

# EMISSIONS REDUCTION TECHNOLOGIES IN OIL & GAS E&P

Key mitigation measures identified for the Brazilian exploration and production (E&P) segment

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FS-EPE-DPG/DEA-SPG/SMA-001-2025

## WHAT ARE MITIGATION MEASURES?

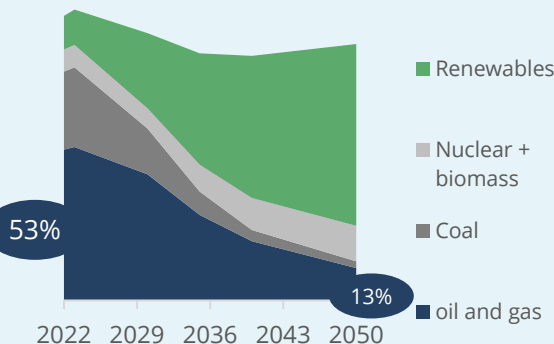


- Actions planned to reduce or avoid greenhouse gas (GHG) emissions
- Involve adopting practices and technologies that reduce the amount of pollutants released into the atmosphere
- Most of these measures focus on improving process efficiency and promoting the use of lower-carbon energy sources
- Their goal is to control emissions at the source, contributing to reducing climate change impacts

## HOW DOES THE E&P SEGMENT FIT INTO A LOW-CARBON FUTURE?

1 - The **oil and gas industry** will continue to **play an important role** in the global energy mix, alongside alternative sources, **even in net-zero emissions scenarios**

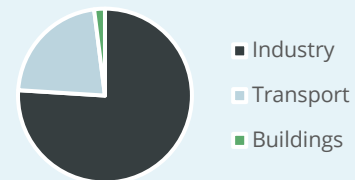
Energy supply<sup>1</sup>  
IEA net-zero scenario



2 - Despite the projected decline in demand by 2050, there are **energy-intensive sectors** - especially in industry - that face technological and/or economic barriers to fully replacing their current fuels

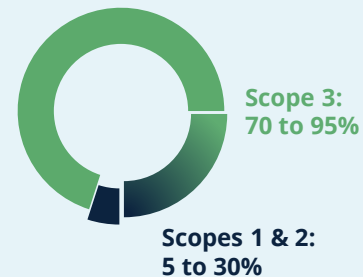
### Final consumption: O&G<sup>1</sup>

IEA net-zero scenario



3 - With Scope 3 emissions - mainly from **product use** - accounting for 70-95% of total emissions, companies must invest in reducing the carbon intensity of oil and gas production, helping **cut emissions in sectors that rely on these fuels**

### Emissions by Scope<sup>2</sup>



## WHAT ARE EMISSIONS SCOPES?<sup>3</sup>

**Scopes 1, 2, and 3** are categories used to classify the different types of greenhouse gas (GHG) emissions generated by companies across their operations and value chains.

- Scope 1 refers to direct emissions (e.g., *GHGs from burning natural gas in an industrial boiler*);
- Scope 2 covers indirect emissions from purchased electricity (e.g., *GHGs from electricity used in office operations*);
- Scope 3 includes all other indirect emissions across the value chain — such as *those from suppliers and from the use of the company's products by customers*.

## REDUCING EMISSIONS INTENSITY RELIES ON THREE ESSENTIAL PILLARS<sup>4</sup>

### REDUCTION

- Focuses on energy efficiency and process optimization
- Includes project redesign and behavioral change incentives in operations
- Features low implementation barriers, with reduced CAPEX and early-stage project applicability

### REPLACEMENT

- Prioritizes replacing fossil fuels with low-carbon alternatives
- Particularly challenging to adapt existing assets and legacy infrastructure
- Requires the integration of new technologies and supportive policies to enable large-scale deployment and sustained decarbonization

### REMOVAL

- Involves capturing and storing emitted GHGs, mainly CO<sub>2</sub> and CH<sub>4</sub>
- Includes carbon sequestration technologies such as CCS (carbon capture and storage)
- Especially relevant for methane (CH<sub>4</sub>), which, though emitted in smaller volumes than CO<sub>2</sub>, has a significantly higher global warming potential

