Global Gas Flaring Tracker Report

MARCH 2023

GGFR
Global Gas Flaring Reduction Partnership

THE WORLD BANK
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Foreword

After a decade of little progress, global gas flaring volumes fell by around 3% in 2022. However, despite this welcome reduction, greater and sustained efforts are needed to end this wasteful and polluting practice.

The growing sense of urgency in tackling global gas flaring is further fueled by an increased concern regarding the amount of methane emitted during flaring. This year, our Global Gas Flaring Tracker Report considers the 'state of the science' and the uncertainty surrounding methane destruction efficiency of flares. It draws the worrying conclusion that, globally, CO_2 equivalent emissions due to flaring could be higher than previously estimated.

The global gas flaring estimates that we produce yearly allow us to better understand the evolving situation and what we—as a partnership of governments, companies, and multilateral organizations—must do to end routine gas flaring by 2030.

This year's Global Gas Flaring Tracker Report, a leading global and independent indicator of gas flaring, finds that 139 billion cubic meters (bcm) of gas was flared at upstream oil and gas facilities across the globe in 2022. This wasted gas could displace dirtier sources of energy and increase energy access in some of the world's poorest countries. Routine gas flaring also represents a lost opportunity to provide many countries worldwide with much-needed energy security.

Indeed, energy security has been a critical consideration throughout 2022, and reassuringly our estimates find that even as many countries have shifted away from importing Russian oil and gas, this has not resulted in a noticeable increase in Russian flaring. At the same time, we find that the energy sources that many countries are turning to have, in many cases, been produced by countries who are also taking steps to reduce their gas flaring.

Three countries—Nigeria, Mexico, and the United States—accounted for most of the decline in global gas flaring in 2022, with two other countries—Kazakhstan and Colombia—standing out for consistently reducing flaring volumes in the last seven years.

Two developing countries—Algeria and Egypt—also give us hope that progress on gas flaring reduction will accelerate as key ingredients for success, such as effective regulation, political will, and infrastructure are put in place. In both countries, we see noteworthy flaring reductions over the last few years but, perhaps more importantly, there are clear opportunities and efforts to further reduce flaring and utilize associated gas.

We urge all governments and operators to carefully assess how they produce oil and gas and identify and seize opportunities for effective and long-term flaring reduction. It is our hope that governments and operators will use the data and insights in this report to kickstart projects in their countries and make investments in gas flaring and venting reduction a key priority, significantly contributing to emissions reduction, energy security, and energy access in the process.

