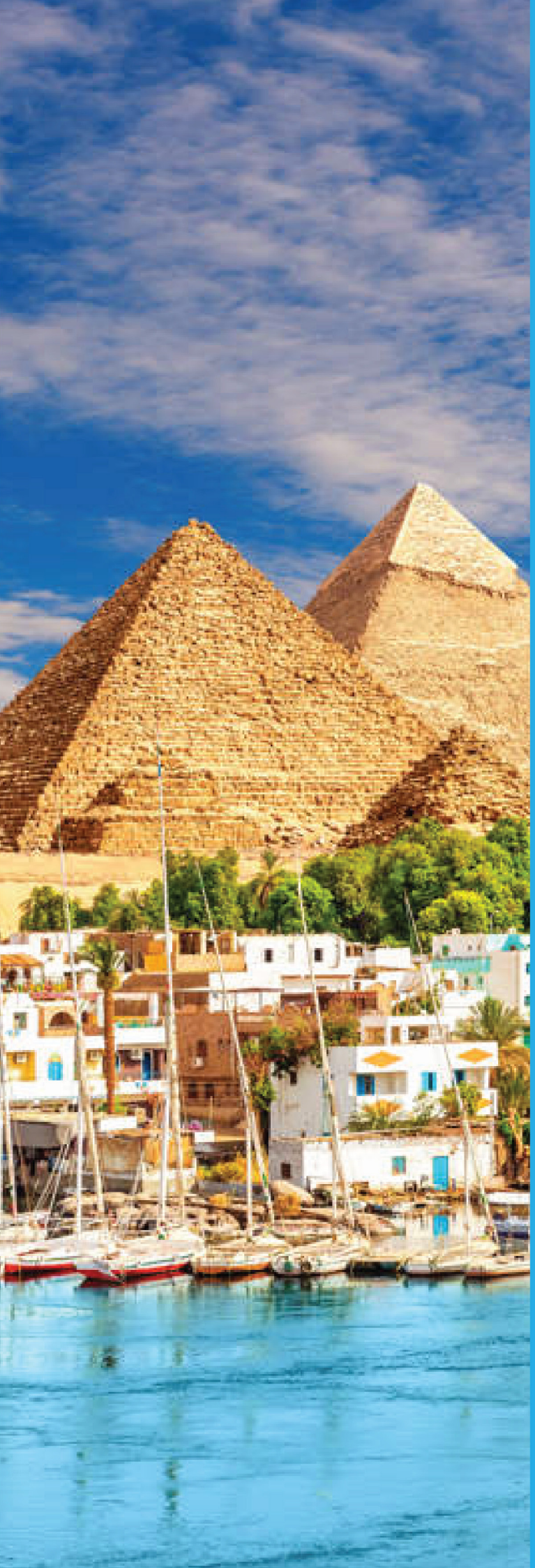


وزارة البترول والثروة المعدنية
Ministry of Petroleum & Mineral Resources
جمهورية مصر العربية

CURBING METHANE EMISSIONS

IN EGYPT'S OIL AND GAS SECTOR

DECEMBER 2023

COP28 UAE

PUBLISHED BY

EGYPT OIL&GAS
RESEARCH & ANALYSIS

TABLE OF CONTENTS

MESSAGE FROM THE MINISTER

TAREK EL MOLLA

Egyptian Minster of Petroleum ana Mineral Resources

In the face of a rapidly changing climate, the oil and gas industry stands at a critical juncture. While energy demands continue to rise, so does the urgency to mitigate the environmental impact of energy production. Methane, a potent greenhouse gas with a global warming potential more than 25 times greater than carbon dioxide, represents a significant challenge. However, it also presents an opportunity for the oil and gas industry to demonstrate its commitment to environmental stewardship and sustainable practices.

Reducing methane emissions from the oil and gas sector offers a wealth of benefits, not only for the environment but also for the industry itself. By curbing methane leaks and emissions, companies can enhance their environmental performance, gain a competitive edge, and strengthen their reputation as responsible energy providers. Moreover, methane emission reduction strategies can lead to significant cost savings through improved energy efficiency and reduced resource losses.

Egypt's oil and gas sector continues to recognize the importance of addressing methane emissions. The sector has also supported Egypt's joining the Global Methane Pledge as kindly announced by H.E. Abdel-Fattah El-Sisi, President of the Arab Republic of Egypt, in June 2022. Egypt's Nationally Determined Contributions (NDCs) also included targets for reducing methane emissions from the oil and gas sector by 65% in 2030. These actions reflect Egypt's leadership in the region and its dedication to environmental sustainability.

One key initiative that I have personally supported throughout its development is the Sharm El Sheikh Oil & Gas Methane Reduction Roadmap, which was announced during the first ever Decarbonization Thematic Day organized by the Ministry of Petroleum and Mineral Resources at COP27. This template provides a comprehensive approach to how countries can establish their own roadmap to reduce methane emissions in the oil and gas sector. It was informed by a review of public resources, over 20 interviews with global stakeholders and two workshops at COP27.

Egypt's oil and gas sector has also forged partnerships with international organizations and industry leaders to enhance its methane emission reduction efforts.

As the world transitions towards a low-carbon future, Egypt's oil and gas sector efforts to curb methane emissions will not only safeguard the environment but also pave the way for a more sustainable and prosperous energy industry.

As we navigate through the pages of this supplement, we invite you to explore Egypt's oil and gas sector efforts for methane abatement, building on the essential collaboration with our key partners. Together, we can forge a more sustainable future, where the energy industry thrives responsibly, minimizing its environmental impact, and contributing to energy security as well as global efforts to combat climate change.

WHY METHANE

Methane is a powerful greenhouse gas that contributes to global warming and climate change. It is emitted by natural sources such as wetlands, volcanoes and termites, as well as human activities such as agriculture, fossil fuel extraction and waste management. Methane has a shorter atmospheric lifetime than carbon dioxide, but it is more efficient at trapping heat.

Compared to CO_2, methane has a much higher global warming potential (GWP), meaning it can absorb more energy and heat up the atmosphere faster. Over a 20-year period, methane has a GWP of 84-87, while over a 100-year period, it has a GWP of 28-36. Methane also affects air quality by forming ground-level ozone, a harmful pollutant.

Methane emissions come from both natural and human sources, but the energy sector, especially oil and gas operations, is a major source of anthropogenic methane emissions that can be reduced cost-effectively. The oil and gas industry is one of the largest sources of methane emissions, accounting for about 23% of the global total in 2020. Reducing methane emissions from this sector is therefore crucial for mitigating the impacts of climate change and meeting the goals of the Paris Agreement.

There are many benefits of reducing methane emissions in the oil and gas industry, both for the environment and for the industry itself. For the environment, reducing methane emissions can lower the global warming potential of the sector, improve air quality and public health, and protect biodiversity and ecosystems. For the industry, reducing methane emissions can increase operational efficiency, reduce waste and losses, enhance reputation and social license, and create new opportunities for innovation and collaboration.

There are also many solutions available for reducing methane emissions in the oil and gas industry, ranging from detection and measurement technologies, to leak prevention and repair practices, to flaring reduction and utilization strategies, to policy and regulatory frameworks. These solutions can be implemented at various stages of the oil and gas value chain, from production to processing to transportation to distribution. Some of these solutions are low-cost or even profitable, while others may require more investment and support.

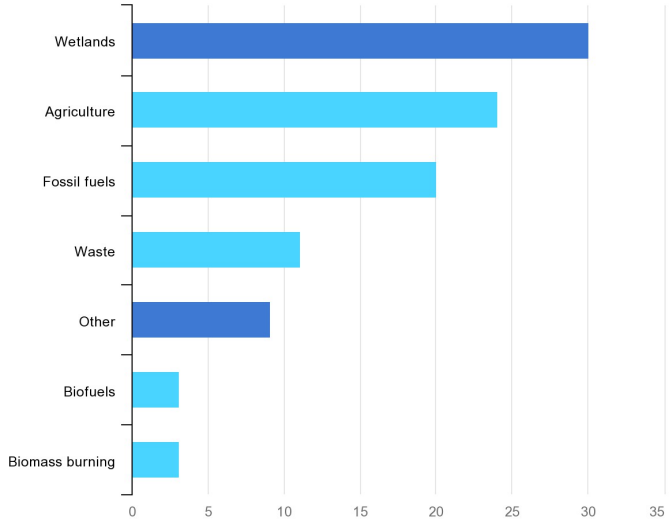
Reducing methane emissions in the oil and gas industry is not only important, but also feasible and beneficial. It is a win-win situation for both the climate and the economy. The oil and gas industry has a responsibility and an opportunity to take action on this issue and demonstrate its commitment to sustainability and social responsibility.

Methane Factsheet (UNEP IMEO website accessed 2023)

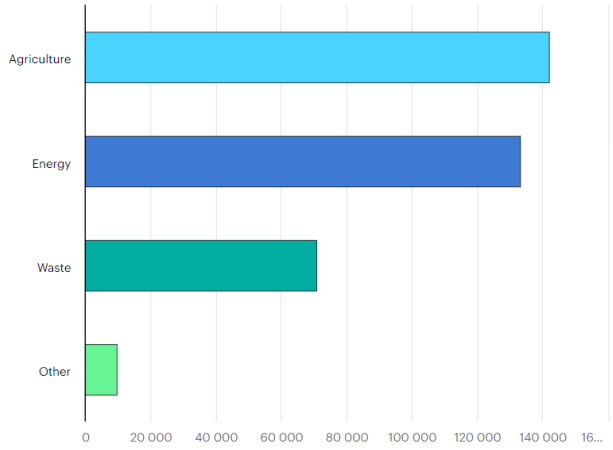
What you need to know about methane

- Methane (CH_4), the primary component of natural gas, is responsible for more than 25 per cent of the warming we are experiencing today. (EDF)
- Methane is a powerful greenhouse gas, with a Global Warming Potential more than 80 times greater than that of carbon dioxide (CO_2) during the 20 years after it is released into the atmosphere. (EDF)
- Methane is responsible for around half of the growth in tropospheric ozone formation, which is a potent local air. (UNEP)
- Limiting climate warming below 1.5 -degrees will require "rapid, far-reaching, and unprecedented changes", including "deep reductions" in non-CO2 emissions like methane. (IPCC)
- The Paris Agreement cannot be achieved without reducing methane emissions by 40-45 per cent by 2030. Reduction of this magnitude would avoid nearly 0.3° C of warming by 2045 and complement long-term climate change mitigation efforts. (CCAC)
- Methane is increasingly a global climate priority, with ambition for addressing emissions building among both governments and companies. (UNEP)
- Agriculture is estimated to be the largest single source of global methane emissions, responsible for roughly 40 per cent of anthropogenic emissions; Fossil fuels are the second largest source, responsible for approximately 36 per cent of emissions, with waste and others making up the rest. (CCAC)
- Fossil fuels have by very far the greatest short-term reduction potential and therefore are prioritised.

