+III)	-1.223E-09
Ammonia	-6.543E-07
Bromide	-1.729E-10
Calcium (+II)	-1.176E-09
Chloride	-2.018E-07
Chlorine	-1.370E-17
Fluoride	-5.765E-09
Magnesium (+III)	-1.647E-10
Phosphorus	-6.889E-08
Potassium (+I)	-1.367E-07
Sodium (+I)	-1.025E-10
Sulphate	-1.935E-08
Sulphide	-1.161E-07
Organic emissions to industrial soil	-1.209E-09
Oil (unspecified)	-1.209E-09
Radioactive emissions to industrial soil	0.000E+00

Process or Category	CTG
Uranium	0.000E+00
Calcium Fluoride	-2.689E-09
Radionuclide	0.000E+00

Embedded Unit Processes

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Section IV: Disclaimer