NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Trunkline Construction

Reference Flow: 1 pcs of trunkline

Brief Description: The materials used for the construction of a trunkline that connects an electric power plant to the main electricity transmission grid.

Section I: Meta Data

Geographical Coverage: US **Region:** Average

Year Data Best Represents: 2010

Process Type: Transport Process (TP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: All 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 Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

DISTANCE	*Length of trunkline, between energy conversion facility and main transmission line. 161 km = 100 mi is the default distance between wind farm and main transmission line.*
CF	*Capacity factor of wind farm; default value of 0.30 represents a capacity factor of 30%.*
Steel_km	*Mass of steel used for trunkline construction; expressed in units of kg/km.*
Aluminum_km	*Mass of aluminum used for trunkline construction; expressed in units of kg/km.*

Concrete_km	*Mass of concrete used for trunkline construction; expressed in units of kg/km.*

Tracked Input Flows:

Steel cold rolled (St) [Metals]	*Steel plate used for trunkline construction; steel is made in a blast furnace (BF)*
Aluminum [Metals]	*Aluminum used for trunkline construction*
Concrete	*Concrete used for trunkline construction*

Tracked Output Flows:

Construction per MWh	*Reference flow; fraction of trunkline construction apportioned to 1 MWh of electricity generation*
Steel scrap [Waste for recovery]	*Mass of steel scrap that is recovered for recycling during the end-of-life disposition of the trunkline.*
Aluminum scrap [Waste for recovery]	*Mass of aluminum scrap that is recovered for recycling during the end-of-life disposition of the trunkline.*
Unspecified scrap waste [Consumer waste]	*Mass of end-of-life waste that is landfilled*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_C_Trunkline_2010.01.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 construction of a trunkline that connects an electric power plant to the main electricity transmission grid. Key components include steel towers, concrete foundations, and steel-clad aluminum conductors. The scrap materials generated during the end-of-life disposition of the trunkline are also calculated in this unit process. The lifetime electricity throughput of the trunkline is estimated in order to express the inputs and outputs on the basis of mass of materials per 1 MWh of electricity transport.

This unit process is combined with other wind farm construction unit processes in the Wind Farm, Construction unit process: DF_Stage3_C_Wind_Farm _2010.01.doc.

Figure 1 provides an overview of the boundary of this unit process. The cradle-to-gate emissions for the production of materials used for trunkline construction (e.g., cold rolled steel, aluminum, and concrete) are calculated outside the boundary of this unit process and are based on profiles available within the life cycle inventory (LCI) databases.

Boundary and Description

Wind farms require a trunkline that connects the switchyard of the wind farm to the main electricity transmission grid. This unit process accounts for the materials required for the construction of a trunkline.

Most wind farms are located in remote areas that are farther from the main electricity transmission grid than other types of power plants. This analysis assumes that the length of the trunkline is 100 miles. This distance has been parameterized in the unit process and can thus be evaluated through sensitivity analysis if necessary.

The construction materials required for the construction of a trunkline tower are estimated from a case study on the restoration of a damaged power line system in Nebraska (Brune 2008). A single tower requires 7,940 kg of steel, 14,100 kg of concrete. Aluminum-clad, steel-reinforced cables are required for the transmission lines. The mass is aluminum in a transmission cable is 5,360 kg/km; the mass of steel in a transmission cable is 885 kg/km (Phelps Dodge 2005). These material requirements are scaled to the basis of the entire trunkline system by assuming the distance between towers is 274 meters (900 feet) and that there is no sag in the transmission lines.

This unit process assumes that scrap material is generated by the end-of-life disposition of the trunkline. The outputs of this unit process include the mass of metals that are recovered for recycling and the mass of metals that are landfilled. 95 percent of the metal in the trunkline is recovered for recycling and 5 percent is landfilled. The concrete used by the trunkline is not recovered for recycling and is assumed to be landfilled during the end-of-life disposition of the trunkline.

This analysis apportions the construction requirements for the trunkline to 1 MWh of electricity generation. The fraction of construction requirements per 1 MWh of electricity generation is the reciprocal of the lifetime electricity produced by the wind farm. Lifetime electricity is a function of wind farm capacity factor (which has a default value of 30 percent), and wind farm life span (which has a default value of 30 years).