Contributions of Sources Methane Emissions (IEA website accessed 2023)



World methane emissions from all sources (IEA website accessed 2023)



EGYPT'S GHG EMISSIONS

The Paris Agreement builds upon the United Nations Framework Convention on Climate Change (UNFCCC), and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries. The Paris Agreement charts a new course in global climate change action and a base to build an equitable agreement between all countries.

With Egypt's endorsement of the UNFCCC's Paris Agreement in April 2016 and then ratification by the Egyptian Parliament in June 2017, Egypt is committed to submit this first Biennial Update Report (BUR). H.E. Abdel Fattah El-Sisi, President of Egypt and Coordinator of the Committee of the African Heads of State and Government on Climate Change (CAHOSCC), gave an official speech during COP21 in Paris in 2015. His excellency stressed on the seriousness of the current situation stating that: "the African continent is the lowest contributor to climate change in the world, though it is the most affected by its negative impacts" and invited the international community to provide the needed support to shift this course. Egypt met its commitments on submitting the intended nationally determined contributions (INDC), and in parallel launched Egypt's Sustainable Development Strategy for 2030 as a pledge towards sustainability and preserving the environment for future generations.

According to the first biennial update report (BUR) submitted by Egypt to the UNFCCC in 2019, The GHG inventory (GHGI) has been prepared according to 2006 Intergovernmental Panel on Climate Change (IPCC) GHGI Guidelines for the time series between 2005 (last year covered by the TNC GHG Inventory) and 2015. As per IPCC guidelines, the GHGI covers four sectors: i) Energy, ii) Industrial Process and Product Use (IPPU), iii) Agriculture, Forestry, and Other Land Use (AFOLU), and iv) Waste.

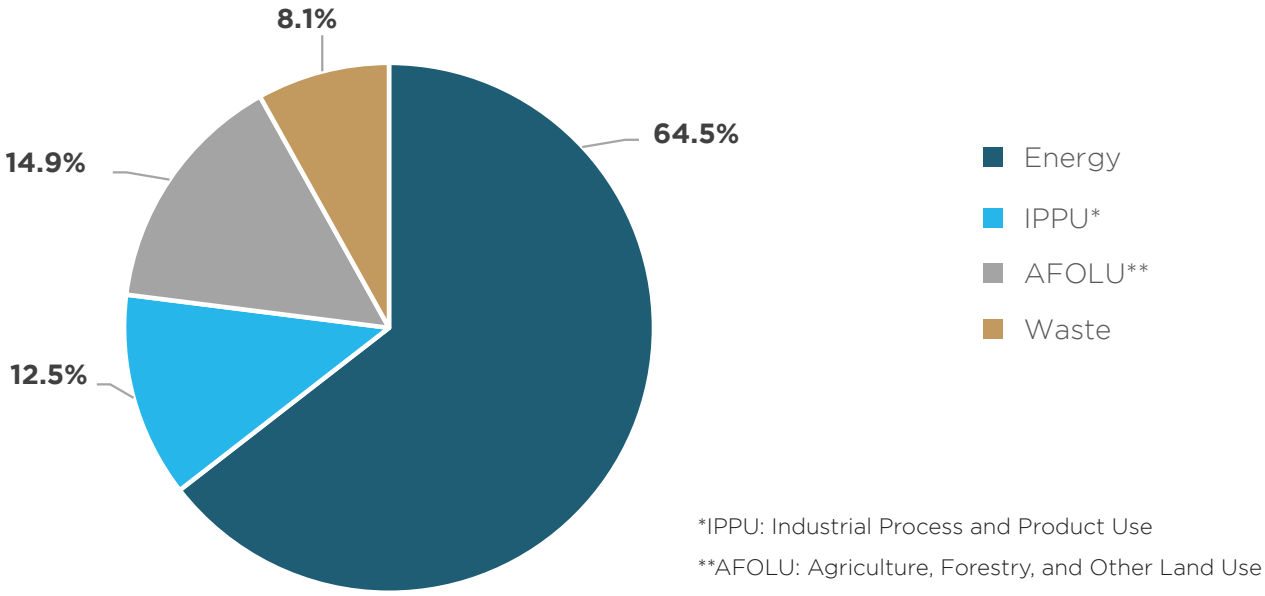
It includes a breakdown of Egypt's anthropogenic GHG emissions by source of carbon dioxide (CO_2), methane(CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per-fluorocarbons (PFCs) and sulphur hexafluoride (SF_6) as well as precursors (NOx, CO, NMVOCs, SO_2).

Egypt's GHG emissions for 2015 totaled 325,614 Gg CO_2e. The breakdown by gas is 237,871 Gg CO_2e from CO_2 emissions, 41,483 Gg CO_2e. from CH_4 emissions, and 38,574 Gg CO_2e. from N_2O emissions. Total GHG emissions have increased by 31% from 2005 to 2015 with an average annual growth rate of 2.35%. GHG emissions from the Energy, IPPU, and Waste sectors have increased by 40%, 49%, and 34% respectively, while the emissions from the AFOLU sector have decreased by 7% over the same period.

ENERGY SECTOR:

According to Egypt's BUR report, energy is the highest GHG-emitting sector accounting for 64.5% of the total emissions for 2015 (210,171 Gg CO_2e).

GHG Contribution of Each Sector to the Total Emissions, 2015 (Egypt BUR)



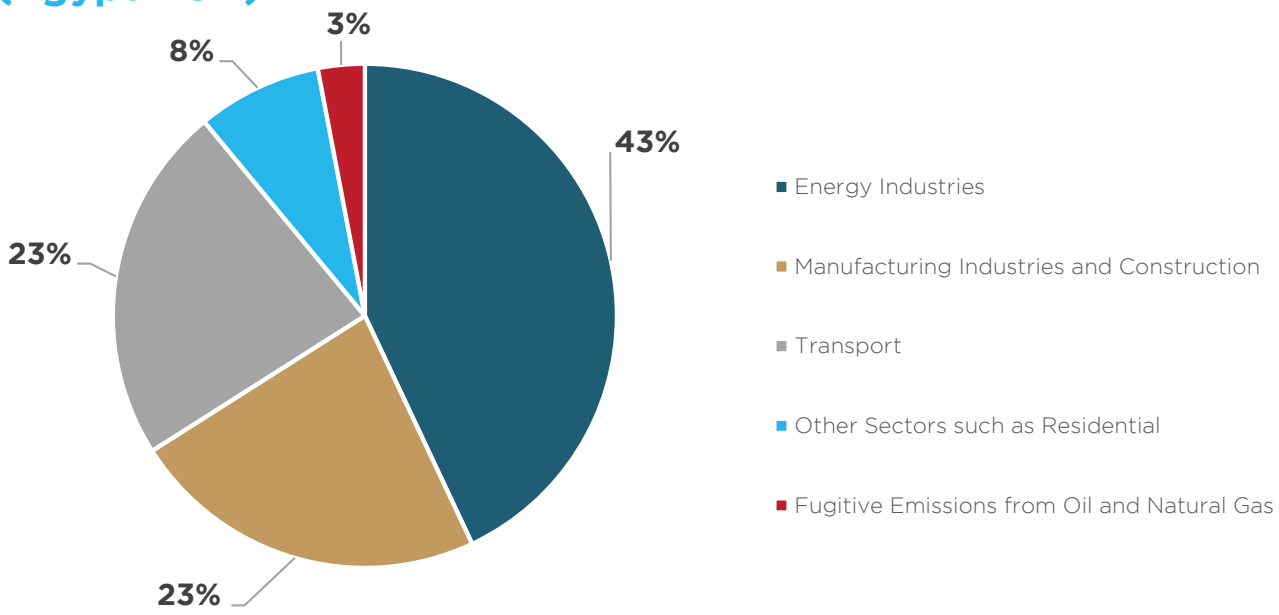
*IPPU: Industrial Process and Product Use

**AFOLU: Agriculture, Forestry, and Other Land Use

The main three categories of the emissions in the energy system are scope 2 and scope 3 emissions, which include Power Generation, manufacturing industries and construction and the transport.

The energy sector contributed 87% of national CO_2 emissions, 3% of CH_4 emissions, and 2% of N2O emissions in 2015. Energy sector emissions resulted from 1) fuel combustion activities (97%) and 2) fugitive emissions from oil and natural gas (3%), Analysis performed using the IPCC software yielded a total of 3% Uncertainty for the energy. sector inventory and 4% trend uncertainty between 2005 till 2015

Emissions per Category for the Energy Sector, 2015 (Egypt BUR)



Energy Industries include power generation and oil refining where oil refining represents less than 3% of the total emissions (which is the lowest contribution). Accordingly, fugitive emissions from oil and natural gas are low compared to other sectors.

It is worthy to note that for overall country level emissions, Egypt accounts for about 0.6% of the global greenhouse gas (GHG) emissions, one of the lowest globally, according to the latest data from the World Bank.

DECARBONIZATION AND ENERGY TRANSITION FOR EGYPT'S OIL AND GAS SECTOR

As the world will continue to need energy for prosperity, enhancement of living conditions, and sustainable development, what is important now and more than ever is not to focus on the energy source, but to focus on reducing energy emissions.

Accordingly, Egypt's oil and gas sector is looking into all possible sources and technologies to fulfil both local and global energy in ways that are more responsible, environmentally friendly and with reduced impacts on the climate.

Therefore, decarbonization and energy transition are integrated as core aspects within the MoPMR strategic pillars.

Building upon the successful outcomes of COP27 decarbonization day, the MoPMR is continuing its efforts to drive and accelerate its decarbonization agenda in collaboration with our partners.

