NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Natural Gas Well Construction and Installation (conventional onshore)

Reference Flow: 1 pcs/kg kg

Brief Description: Materials of construction and installation fuels and emissions for a natural gas well (conventional onshore).

Section I: Meta Data

Geographical Coverage: United States **Region:** N/A

Year Data Best Represents: 2012

Process Type: Installation Process (IP)

Process Scope: Gate-to-Gate (GG)

Allocation Applied: No

Completeness: Individual 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_speed	*Drilling rate (m/hr)*
Drill_depth	*Depth of well (m)*
Product_rate	*Production rate of well (kg/d)*
Life_well	*Useful life of well (yr)*

Tracked Input Flows:

Steel, pipe welded	*Steel pipe used for well casing; steel content of pipe is 85% recycled*
Concrete, ready mix	*Concrete used for well casing*
Diesel	*Diesel used as a fuel during well installation*

Tracked Output Flows:

Natural Gas Well Construction and Installation	*Reference flow; expressed on the basis of fraction of well per kg of natural gas extraction (pcs/kg NG)*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_C_NG_Well_Conventional_Onshore_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 energy inputs and material outputs for the construction and installation of a conventional, onshore natural gas well. The unit process is based on the reference flow of 1 pcs/kg NG, which represents the fraction of the well construction and installation burdens per kilogram of natural gas extraction. The relevant flows of this unit process are described below and shown in **Figure 1.**

The inputs to this unit process are steel pipe and concrete (which are used as casing materials for the well) and diesel (which is combusted in drilling equipment during well installation). The energy and material flows for the upstream production and delivery of steel, concrete, and diesel are not included in this unit process but are accounted for by other unit process. The output of this unit process is the fraction of the well materials and installation energy that is attributable to one kg of extracted natural gas. This unit process also accounts for environmental emissions that are directly released by the combustion of diesel during well installation. This unit process is an input to the natural gas assembly process, which is a modeling tool for tying together the operation and construction activities of the natural gas supply chain.

Boundary and Description

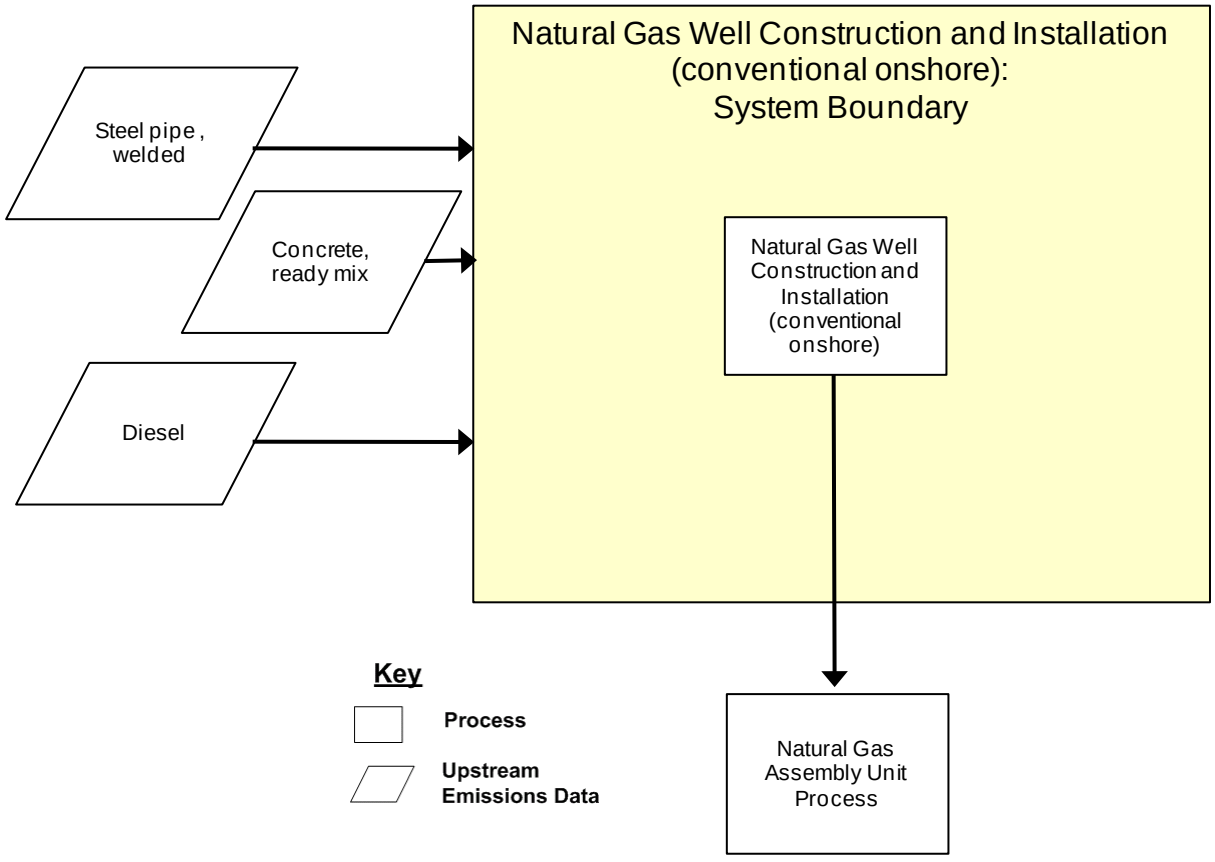
The installation of natural gas wells includes the drilling of the well, followed by the installation of a well casing that provides strength to the well bore and prevents contamination of the geological formations that surround the gas reservoir.

