NETL Life Cycle Inventory Data
Process Documentation File

Process Name: SRWC Land Preparation, Operation

Reference Flow: 1 kg of Biomass Operation

Brief Description: This unit process includes operations for land preparation for short rotation woody crops (SRWC) including an input of combusted diesel, dust emissions, and a calculation of required land area.

Section I: Meta Data

Geographical Coverage: US **Region:** Midwest

Year Data Best Represents: 2007

Process Type: Extraction Process (EP)

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

Allocation Applied: No

Completeness: All Relevant Flows Recorded

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:

SRWC yield (Biomass_yield_y)	*Represents the SRWC biomass annual yield*
Plant Capacity Factor (CF)	*Capacity factor of CBTL plant, allows calculation of amount of biomass to supply the plant*

Tracked Input Flows:

Diesel Combustion, Mobile Sources, Truck [Refinery products]	*Amount of diesel combusted within the mobile source.*
Equipment Assembly per kg Biomass	*Amount of farm equipment required for*

[Valuable substances]	*1 kg of biomass.*

Tracked Output Flows:

Biomass Operation [Installation]	*This unit process is assembled with the biomass cultivation operation unit process in series, therefore the reference flow is assumed to be 1 kg biomass operation*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_SRWC_Land_Preparation_2010.03.xlsx*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

The scope of this unit process covers the operations of farming activities used for land area preparation for short rotation woody crops (SRWC) biomass in Life Cycle (LC) Stage #1. This unit process is based on the reference flow of 1 kg of biomass operation, as described below, and in **Figure 1.** The inputs to the unit process include diesel combustion (technosphere) and land use (resource). Diesel is used as fuel for the land preparation equipment (a tractor used to pull a disk tiller); the energy and material flows for the upstream production and delivery of diesel as well as life cycle emissions of diesel production and combustion are not included in the boundary of this process. Land use, expressed in terms of acres per unit production of SRWC, is considered a resource that involves no upstream operating or construction activities. The fugitive dust emissions from the use of land preparation equipment are included in this unit process boundary. Fugitive dust is categorized as PM (particulate matter) emissions to air. Water use and emissions to water are not characterized in this process, because they are assumed to comprise a negligible contribution to the direct operations of land preparation.

Boundary and Description

The LC boundary of this unit process starts with farming activities to prepare land area for seeding of biomass and ends with a unit land area ready to seed. Land preparation is assumed to occur once during (at the very beginning of) the study period. Operations for the preparation of land for SRWC production are based on the estimated diesel consumption of farming equipment, the fugitive dust emissions caused by surface dust that is disturbed by land preparation equipment, and the annual yield rate of SRWC. Figure 1 provides an overview of the boundary of this unit process. As shown, upstream emissions associated with the production and delivery of diesel fuel are accounted for outside of the boundary of this unit process. The methods for calculating these operating activities are described below.

There are two adjustable parameters in this unit process: the annual yield of SRWC and the fuels production plant capacity factor. These are designed to allow modeling flexibility to enable the modeler to update the unit process to meet specific assumptions and study criteria, as relevant. Additionally, these values may be updated as needed to incorporate newer or revised data sources. SRWC per year indicates the annual yield of SRWC per acre. NETL currently recommends a default value of 6,214 kg/acre-year for this parameter (NETL 2011). The annual yield of SRWC (kg/acre-year) is used to translate the values for diesel consumption, land use, and fugitive dust emissions from a basis of quantity per acre to a basis of quantity per kg of SRWC biomass production. Capacity factor of the plant indicates the production capacity. NETL currently recommends a default value of 85 percent for this parameter.