Zubin Bamji
Program Manager
Global Gas Flaring Reduction Partnership
World Bank

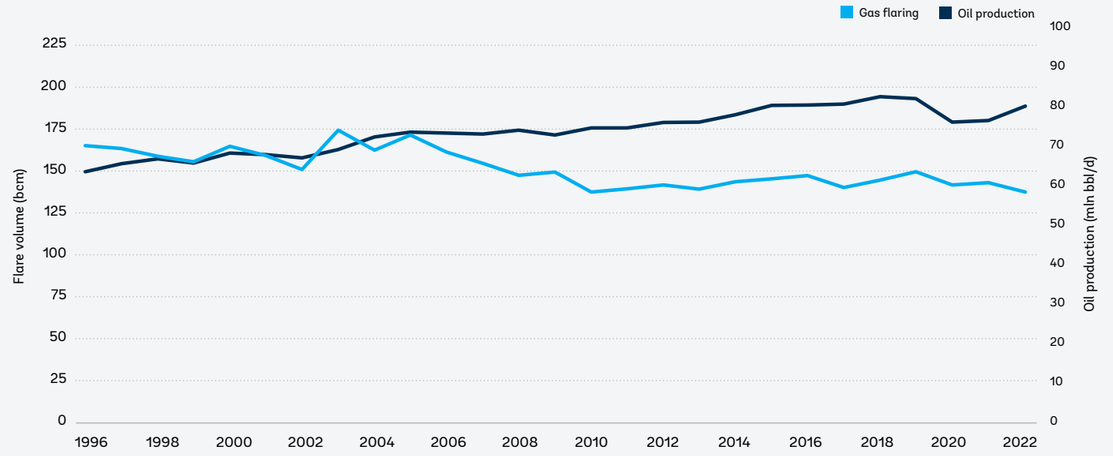
Global Perspective

During 2022, global gas flaring reduced by 3% from 144 bcm in 2021 to 139 bcm, according to satellite-based estimates. In the same period of time, oil production increased by 5% from 77 million barrels per day (bbl/d) in 2021 to 80 million bbl/d in 2022[1]. This decoupling of gas flaring and oil production is notable and led to a reduction in the global average flaring intensity, the amount of gas flared per barrel of oil produced, from 5.1 cubic meters of gas flared per barrel of oil produced (m^3/bbl) in 2021 to 4.7 m^3/bbl in 2022.

Nigeria contributed the most to the overall global reduction, reducing its flare volumes by 1.3 bcm in 2022, a 20% reduction from 2021 levels. This was largely attributable to a 14% decline in oil production during the same period, although Nigeria did experience a slight improvement in its flaring intensity, reducing from 11.8 m^3/bbl in 2021 to 11.1 m^3/bbl in 2022.

There was also a reduction of flaring in Mexico of around 0.8 bcm, a 13% reduction from 2021 levels. This reduction occurred mainly in the offshore fields of Ku-Maloop-Zaap (KMZ) and Akal (part of the Cantarell complex), which together experienced a 0.45 bcm reduction, and in the Cactus conventional oil field onshore, which experienced a 0.3 bcm reduction. We understand these reductions are a result of the shutting-in of wells with high gas-to-oil-ratios (GOR). Indeed, flaring in these fields alone has reduced by over 1 bcm in the past two years due to this welcome policy change in GOR control. Overall oil production levels did not materially change in Mexico during 2022, and this decrease in flaring led to an improvement in Mexico's flaring intensity from 10.3 m^3/bbl in 2021 to 9.0 m^3/bbl in 2022.

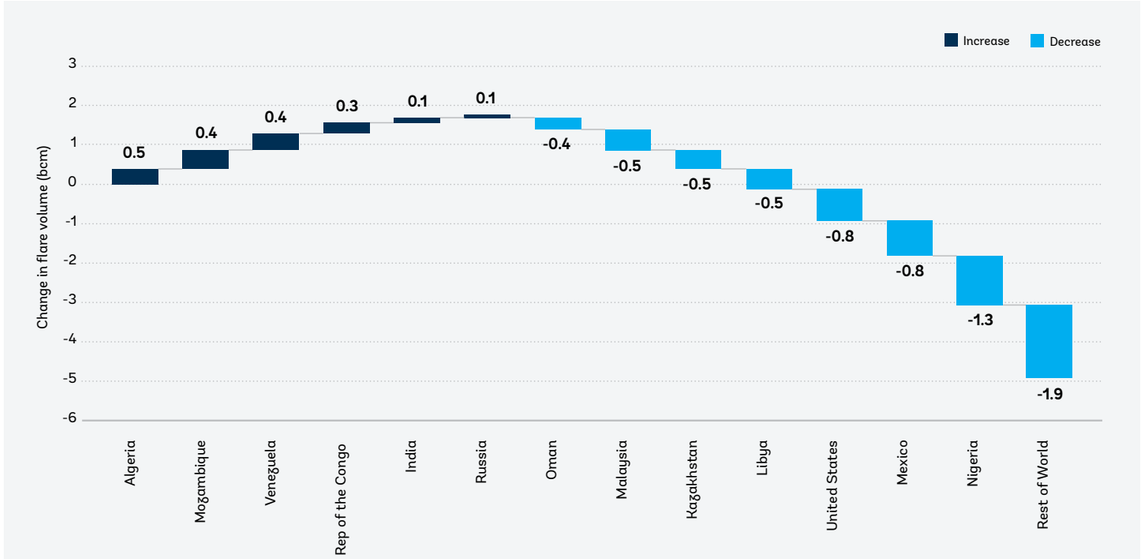
Figure 1 Global gas flaring and oil production 1996 to 2022 (flaring at upstream oil and gas and LNG plants only)



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

1 Oil production data from the United States Energy Information Administration (EIA) as reported through November 2022, with estimates for December.