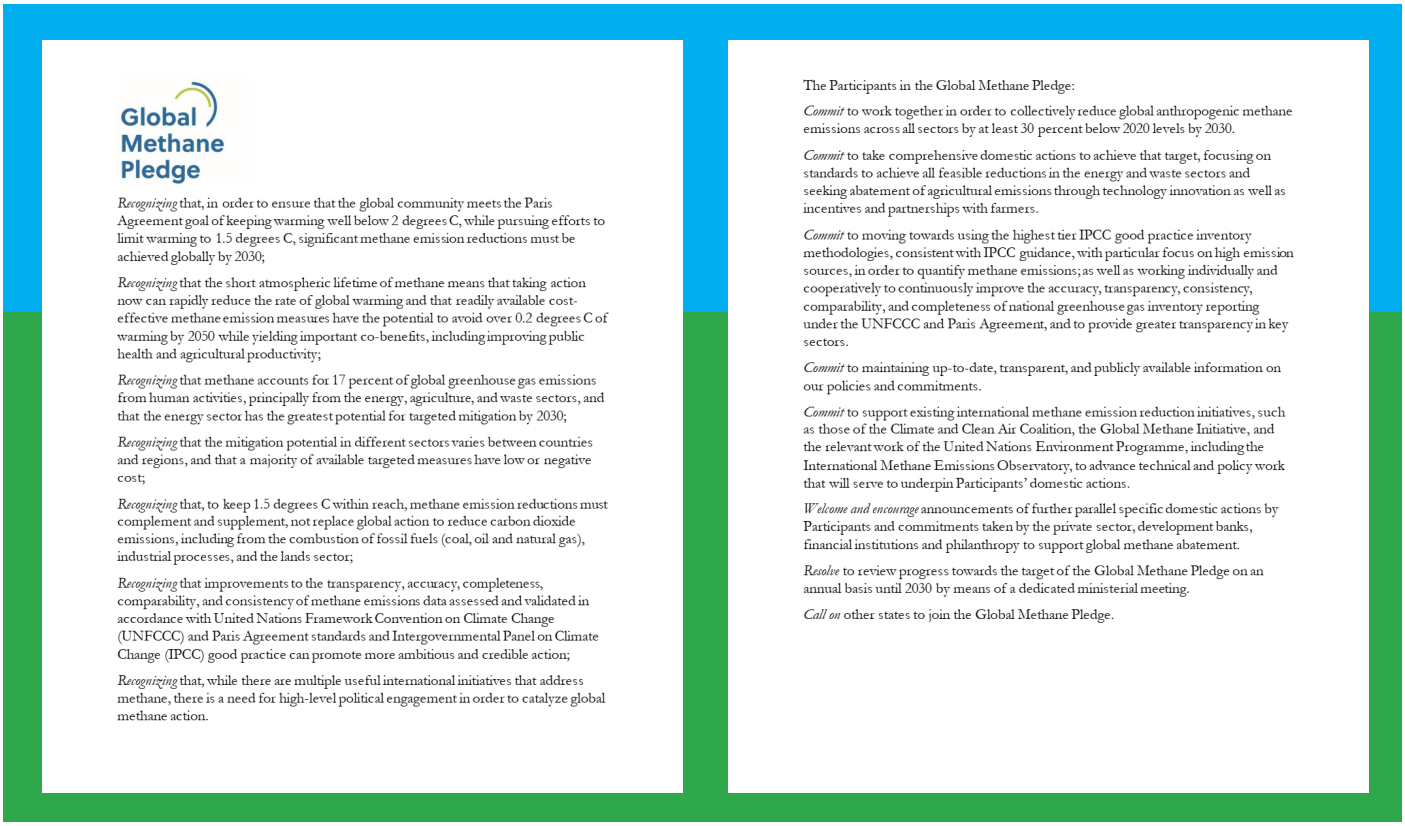
In this respect, the MoPMR is working on six key pillars for addressing decarbonization in Egypt's oil and gas sector.

Methane abatement is considered within the pillar related to reducing the carbon intensity of the oil & gas resources.

GLOBAL METHANE PLEDGE

BRIEF:

The global methane pledge is an initiative launched by the United States and the European Union to reduce methane emissions by at least 30% by 2030, compared to 2020 levels.



Global Methane Pledge

Recognizing that, in order to ensure that the global community meets the Paris Agreement goal of keeping warming well below 2 degrees C, while pursuing efforts to limit warming to 1.5 degrees C, significant methane emission reductions must be achieved globally by 2030;

Recognizing that the short atmospheric lifetime of methane means that taking action now can rapidly reduce the rate of global warming and that readily available cost-effective methane emission measures have the potential to avoid over 0.2 degrees C of warming by 2050 while yielding important co-benefits, including improving public health and agricultural productivity;

Recognizing that methane accounts for 17 percent of global greenhouse gas emissions from human activities, principally from the energy, agriculture, and waste sectors, and that the energy sector has the greatest potential for targeted mitigation by 2030;

Recognizing that the mitigation potential in different sectors varies between countries and regions, and that a majority of available targeted measures have low or negative cost;

Recognizing that, to keep 1.5 degrees C within reach, methane emission reductions must complement and supplement, not replace global action to reduce carbon dioxide emissions, including from the combustion of fossil fuels (coal, oil and natural gas), industrial processes, and the lands sector;

Recognizing that improvements to the transparency, accuracy, completeness, comparability, and consistency of methane emissions data assessed and validated in accordance with United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement standards and Intergovernmental Panel on Climate Change (IPCC) good practice can promote more ambitious and credible action;

Recognizing that, while there are multiple useful international initiatives that address methane, there is a need for high-level political engagement in order to catalyze global methane action.

The Participants in the Global Methane Pledge:

Commit to work together in order to collectively reduce global anthropogenic methane emissions across all sectors by at least 30 percent below 2020 levels by 2030.

Commit to take comprehensive domestic actions to achieve that target, focusing on standards to achieve all feasible reductions in the energy and waste sectors and seeking abatement of agricultural emissions through technology innovation as well as incentives and partnerships with farmers.

Commit to moving towards using the highest tier IPCC good practice inventory methodologies, consistent with IPCC guidance, with particular focus on high emission sources, in order to quantify methane emissions; as well as working individually and cooperatively to continuously improve the accuracy, transparency, consistency, comparability, and completeness of national greenhouse gas inventory reporting under the UNFCCC and Paris Agreement, and to provide greater transparency in key sectors.

Commit to maintaining up-to-date, transparent, and publicly available information on our policies and commitments.

Commit to support existing international methane emission reduction initiatives, such as those of the Climate and Clean Air Coalition, the Global Methane Initiative, and the relevant work of the United Nations Environment Programme, including the International Methane Emissions Observatory, to advance technical and policy work that will serve to underpin Participants' domestic actions.

Welcome and encourage announcements of further parallel specific domestic actions by Participants and commitments taken by the private sector, development banks, financial institutions and philanthropy to support global methane abatement.

Resolve to review progress towards the target of the Global Methane Pledge on an annual basis until 2030 by means of a dedicated ministerial meeting.

Call on other states to join the Global Methane Pledge.

Methane is a potent greenhouse gas that contributes to global warming and climate change. Reducing methane emissions is a cost-effective and feasible way to limit the rise in global temperatures and avoid the worst impacts of climate change. Rapidly reducing methane emissions from energy, agriculture, and waste can achieve near-term gains in our efforts in this decade for decisive action and is regarded as the single most effective strategy to keep the goal of limiting warming to 1.5°C within reach.

The Global Methane Pledge was launched at COP26 in November 2021 in Glasgow. The pledge aims to mobilize countries, companies, civil society, and other stakeholders to take action to cut methane emissions from various sources, such as oil and gas, agriculture, waste, and coal. The pledge also supports the implementation of the Paris Agreement and the achievement of the Sustainable Development Goals.

The global methane pledge is open to all countries and entities that are willing to commit to the 30% reduction target and report on their progress. By joining the pledge, participants demonstrate their leadership and ambition in tackling one of the most urgent environmental challenges of our time.

This is a global, not a national reduction target. Participants also commit to moving towards using the highest tier IPCC good practice inventory methodologies, as well as working to continuously improve the accuracy, transparency, consistency, comparability, and completeness of national greenhouse gas inventory reporting under the UNFCCC and Paris Agreement, and to provide greater transparency in key sectors.

With over 150 countries on board, the Pledge goal is aiming to prevent more than 8 gigatons of carbon dioxide equivalent emissions from reaching the atmosphere annually by 2030.

Egypt joining the Global Methane Pledge

In June 2022, H.E. Abdel-Fattah El-Sisi, President of the Arab Republic of Egypt, announced Egypt joining the Global Methane Pledge in the oil and gas track through which Egypt will seek to boost its efforts regarding reducing methane emissions from the petroleum and natural gas sectors.

H.E. President El-Sisi made the announcement during the Major Economies Forum on Energy and Climate Change summit, which was held under the auspices of US President Joe Biden. H.E. President El-Sisi kindly participated in the forum as the host and president of the 2022 UN Climate Change Conference COP27 in Sharm El-Sheikh.

FLARE GAS RECOVERY

1. World Bank Zero Routine Flaring by 2030

The World Bank launched the Zero Routine Flaring by 2030 (ZRF) initiative in 2015 with the aim of ending the wasteful and polluting practice of burning associated gas during oil production. Flaring is the burning of excess gas that cannot be used or transported, and it contributes to climate change by releasing greenhouse gases and pollutants into the atmosphere.

The initiative, launched in 2015, brings together governments, oil companies, development institutions and civil society organizations to work together to find solutions to eliminate routine flaring. ZRF endorsers now account for approximately 60 percent of total global gas flaring.

The initiative also supports the Sustainable Development Goals and the Paris Agreement on climate change. By joining the initiative, participants commit to not flare gas from new oil fields, and to develop plans to end routine flaring from existing fields as soon as possible.

The initiative has been endorsed by 35 governments and 53 oil companies, who have committed to report their flaring and progress annually. The ZRF initiative supports cooperation between all stakeholders to find solutions to gas flaring through appropriate regulation, application of technologies, and financial arrangements. By eliminating routine flaring, the initiative contributes to climate change mitigation and resource management, as well as enhancing energy security and economic development.

