Economic Analysis of Methane Emission Reduction Opportunities in the Mexican Oil and Natural Gas Industries

1. Executive Summary

Methane is an important climate change forcing greenhouse gas (GHG) with a short-term impact many times greater than carbon dioxide. According to Mexico's fifth national communication to the UNFCCC published in 2012, methane accounted for approximately 27% of Mexico's total emissions, resulting from activities in the IPCC sectors such as agriculture and waste, as well as emissions from oil and natural gas systems[1], and would comprise a substantially higher portion based on a shorter timescale measurement. A recent emissions inventory published in 2015 by Mexico's Instituto Nacional de Ecología y Cambio Climático (INECC)[2] estimates total methane emissions to be 19% of total emissions. Regardless of which estimate is used, recent research also suggests that mitigation of short-term climate forcers such as methane is a critical component of a comprehensive response to climate change[3].

Methane is the primary component of natural gas. As a result, methane emissions occur throughout the oil and gas industry, and are one of the largest anthropogenic sources of Mexican methane emissions[4]. At the same time, there are demonstrated methods to reduce emissions of fugitive and vented methane from the oil and gas industry and, because of the value of the gas that is conserved, some of these measures could potentially increase revenue (e.g. reduce lost product) or have limited net cost. The Mexican federal government has also discussed reducing these emissions as part of its commitment to international GHG reduction efforts, and pledged to cut GHG by 25% by the year 2030[5].

International nonprofit organization Environmental Defense Fund (EDF) commissioned this economic analysis of methane emission reduction opportunities from the Mexican oil and natural gas industries to identify the most cost-effective approaches to reduce these methane emissions. This study is solutions-oriented and builds off similar studies that ICF undertook for EDF on oil and gas methane reductions in Canada and the United States[6]. This study attempts to project the trajectory of methane emissions from these industries through 2020. It then identifies the largest emitting segments and estimates the magnitude and cost of potential reductions achievable through currently available and applicable technologies. The key conclusions of the study include:

- **22.7 BCF of Emissions in 2020** - Methane emissions from oil and gas activities are projected to decrease from 14.6 million metric tons of CO_2e (27.05 Bcf) in 2013 to 12.2 million metric tons of CO_2e (22.7 Bcf) in 2020.

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[1] National Inventory Report – Greenhouse Gas Sources and Sinks in Mexico derived using the 100 year GWP.. https://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

[2] INVENTARIO DE GASES Y COMPUESTOS DE EFECTO INVERNADERO 2013 http://www.inecc.gob.mx/descargas/cclimatico/2015_inv_nal_emis_gei_result.pdf

[3] Shoemaker, J. et. al., "What Role for Short-Lived Climate Pollutants in Mitigation Policy?". Science Vol 342 13 December 2013

[4] Mexican UNFCCC Submission Report section IV.4 "Panorama genera" and IV.5 "Emisiones de gases de efecto invernadero por gas"

[5] Mexican INDC submission: http://www.semarnat.gob.mx/sites/default/files/documentos/mexico_indc.pdf