Figure 2 Change in flare volume between 2021 and 2022, individual countries with significant change indicated, rest of world combined, overall global reduction of around 5 bcm



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

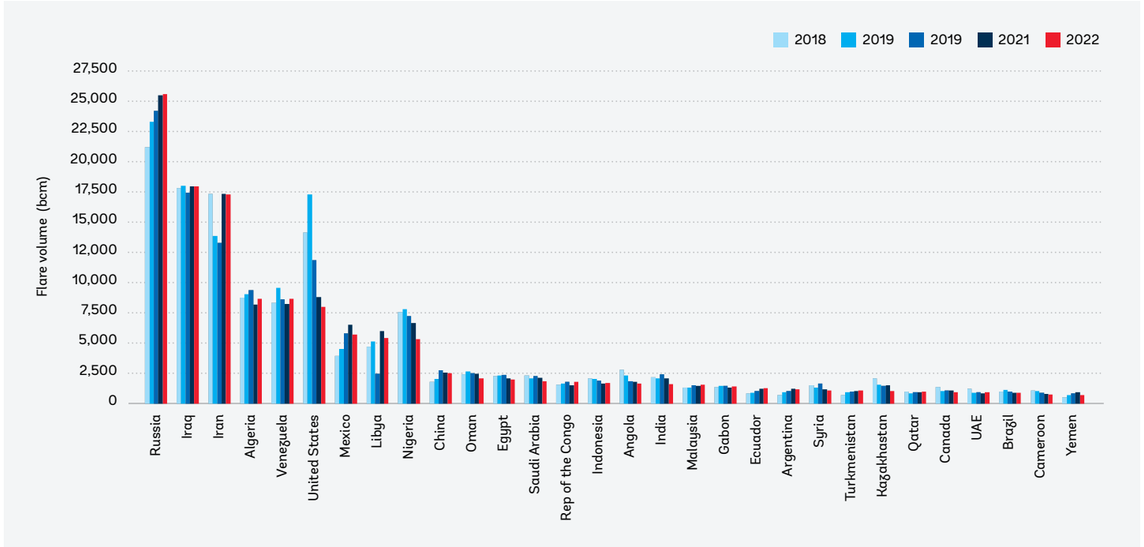
The United States (US) continued to make steady progress and achieved a 9% (0.8 bcm) reduction in flaring from 2021 to 2022. Moreover, in 2022, the United States also significantly increased oil production by 18%, which led to a reduction in its overall flaring intensity from 2.1 m^3/bbl to 1.8 m^3/bbl, the lowest value recorded for the United States in the last ten years.

Also noteworthy are two countries—Kazakhstan and Colombia—both spotlight countries in last year's tracker report who have consistently, for the last seven straight years, achieved a decline in flare volumes.

Consistent with previous years, flaring during 2022 was dominated by a relatively small number of countries, with the top nine flaring countries responsible for 74% of flare volumes and 45% of global oil production. These are, in order, Russia, Iraq, Iran, Algeria, Venezuela, the United States, Mexico, Libya, and Nigeria.