In 2017, The MoPMR endorsed the ZRF initiative aiming at eliminating zero routine flaring of the associated petroleum gases at the production sites by 2030. The MoPMR is working on a program to monetize the flared gases. The program comprises 4 elements: the institutional setup, guidelines and policies, data management and verification, and market establishment. Moreover, the MoPMR had implemented several projects to eliminate the routine flaring in the production sites and refineries as listed hereafter.

2. Flare Gas Recovery Projects

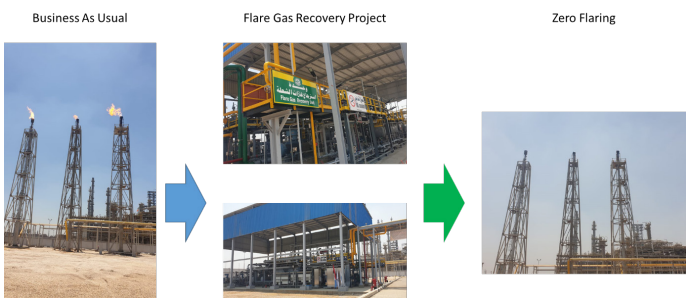
The MoPMR had successfully implemented 29 projects to recover the flared gases. The amount of the gas recovered was approximately 65 MMSCFD and the annual emissions reduction reached 1.4 million Ton CO_2 equivalent. Moreover, these projects reduced the diesel consumption in power generation at the production sites and valuable petroleum products were recovered such as LPG and condensate.

- CAIRO OIL REFINING COMPANY (CORC)

The zero flaring project at CORC aims at the recovery of flared gases and reusing them as fuel for furnaces and recovering valuable products such as LPG and Gasoline, which promote energy conservation and eliminate the emissions from the flare.

The project comprises the recovery of flared gases at the distillation units, reformers, and isomerization unit, where the flared gases are compressed in (Liquid ring compressor) and the compressed gases are cooled and then separated to recover the gases and direct them to the existing gas recovery unit to extract the valuable product and the remaining lean gas is directed to the fuel gas system as a fuel for furnaces. The design capacity of the unit is 4 tons/hour (2 tons/hour per Train) to recover 1 ton/hour of LPG product and 3 tons/hour of fuel gases.

The project was implemented in cooperation with the private sector to carry out the supply, design, and supervision of installation, testing, and operation. Cairo Petroleum Refining Company carried out civil works and installations.



- DISOUQ PETROLEUM COMPANY (DISOUCO)

In 2022, Wintershall Dea and EGAS signed a letter of intent, committing to significantly reduce operational greenhouse gas emissions at Disouq for gas and oil exploration & production in the Nile Delta of Egypt. The elimination of routine flaring is one of a number of initiatives to deliver that commitment. This was an important step in line with the Energy Transition Pathway towards a more sustainable sector in Egypt in alignment with the Ministry of Petroleum and Mineral Resources in Egypt.

The zero flaring project was executed successfully by the DISOUCO JV. The project involved modifications of the process design in the Central Treatment Plant (CTP) and the optimization of a recycle gas compressor to handle flare gas. In addition, the automated ignition system was also installed to ignite the flare in emergency cases, replacing a pilot flare. The project was fully implemented during the plant maintenance shutdown in December 2022. Since then, routine flaring in the Disouq field has been completely eliminated. The flared gas is now re-routed for fuel gas usage for power generation and sales.

As a result, a GHG emission reduction of 11,000 tons of CO_2 equivalent per year could be achieved, and additional sales gas of almost 180 MMSCFD generated.

3. Egypt Nationally Determined Contributions (NDC)

Egypt ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 to be among the first countries to respond to the threats of climate change as per the equity principle of common but differentiated responsibilities in accordance with the respective national capabilities.

Egypt submitted its Intended Nationally Determined Contribution (INDC) in November 2015 to achieve the global targets set out in the UNFCCC's Paris Agreement. After Egypt signed the Paris Agreement on the 22nd of April 2016 and ratified it on the 29th of June 2017, the INDC is considered Egypt's first NDC.

In June 2022, Egypt submitted the updated first NDC, covering the period between 2015 and 2030. The NDC update is aligned with Egypt's developmental and climate change policies, including Sustainable Development Strategy: Egypt's Vision 2030, the emerging Long Term Low Emission Development Strategy 2050 (LT-LEDS), the National Climate Change Strategy 2050 (NCCS), National Strategy for Disaster Risk Reduction 2030, and the National Strategy for Adaptation to Climate Change in addition to sectoral strategies.

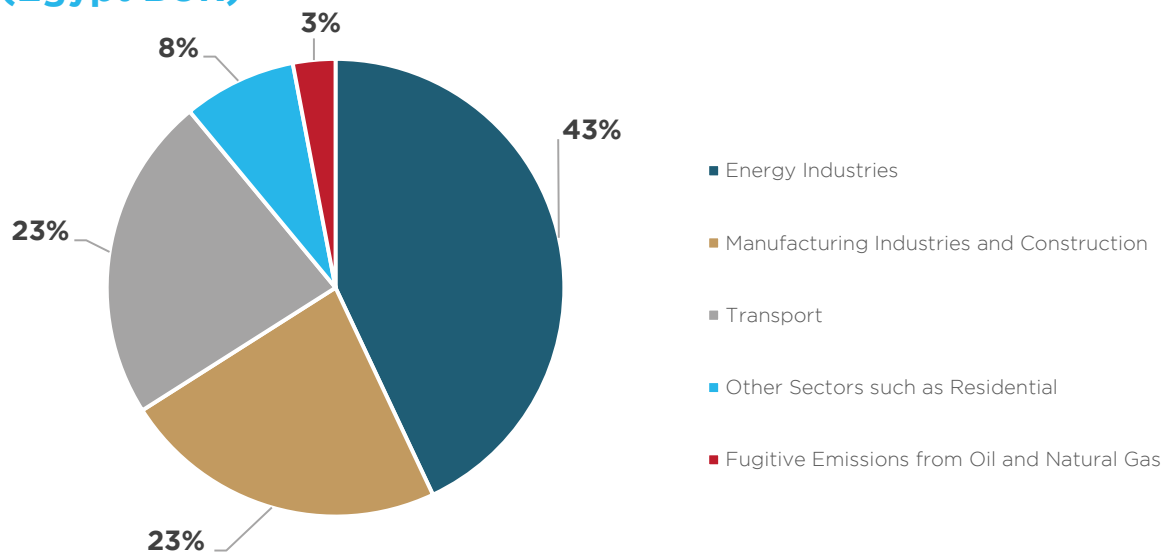
The first updated NDC is Egypt's pledge for climate change action up to 2030 anchored and dependent on international financial support, ensuring just transition and appropriateness to national capabilities.

OIL AND GAS COMPONENT IN THE NDC

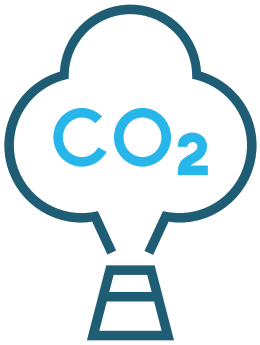
Egypt's oil and gas sector recognizes the importance of implementing flare gas recovery projects to achieve emission reductions. Flare gas recovery technologies are mature and cost-effective. The MoPMR deployed different business models to foster the implementation of the projects such as BOO and BOOT. The projects were executed in partnership with the IOCs and the private sector. Flare gas projects are in line with the Ministry's vision for reducing the carbon footprint of its upstream activities.

As a key sector in Egypt's economy, and in view of the MoPMR efforts in prioritizing implementation of flare gas recovery projects, the oil and gas sector quantified targets for emission reduction were incorporated in Egypt's NDC. Accordingly, the NDC target for Egypt's oil and gas sector is to reduce the GHG emissions from flaring the associated petroleum gases by 1.682 Million ton CO2 (65%) by 2030 compared to baseline GHG emissions at 2015. Such reduction will be primarily through recovery and utilization of associated gases generated from the crude oil fields. Instead of flaring, the associated gases will be directed to gas processing facilities to produce LPG, natural gas and condensates.

Emissions per Category for the Energy Sector, 2015 (Egypt BUR)

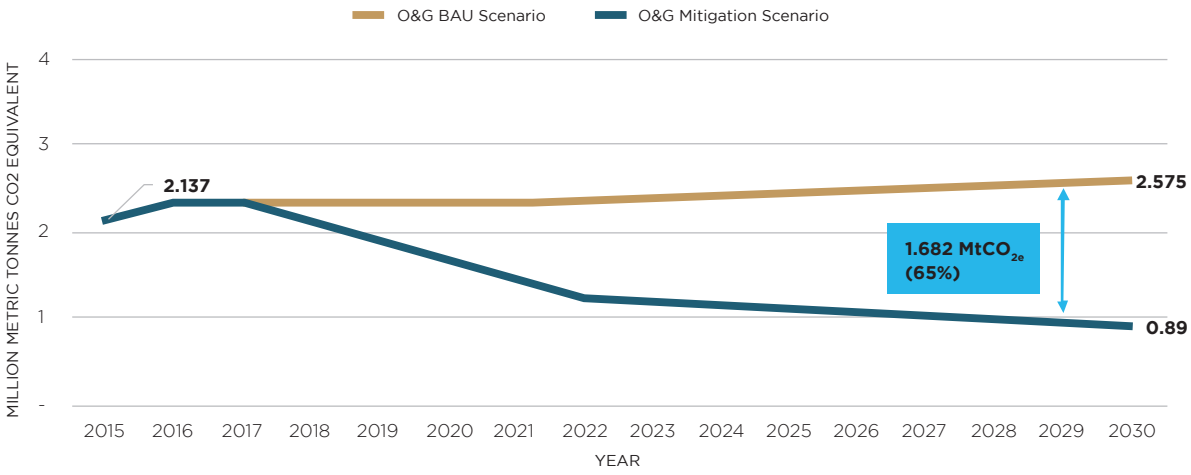


GHG Emissions Reduction from Associated Gases Subsector



1	Baseline GHG Emissions in 2015	2,137 Gg Co_{2e}
2	BAU GHG Emissions by 2030	2,575 Gg Co_{2e}
3	GHG Reduction % Compared to BAU in 2030	65%
4	Mitigation Target by 2030	1,682 Gg Co_{2e}

GHG Emissions Reduction Scenarios




COP27
SHARM EL-SHEIKH
EGYPT 2022

SHARM EL SHEIKH OIL AND GAS METHANE REDUCTION ROADMAP

1. COP27 Decarbonization Day

"Reducing methane emissions is one of the fastest ways to decrease the rate of global warming to keep us on track in meeting climate objectives. The Sharm El Sheikh Oil and Gas Methane Reduction Roadmap was developed as Egypt's contribution to advance the Global Methane Pledge around the world, driving near term methane emissions reduction and closing gaps to achieve medium term impact."