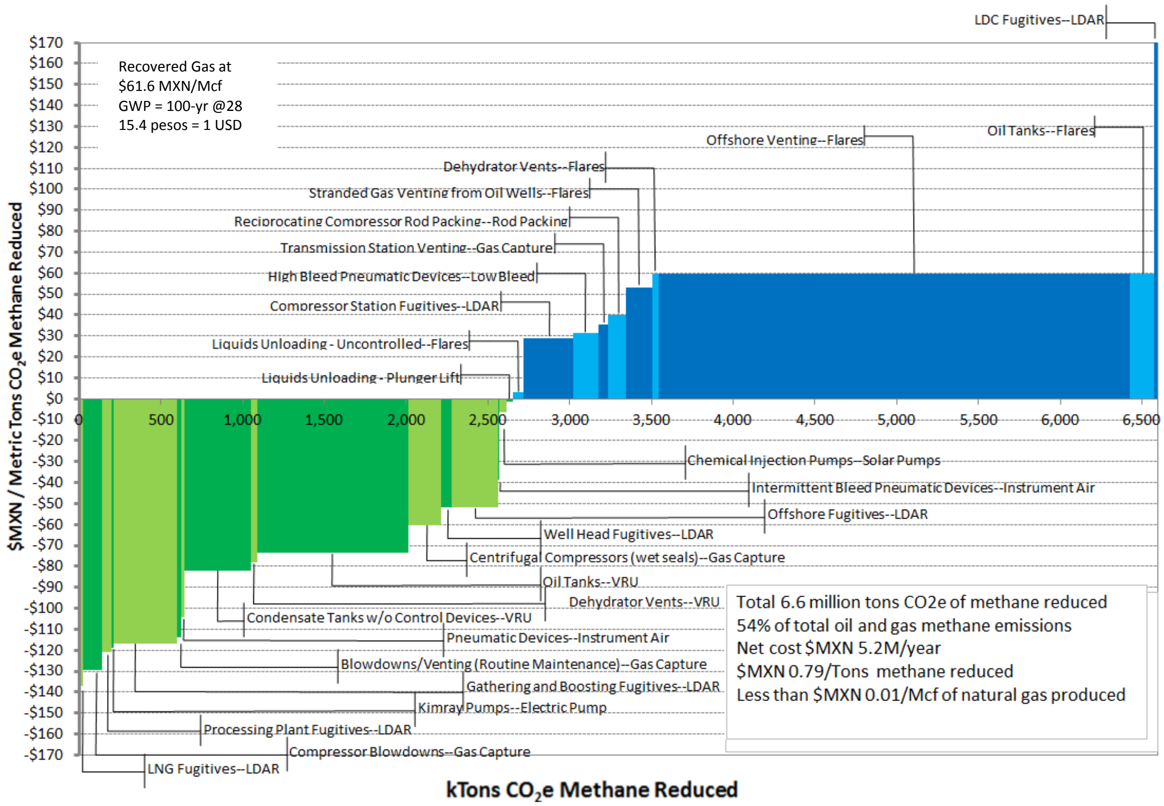
[6] Available at: https://www.edf.org/energy/icf-methane-cost-curve-report

- The opening up of Mexico's oil and gas sector to foreign companies was analyzed as part of this emissions analysis but not found to significantly affect emissions in 2020 as projects will not yet be online.
- The majority of this emissions decrease is caused by the continued decline of Mexico's most prolific offshore producing field - Cantarell. Offshore fields such as Ku-Maloob-Zaap (KMZ) are also projected to decline from 2013 to 2020, contributing to an overall decrease in emissions.
- Existing 2013 emissions sources account for over 90% of emissions in 2020.

- **Concentrated Reduction Opportunities** - 21 of the over 100 emission source categories[7] account for over 80% of the 2020 emissions, primarily at existing facilities. Thus, reductions from these sources offer the opportunity for high overall reductions.
- **54% Onshore and Offshore Emissions Reduction Possible with Existing Technologies[8]** – This 54% reduction of all oil and gas methane is equal to 6.6 million metric tons CO_2e (12.2 Bcf of methane) and is achievable with existing technologies and techniques. This reduction:
  - Comes at a net total cost of $0.43 MXN[9] /Mcf reduced ($0.03 USD/Mcf reduced) or for less than $0.01 MXN /Mcf of gas produced nationwide[10], taking into account savings that accrue directly to companies implementing methane reduction measures (Figure 1-1).
  - Is equal to $0.79 MXN / metric tons CO_2e reduced. If the natural gas is valued at $62 MXN/Mcf ($4/Mcf), the methane reduction potential includes recovery of gas worth approximately $483.6 million MXN[11] ($31.4 million USD) per year.
  - Is achievable at a net cost of over $5.2 million MXN per year ($313,546 USD) if the full economic value of recovered natural gas is taken into account and not including savings that do not directly accrue to companies implementing methane reduction measures[12]. If the additional savings that do not accrue to companies are included, the 54% reduction is achievable at a net savings of $78 million MXN ($5 million USD).
  - Is in addition to regulations already in place as well as projected voluntary actions companies will take by 2020.
- Capital Cost – The initial capital cost of the measures is estimated to be approximately $1.6 billion MXN ($106 million USD).