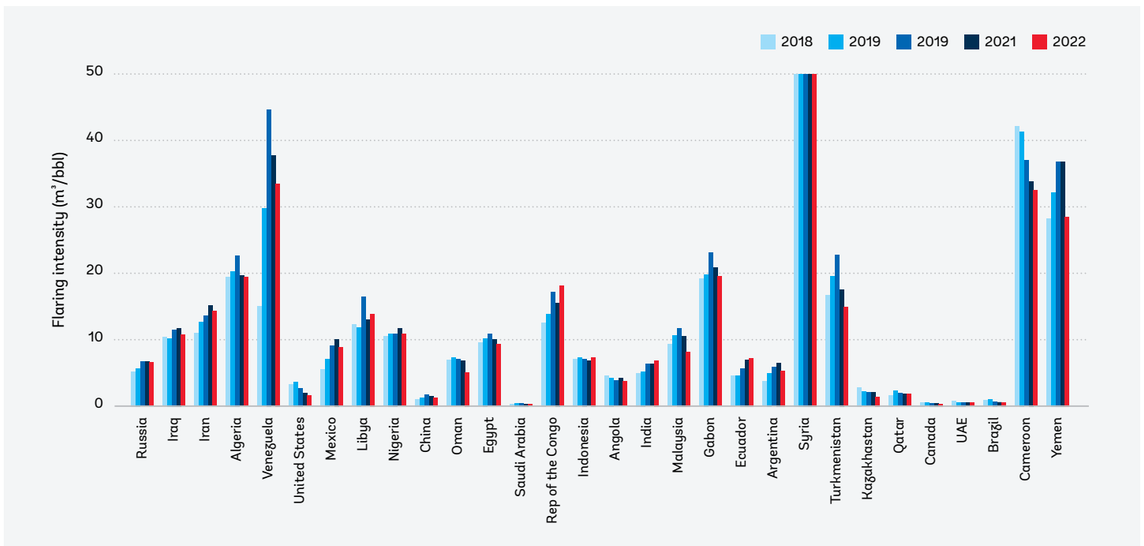
When we look at flaring intensity, in particular the trends over the last five years, the Republic of Congo, India and Ecuador have steadily increased flaring intensity year-on-year. In addition, as in previous years, the highest flaring intensities continued to be in fragile and conflict-affected countries, such as Syria, Venezuela and Yemen. Notably, both Venezuela and Yemen experienced a decrease in flaring intensity from 2021 to 2022.

Figure 3 Flare volumes for the top 30 flaring countries from 2018 to 2022 (sorted by 2022 flare volume)



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Figure 4 Flaring intensity for the top 30 flaring countries from 2018 to 2022 (sorted by 2022 flare volume)



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

The Russian Invasion of Ukraine & the Impact on Gas Flaring

During 2022, European energy security has been at the forefront of policymakers' agendas, following Russia's invasion of Ukraine in February 2022. This report asks two key questions relevant to the critical and interrelated issues of energy supply and gas flaring as a consequence of the invasion:

1) If Europe is reducing its gas imports from Russia, is Russia resorting to flaring this gas instead?

2) Has there been a notable change in gas flaring in other countries as they increase gas exports to Europe?

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Gas Flaring in the Russian Federation

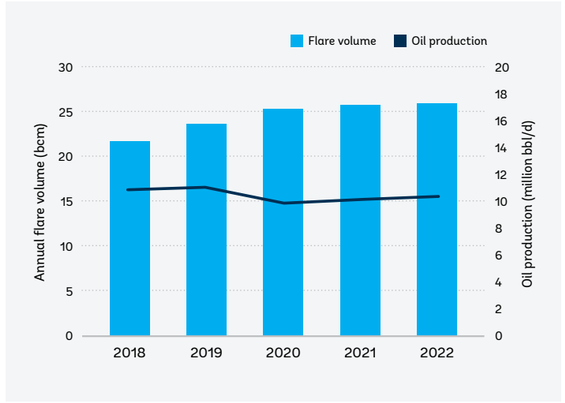
During June and July 2022, Gazprom dramatically reduced gas flows to Europe via the Nord Stream pipeline system, ostensibly due to prolonged maintenance issues with a critical compressor station. During August 2022, the system was operating at around 32 million cubic meters of gas per day (mcm/day), just 20% of its maximum capacity. In late September, pipeline operations were halted completely after a subsea explosion and, at the time of writing, have yet to be restarted.

In 2021, Russia was one of the largest gas exporting countries in the world, exporting around 210 bcm via pipeline and some 40 bcm in the form of liquified natural gas (LNG). Of its pipeline exports, Nord Stream accounted for around 58 bcm in 2021, some 28% of total pipeline exports. So, with a significant reduction in gas exports through the summer of 2022, culminating in the total shutdown of Nord Stream in late September, has this led to an increase in gas flaring in Russia?

Perhaps contrary to some expectations, there has not been an observable increase.

