NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Horisontal Wind Turbine, 35 kV Cables, Manufacturing

Reference Flow: 1 meter of Horizontal Wind Turbine, 35 kV Cables

Brief Description: This unit process quantifies the materials needed for the manufacture of 1 meter of 35 kV capacity cable, for use with horizontal wind turbines ranging in capacity from 1.5 to 6 MW, with copper and aluminum used for cable fabrication.

Section I: Meta Data

Geographical Coverage: US **Region:** Average

Year Data Best Represents: 2010

Process Type: Manufacturing Process (MP)

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:

MNU_WSTE	*Percentage of manufacturing waste in this process*
RECYCLE	*Recycling percentage of recyclable materials (copper, aluminum)*

Tracked Input Flows:

Copper wire [Metals]	*Copper used for wire manufacture*
Aluminum [Metals]	*Aluminum used for wire manufacture*

Tracked Output Flows:

Horizontal Wind Turbine, 35 kV Cables [Manufacturing]	*Manufacturing of one meter of 35 kV cables*

	supporting a horizontal wind turbine
Copper Scrap [Waste for Recovery]	*Mass of copper scrap waste that is recovered for recycling*
Aluminum scrap [Waste for Recovery]	*Mass of aluminum scrap waste recovered for recycling*
Unspecified Scrap waste [Consumer Waste]	*Mass of unspecified scrap waste that is recovered for recycling*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_M_HTurbine_35kV_Cables_2010.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process encompasses the material inputs for the manufacture a single meter of 35 kV capacity cable, used in support of a horizontal wind turbine, with wind turbine capacities ranging from 1.5 to 6.0 MW. The unit process is based on the reference flow of 1 meter of cable. The relevant flows of this unit process are described below and shown in **Figure 1.**

This unit process is combined with other wind turbine component unit processes in an assembly unit process for a single horizontal wind turbine: DF_Stage3_M_Assembly_Turbine_2010.01.doc. The assembly unit process quantifies the number of each wind turbine component required to assemble a single horizontal wind turbine.

Boundary and Description

The mass of materials needed for the construction of 1 meter of 35 kV cable, in support of 1.5-6 MW wind turbines, was estimated based on available manufacturing data for the fabrication of 20.04 mm wires, including two layers of insulation, for a total diameter of 42.20 mm (Energex 2010). These weights are representative of 2010 technologies, and are applicable to both conventional and advanced wind turbine designs. These values are summarized in **Table 1**.

The types of materials used for cable manufacture are also based on data available from Energex (2010), wherein approximately 62% of the total mass of the conductor is comprised of copper, while the remaining 38% is comprised of aluminum. Although the wires considered for use in this unit process include insulation, the mass of insulation on a per meter basis is assumed to be negligible, in comparison to the total mass of the cable, per meter. Accurate data representing the mass of

insulation included in the cable were not available, and therefore are considered a data limitation within this unit process.

This unit process assumes that no waste metal is generated during the wire fabrication process. NETL recommends the use of zero percent waste for this parameter. However, this value is included as an adjustable parameter, and can be altered by the analyst as warranted. During the decommissioning process, it is assumed that 95 percent of the total copper and aluminum mass would be landfilled, with the remaining 5 percent being recovered for recycling, consistent with manufacture/ decommissioning for other horizontal wind turbine components.

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

Figure 1: Unit Process Scope and Boundary

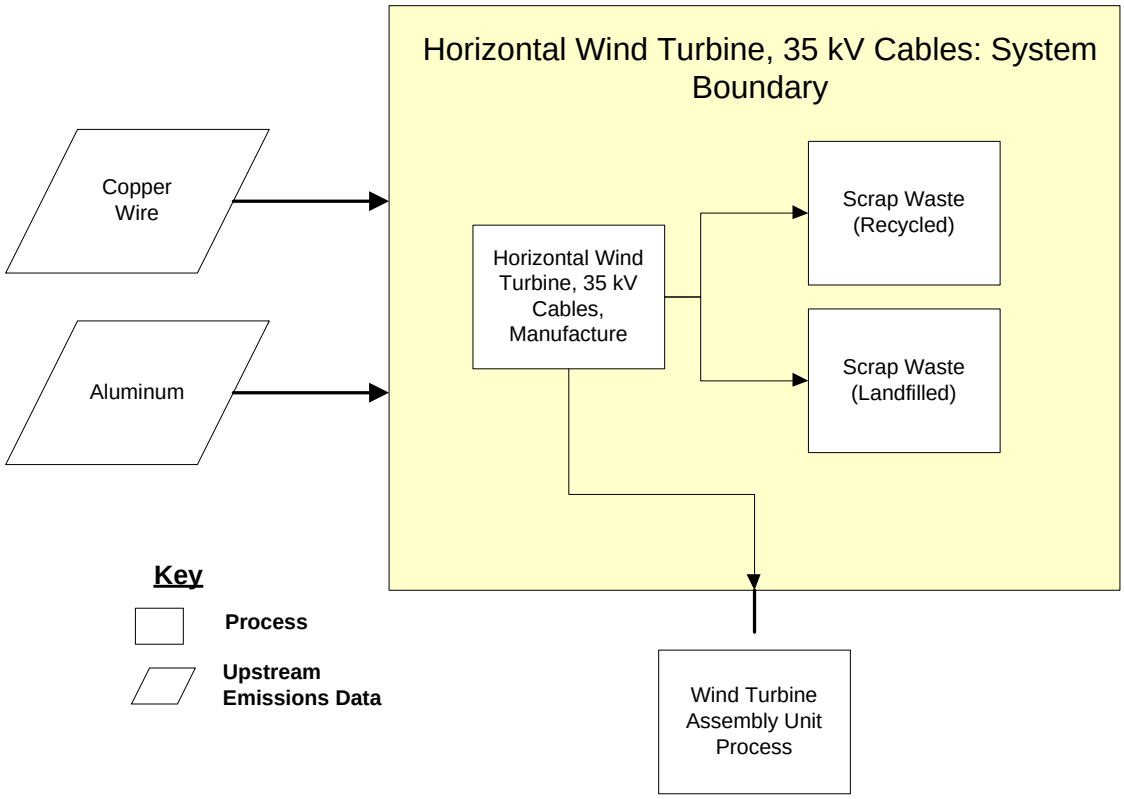

Table 1: Diameter and Mass Values for 35 kV Cables

Component	Value	Source
Conductor Diameter	20.04 mm	Energex 2010
Total Diameter (Conductor + Insulation)	42.20 mm	Energex 2010
Copper: mass per km	4,025 kg	Energex 2010
Aluminum: mass per km	2,425 kg	Energex 2010

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Copper Wire [Metals]	4.03	kg
Aluminum [Metals]	2.43	kg
Outputs		
Horizontal Turbine, 35 kV Cables [Manufacturing]	1.0	m
Copper scrap [Waste for Recovery]	3.82	kg
Aluminum scrap [Waste for Recovery]	2.30	kg
Unspecified scrap waste [Consumer Waste]	0.32	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

Energex 2010 — Energex 2010. *Energex SP Power Cables*. Available at: http://www.nexanselectricalwire.com/egy/power/energex.pdf Accessed on July 15, 2010.

Section III: Document Control Information

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