TAREK EL MOLLA

Egyptian Minster of Petroleum ana Mineral Resources

"One of the principal things we need to do is focus on where you get the best decarbonization. Methane is 80 times more damaging than CO_2 in the early life, for about a 20-year period. Methane is actually the simplest, easiest, fastest and cheapest way to start getting reductions."

JOHN KERRY

US Special Presidential Envoy for Climate

The COP27 Decarbonization Day that was held on 11 November 2022 for the first time in the history of COP meetings as part of the conference Thematic Days proved to be a valuable window to engage all stakeholders including governments, private sector, international organization and financial institutions to showcase efforts, commitments and enablers for accelerating decarbonization in the hard to abate industries.

The Decarbonization Day featured opening remarks by distinguished members including H.E. John Kerry, U.S. Special Envoy for Climate, H.E. Tarek El Molla, Minister of Petroleum and Mineral Resources, and H.E. Gerd Muller, UNIDO Director General. The day covered eight sessions and addressed different aspects of decarbonization and its enablers.

Since Egypt hosted COP27 on behalf of the African continent, and in line with the common but differentiated responsibilities and respective capacities, Africa's ambitions for sustainable growth and prosperity were discussed considering overcoming its significant energy poverty challenges.

As Energy Efficiency is considered as a cost effective way to reduce emissions, the "Egyptian Petroleum Sector Energy Efficiency Strategy 2022-2035" was announced on the sidelines of the Decarbonization Day, with an identified vision, goals and measures to further improve energy efficiency to help meet rising energy demands with lower emissions.

In view of its significant global warming potential, a specific session was dedicated to methane to discuss ways to advance the Global Methane Pledge that is now joined by 150 countries, including Egypt. During this session, Egypt launched Sharm El-Sheikh Oil and Gas Methane Reduction Roadmap as a road map to drive near term methane emissions reduction and closing gaps to achieve medium term impact.

The process of developing this road map started with review of public resources, then interviews over 20 global stakeholders and two workshops on 8 November 2022 at Sharm El Sheikh during COP27.

2. Sharm Elsheikh Oil and Gas Methane Reduction Roadmap

As part of its contributions to the energy industry, and recognizing the importance of acting on reducing methane emissions as a quick win, the MoPMR announced the Sharm El Sheikh Oil and Gas Methane Reduction Roadmap at COP27 Decarbonization Day.

The roadmap defines a comprehensive approach and framework of how any country can establish its own O&G roadmap to reduce methane emissions and advance the global methane pledge. It is informed by a review of public resources.

This roadmap provides important steps and frameworks that governments and industry can follow to drive and coordinate action on methane emissions. It is designed to supplement and amplify existing resources by OGCI, MGP, CCAC, EDF, and many others.

The roadmap can help advance Global Methane Pledges around the world by providing:

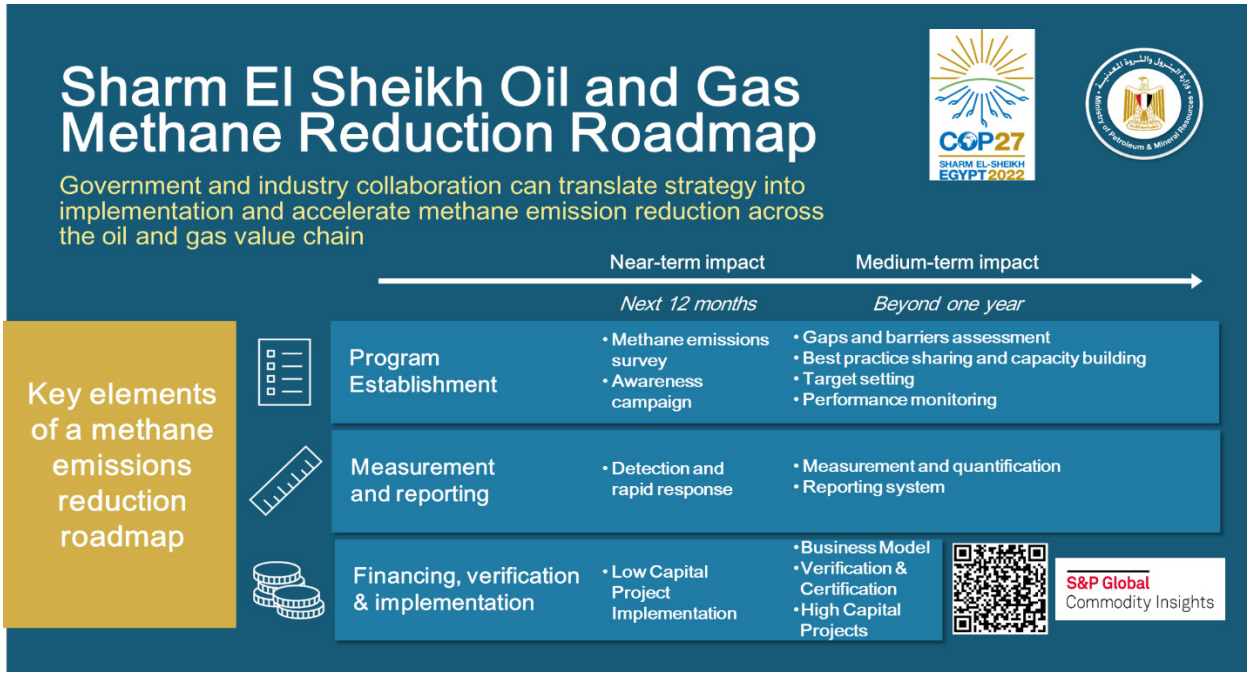
» Key elements in an O&G methane emission reduction roadmap

» Immediate actions to drive near-term methane and flare reduction in the O&G sector

» Gaps in existing resources and associated collaboration and recommendations

The roadmap was developed through technical assistance provided by the Global Methane Hub and in cooperation with world's leading consulting firm S&P Global, and the engagement of several companies, governments and international organizations, over 20 interviews with global stakeholders and two workshops at COP27.

KEY ELEMENTS OF THE ROADMAP



While methane emission reduction roadmaps take time to develop, there are immediate steps governments and industry can take. Satellite and aerial surveys will highlight large opportunities that can be prioritized based on cost, complexity, and impact.

Risk for initial abatement efforts can be managed by focusing on abatement opportunities that utilize more mature abatement technologies and offer stronger net present values for emission abatement.

Near-term impact includes the Proven, low-cost, high-impact opportunities. The elements of the near-term opportunities were evaluated based on the timing and ease of implementation.

Element	Description	Remaining gaps
Methane emissions survey	Satellite or aerial inspections and high-level equipment inventory can support first level surveys of large emission sources and identify and prioritize major opportunities	Pairing methane emissions surveys with supportive analysis (e.g., developing a marginal abatement cost curve) enables informed prioritization
Awareness campaign	Informational campaign to raise awareness of methane emissions abatement benefits, likely sources, technologies, and available data	Increased awareness and experience are needed with low-cost options to both develop an initial methane assessment and abate identified methane emission sources, particularly important for smaller, local operators and regions historically focused on oil
Detection and rapid response program	Programs to immediately respond to methane emissions detected by satellite, aerial and on-the-ground measurements	Additional coordination and engagement between public and private entities are needed to build on-the-ground capabilities for local operators to interpret and respond to unexpected emission sources identified by satellites and fly-overs
Low capital project implementation	O&G industry best practices for mitigating methane emissions identified in survey which have relatively low capital requirements (and high value)	

Timing of Implementation
(years)

< 1 | 1–3 | > 3

Remaining gaps

Low | Mid | High

3. Implementation Progress

-EMISSIONS INVENTORY

The MoPMR managed to implement two methane quantification measurement campaigns. The first campaign was conducted in May 2022, while the second campaign in June 2023, with the following goals;

Primary Goal: Identify and quantify methane emissions from the Gas Supply Chain and mitigation opportunities. Conduct a techno-economic analysis (pre-feasibility assessment) to evaluate the potential viability of the identified mitigation opportunities. In addition, Rank these opportunities/projects based on their potential to reduce methane emission by 25%, 50%, and 75%.

Secondary Goal: Provide hands-on training to EGAS/EGPC company personnel on Measurement techniques and selecting sampling locations.

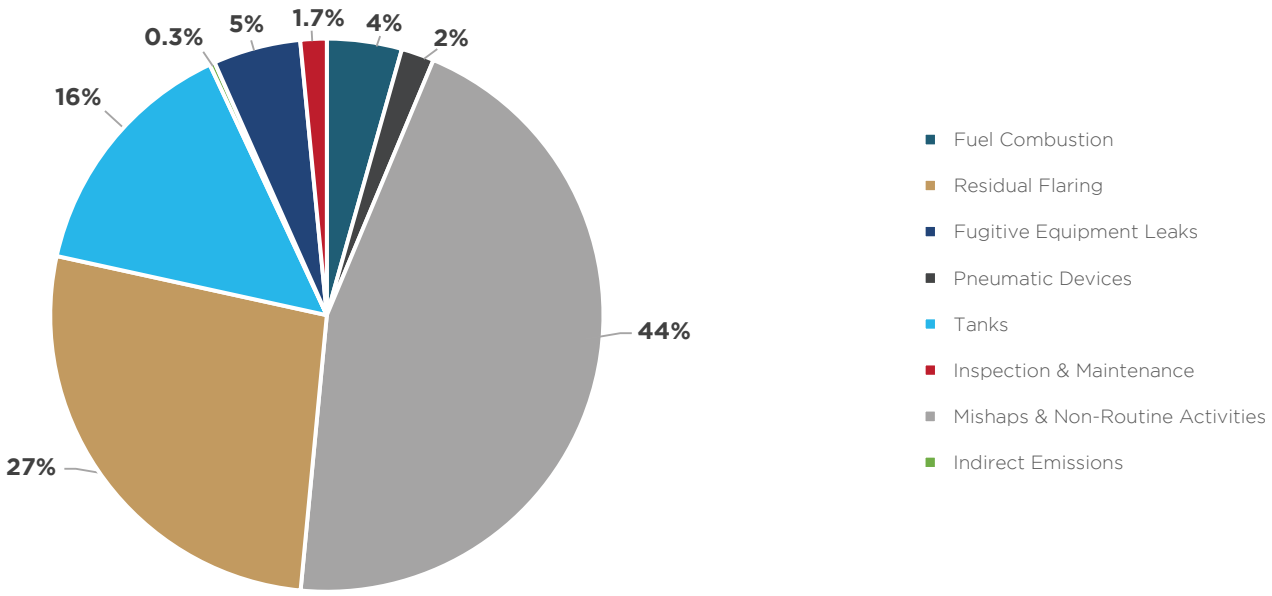
First Measurement Campaign

During the period from 22 May to 2 June 2022, EBRD's consultant Tetra Tech and its subcontractors conducted the first pilot measurement campaign in Egypt as part of the Methane Emissions Reduction Program in the Gas Supply Chain in Egypt.

