NETL Life Cycle Inventory Data
Process Documentation File

Process Name: DF_Stage3_M_Horizontal Turbine_Main_Frame_1.5-6 MW_2010.01

Reference Flow: 1 piece (pcs) of Horizontal Turbine Main Frame, 1.6-6 MW Capacity

Brief Description: Manufacture of a horizontal wind turbine main frame, based on NREL specifications for a multi capacity (range 1.5MW - 6MW) wind turbine main frame (bed).

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:

HT_CPTY	*Power production capacity of the wind turbine*
DIAMETER	*Diameter of the rotor*
MNU_WASTE	*Percentage of manufacturing waste in this process*
MJ_KG	*Required energy (electricity) to manufacture one kg of total main frame*
ST_PER	*Percentage of steel or cast iron scraps recovery*
PER_ST	*Percentage of steel required to manufacture one piece of main frame*

Tracked Input Flows:

Cast iron part [Metal parts]	*Cast iron used for main frame manufacture*
Steel cold rolled [Metals]	*Steel used for main frame manufacture*
Power [Electric power]	*Electricity used for main frame manufacture*

Tracked Output Flows:

Horizontal Turbine Main Frame [Manufacturing]	*Manufacturing of a single main frame piece supporting multi-megawatt capacity horizontal wind turbines*
Unspecified scrap waste [Consumer waste]	*Mass of manufacturing waste that is landfilled*
Scrap waste [Waste for recovery]	*Mass of manufacturing 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_Main_Frame_1.5-6MW_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 and energy inputs for the manufacture a single main frame piece for a horizontal wind turbine ranging from 1.5 to 6.0 MW in capacity. The unit process is based on the reference flow of 1 pcs of main frame. 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 each wind turbine component needed to assemble a single horizontal wind turbine.

Boundary and Description

The mass relationships between turbine capacity and turbine components are based on equations developed using a wind turbine scaling model (NREL 2006). The conventional

components are representative of 2002 technologies, while the advanced components represent pending designs. The equations for estimating conventional and advanced main frame mass are shown in **Table 1**.

The types of materials used for main frame manufacture are based on estimated material profiles for wind turbine components (NREL 2006). The main frame is assumed to be manufactured from 60 percent cast iron, while the rest of the main frame consists of cold rolled steel (NREL 2006). The percentages for estimating the material compositions of conventional and advanced main frames are shown in **Table 1**.

This unit process assumes that scrap material is generated by the manufacturing process at a rate of one percent of the weight of the finished generator. Of this manufacturing scrap, 90 percent of the cast iron and steel materials are recovered for recycling and 10 percent is landfilled (Nalukowe *et al* 2006).

Figure 1 provides an overview of the boundary of this unit process. The cradle-to-gate emissions for the production of materials used for main frame manufacture (e.g., cast iron and steel) 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

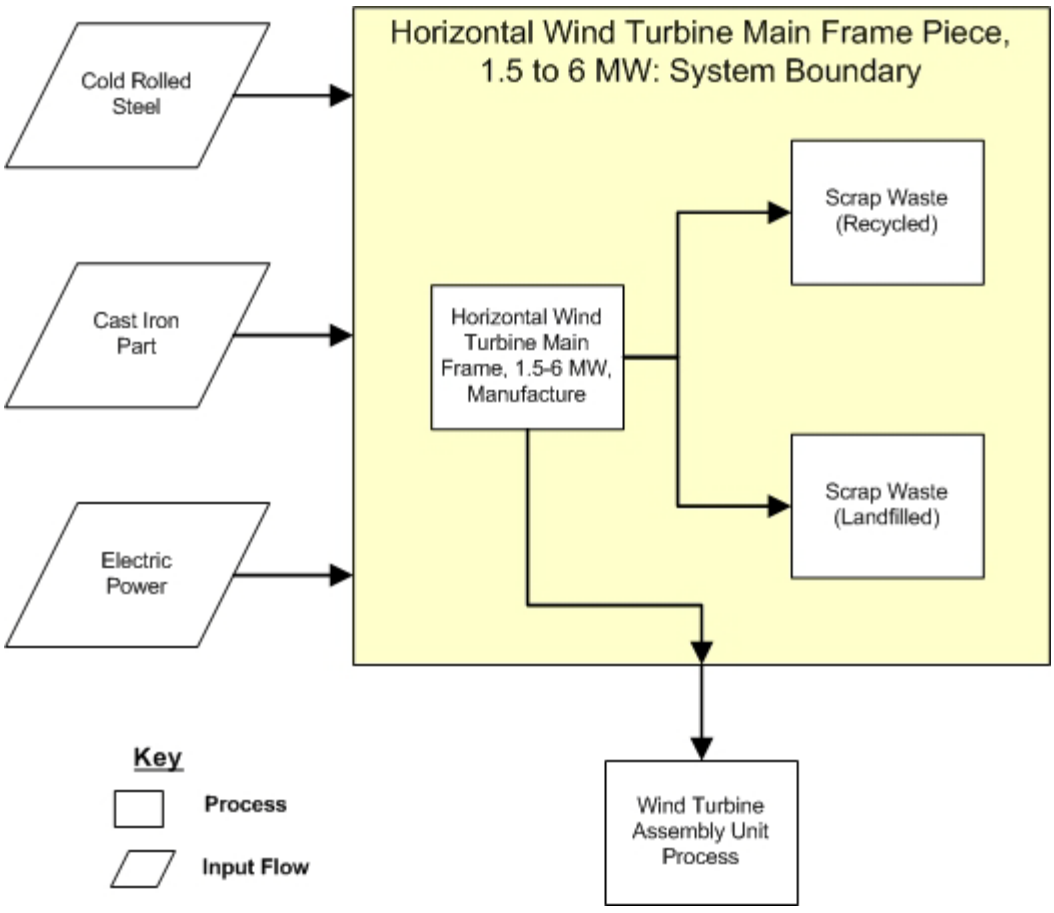

Table 1: Mass Scaling Equations for a Main Frame Piece

Component	Conventional Turbine	Advanced Turbine	Notes	Source
Mass scaling equation	$1.295 \times d^{1.953}$	$2.233 \times d^{1.953}$	d = rotor diameter in *m*	NREL 2006
Cast iron	60%	60%	none	NREL 2006
Cold rolled steel	40%	40%	none	NREL 2006

Table 2: Unit Process Input and Output Flows

Flow Name*	Conventional Turbine	Advanced Turbine	Units (Per Reference Flow)
Inputs			
Cast iron part [Metal parts]	5376	5376	kg
Steel cold rolled [Metals]	3584	3584	kg
Power [Electric power]	27690	27690	MJ
Outputs			
Horizontal Turbine Main Frame [Manufacturing]	1.00	1.00	pcs
Unspecified scrap waste [Consumer waste]	905.1	905.1	kg
Scrap waste [Waste for recovery]	8145	8145	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

NREL 2006 — Fingersh, L. Hand, M. Laxson, A. 2006. *Wind Turbine Design Cost and Scaling Model.* National Renewable Energy Laboratory. NREL/TP-500-40566. Golden, Colorado. December 2006. (Accessed June 15, 2010).

Nalukowe *et al*. 2006 — Nalukowe, B.B. Liu, J. Damien, W. Lukawski, T. 2006. *Life Cycle Assessment of a Wind Turbine*. May 22, 2006.

Section III: Document Control Information

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