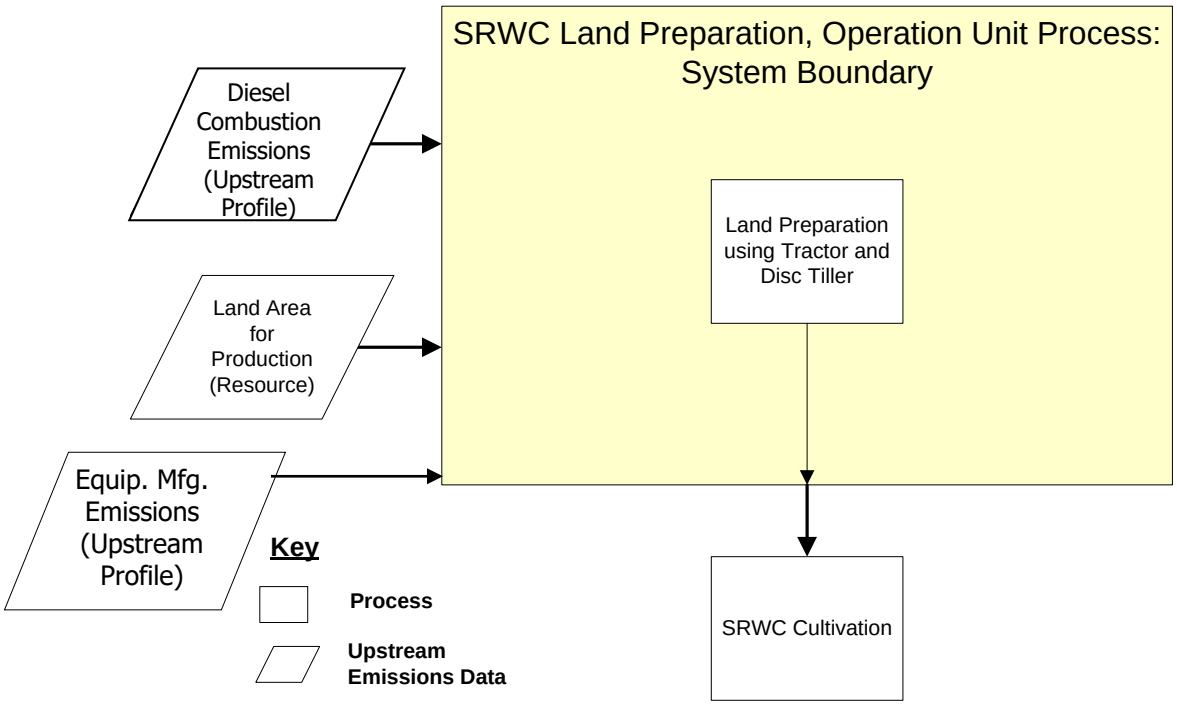
Diesel is consumed by the tractor as it pulls the disk tiller. A tractor consumes an average of 10.26 gallons of diesel per hour (John Deere, 2009a). The diesel consumption of equipment used in farming cultivation activities was calculated based on specifications of a 1,953 rpm tractor consuming 10.26 gal/hour of diesel fuel and a disk tiller of 4.78 m (188 inches) width (John Deere 2009a, John Deere 2009b). Assuming that the tractor operates at 5.8 miles per hour (mph), an average operating speed, and by multiplying the width of the disk tiller by the operating speed of the tractor, the land coverage rate is estimated at 11 acres per hour (Caterpillar 2010). Multiplying this land coverage rate by the fuel consumption rate, the estimated diesel consumption is 0.93 gal/acre-pass. This calculation assumes that the tractor makes two passes over the site and the total diesel consumption is 1.86 gal/acre calculated. This unit process assumes that the engine of the tractor is greater than 175 horsepower.

The emissions for the required amount of diesel combusted for this process are accounted for in an upstream diesel combustion process. That process is pulled as an input to this process. The impacts associated with the manufacturing of the land preparation equipment are accounted for in a separate unit process. This process scales the manufacturing processes based on the amount of biomass demanded.