The primary objective of the first pilot measurement campaign was to compile accurate methane emissions measurement data as well as collect information that can be potentially used to improve the accuracy of its methane emission monitoring and reporting initiatives. The data collected during the first campaign will also help to identify high-impact opportunities for cost-effectively reducing methane emissions at gas facilities in Egypt.

The first campaign targeted six natural gas processing and transmission facilities as well as one crude oil pipeline and is the first in a series of such surveys being planned. The results and learnings from this first pilot measurement survey will help inform refinements to the measurement protocols and procedures for the subsequent surveys, as well as strategic targeting of high-impact methane mitigation opportunities on Egypt's natural gas system.

Contribution by Source Category To The Total Assessed CH_4 Emissions



The low contribution from pneumatic devices is because all the facilities survey used compressed air as the supply medium for pneumatic devices. The assessed contributions due to pneumatic devices is the vent gas from process analyzers.

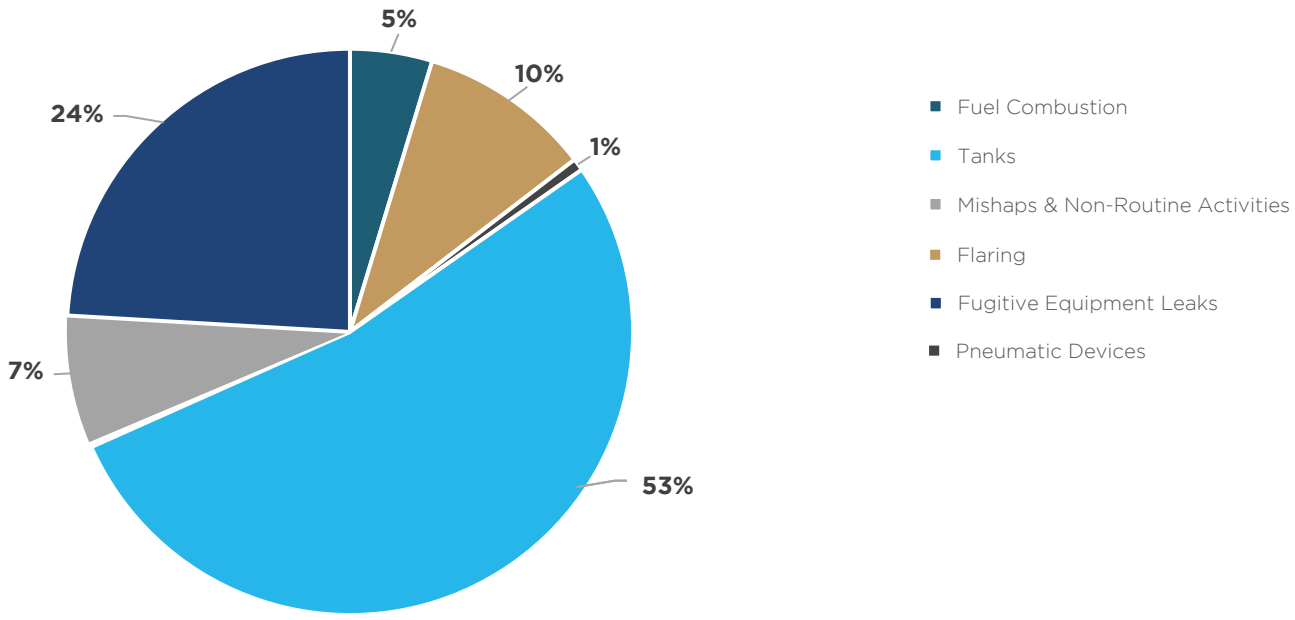
Second Measurement Campaign

The second measurement campaign comprised interviews with the facility's engineering, operations and environmental staff, a review of relevant engineering drawings, a compilation of key operating and emissions data, and a review of their leak detection and repair (LDAR) programs and their effectiveness. As well as a general survey of the site using an optical gas imaging (OGI) infrared (IR) camera and, quantification of the detected methane and hydrocarbon vapor emissions.

Additionally, a mobile monitoring system (MMS) was deployed to quantify and help streamline the onsite measurement by directing the team to the emission hotspots while also providing verification that all major emissions sources were detected and their emissions quantified. The time spent at each facility was limited to one day and in many cases was less than that.

The second measurement campaign was conducted in 28 facilities; 20 natural gas facilities (11 gas processing and LPG recovery plants, 1 gas gathering compressor station, 1 offshore production platform, and 7 gas distribution metering and valve stations). During the survey, 8 additional facilities were added to the list (2 gathering compressor stations, 1 offshore production platform, 2 tank crude oil tank farms, 2 petroleum refineries, and one distribution valve station).

Contribution by Source Category To The Total Assessed CH_4 for Second Survey



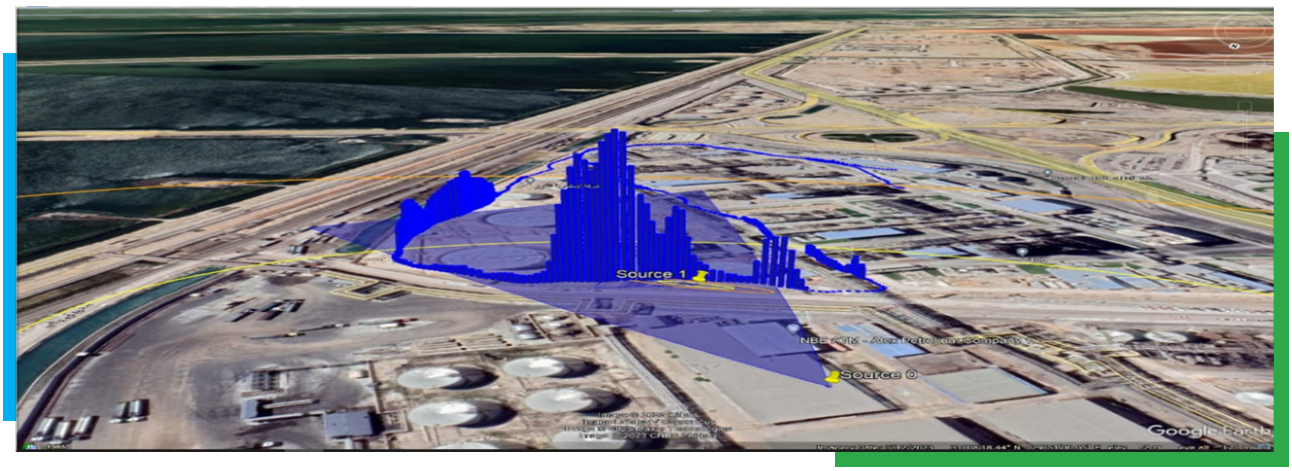
Equipment Used for the Surveys

The MMS comprises a motor vehicle fitted with a high-accuracy CH_4 analyzer, acoustical wind anemometer, sampling system, power inverter, data acquisition system, and special software.

This instrumented vehicle collects data as it drives along predetermined monitoring routes. Real-time viewing of certain monitoring parameters is available during each monitoring session.

A single survey comprises driving a preplanned route across the downwind side of a target facility. This process is repeated for each CH_4 emissions plume detected along the monitoring route to obtain replicate plume transect readings (typically 3 runs per source).

The MMS was operated by a two-person team: a driver and an engineer or scientist responsible for the operation and monitoring of the MMS's instrumentation as well as instructing the driver on where to go during individual monitoring runs.



The ground survey team conducted a survey of key sources of each facility to identify individual methane sources and quantify their emission. In addition, the team also collected information needed to inform subsequent evaluations of mitigation options. The ground survey team was equipped with a selection of measurement tools needed to pin-point emission source locations and quantify emission rates (e.g., Optical Gas Imaging [OGI] camera, Hi-Flow Sampler, hand-held gas detectors, portable ventgas flow meters, and velocity probes).

Initially the ground-based team used an OGI infrared (IR) camera to detect individual hydrocarbon emission sources. An OGI IR camera also provides digital photos and videos of emissions and their source.

Hydrocarbons absorb infrared light at respective specific wavelengths. The IR camera uses this characteristic to detect gas emissions from equipment. The IR camera scans the leak area in real-time at 60-hertz scan frequency and spectral range of 3.2-3.4 microns (µm). This scanned area is then converted into a moving image in real-time such that the gas plumes are visible due to their absorption of the IR light.

Main Results

IEA estimates a methane emissions intensity of 0.201 tonnes of CH4 per MMscf of natural gas production for Egyptian Petroleum Sector. In contrast, and according to the result of the campaign, the CH4 per MMscf of natural gas production in comparison is 0.024 tonnes CH4 per MMscf.

The main source of methane emissions at the upstream sites is the vent of crude oil storage tanks. The fugitive emissions of pneumatic devices are very low compared to IEA estimation as most companies in Egypt's oil and gas sector are employing compressed air as the supply medium for pneumatic devices rather than natural gas. Based on the result of the first campaign in gas processing facilities, it was evident that less than 2 percent of the components of each type in natural gas service were leaking. One of the surveyed gas facilities had no equipment component leaks, but did have some emissions from compressor seal venting. Generally, a leak frequency of 2 percent is a benchmark used to assess the effectiveness of the LDAR programs.

