A Methane Emission Estimation Tool (MEET) for prediction of natural gas emissions with high temporal and spatial resolution: Emission Composition Tool Software Users Guide

James Van Horne∥, Yosuke Kimura†, David T. Allen†, Matthew Harrison∥

†Center for Energy and Environmental Resources, University of Texas at Austin, 10100 Burnet Road, Austin, TX 78758, USA

∥SLR International, 22118 20th Ave SE, Suite G202, Bothell, WA 98021, USA

January 23, 2021

1 Introduction

The Methane Emissions Estimation Tool (MEET) is a computer model built to simulate methane and other hydrocarbon emissions from the onshore natural gas industry over time. The model can estimate emissions from either a single facility or multiple facilities in a geographic area. Emissions are estimated using data from published research, or from custom data entered by the user. Industry segments in the model include onshore natural gas production, gathering and boosting, gas processing, and transmission and storage. The most fully developed models as of release of this user's guide are onshore production sites and midstream gathering compressor stations.

The model reports methane as well as other light alkane and VOC emissions. Consequently, emission compositions are needed for the Tool. This users' guide describes a stand-alone Emissions Composition Tool (ECT). Sample input tables and output formats for the ECT are described at the ECT web site (http://dept.ceer.utexas.edu/ceer/ect/index.cfm). This guide provides detailed descriptions of the entries required in the input tables. The input tables are constructed to be compatible with the full MEET model. When used in stand-alone form to generate emission composition estimates, the ECT should be run using the "thermodynamics" option as described in Section 2.2.2.

2 Inputs

Inputs to the model are specified in the developer provided Excel intake file. A template file should be used as a starting point and modified to the user's specific needs.

2.1 General Input Instructions

The input sheet is a Microsoft Excel workbook. There are a number of smart features to ensure the correct information is input into the sheet including drop down lists and conditional formatting. In general, yellow (⬜) cells are mandatory inputs, grey cells (⬜) are optional inputs which will override defaults, and black cells (⬛) are not used.

Rows in most sheets can be added by copying the last formatted row and pasting it below the last formatted row. Changes should not be made to the three sheets labeled "InternalUseOnly_…"

2.2 Sheet Instructions

The Composition sheet specifies the composition of emissions from each facility. Many of the values may fluctuate depending on several variables such as time of year and age of wells. If possible, this value should correspond to the measurement of this value during the time the model is run (see Simulation Start Date in Global_Simulation_Parameters). Some of the required inputs for specific wells or regions may be publicly available from a state's oil and gas regulator. A list of regulators in select states can be found in Appendix C. Careful review of the data should be conducted as requirements for data quality vary.

2.2.1 Composition Profile ID

A unique ID for each composition profile. This ID cross references to the Composition Profile ID in the Facility_Lists sheet.

Column	A
Format	Text, number or a combination of both
Units	N/A
Limitations	none
Required if	Always
Optional if	N/A
Suggested Default	N/A

2.2.2 Composition Data Source

The method used to calculate the composition of gas on the site. The "thermodynamics" option calculates different compositions for different sources (for example the composition of flash gas from storage tanks will be different from the actuation gas of a pneumatic device). For the other options a single composition will be used for all sources at a site.

Column	B
Format	Text
Units	N/A
Limitations	Must be one of the options in the drop-down list
Required if	Always
Optional if	N/A
Suggested Default	• Production Facilities: "thermodynamics" • Gathering and Boosting Facilities : "user specified" • Processing Facilities: "user specified" • Transmission and Storage Facilities: "Cardoso 2019 correlation"

2.2.3 Condensate (or OIL formation)

If the formation is considered condensate or oil. If the formation is oil it will in general result in lower amount of flash emissions from the storage tanks.

Column	C
Format	Yes or No
Units	N/A
Limitations	Must be one of the options in the drop-down list
Required if	Composition data source is "thermodynamics"
Optional if	N/A
Suggested Default	Two or more stage of gas/hydrocarbon separation: "yes" Stock Tank API Gravity of 38 or less: "no"

2.2.4 Number of Separator Stages

If the formation is oil (i.e. column C is set to "no") the number of separator stages must be 1.

Column	D
Format	Integer
Units	N/A
Limitations	1 or 2 Must be 1 if Condensate (or OIL formation) is "no"
Required if	Composition data source is "thermodynamics"
Optional if	N/A
Suggested Default	• Number of stages of separation is one or unknown: "1" • Number of stages is two or more: "2"

2.2.5 API Gravity

The API gravity[1] (i.e. specific gravity) of the stock tank condensate. A higher API gravity tends to yield more methane emissions from the storage tank source. This value may fluctuate over time and may be publicly available from an oil and gas regulator.