Fugitive dust emissions are generated by the disturbance of surface soil during land preparation. Fugitive dust emissions from land preparation are estimated using an emissions factor specified by WRAP (Western Regional Air Program) (Countess Environmental. 2004), which conducted air sampling studies on ripping and sub-soiling practices used for breaking up soil compaction. The emissions factor for fugitive dust is 1.2 lb PM/acre-pass. The total emissions of fugitive dust are 1.09 kg PM/acre (5.84E-06 kg/kg biomass). The emissions factor for fugitive dust is 1.2 lb PM/acre-pass and the PM2.5/PM10 ratio is 0.15 kg/kg.

The yield rate of SRWC is based on independent studies on willow and poplar hybrids in the Central Upper Peninsula of Michigan by Michigan State University (Miller and Bender 2008). Based on this data, an average SRWC yield of 2.8 tons/acre (2540 kg/acre) is used for this study.

Figure 1: Unit Process Scope and Boundary



Properties of SRWC relevant to this unit process are indicated in **Table 1**. Heating values for SRWC are provided as a reference point to document assumptions and for comparison with other biomass types applied outside of this unit process, as relevant. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS sheet.

Table 1: Properties of Land Preparation Operation Activities (NETL 2011, 2012)

Property	Value	Units
SRWC yield	6214	kg/acre-year
SRWC LHV at 50% moisture	3969	Btu/lb
SRWC HHV at 50% moisture	4219	Btu/lb

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)	DQI
Inputs			
Diesel Combustion, Mobile Sources, Truck [Refinery products]	**3.19E-05**	**kg**	**2,2**
Equipment Assembly per kg Biomass [Valuable substances]	**1.00E+00**	**Pieces**	**2,2**
Area of Production Land	5.36E-06	acres	2,1
Outputs			
Biomass Operation [Installation]	1	kg	2,2
Dust (PM10) [Particles to air]	5.84E-06	kg	2,2
Dust (PM2.5) [Particles to air]	8.76E-07	kg	2.2

* **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 1.

Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

Countess Environmental 2004 — Countess Environmental, 2004. *WRAP Fugitive Dust Handbook.* WGA Contract No. 30204-83. Western Regional Air Partnership.

John Deere 2009a — John Deere. 2009. *John Deere Model 7830 165 PTO hp (Manufacturer Specifications)*. Deere & Company.

John Deere 2009b — John Deere. 2009. *John Deere Model 425 Disk Harrow Wheel Type Offset (Manufacturer Specifications)*. Deere & Company.

Miller and Bender 2008 — Miller, R. and B. Bender. 2008. Growth and Yield of Willow and Poplar Hybrids in the Central Upper

	Peninsula of Michigan. Michigan State University, August, 2008.
NETL 2011	NETL. (2011). *Calculating Uncertainty in Biomass Emissions Model, Version 2.0 (CUBE 2.0): Model and Documentation*. (DOE/NETL-2012/1538). Pittsburgh, PA: National Energy Technology Laboratory, from http://www.netl.doe.gov/energy-analyses/refshelf/PubDetails.aspx?Action=View&PubIP=409
NETL 2012	NETL. (2012). *Greenhouse Gas Reductions in the Power Industry Using Domestic Coal and Biomass Volume 2: Pulverized Coal Plants*. (DOE/NETL-2012/1547). Pittsburgh, PA: National Energy Technology Laboratory, from http://www.netl.doe.gov/energy-analyses/refshelf/PubDetails.aspx?Action=View&SourSo=Main&PubId=426
Tillage 2009	Tillage Answers. 2009. *Tillage Calculators*. www.tillageanswers.com/tandem_calculator.cfm (Accessed February 04, 2010).

Section III: Document Control Information

Date Created: February 04, 2010

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Revision History:

13JUNE2012	Updated to revised parameter values.
29DECEMBER2014	Updated to reflect combustion removal. Diesel combustion is now an input. Added inventory item DQI data to the data summary tab. Speciated PM emissions by size.

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