Figure 2-FLIR Camera to detect methane emissions.

Figure 4 - Leak Quantification - QL320 Optical Gas Imaging System.

- LDAR VOLUNTARY PROGRAMS APPLIED BY COMPANIES

Recognizing the importance of identifying and eliminating the sources of methane emissions in oil and gas activities, 27 companies in the petroleum sector arranged several surveys to detect and repair the methane leakage in the downstream and midstream activities. The surveys were conducted with local private sector companies in three geographic locations.

The first location is central Cairo, Mostord Area. The survey was conducted in 8 companies where 159 leakage points were identified and 30% were immediately fixed and repaired.

The second location is Alexandria in North Egypt. The survey was conducted in 14 companies where 3150 leakage points were identified and 77% were immediately fixed and repaired.

The third location is Assiut in Upper Egypt. The survey was conducted in 5 companies where 37 leakage points were identified.

In addition, many companies are arrangingsurvey to identify the sources of methane emissions and fixing the leakages on a quarterly basis.

- CAPACITY BUILDING

COLLABORATION

Enhanced collaboration with Egypt's oil and gas sector partners continued to be a key success factor through sharing best practices, lessons learned, identifying finance opportunities, receiving technical assistance and engaging in capacity building programs.

The following provides highlights of ongoing collaboration between the MoPMR main state owned entities (particularly EGPC and EGAS) and the oil and gas sector partners related to methane abatement:

Eni

In 2023, a data collection initiative has been collectively launched by Eni and EGAS for EGAS subsidiaries in order to evaluate methane emissions. Furthermore, a pre-assessment has been carried out with the aim to identify potential mitigation actions required to reduce the emissions of 21 EGAS subsidiary sites. A further and detailed energy assessment shall be performed in 2024 to confirm the initiatives and develop the implementation plan. Moreover, in 2023 a fugitive and venting emission monitoring campaign has been implemented in the Egyptian Natural Gas Company (GASCO) Western Desert Gas Complex.

Chevron

On the sideline of Egypt's Petroleum Show (EGYPS) 2022, MoPMR signed a memorandum of understanding (MOU) to share best practices and expertise related to the reduction of methane emissions.

The MoU, which was witnessed by H.E. the Egyptian Minister of Petroleum and Mineral Resources Eng. Tarek El Molla and Clay Neff, president of Chevron International Exploration and Production, builds on the Sharm El Sheikh Oil & Gas Methane Reduction Roadmap that was announced by El Molla during Decarbonization Day at COP 27 in November 2022, and is aligned with Egypt's membership in the oil and gas track of the Global Methane Pledge.

The MOU includes methane and decarbonization study tours and workshops for MoPMR employees, at Chevron facilities in the US and other locations, to build awareness of methane control technologies, measurement practices and projects to effectively develop projects to reduce carbon emissions.

SLB

SLB End-to-end Emissions Solutions (SEES) offers tailored solutions that work best for oil and gas sites and activities. SLB tackle methane and flaring challenges head-on with the tools and services needed to measure emissions, reduce methane, and achieve zero routine flaring.

The MoPMR is coordinating with SLB to implement methane emissions reduction projects through the SLB End-to-End Emissions Solutions (SEES) approach, which provides emission reduction solutions tailored to the sector company's applications, processes and the company's economics. These solutions contribute to the measurement, monitoring, and reporting of operational methane emissions and routine flaring, and Implementation of procedures and methane reduction projects economically.

United States Trade and Development Agency (USTDA)

The United States Trade and Development Agency (USTDA) is a main partner of Egypt's oil and gas sector, especially for technical assistance and capacity building. The Reverse Trade Missions (RTM) provide a valuable opportunity for calibers from Egypt's oil and gas sector to get exposed to latest state-of-art technologies and practices at the USA. Most recently in May 2023, an RTM was jointly arranged with USTDA to address methane abatement technologies. This RTM offered an insightful avenue for participants from Egypt's oil and gas sector to closely observe the on-ground best practices and leading innovations for methane emissions reduction from leading US industry players.

USTDA is also supporting the MoPMR in technical assistance for developing the detailed methane reduction roadmap for Egypt's oil and gas sector, which will build upon the Sharm El Sheikh Oil and Gas Methane Reduction Roadmap template.

Global Methane Hub

Through technical assistance from the Global Methane Hub, the Sharm El Sheikh Oil and Gas Methane Reduction Roadmap was developed (which was announced at COP27 Decarbonization Day).

Carbon Limits

Carbon Limits will collaborate with the MoPMR in the areas of reducing methane emissions to support efforts of national oil and gas companies to reduce methane emissions. This collaboration will include capacity building and implementation of training programs on monitoring, measuring and verifying emissions and training on the economics of methane reduction projects, implementing a methane measurement campaign, preparing a program on identifying and repairing methane leaks, technical and economic feasibility study for projects to reduce methane emissions in a number of sites and identifying opportunities for cooperation with international organizations and bodies in the field of methane). This engagement is supported by the Montpelier Foundation.

METHANE ABATEMENT BEST OPERATIONAL PRACTICES IN EGYPT'S OIL & GAS SECTOR

Egypt's commitment to the Global Methane Pledge marks a significant step towards reducing methane emissions in the oil and gas sector. Recent methane measurement campaigns conducted in collaboration with the EBRD have highlighted the adoption of best practices within Egypt's oil and gas facilities such as the utilization of dry gas seals on centrifugal compressors, connecting pressure relief valves to the flare systems, capturing, and controlling vent gases, and employing compressed air as the supply medium for pneumatic devices. Additionally, several of Egypt's oil and gas facilities demonstrate commendable measures for managing fugitive emissions through formal leak detection and repair programs.

These practices align with global standards and emphasize various modern design features aimed at minimizing methane emissions.

The following tables list 11 important sources of methane emissions along Egypt's oil and gas value chain. Each emission source is accompanied by a brief description and outlines a typical mitigation technique employed within Egypt's oil and gas facilities.

Casing-Head Venting from Oil Wells

Description of the emission source	Casing Head gas can be built up in the annular wellbore space between the tubing and casing. In mature oil wells equipped with a beam pump or electric submersible pump, this gas can begin to restrict oil flow, thereby decreasing a well's production with vapor locking the pump. Combined with the backpressure of an oil well's surface equipment, the resultant pressure from casing head gas can severely restrict oil production. The gas pressure build-up in a well's annular space must therefore be removed to maintain production, and a common solution is to vent the casing head gas to the atmosphere or a flare at or near the wellhead.
Mitigation technique employed within Egypt's oil and gas facilities	• Re-route casing-head gas to flare, up to 95% emission reductions achievable

Liquids Unloading from Gas Wells

Description of the emission source	Many natural gas wells initially have sufficient reservoir pressure when completed to flow the formation fluids to the surface along with the produced gas. However, as gas production progresses and the reservoir pressure declines, the velocity of the fluid in the well tubing keeps decreasing. Eventually, the gas velocity up the production tubing is no longer sufficient to lift liquid droplets to the surface and the liquid droplets begin to accumulate in the tubing. This creates an additional pressure drop and significantly slows the gas velocity. As the bottom well pressure approaches the reservoir shut-in pressure, gas flow ultimately stops, and the liquids accumulate at the bottom of the tubing. A common approach for wells that infrequently need unloading to temporarily restore flow is to vent the well to the atmosphere (well "blowdown"), which can produce substantial methane emissions.
Mitigation technique employed within Egypt's oil and gas facilities	• Re-route hydrocarbon liquids to flare, up to 95% emission reductions achievable

Glycol Dehydrators

Description of the emission source	Glycol dehydrators in the natural gas industry remove water from an incoming wet gas stream using mono-ethylene glycol, diethylene glycol, or, most commonly, tri-ethylene glycol. Glycol is pumped via a pneumatic or electric pump to a gas contactor where it mixes with the natural gas stream. Resulting emissions are highly dependent on how a unit is configured and operated, but the two potential emission points are the flash tank overhead gas and the regenerator vent off-gas. Dehydrating the gas is necessary in some settings to meet pipeline specifications designed to maintain pipeline integrity.
Mitigation technique employed within Egypt's oil and gas facilities	• Installing flash tank separator and optimizing glycol circulation rates, up to 90% emission reductions achievable. • Routing flash tank and dehydrator regenerator vents to VRU for beneficial use, such as fuel gas, up to 90% emission reductions achievable, • Re-routing vents to flare, up to 98% emission reductions achievable. • Utilization of Desiccant dehydrators, up to 90% emission reductions. • Rerouting glycol skimmer gas, up to 95% emission reductions achievable.

Natural Gas Driven Pneumatic Controllers and Pumps

Description of the emission source	Natural gas-driven pneumatic controllers are used widely in the oil and natural gas industry to control liquid level, temperature, and pressure during the production, processing, transmission, and storage of natural gas and petroleum products. Natural Gas driven control devices emit CH4 both through continuous bleeding and during actuating. Emissions vary greatly depending on the design, the working pressure, the type and conditions of the instrument, and the frequency of actuating. Some controllers (continuous bleed) will have emissions dominated by bleeding while others (intermittent vent) will be a result of actuations. In addition, when operating not as designed, intermittent vent pneumatic controller loops and pneumatic pumps can emit gas due to a defect or maintenance issue.
Mitigation technique employed within Egypt's oil and gas facilities	• Most of the Egypt's oil and gas facilities utilize compressed air as the supply medium for pneumatic devices, up to 100% emission reductions achievable.

Wet-Seal Centrifugal Compressors

Description of the emission source	In wet seal centrifugal compressors, high-pressure oil is used as a barrier against escaping gas in centrifugal compressor shafts. Very little gas escapes through the oil barrier, but under high pressure, considerably more gas is entrained by the oil. The seal oil is purged of the entrained gas (using heaters, flash tanks, and degassing techniques) and recirculated. The gas purged is commonly vented to the atmosphere. The mechanical dry seal system is an alternative to the traditional wet seal. Using high-pressure gas to seal the compressor, dry seals result in much lower levels of emissions compared to wet seals.
Mitigation technique employed within Egypt's oil and gas facilities	• Most of the gas production and processing facilities that have centrifugal natural gas compressors featured the use of dry-gas seals, which is consistent with current best practice.

