

Updated Vented, Flaring, and Fugitive Greenhouse Gas Emissions for Crude Oil Production in the GREET1_2018 Model

by
L. Ou, H. Cai
Systems Assessment Group
Energy Systems Division, Argonne National Laboratory

October 2018

CONTENTS

1. BACKGROUND	1
2. DATA	2
3. RESULTS	2
4. DISCUSSION	3
5. REFERENCES	4

TABLES

Table 1 VFF emission results in GREET 2017 and 2018.....	3
--	---

Updated Vented, Flaring, and Fugitive Greenhouse Gas Emissions for Crude Oil Production in the GREET1_2018 Model

Longwen Ou, Hao Cai
Argonne National Laboratory
October 2018

1. BACKGROUND

Life-cycle analysis of greenhouse gas (GHG) emissions of petroleum fuels pathways requires careful accounting of GHG emissions from both process fuel combustion and non-combustion activities associated with crude oil production and storage, transportation, refining operations, distribution of fuels and their end use by vehicles. Vented, fugitive, and flaring (VFF) CH₄ and CO₂ emissions can be released to the atmosphere during crude oil production processes (U.S. Environmental Protection Agency, 2018). Argonne researchers regularly estimate such emissions for modeling petroleum-based fuel pathways in the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREETTM) model primarily based on the annual GHG Emission Inventory Report by United States Environmental Protection Agency (EPA). Recently, EPA has adopted new data and methodology to estimate CH₄ and CO₂ emissions for petroleum systems (U.S. Environmental Protection Agency, 2018). These revisions caused changes to the VFF CH₄ and CO₂ emissions from domestic crude oil production in the U.S. The aim of this technical memorandum is to update VFF CH₄ and CO₂ emissions in the GREET model by incorporating these revisions in the latest EPA GHG emission inventory.

2. DATA

In the 2018 EPA GHG Emission Inventory, EPA makes revisions to the GHG emission inventory with improved methods and/or data. The major revisions that impact VFF GHG emissions in the 2018 EPA GHG emission inventory include:

- Flaring emissions specific to petroleum production were estimated separately from those associated with natural gas production, where previous methodology assigned all flaring emissions (including flaring from miscellaneous sources and associated gas) to natural gas production. Therefore, we previously estimated flaring emissions from crude oil production by allocating part of the emissions to crude oil production based on the outputs of oil and natural gas by energy.
- CO₂ emission estimation methods for production segment sources were revised using data from EPA's Greenhouse Gas Reporting Program (GHGRP) for consistency with the approach applied for CH₄ emission estimates.

For this update, we used the estimated 2016 emissions in the 2018 EPA GHG Emission Inventory pertaining to crude oil production to calculate VFF CH₄ and CO₂ emissions per mmBTU of domestic U.S. crude oil production.

3. RESULTS

We estimated VFF CH₄ and CO₂ emissions of crude oil production by dividing the total VFF emissions in 2016 by the total production of crude oil in the same year. Total U.S. crude oil production in 2016 was 3232.0 million barrels (U.S. Energy Information Administration, 2018), which equals to 1.76e10 mmBTU of crude oil on the basis of Lower Heating Value (LHV). The 2018 EPA GHG inventory reported in detail CH₄ and CO₂ emissions from various segments like fugitive emissions from compressors, venting emissions from well completion, etc. These emissions included VFF emissions as well as emissions from combustion of fuels by onsite equipment, e.g. gas engines. We calculated total VFF emissions by summing up emissions from

all sources expect for those involving fuel combustion like exhaust from gas engines. Annex Table 3.5-2 in the 2018 EPA GHG inventory report shows an exhaustive list of all CH₄ emission sources pertaining to crude oil production. We summed up all CH₄ emissions from the exploration and production segment excluding combustion-related emissions to obtain total VFF CH₄ emissions of 1.41 million metric tons in 2016. We then estimated that VFF CH₄ emissions of crude oil production in 2016 was 80 g CH₄/mmBTU of crude oil produced. The same approach was applied for estimation of VFF CO₂ emissions from crude oil production. An exhaustive list of CO₂ emission sources pertaining to crude oil production is shown in Annex Table 3.5-7 in the 2018 EPA GHG inventory report. By summing up CO₂ emissions from all sources expect for those involving fuel combustion by onsite equipment, we estimated total VFF CO₂ emissions from crude oil production in 2016 was 19.1 million metric tons. VFF CO₂ emissions from crude oil production was then estimated to be 1083 g CO₂/mmBTU of crude oil produced. Table 1 lists the VFF CH₄ and CO₂ emission results in GREET 2017 and GREET 2018 for comparison.

Table 1 VFF emission results in GREET 2017 and 2018

	GREET 2017	GREET 2018
VFF CH ₄ emissions (g CH ₄ /mmBTU)	155	80
VFF CO ₂ emissions (g CO ₂ /mmBTU)	524	1083

4. DISCUSSION

The updated VFF CH₄ emissions in GREET 2018 are much lower than the value in GREET 2017 while the updated VFF CO₂ emissions are much higher. Since both GREET 2017 and GREET 2018 used the EPA GHG inventory in the corresponding year as the primary data source, the changes in VFF emissions are direct results of the revisions of the EPA GHG inventory. In particular, VFF CH₄ emissions decrease is a result of revised methodology EPA applied for estimation of associated gas venting and flaring emissions. EPA used a basin-level approach for estimation of associated venting and flaring emissions in the 2018 GHG inventory,

as opposed to the national-level based approach used in the 2017 GHG inventory, to take into account differences in associated gas venting and flaring among geographic regions.

Increase in VFF CO₂ emissions are primarily due to revisions in the new data and methodology used for CO₂ emission estimation in the 2018 EPA GHG inventory. 2017 EPA GHG inventory allocated all CO₂ to natural gas production because data were not available to disaggregate flaring to crude oil production from natural gas systems. Therefore, Argonne researchers allocated the total flaring emissions to crude oil and natural gas production based on their outputs by energy. 2018 EPA GHG inventory used the GHGRP data that enables direct calculation of flaring emissions for crude oil production, and indicate increase in VFF CO₂ emissions.

5. REFERENCES

U.S. Environmental Protection Agency, 2018. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016.

U.S. Energy Information Administration, 2018. Crude Oil Production.