## EMISSIONS IN E&P

47%

Share of E&P in total oil and gas sector emissions (2023)<sup>1</sup>

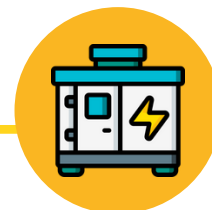
### TYPES OF EMISSIONS

Greenhouse gas (GHG) emissions in exploration and production (E&P) can be categorized in several ways. In this factsheet, emissions are classified **according to their source**. Thus, **4 types** are considered:

- Combustion
- Venting
- Flaring
- Fugitive emissions



Share by type of emission in total E&P emissions (CO<sub>2</sub>eq)<sup>1</sup>



70%

### COMBUSTION

Combustion emissions occur when **fossil fuels**, such as oil and gas, are **burned** to meet the energy demand of E&P operations. This process releases GHGs, mainly CO<sub>2</sub>. Combustion is used in engines, turbines, and heaters, and is the **main source of direct emissions** in E&P activities.

3%

### VENTING

Refers to the **intentional release of natural gas** directly into the atmosphere. It can occur in processing units, during maintenance, or to relieve pressure and ensure operational safety. **Methane**, the main component of natural gas, has a much higher Global Warming Potential (GWP) than CO<sub>2</sub>, increasing venting's environmental impact.

### FLARING

25%

Involves **burning natural gas in safety flares**, converting CH<sub>4</sub> into CO<sub>2</sub> — a greenhouse gas with lower global warming potential. It is a common **safety practice** in E&P and, although used as an **alternative to venting methane**, it still contributes to climate impacts.

### FUGITIVES

2%

**Unintentional gas leaks** — mainly methane — that occur during oil and gas operations. These leaks often happen in valves, connections, and pipelines, and are **harder to detect and control**. Despite being accidental, fugitive emissions significantly contribute to the sector's climate footprint.

### MITIGATION MEASURES

Emissions mitigation in E&P involves **strategies to reduce GHG releases**, including preventing methane venting, minimizing unnecessary flaring, and controlling fugitive emissions. Adopting more efficient operations and continuous, rigorous monitoring is essential to **lower emissions intensity**.

### CNPE RESOLUTION 08/2024

Assigns EPE the task of proposing measures to support the decarbonization of oil and gas E&P activities, including a study with scenarios and the expected impacts of these measures.

**The emission activities presented on this page and the mitigation measures outlined in this Factsheet are part of that study, which will be made publicly available in accordance with the Resolution's timeline.**



# THE SUITABILITY OF EACH MEASURE DEPENDS ON ITS SPECIFIC OBJECTIVE AND THE OPERATIONAL CONTEXT...

## ELECTRIFICATION



Replacing gas-powered equipment with electric motors **reduces combustion-related emissions**, whether through higher efficiency or sourcing low-carbon electricity. It also **reduces fugitive emissions** by eliminating gas-handling components. While the benefits are clear, **economic and technological challenges remain**.

## COMBINED-CYCLE GAS TURBINES (CCGT)



In **energy-intensive upstream operations**, coupling conventional open-cycle gas turbines with a Heat Recovery Steam Generator (HRSG) to power a steam turbine forms a combined-cycle system. This setup increases efficiency, **reducing fuel consumption and GHG emissions** per unit of energy produced.

## ROUTINE FLARING REDUCTION/ELIMINATION



Brazil's **ANP Resolution No. 806 prohibits routine flaring/venting** of non-associated gas and oil (exceptions apply). Associated gas flaring is limited to 2% (offshore units commissioned from Jan 2025) and 3% (onshore or offshore commissioned before 2025). **Stricter operational controls and infrastructure are key to eliminating routine flaring.**

## GAS VENTING MANAGEMENT



Several operational measures and equipment can significantly reduce venting. **Vapour Recovery Units (VRUs)** effectively capture gases from **storage tanks** and other low-pressure vented sources across O&G operations. If recovery is not feasible, routing gas to a flare is environmentally preferable to direct venting, avoiding direct methane emissions.