Vertical drilling is used for conventional wells, which recover natural gas from reservoirs with large pockets of oil or natural gas. Horizontal drilling is used for unconventional natural gas reserves where hydrocarbons are dispersed throughout a matrix of shale or coal. Horizontal drilling is often accompanied by hydrofracing (short for hydraulic fracturing). The installation of conventional onshore wells is done with vertical drilling and does not require hydrofracing.

An advanced drilling rig has a drilling speed of 17.8 meters per hour (Natural Gas.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 diesel consumption per hour of drilling was calculated from the above horsepower and heat rate and was applied to AP-42 emission factors for diesel combustion in stationary industrial engines (EPA, 1995) in order to determine the emissions from the installation of a well.

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 (Natural Gas.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 above linear weight of carbon steel and concrete.

Figure 1: Unit Process Scope and Boundary



Key properties of the well construction and installation process are summarized in **Table 1.** The inputs and outputs of this unit process are summarized in **Table 2.**

Table 1: Properties of Natural Gas Well Construction and Installation (conventional onshore)

Property	Value	Source
Drilling direction	vertical	Natural Gas.org 2004; Reum, D. et al. (2008)
Drilling depth, m	1,500	Reum, D. et al. (2008)
*Well production rate, kg/day	15,900	EIA 2009
*Well life, yr	25	Study assumption
Inner diameter, in	8.6	Natural Gas.org 2004
Steel casing thickness, in	0.75	Natural Gas.org 2004
Steel casing mass, kg/m	36	Natural Gas.org 2004

***** Values for well production rate and life are used to apportion construction and installation requirements to one kilogram of natural gas extracted

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Steel, pipe welded, BF (85% Recovery Rate) [Metals]	3.69E-04	kg
Concrete, ready mix, R-5-0 [Concrete_Cement]	3.69E-04	kg
Diesel [Crude oil products]	5.73E-05	kg
Outputs		
Natural Gas Well Construction and Installation	1.00	kg
Carbon dioxide [Inorganic emissions to air]	1.83E-04	kg
Methane [Organic emissions to air (group VOC)]	1.00E-08	kg
Nitrogen oxides [Inorganic emissions to air]	3.79E-06	kg
Sulphur oxides [Inorganic emissions to air]	6.39E-08	kg
Carbon monoxide [Inorganic emissions to air]	8.69E-07	kg
NMVOC (unspecified) [Group NMVOC to air]	1.01E-07	kg
Dust (PM10) [Particles to air]	1.11E-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 2.

Embedded Unit Processes

None.

References

ALL Consulting (2004). Coal Bed Methane Primer: New Source of Natural Gas -- Environmental Implications.

EIA. (2009) United States Total 2008: Distribution of Wells by Production Rate Bracket. Energy Information Administration. 2009.

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

Offshore-technology.com (2010). Mars, Gulf of Mexico, USA. Net Resources International. http://www.offshore-technology.com/projects/mars/(Accessed June 11, 2010)

Reum, D. et al. (2008) Four-blade bit helps reduce drilling time by as much as half. World Oil. September 2008.

Section III: Document Control Information

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