

Scope of Work

AQRP Project: 18-023

Emission Inventory Development and Projections for the Transforming Mexican Energy Sector

Prepared for

The Texas Air Quality Research Program (AQRP)
The University of Texas at Austin

By

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QA Requirements: Audits of Data Quality, 10% Required
Report of QA Findings: Required in Final Report

**NOTE: The workplan package consists of the following three independent documents:
Scope of Work, Quality Assurance Project Plan (QAPP), and Budget and Justification**

Approvals

This Scope of Work was approved electronically on Aug. 31, 2018 by David Sullivan, The University of Texas at Austin

David Sullivan
Project Manager, Texas Air Quality Research Program

This Scope of Work was approved electronically on Sept. 4, 2018 by Michael Ege, Texas Commission on Environmental Quality

Michael Ege
Project Liaison, Texas Commission on Environmental Quality

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1.0 Abstract

Within Texas, characterizing emission sources along its border and within Mexico has been recognized as essential for air quality modeling. Mexico's energy sector has been undergoing potentially transformational changes as part of Constitutional reforms ratified in 2013. A primary motivation is to encourage domestic and foreign investment and productivity growth in the oil, gas and power sectors. The reforms have the potential to significantly transform the magnitudes and spatial distributions of emissions from the oil and gas and power generation sectors over the next one to two decades. The overall objective of the proposed project is to apply new information to develop a bottom-up assessment of emissions for the upstream and midstream oil and gas sectors and power sector and to develop future emission projections based on likely outcomes of on-going bid rounds that are attracting new investment for exploration and production of oil and gas resources. Information and analytics for Mexico's upstream and midstream oil and gas sectors and power sector will be used to develop a 2016 base year emissions inventory, which coincides with the U.S. Environmental Protection Agency's (EPA's) national air quality modeling platform and will likely be the basis for future air quality modeling by the Texas Commission on Environmental Quality (TCEQ). Plans and results for the hydrocarbon bid rounds will be used as the basis for three future emissions projections that compare continued development of Mexico's onshore conventional and shallow water resources, which is consistent with historical practices, with expansion of its deep water and onshore shale regions that have been underdeveloped to date relative to their potential. The project is a collaborative effort between the University of Texas at Austin (UT Austin) and Ramboll.

2.0 Background

Understanding the influences of transboundary air pollution between the United States and its neighbors, Canada and Mexico, on domestic air quality is required for effective air quality planning and management. Emissions inventories for these countries have become essential components of air quality modeling in U.S. border states and at a national scale. Within Texas, characterizing emission sources along its border and within Mexico has been recognized as particularly important. The domain that the TCEQ will use in its future air quality modeling has been extended to encompass all of Mexico and large parts of Central America and the Caribbean (Estes, 2018).

Mexico's energy sector has been undergoing potentially transformational changes (IEA, 2017; Vietor and Sheldahl-Thomason, 2017). Its long history of oil production has been central to its economy. Although the country has been and continues to be an exporter of crude oil; it is an importer of refined petroleum products, coal, and natural gas, despite its natural resources. Declining oil production revenue and insufficient resources for exploration and downstream investment have plagued Mexico, while energy demand is increasing. Energy reform was part of a structural and institutional reform package known as Pacto Por Mexico initiated under President Peña-Nieto. The reform required ratification of amendments to the Mexican Constitution that were adopted in December 2013. Secondary legislation was signed into law in August 2014. A primary motivation was to encourage domestic and foreign investment and productivity growth in the oil, gas and power sectors ending the state-owned monopolies of Petr leos Mexicanos (Pemex) and Comisi n Federal de Electricidad (CFE). To that end, Mexico has been holding bid rounds as part of a five-year plan for 2015-2019 to attract new investment for exploration and production.

Accelerated Mexican oil and gas development following regulatory reform has the potential to radically transform the magnitudes and spatial distributions of emissions from the oil and gas and power generation sectors over the next one to two decades. As in the United States where profound changes in the energy sector have influenced emission inventories, it will be important to understand both the existing status of

the inventories for these sectors in Mexico and how they could change in the future. The project is a collaborative effort between UT Austin and Ramboll that combines insights from UT Austin into Mexico's rapidly developing energy sector with oil and gas emission inventory expertise from Ramboll. The project leverages the experience from but does not overlap with efforts for other previous or on-going projects. The project will be led by Dr. Elena McDonald-Buller (Principal Investigator) from UT Austin and Dr. Greg Yarwood (Co-Principal Investigator) from Ramboll. Other key personnel will include Mr. Gary McGaughey and Dr. Yosuke Kimura of UT Austin and Mr. John Grant, Mr. Tejas Shah, Ms. Rajashi Parikh, and Ms. Lynsey Parker from Ramboll.