Reciprocating Rod-Packing Compressors

Description of the emission source	Though there are a number of leak points, the highest volume of gas loss within the reciprocating compressors is associated with piston rod packing systems, which are the components ensuring the sealing of the compressed gas. Piston rod packing consists of a series of cups containing several seal rings side by side, held together by a spring installed in the groove running around the outside of the ring. Considerable leak reduction could be achieved by periodic replacement packing rings and, in some cases, the piston rods.
Mitigation technique employed within Egypt's oil and gas facilities	• For reciprocating rod-packing compressors utilized within Egypt's oil and gas facilities, maintenance plans and regular checks play a pivotal role in achieving substantial reductions in methane leakage. This maintenance strategy includes scheduled replacements of packing rings and piston rods, effectively minimizing the risk of methane leaks. Up to, 50-65% emission reductions achievable.

Venting of Associated Gas at Upstream Oil Production Facilities

Description of the emission source	The venting of associated gas at oil production facilities is the discharge or disposal of gases produced as a by-product at oil production facilities. The gases are released directly and unburned into the atmosphere where there is inadequate infrastructure for the possibility of economical utilization of this gas. Venting of associated gas can also occur during gas flaring when a gas flare fails to ignite or is shut down and the associated gas is released unburned into the atmosphere.
Mitigation technique employed within Egypt's oil and gas facilities	• Flaring gas instead of venting, up to 98% methane emission reductions achievable.

Hydrocarbon Liquid Storage Tank, Loading & Transportation, Produced Water Discharge

Description of the emission source	• Vapors, consisting of methane, VOCs and other hazardous air pollutants are released from liquid hydrocarbon products during storage and loading due to flashing losses (due to a rapid pressure drop, typically representing a large share of the total emissions), working losses (from changing fluid levels) and standing losses (due to ambient temperature and pressure changes). The volume of vapor emitted from a fixed-roof storage tank is dependent on several factors including the composition of the hydrocarbon liquid, the pressure in the gas/liquid separator, and the hydrocarbon flow rate from this separator into the tank. • During loading and unloading (transfer) activities between storage tanks (including for transportation), emissions released are attributed to physical displacement of residual vapors by the incoming liquid, evaporation effects promoted by agitation, and also leakage/spillage during the connection/disconnection of transfer lines and during the transfer process. • Blanket gas represents an additional source of emissions during loading/unloading. • Finally, emissions from produced water discharged are grouped into this source as they arise from a similar physical process.
Mitigation technique employed within Egypt's oil and gas facilities	• Installing a Vapor Recovery Unit (VRU) and directing it to productive use as fuel gas, emission reductions of up to 98%. • Flaring gas, instead of venting, up to 98% methane emission reductions achievable.

Equipment Depressurization and Blow-Downs from Pipelines and Facilities

Description of the emission source	The term gas blow-down refers to the venting of gas accumulated in equipment, process facilities, and pipelines. During equipment depressurization and blow-down, gas is released from a pipeline or other equipment and facilities prior to maintenance or in the case of emergency shutdown. In the case of a pipeline blow-down for example, the amount of methane released is related to the diameter of the pipe, the pressure of the gas in the pipe, and the length of the section that is blown down. The amount of methane released from general equipment depressurization is extremely variable.
Mitigation technique employed within Egypt's oil and gas facilities	• Lowering pressure in the pipeline prior to event through a mobile compressor station (for pipeline repairs). • Installing plugging equipment to shorten segment of pipeline involved in outage. • Utilization of isolation valves to minimize impact. • Rerouting the natural gas to flare system.

Incomplete Combustion (Including Associated Petroleum Gas (APG) Flaring, Engines, Turbines, Fired Heaters)

Description of the emission source	Methane emissions result from the incomplete combustion of natural gas, which allows some of the methane in the fuel to be emitted with the exhaust stream. While it is a small percentage, it can represent a significant source of emission in aggregate, especially in gas engines which emit 40 to 150 times more methane than gas turbines : Methane emissions from APG flares are the result of incomplete combustion of the waste gas. A number of external parameters including gas composition, gas velocity, wind velocity, atmospheric pressure and relative humidity play a significant role in affecting the combustion efficiency.
Mitigation technique employed within Egypt's oil and gas facilities	• Improve combustion efficiency (Changing flare tip, Install flare ignition systems)

Component and Equipment Leaks

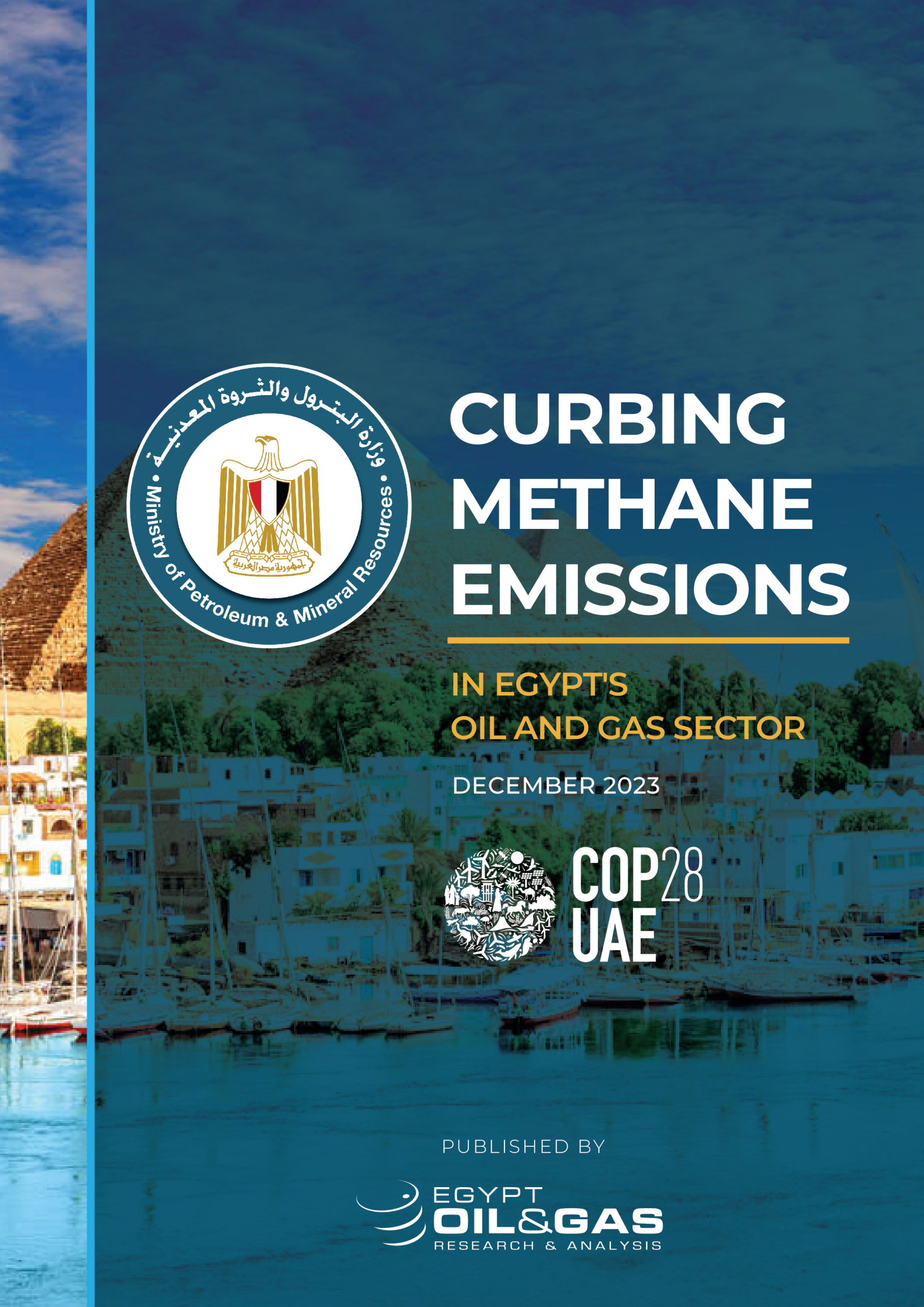
Description of the emission source	The potential variety of components or sources of unintentional emissions from operations at oil and gas installation and operations include flanges, screw and compression fittings, stem packing in valves, pump seals, compressor components, and through-valve leaks in pressure relief valves, tubing fittings, hatches, meters, open ended lines and improperly operated storage tanks. Leaks can be found along the full gas value chain, including in upstream facilities, processing plants, compressor stations, metering stations, and along gas pipelines. This category also includes unintended emission due to e.g., excavating pipelines or plugged/abandoned wells which can also represent a source of gas leakage (and require different mitigation than traditional LDAR). Methane emissions from equipment designed to vent as part of normal operations, such as gas-driven pneumatic controllers, are not considered leaks.
Mitigation technique employed within Egypt's oil and gas facilities	• Leak detection and repair (LDAR) • Direct Inspection and Maintenance (DI&M) • Plugging the abandoned wells

WAY FORWARD

Building on the success of COP27 Decarbonization Day, and the Ministry's decarbonization and energy transition pillars, the MoPMR will continue to collaborate with its partners to seek further opportunities for concessional finance, technology transfer and capacity building to support further emissions reduction within Egypt's oil and gas sector.

Engaging all stakeholders from the energy industry, including governments, operators, service companies, technology companies and international organizations is key to establishing an effective methane emission reduction program.

As the next important achievement in its methane abatement efforts, Egypt's oil and gas sector will complete a detailed methane abatement road map, building off of the framework presented at COP27. This detailed roadmap will seek to define more precise targets and key milestones for methane abatement. The Roadmap shall also provide methodologies to quantify, prioritize and implement methane abatement efforts across the oil and gas sector. Through benchmarking, case studies and stakeholder engagement, the roadmap will help to inform potential internal policy and regulatory approaches and options for managing methane emissions to achieve the defined targets and milestones. Developing and implementing this detailed roadmap, subject to mobilization of necessary concessionary finance and international support, is expected to support Egypt's participation in the Global Methane Pledge



CURBING METHANE EMISSIONS

IN EGYPT'S OIL AND GAS SECTOR

DECEMBER 2023

COP28 UAE

PUBLISHED BY

EGYPT OIL&GAS
RESEARCH & ANALYSIS