Column	E
Format	Number
Units	Degrees API
Limitations	Must be between 38 and 62.8 degrees API
Required if	Composition data source is "thermodynamics" and Condensate (or OIL formation) is "yes"
Optional if	N/A
Suggested Default	Look up from state regulator (see appendix C)

---

[1] API Gravity may be calculated from specific gravity (1=water) using the following formula:
API Gravity=141.5/(SG-131.5)

2.2.6 Gas to Oil Ratio

The ratio of gas volume produced to stock tank oil volume produced. This value may fluctuate over time and may be publicly available from an oil and gas regulator.

Column	F
Format	Number
Units	standard cubic foot per petroleum barrel (scf/bbl)
Limitations	Must be between 477 scf/bbl and 58,200 scf/bbl
Required if	Composition data source is "thermodynamics" and Condensate (or OIL formation) is "yes"
Optional if	N/A
Suggested Default	Calculated from production data from state regulator (see appendix C)

2.2.7 Temperature

The temperature of the separator(s) at the facility. This value may fluctuate over time. A lower temperature tends to yield higher methane emissions from the storage tanks. If multiple separators are on site and they operate at different temperatures it is recommended the temperature of the last stage of separation be used.

Column	G
Format	Number
Units	Degrees Fahrenheit (°F)
Limitations	Must be between 20 °F and 120 °F
Required if	Composition data source is "thermodynamics"
Optional if	N/A
Suggested Default	N/A

2.2.8 1st Stage Pressure

The average pressure of the first stage of separation at the facility. This value may fluctuate over time. A higher pressure tends to yield higher methane emissions from the storage tanks.

Column	H
Format	Number
Units	Pounds per Square Inch Absolute (psia)
Limitations	Must be between 80 psia and 1,400 psia
Required if	Composition data source is "thermodynamics"
Optional if	N/A
Suggested Default	N/A

2.2.9 2nd Stage Pressure

The average pressure of the second stage of separation at the facility. If the facility has more than two stages of separation this should instead be the pressure of the last stage

of separation. This value may fluctuate over time. A higher pressure tends to yield higher methane emissions from the storage tanks. This field is only required if the composition data source is "thermodynamics" and Number of Separator Stages is "2".

Column	I
Format	Number
Units	Pounds per Square Inch Absolute (psia)
Limitations	Must be between 20 psia and 380 psia
Required if	Composition data source is "thermodynamics" and Number of Separator Stages is "2"
Optional if	N/A
Suggested Default	N/A

2.2.10 Methane

The average mole fraction of methane in the sales gas. This value may fluctuate over time and may be publicly available from an oil and gas regulator.

Column	J
Format	Number
Units	Moles of methane per moles of gas (molar fraction)
Limitations	Must be less than 1 If Composition Data Source is "thermodynamics" must be between 0.58 and 0.90
Required if	Always
Optional if	N/A
Suggested Default[2]	User Specified value is preferred but if value is unknown: • Production: "0.79" • Gathering and Boosting: "0.79" • Processing: "0.82" • Transmission and Storage: "0.94"

2.2.11 Ethane

The average mole fraction of ethane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	K
Format	Number
Units	Moles of ethane per moles of gas (molar fraction)
Limitations	Must be less than 1 If Composition Data Source is "thermodynamics" must be between 0.028 and 0.159
Required if	Composition data source is "user specified"
Optional if	Composition data source is "thermodynamics"
Suggested Default	None

---

[2] From U.S. EPA Natural Star Program

2.2.12 Propane

The average mole fraction of Propoane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	L
Format	Number
Units	Moles of propane per moles of gas (molar fraction)
Limitations	Must be less than 1 If Composition Data Source is "thermodynamics" must be between 0.0087 and 0.0800
Required if	Composition data source is "user specified"
Optional if	Composition data source is "thermodynamics"
Suggested Default	None

2.2.13 Butane

The average mole fraction of butane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	M
Format	Number
Units	Moles of propane per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.14 Isobutane

The average mole fraction of isobutane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	N
Format	Number
Units	Moles of isobutane per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.15 Pentane

The average mole fraction of pentane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator. Other pentanes such as neopentane should be grouped with normal pentane and entered here.

Column	O
Format	Number
Units	Moles of pentane per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.16 Isopentane

The average mole fraction of isopentane in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	P
Format	Number
Units	Moles of isopentane per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.17 Hexane

The average mole fraction of hexanes and heavier hydrocarbons in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator. All hexanes and hydrocarbons heavier than hexane should be grouped and entered here.

Column	Q
Format	Number
Units	Moles of hexane+ per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.18 CO2

The average mole fraction of carbon dioxide in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	R
Format	Number
Units	Moles of carbon dioxide per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.19 N2

The average mole fraction of nitrogen in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	S
Format	Number
Units	Moles of nitrogen per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None

2.2.20 H2S

The average mole fraction of hydrogen sulfide in the sales gas. This value may fluctuate over time and may be publicly available for an oil and gas regulator.

Column	R
Format	Number
Units	Moles of hydrogen sulfide per moles of gas (molar fraction)
Limitations	Must be less than 1
Required if	Composition data source is "user specified"
Optional if	N/A
Suggested Default	None