NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Natural Gas Well Construction and Installation

Reference Flow: 1 piece (pcs) per kg of Natural Gas Well Construction and Installation

Brief Description: This unit process quantifies the materials, fuels, and emissions that are needed for/would result from construction and installation of a generic natural gas (NG) well.

Section I: Meta Data

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

Year Data Best Represents: 2011

Process Type: Installation Process (IP)

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:

Drill_depth	*Depth of natural gas well*
Product_rate	*Daily production rate of natural gas and petroleum as relevant*
Drill_power	*Power of drilling equipment; brake specific power*
Diesel_rate	*Use rate of diesel; kg of diesel combusted per MWh of brake-specific drilling energy*

Tracked Input Flows:

Steel Plate, BF (85% Recovery Rate) [Metals]	*Steel plate from blast furnace used to construct the blasthole drill, assumes 85 percent recycled/recovery rate*

Tracked Output Flows:

Blasthole Drill, 250,000 lbs [Construction]	*Construction of a single P&H 250,000 lb, model 250XP-DL dragline blasthole drill*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_C_Natural_Gas_Well_Generic_2013.01.xls*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

The scope of this unit process encompasses the materials and weights of those materials necessary to construct a natural gas well, within a generic formation, and the energy use and air emissions associated with installation of the well. This unit process is relevant to all modeled natural gas extraction profiles, including conventional onshore, conventional offshore, associated gas, Barnett Shale, Marcellus Shale, and coal bed methane. The process is based on the reference flow of 1 piece per kg of natural gas well construction and installation, as described below, and as shown in **Figure 1.** The natural gas well is assumed to be constructed of a combination of steel pipe and concrete casings. Other materials are assumed to be negligible.

This process is used during LC Stage #1 to assist in the extraction of natural gas from the subsurface, and associated processing. It is combined with other natural gas extraction and processing equipment/operations unit processes in the assembly unit process, DF_Stage1_O_Natural_Gas_Assembly_2011.01.doc. This assembly unit process quantifies the fraction of each piece of equipment and proportion of operations needed under LC Stage #1 to produce 1 kg of natural gas ready for transport (LC Stage #2) to the energy conversion facility (LC Stage #3).

Boundary and Description

This unit process includes the construction and installation activities for natural gas wells. Construction is defined as the cradle-to-gate burdens of key materials that embody key equipment and structures. Installation is defined as the activity of preparing a site, erecting buildings or other structures, and putting equipment in place.

The construction of natural gas wells requires a well casing that provides strength to the well bore and prevents contamination of the geological formations that surround the gas reservoir. In the case of offshore extraction, a large platform is also required. A well is lined with a carbon steel casing that is held in place with concrete. A typical casing has an inner diameter of 8.6 inches, is 0.75 inches thick, and weighs 24 pounds per foot (NaturalGas.org 2004). The weight of concrete used by the well walls is assumed to be equal to the weight of the steel casing. The total weight of materials for the construction of a well bore is estimated by factoring the total well length by the linear weight of carbon steel and concrete.

The installation of natural gas wells includes the drilling of the well, followed by the installation of the well casing. Horizontal drilling is used for unconventional natural gas reserves where the distribution of hydrocarbon is dispersed throughout a matrix of shale or coal. An advanced drilling rig has a drilling speed of 17.8 meters per hour, which translates to the drilling of a 7,000 foot well in approximately 10 days (NaturalGas.org 2004). A typical diesel engine used for oil and gas exploration has a power of 700 horsepower and a heat rate of 7,000 BTU/hp-hr (EPA 1995). The methane emissions from well installation is the product of the following three variables: heat rate of drilling engine (7,000 BTU/hp-hr), methane emission factor (EPA 1995) for diesel combustion in stationary industrial engines (6.35E-05 lb/hp-hr), and the total drilling time (in hours). The construction and material requirements are apportioned to one kilogram of natural gas product by dividing them by the lifetime production of the well.

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the physical assembly of the baler (e.g., that are emitted while putting together the components of a blasthole drill, including transport of those components) are not considered in this study. Upstream emissions from the production of raw materials used for the construction of the blasthole drill (e.g., steel plate) are calculated outside the boundary of this unit process, based on proprietary profiles available within the GaBi model. As shown in **Figure 1** and discussed above, the blasthole drill constructed in this unit process is incorporated into the surface mine assembly processes for LC Stage #1 for surface mined Powder River Basin sub-bituminous coal.

The total weight of a blasthole drill was readily available but reliable data for the material breakdown of baler subcomponents were not. Therefore, the blasthole drill was assumed to be composed entirely of steel plate (Steel plate, BF (85% Recovery Rate) [Metals]).

Table 1 shows values for each of the five adjustable process parameters listed in Section I of this unit process. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS sheet.