## FLARING SYSTEMS AS METHANE MITIGATION

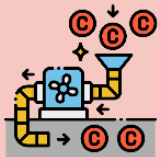


Venting typically occurs during upset conditions or maintenance in E&P operations. Since **methane has a far greater GWP** than carbon dioxide, **flaring** – which combusts most CH<sub>4</sub> to CO<sub>2</sub> – is generally **preferred from a climate perspective**. However, flaring should only be adopted **when gas recovery or reuse systems are neither technically nor economically feasible**.

## GAS RECOVERY FROM PIPELINE OPERATIONS



To maintain optimal gas flow, hydrocarbon-rich liquids, or condensate, formed within pressurized gas pipelines, are removed through **"pigging" operations**. During this process, **condensates and methane-rich gases are often vented** from pipelines and can be captured using vapor recovery systems or routed to central processing facilities.



## CCUS

CCUS technologies can be deployed across various stages of the O&G value chain, targeting different emission sources and **supporting net-zero goals**. The industry may benefit from shared infrastructure with **hard-to-abate industries**. Capture can occur pre- or post-combustion, or via Direct Air Capture (DAC), with a notable application being the **capture of CO<sub>2</sub> from natural gas processing**.

## PNEUMATIC DEVICE REPLACEMENT



**Pneumatic controllers**, powered by pressurized natural gas, are common sources of methane emissions through the **release of CH<sub>4</sub> from leaks** that are often difficult to detect and repair. **Replacing them with instrument air systems or mechanical alternatives** eliminates vented gas from these operations.



## LDAR



**Leak Detection and Repair (LDAR)** refers to the process of identifying, quantifying, and fixing leaks that result in **fugitive emissions** across facilities. Technologies include optical gas imaging, sniffers, drones, and satellites. **Frequent, systematic LDAR campaigns** are critical for reducing emissions in E&P operations.

### WHY IS IT RELEVANT?

Reducing GHG emissions is a goal **applicable to all Exploration and Production projects.**

However, **understanding the stage** of an E&P project is **crucial** for selecting the **most fitting mitigation measures.**

Projects fall into **two categories:** those still in the planning phase (**greenfield**) and those already in operation (**brownfield**).

### GREENFIELD PROJECTS



#### Greater flexibility

Since these projects are in the planning phase, there is more freedom to define strategies and technical specifications or to incorporate innovations.



#### Higher initial investment and longer payback time

These projects require substantial upfront capital and take more time to become operational.

### BROWNFIELD PROJECTS



**Reutilizing existing infrastructure** can reduce costs and shorten the time to become operational



**Design flexibility is limited** to solutions compatible with the constraints of the existing structure.



Even in assets not originally designed to operate with mitigation measures in place, it is possible to develop **flexible infrastructure** with **future adaptations** in mind. This approach enhances operational flexibility and extends the asset's lifespan, reducing the need for new investments and retrofitting. This strategy is particularly important for **offshore projects.**



#### Feasibility of Integration with Existing Infrastructure

Assess whether the measure can be incorporated into already constructed facilities, requiring minimal adaptations to technology and operational processes



#### Cost-Effectiveness

Prioritize measures that offer the best cost-benefit ratio, especially in projects with limited budgets, to achieve maximum emissions reduction at the lowest possible cost



#### Availability of Technological Expertise

Verify whether there is an existing team with the necessary expertise or if specific training will be required to ensure effective and safe deployment



#### Regulatory Framework and Incentives

Identify which measures are regulated or incentivized, considering the evolving legal and regulatory framework



#### Return on Investment Timeline

Consider the timeframe for the measure to begin generating economic or environmental returns and evaluate whether it aligns with the goals of the project and E&P operations



#### Environmental and Social Impact

Analyze the potential positive impact of the measure on the environment and local communities, especially in environmentally sensitive areas or those projects near populated regions

Stay tuned for more updates from EPE:



The measures presented are part of the studies EPE conducted to comply with CNPE Resolution No. 8/2024



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