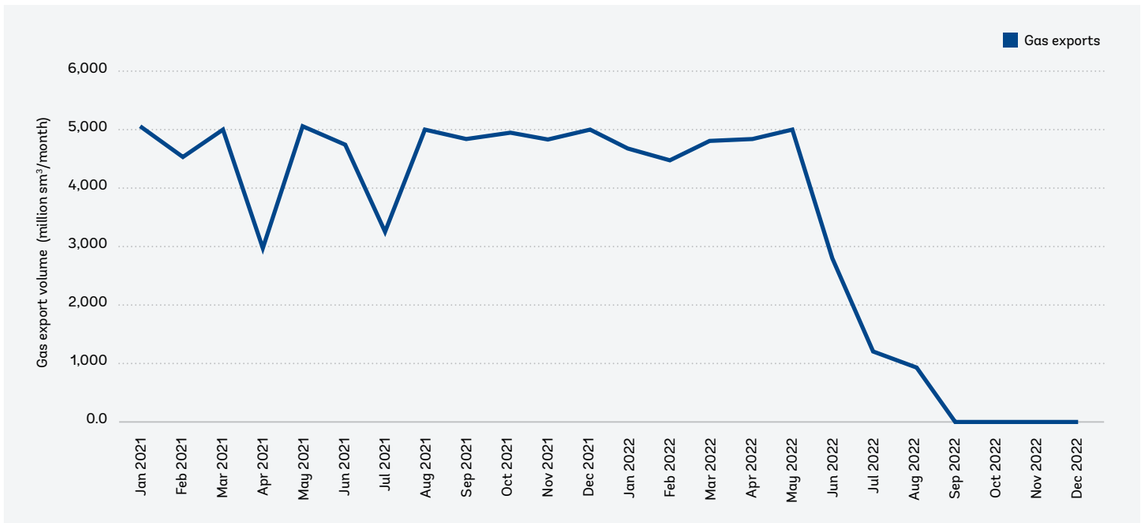
Considering annual total flaring volumes, Russia's flare volumes were largely static between 2021 and 2022, while oil production increased slightly by 2%. This led to a marginal decrease in Russia's flaring intensity from 6.9 m^3/bbl in 2021 to 6.8 m^3/bbl in 2022.

Figure 5 Russian annual flare volume and oil production, 2018 to 2022



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Figure 6 Monthly gas imports to Europe (Germany) via the Nord Stream pipeline



Source: IEA Gas Trade Flows, 17 February 2023

Photo credit: ©Leonid Eremeychuk / Shutterstock

Gas Flaring in Key Gas Exporting Countries

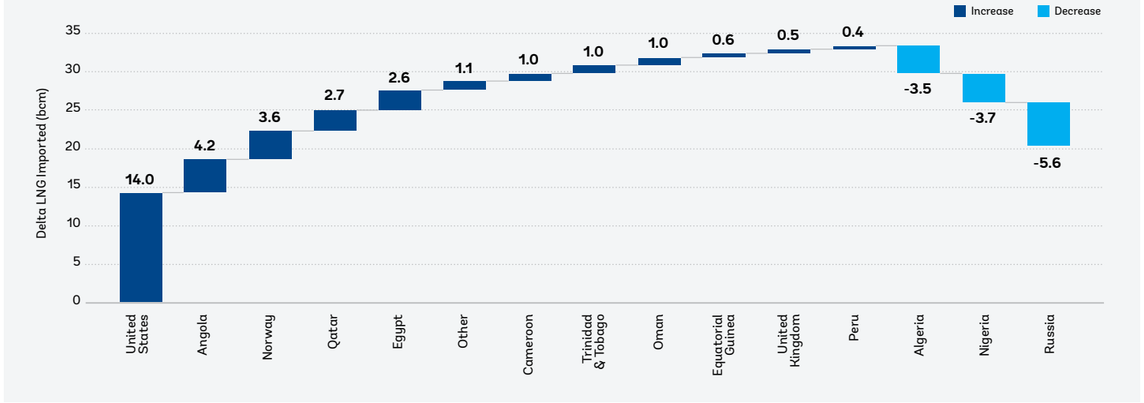
In 2021, Russian gas exports accounted for around 45% of the total gas supply to the European Union (EU). Over the course of 2022, the gas imports mix of the EU shifted dramatically, with several oil- and gas-producing nations increasing their gas supply to the EU, both via pipeline and, in the form of LNG.

Most notably, the EU has significantly increased its gas imports in the form of LNG from the United States, Angola, Norway, Qatar, and Egypt, and via pipeline from Azerbaijan and Norway.

In addition to the significant reduction in gas imports from Russia, there has also been a decrease in overall gas imports via pipeline from Algeria and via LNG from both Nigeria and Algeria.