Figure 1: Unit Process Scope and Boundary

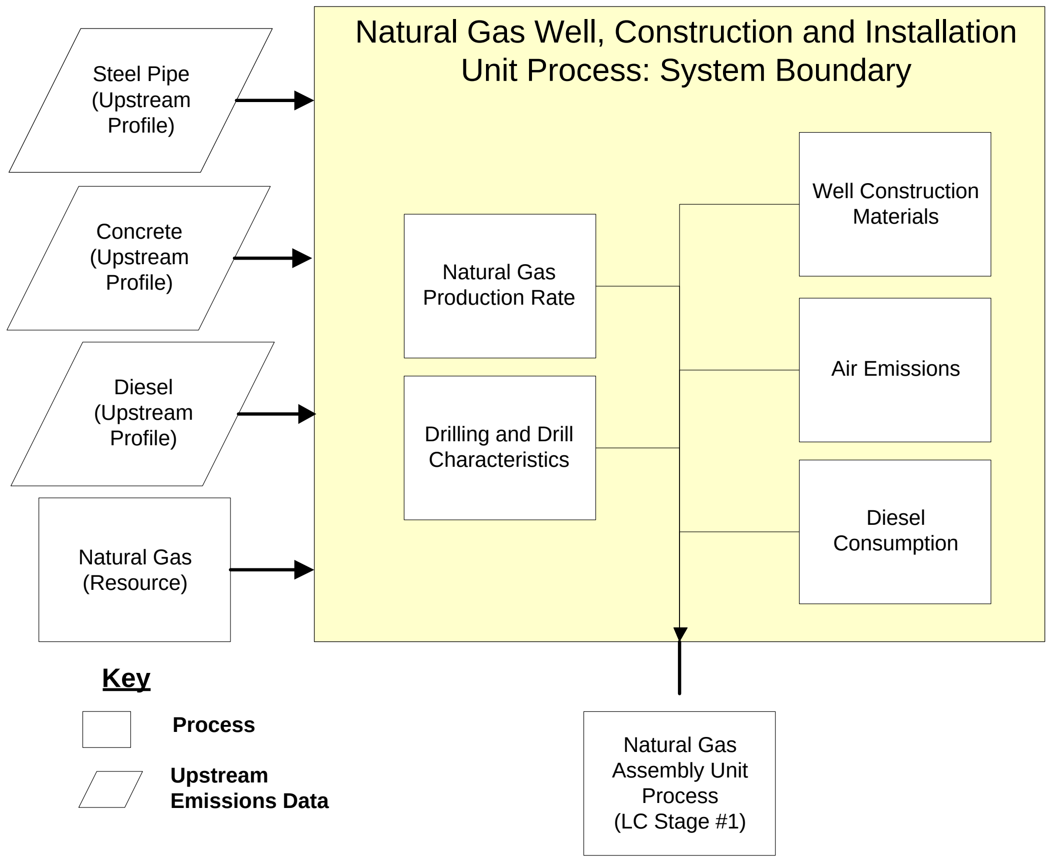

Table 1: Adjustable Parameter Values for Different Natural Gas Types

Natural Gas Type	Drill_depth (m)	Product_rate (kg/day)
Conventional Onshore	460	1,257
Conventional Offshore	2,300	53,342
Associated Gas	460	2,305
Barnett Shale	4,600	5,220
Marcellus Shale	4,600	5,658
Coal Bed Methane	460	2,000
Tight Gas	460	2,096

Table 2: Unit Process Input and Output Flows (Representative of Onshore Conventional Wells)

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Steel, pipe welded, BF (85% Recovery Rate) [Metals]	**0.00119**	**kg**
Concrete, ready mix, R-5-0 [Concrete_Cement]	**0.00119**	**kg**
Diesel [Crude oil products]	**0.00018**	**kg**
Outputs		
Natural Gas Well Construction and Installation [Construction]	**1.00**	**piece/kg**
Carbon dioxide [Inorganic emissions to air]	5.90E-04	kg
Methane [Organic emissions to air (group VOC)]	3.23E-08	kg
Nitrogen oxides [Inorganic emissions to air]	1.22E-05	kg
Sulphur oxides [Inorganic emissions to air]	2.06E-07	kg
Carbon monoxide [Inorganic emissions to air]	2.80E-06	kg
NMVOC (unspecified) [Group NMVOC to air]	3.26E-07	kg
Dust (PM10) [Particles to air]	3.56E-07	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 1. Values shown reflect default values based on the conventional onshore profile, with adjustable parameters set as shown in Table 1. Inputs and outputs for other natural gas profiles can be derived using the associated DS along with the relevant parameter values, as listed in Table 1.

Embedded Unit Processes

None.

References

EPA 1995 — United States Environmental Protection Agency. 1995. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42. Available at http://www.epa.gov/ttnchie1/ap42/ (Accessed May 18, 2010).

Natural Gas.org 2004. — Natural Gas.org. 2004. *Well Completion.* Available at http://naturalgas.org/naturalgas/well_completion.asp#liftingwell (Accessed July 1, 2010).

Section III: Document Control Information

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