3.0 Objectives

The overall objective of the proposed project is to apply new information and analytics to develop a bottom-up assessment of emissions for the upstream and midstream oil and gas sectors and power sector and to develop future emission projections based on likely outcomes of the upstream sector bid rounds. Future projections will compare continued development of Mexico's onshore conventional and shallow water resources, which is consistent with historical practices by Pemex, with expansion of its deep water and onshore shale regions that have been underdeveloped to date relative to their potential.

4.0 Task Descriptions

4.1 Base Year Emission Inventory Estimates

IHS Markit provides information and analytics at global and regional market levels for the energy and natural resources sectors. UT Austin has an annual subscription for IHS Markit's EDIN database that includes their Exploration and Production as well as Midstream Essentials data domains for Mexico. The database subscription spans much of the time period of this project. The Exploration and Production domain within EDIN includes well data and production data at the field level. The Midstream Essentials data includes electric power plants, natural gas processing facilities, liquefied natural gas (LNG) plants, pipelines, ports, and refineries.

Access to the IHS database is contractually limited to the UT Austin team members. UT Austin and Ramboll will jointly identify the database parameters that are useful for emission inventory development. Ramboll will develop emission calculation methodologies that use the available data. UT Austin will then process the detailed IHS data to produce the emission inventory. The base year will be 2016 to coincide with EPA's national air quality modeling platform, which will likely be the basis for future TCEQ air quality modeling.

A literature review will be performed to identify emission profiles (i.e., emission rates per unit of activity for each oil and gas source category) and speciation profiles most representative of oil and gas wells in Mexico based on recent emission inventory studies for the oil and gas sectors. Limited information is expected to be available on Mexico-specific emission profiles. For well type and source category combinations for which Mexico-specific emission profiles are not available, U.S. emissions profiles for similar well types will be used. To the extent feasible, any emission profiles that are not Mexico-specific will be adjusted (e.g., regulatory requirements). Emissions profiles will be combined with IHS Markit 2016 activity estimates to develop emissions estimates.

Midstream facility locations and emissions data available in EPA's point source emission inventory for Mexico from their Air Emissions Modeling site (<ftp://ftp.epa.gov/EmisInventory/2011v6/v3platform/>) will be compared to midstream facility data available from IHS Markit. Review of facility-specific parameters such as location, emission magnitudes, facility throughput, and build date will be used to

develop updates to the current inventory to correct any errors (e.g., incorrect facility location) and fill gaps (e.g., adding emissions for missing facilities). The team will develop an updated Mexico point source emission inventory file.

Finally, the team will develop input files for the base year Mexican upstream and midstream inventories in area and point format, respectively, for Version 3 of the Emissions Preprocessor System (EPS3). For the point source data, the AIRS Facility Subsystem (AFS) work file format is required; and for area source data, the AIRS Area and Mobile Subsystem (AMS) work file format is required (ENVIRON, 2009). The AMS file format will be used for upstream oil and gas sources and will include emission values by municipio and source category code (SCC). The AFS work file will include midstream sources and information such as inventory period, geographical location, source identification, stack characterization, and emission estimates. Any detailed extended gas composition data collected will be converted into Carbon Bond Version 6 (CB6) speciation profiles for EPS3 processing. A speciation cross-reference file will be developed and a shapefile with oil and gas activity data provided to develop spatial surrogates for any modeling domains.

4.2 Mexico Bid Rounds and Future Projection Scenarios

Mexico's bid rounds (Rondas Mexico) to attract private and foreign investment for exploration and production of its oil and gas resources began in 2015. Tender areas are classified according to the type of activity (exploration or extraction) and category including onshore conventional, onshore unconventional, shallow water, and deep water. The plans and results for the hydrocarbon bid rounds will be used as the basis to develop future emissions projections for three potential scenarios for Mexico's upstream oil and gas sector: (1) growth in deep water oil and gas exploration and production, (2) expansion of natural gas exploration and production in the shale-rich Burgos Basin, and (3) growth only in onshore conventional and shallow water oil and gas exploration and production, consistent with historical practices by Pemex.

Emission projections will be developed to forecast emissions from the 2016 base year to future years by scenario based on estimates of changes in oil and gas activity and, if applicable and foreseeable, changes in emissions controls. Each oil and gas well type and emission source category combination will be cross-referenced to the oil and gas activity type available from IHS Markit (e.g., oil production, gas production, drilling events, active well count) most applicable to its emissions. Activity forecast factors will be estimated as the ratio of future year to base year oil and gas activity for each available, relevant oil and gas activity type in the IHS Markit database. On-the-book regulations in Mexico for oil and gas activity sectors will be reviewed to estimate potential impacts on future oil and gas emissions. For each oil and gas well type and emission source category combination, if applicable and foreseeable, emission changes resulting from additional control will be assigned as the control factor. Future year emissions will be estimated by well type and source category as the product of base year emissions, oil and gas activity factor, and control factor. Similar to the base year, EPS3 input files will be prepared for the future year inventories.