Figure 1: Unit Process Scope and Boundary

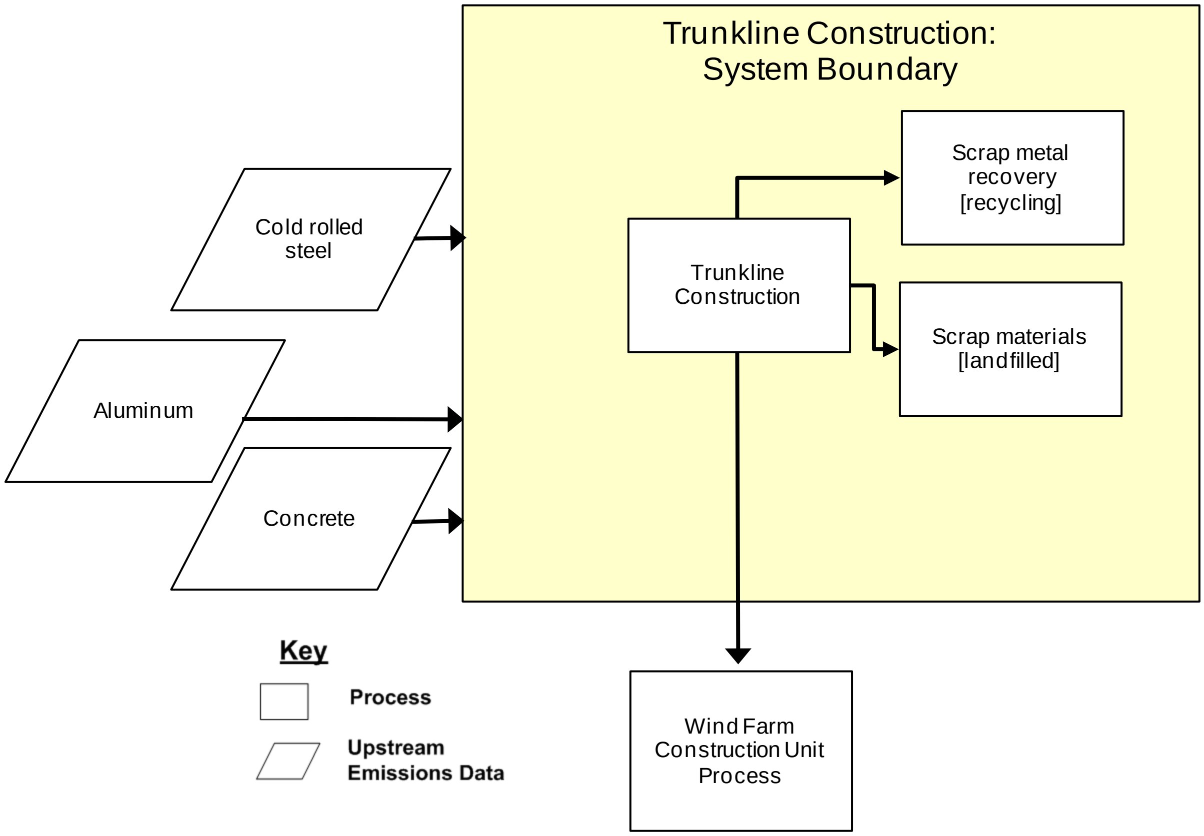

Table 1: Trunkline Characteristics

Property	Value	Source
Tower construction: steel requirements	7,940 kg/tower	Brune 2008
Tower construction: concrete requirements	14,100 kg/tower	Brune 2008
Cable construction: steel requirements	885 kg/km	Phelps Dodge 2005
Cable construction: aluminum requirements	5,360 kg/km	Phelps Dodge 2005

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Steel cold rolled (St) [Metals]	3.04E-01	kg
Aluminum [Metals]	5.47E-02	kg
Concrete, ready mix, R-5-0 [Concrete_Cement]	5.25E-01	kg
Outputs		
construction per MWh	1.00	pcs/MWh
Steel scrap [Waste for recovery]	2.89E-01	kg
Aluminum scrap [Waste for recovery]	5.20E-02	kg
Unspecified scrap waste [Consumer waste]	5.43E-01	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 2.

Embedded Unit Processes

None.

References

Brune, Paul (2008)	*A Pain in the Ice*. Nebraska Public Power District. 2008
Phelps Dodge (2005)	*Aluminum Conductors, Aluminum-Clad Steel Reinforced*. Phelps Dodge International Corporation. 2005.

Section III: Document Control Information

Date Created: November 1, 2010

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: Trunkline Construction.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

Section IV: Disclaimer