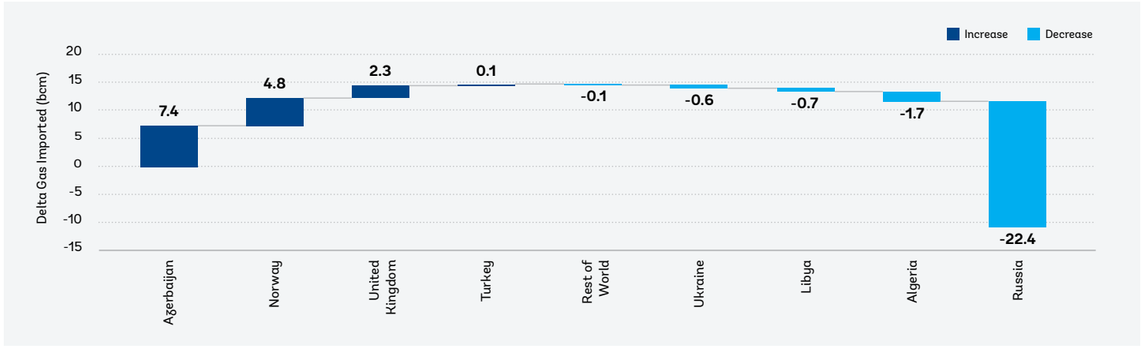
In the following sections, we spotlight a few countries that export gas to the EU and examine their progress to date on flare reduction and the opportunity that increased demand for gas from these countries presents.

Figure 7 Change in LNG imports from various gas exporting countries to the EU between 2021 and 2022
(year-to-date November comparison as this is the latest data available for 2022)



Source: UN Comtrade

Figure 8 Change in EU pipeline gas imports from various gas exporting countries between 2021 and 2022
(year-to-date November comparison as this is the latest data available for 2022)



Source: UN Comtrade

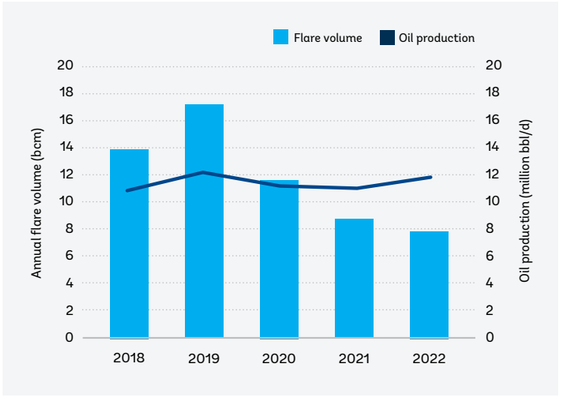
Opportunities Seized

Spotlight: United States

Between 2021 and 2022, the United States decreased its flaring by 9% and reduced its flaring intensity from 2.1 m^3/bbl to 1.8 m^3/bbl, a 14% reduction and the lowest value recorded for the United States in the last ten years. This suggests a continuation of the significant progress made by the United States (discussed in our 2022 Flaring Tracker Report) to expand its integrated gas value chain and to commercialize more associated gas. During 2022, there was also an increase in LNG export globally from the US with a marked increase in the portion of those exports going to Europe from early 2022 onwards.