5.0 Project Reporting and Presentations

As required, monthly technical, monthly financial status, and quarterly reports as well as an abstract at project initiation and, near the end of the project, the draft final and final reports will be submitted according to the schedule shown in Section 8.0. Dr. McDonald-Buller or her designee will electronically submit each report to both the AQRP and TCEQ liaisons and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources (<http://aqrp.ceer.utexas.edu/>). Dr. McDonald-Buller and Dr. Yarwood anticipate attending and presenting at the AQRP data workshop. Draft copies of any planned presentations (such as at technical conferences) or manuscripts to be submitted for publication resulting from this project will be provided to both the AQRP and TCEQ liaisons per the Publication/Publicity Guidelines included in Attachment G of the

subaward. Final project data and associated metadata will be prepared and submitted to the AQRP archive.

Dr. McDonald-Buller will lead the project reporting activities with Dr. Yarwood and with assistance from team members at UT and Ramboll. Deliverables include the abstract, monthly technical reports, monthly financial status reports, quarterly reports, draft final report, final report, attendance and presentation at AQRP data workshop, submissions of presentations and manuscripts, project data and associated metadata. The schedule for deliverables is shown in Section 8.0.

6.0 Project Participants and Responsibilities

Project roles and responsibilities for UT Austin and Ramboll are described in this section.

The University of Texas at Austin

- **Dr. Elena McDonald-Buller** will provide overall supervision and integration of the technical work and will be responsible for the preparation and submission of the monthly progress, quarterly progress, and final reports in collaboration with Dr. Yarwood and Mr. Grant from Ramboll. She will work with Mr. McGaughey on the analyses of the IHS Markit data and evaluation of the Mexican upstream sector bid rounds.
- **Mr. Gary McGaughey** will work with Dr. McDonald-Buller on the analyses of the IHS Markit data and evaluation of the Mexican upstream sector bid rounds. He will lead the application of the emissions estimation approach to the base year and future projected inventories with assistance from Dr. Kimura. Dr. McGaughey will assist Dr. McDonald-Buller with preparation of the final reports.
- **Dr. Yosuke Kimura** will assist Mr. McGaughey with the application of the emissions estimation approach to the base year and future projected inventories. He will also provide computational, programming, and data visualization support for all aspects of the project.

Ramboll

- **Dr. Greg Yarwood** will serve Co-Principal Investigator and will oversee Ramboll's technical activities and provide technical input as needed on all tasks.
- **Mr. John Grant** will lead base year emissions, future year emissions, and midstream emissions tasks with assistance from **Ms. Rajashi Parikh**, **Mr. Tejas Shah**, and **Ms. Lynsey Parker**. Mr. Grant and Ms. Parikh will work with Dr. McDonald-Buller on the development of base year emission inventories and future year emission inventories, respectively, with Ms. Parikh carrying out the literature review, emissions profile development, activity forecast scalar development, and control factor development. Mr. Grant, Mr. Shah, and Ms. Parker will work with Dr. McDonald-Buller on the development of the midstream emission inventories, with Mr. Shah and Ms. Parker carrying out midstream emission inventory review and updates.

7.0 Timeline

A timeline of project activities is shown in Table 1.

Table 1. Schedule of project activities (tasks are bolded).

ID	Task	Aug 2018	Sept 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	July 2019	Aug 2019
1	Base Year Emission Inventory Estimates	X	X	X	X	X								
2	Mexico Bid Rounds and Future Projection Scenarios					X	X	X	X	X	X			
R	<i>Monthly Technical & Financial Progress</i>	X	X	X	X	X	X	X	X	X	X	X	X	X
R	<i>Quarterly</i>		X			X			X			X		
R	<i>Draft Final</i>											X	X	
R	<i>Final</i>													X
R	<i>AQRP Workshop</i>													X

8.0 Deliverables

Project reporting and presentation requirements are described in Section 5.0. Deadlines for required deliverables are presented below.

Abstract: At the beginning of the project, an Abstract will be submitted to the Project Manager for use on the AQRP website. The Abstract will provide a brief description of the planned project activities, and will be written for a non-technical audience.

Abstract Due Date: Friday, August 31, 2018

Quarterly Reports: Each Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the Project Manager as a Microsoft Word file. It will not exceed 2 pages and will be text only. No cover page is required. This document will be inserted into an AQRP compiled report to the TCEQ.