[7] For example, fugitive emissions from reciprocating compressors or vented emissions from liquids unloading.
[8] Converted emissions and monetary values may not exactly match due to rounding
[9] All costs in this report are on a Mexican Peso basis (MXN) unless where specifically expressed as U.S. Dollars (USD). A 2015 monthly average was used to calculate an exchange rate of 15.4 MXN to 1 USD. Figures may not match due to rounding. https://research.stlouisfed.org/fred2/series/EXCAUS/downloaddata
[10] Based on average natural gas production numbers across Mexico
[11] Value is calculated based on whole gas and not just methane, excluding flaring.
[12] Does not include or take into account potential social cost of methane emissions.

Figure 1-1 - Marginal Abatement Cost Curve for Total Oil and Gas Methane Reductions by Source in CO2e



- **Largest Abatement Opportunities -** In 2020, the Offshore segment makes up 54% of total oil and gas methane emissions, follow ed by Gathering and Boosting (19%) and Oil Production (11%). By volume, the top five largest sources of on and offshore Mexican oil and gas methane emissions and reduction opportunities are:
  - Offshore Venting – opportunity to reduce emissions by 78% by installing flares.
  - Venting from Oil Tanks – opportunity to reduce emissions by 48% by installing vapor recovery units.
  - Reciprocating compressor rod packing seals - opportunity to reduce emissions by 22% by replacing rod packing at a higher frequency.
  - Stranded Gas Venting – opportunity to reduce emissions by 78% by installing flares.
  - Venting from Condensate Tanks – opportunity to reduce emissions by 48% by installing vapor recovery units.
- **Co-Benefits Exist** – Reducing methane emissions will also reduce - at no extra cost - conventional pollutants that can harm public health and the environment. The methane reductions projected here would also result in a reduction in volatile organic compounds (VOCs) and hazardous air

pollutants (HAPs) associated with methane emissions from the oil and gas industry. This was not quantified in this study due to lack of data.

There are several caveats to the results:

- This study used as much Mexican-specific data as possible and modeled emissions by resource type and by using Mexico-specific activity data, where possible. Various assumptions across each segment were utilized in conjunction with Mexican-specific data (e.g. Secretaría De Energía (SENER), Petróleos Mexicanos (PEMEX), Instituto Nacional de Ecología y Cambio Climático (INECC), etc.) in order to develop equipment and segment-specific activity estimates for the Mexican oil and gas industry. Where no Mexican data existed, supplementary data from U.S. studies was used. Assumptions about site configurations are also U.S. based. Factors specific to Mexican oil and gas operations were also considered in the estimation of emissions, specifically the presence of sour gas and nitrogen injection in select oil production wells such as the Cantarell for enhanced oil recovery.
- IPCC guidelines[13] for oil and gas methane reporting are split into three regions; U.S. and Canada, Western Europe, and other oil exporting countries. Mexico falls into the last region, which has higher emission factors, specifically for venting and flaring emissions. Mexico prepares its inventory using these IPCC emissions factors and reports it to the UNFCCC[14]. Mexican emissions inventories are higher in comparison to this ICF study, in part, because of the higher IPCC emission factors. The more recent INECC study indicates a different approach to estimating emissions and is significantly lower than the previous UNFCCC reporting. However, if IPCC emission factors used by Mexico are directionally correct, this study provides a conservative estimate for potential reductions.
- This ICF study developed a bottoms up emissions estimate using specific activity and emissions factor data where applicable. Where no Mexican emission factors were available, this study used data from the Subpart W[15] of the U.S. EPA GHG Reporting Rule (GHGRP) which was analyzed in conjunction with regional proxies (based on geology) to develop emission factors that apply to the Mexican case. Source-specific emissions factors from U.S. data are not expected to be significantly different vs. Mexican operations. For example, a pneumatic device made by the same company can reasonably be assumed to operate the same in Mexico as it would in the U.S.
- Various assumptions across each segment were utilized in conjunction with available public reports (e.g. SENER, PEMEX, INECC, etc.) in order to develop equipment and facility information for Mexican segments, which is not otherwise available.
- Emission mitigation cost and performance are highly site-specific and variable. The values used here are estimated average values.

[13] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref8.pdf

[14] http://www.inecc.gob.mx/descargas/cclimatico/inf_inegei_energia_2010.pdf

[15] Subpart W – Petroleum and Natural Gas Systems
http://www.epa.gov/ghgreporting/reporters/subpart/w.html