Quarterly Report Due Dates:

Report	Period Covered	Due Date
Aug2018 Quarterly Report	June, July, August 2018	Friday, August 31, 2018
Nov2018 Quarterly Report	September, October, November 2018	Friday, November 30, 2018
Feb2019 Quarterly Report	December 2018, January & February 2019	Thursday, February 28, 2019
May2019 Quarterly Report	March, April, May 2019	Friday, May 31, 2019
Aug2019 Quarterly Report	June, July, August 2019	Friday, August 30, 2019
Nov2019 Quarterly Report	September, October, November 2019	Friday, November 29, 2019

Monthly Technical Reports (MTRs): Technical Reports will be submitted monthly to the Project Manager and TCEQ Liaison in Microsoft Word format using the AQRP FY16-17 MTR Template found on the AQRP website.

MTR Due Dates:

Report	Period Covered	Due Date
Aug2018 MTR	Project Start - August 31, 2018	Monday, September 10, 2018
Sep2018 MTR	September 1 - 30, 2018	Monday, October 8, 2018
Oct2018 MTR	October 1 - 31, 2018	Thursday, November 8, 2018
Nov2018 MTR	November 1 - 30 2018	Monday, December 10, 2018
Dec2018 MTR	December 1 - 31, 2018	Tuesday, January 8, 2019
Jan2019 MTR	January 1 - 31, 2019	Friday, February 8, 2019
Feb2019 MTR	February 1 - 28, 2019	Friday, March 8, 2019
Mar2019 MTR	March 1 - 31, 2019	Monday, April 8, 2019
Apr2019 MTR	April 1 - 28, 2019	Wednesday, May 8, 2019
May2019 MTR	May 1 - 31, 2019	Monday, June 10, 2019
Jun2019 MTR	June 1 - 30, 2019	Monday, July 8, 2019
Jul2019 MTR	July 1 - 31, 2019	Thursday, August 8, 2019

Financial Status Reports (FSRs): Financial Status Reports will be submitted monthly to the AQRP Grant Manager (Maria Stanzione) by each institution on the project using the AQRP FY16-17 FSR Template found on the AQRP website.

FSR Due Dates:

Report	Period Covered	Due Date
Aug2018 FSR	Project Start - August 31	Monday, September 17, 2018
Sep2018 FSR	September 1 - 30, 2018	Monday, October 15, 2018
Oct2018 FSR	October 1 - 31, 2018	Thursday, November 15, 2018
Nov2018 FSR	November 1 - 30 2018	Monday, December 17, 2018
Dec2018 FSR	December 1 - 31, 2018	Tuesday, January 18, 2019
Jan2019 FSR	January 1 - 31, 2019	Friday, February 15, 2019
Feb2019 FSR	February 1 - 28, 2019	Friday, March 15, 2019
Mar2019 FSR	March 1 - 31, 2019	Monday, April 15, 2019
Apr2019 FSR	April 1 - 28, 2019	Wednesday, May 15, 2019
May2019 FSR	May 1 - 31, 2019	Monday, June 17, 2019
Jun2019 FSR	June 1 - 30, 2019	Monday, July 15, 2019
Jul2019 FSR	July 1 - 31, 2019	Thursday, August 15, 2019
Aug2019 FSR	August 1 - 31, 2019	Monday, September 16, 2019
FINAL FSR	Final FSR	Tuesday, October 15, 2019

Draft Final Report: A Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will include an Executive Summary. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. It will also include a report of the QA findings.

Draft Final Report Due Date: Thursday, August 1, 2019

Final Report: A Final Report incorporating comments from the AQRP and TCEQ review of the Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Final Report Due Date: Tuesday, September 3, 2019

Project Data: All project data including but not limited to QA/QC measurement data, metadata, databases, modeling inputs and outputs, etc., will be submitted to the AQRP Project Manager within 30 days of project completion (September 30, 2019). The data will be submitted in a format that will allow AQRP or TCEQ or other outside parties to utilize the information. It will also include a report of the QA findings.

AQRP Workshop: A representative from the project will present at the AQRP Workshop in the first half of August 2019.

Presentations and Publications/Posters: All data and other information developed under this project which is included in **published papers, symposia, presentations, press releases, websites and/or other publications** shall be submitted to the AQRP Project Manager and the TCEQ Liaison per the Publication/Publicity Guidelines included in Attachment G of the Subaward.

9.0 References

Estes, M, personal communication with E. McDonald-Buller, May 3, 2018.

International Energy Agency, Energy Policies Beyond IEA Countries, Mexico 2017, OECD/IEA, 2017.

Vietor, R.H.K., H. Sheldahl-Thomason, Mexico's Energy Reform, Harvard Business School, 717-027, January 23, 2017.