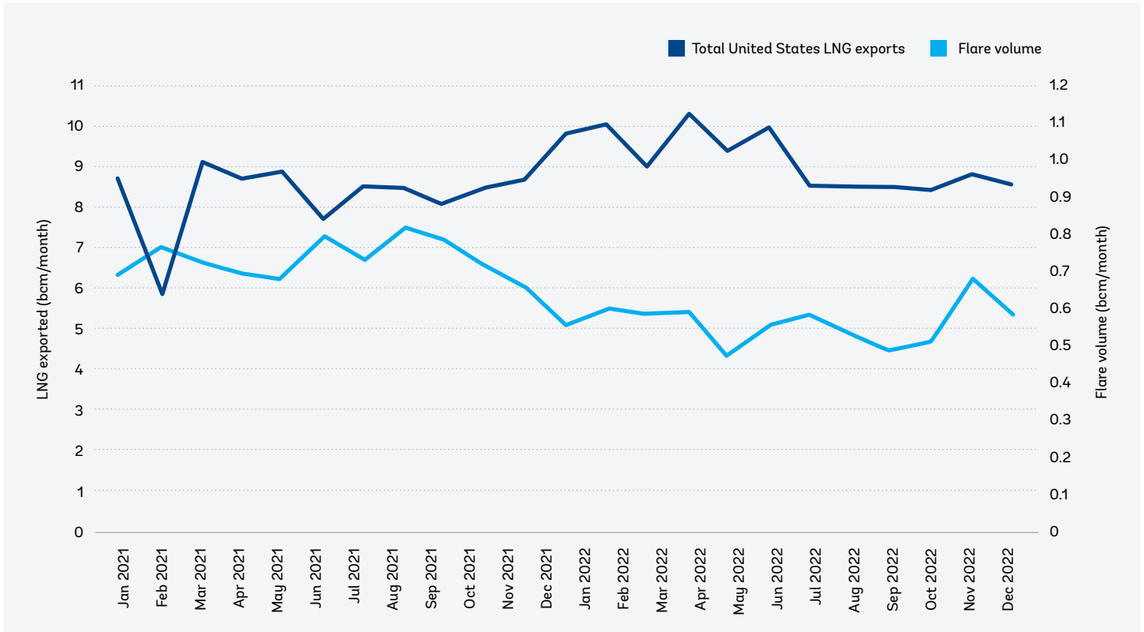
The United States demonstrates the results that can be achieved when private companies (upstream, midstream, and downstream) seek to capitalize on gas market opportunities and are supported by strong regulation on flaring.

Figure 9 United States annual flare volume and oil production, 2018 to 2022.



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Figure 10 United States monthly LNG exports and monthly total flare volume, 2021 to November 2022



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Spotlight: Angola

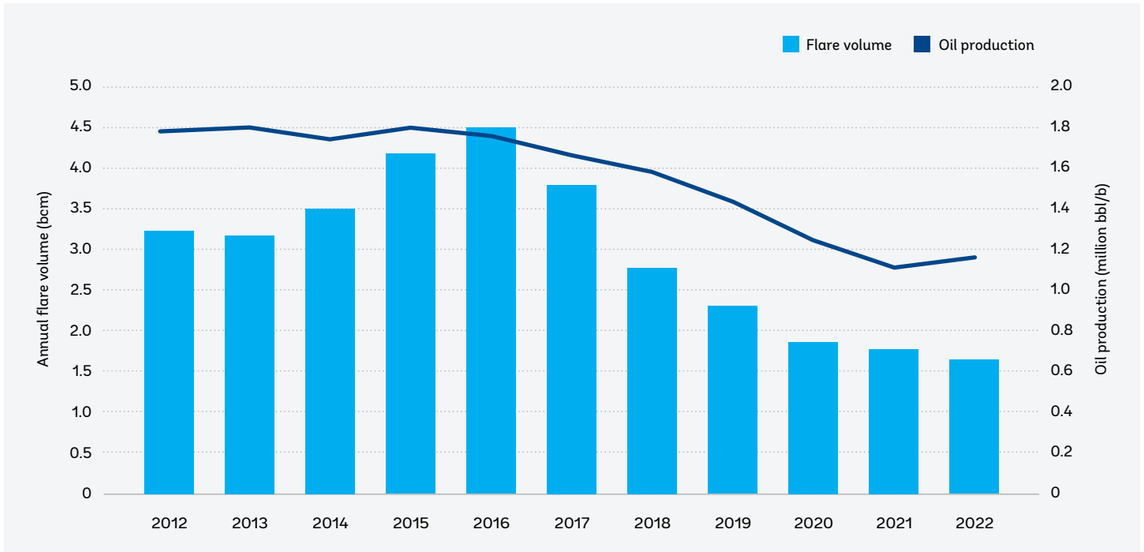
During 2022, the EU increased its LNG imports from Angola by 4.2 bcm. LNG in Angola is produced at the Angola LNG (ALNG) facility located in Soyo, a joint venture between operators Chevron, Azule Energy (a joint venture between bp and Eni), TotalEnergies and Sonangol, Angola's national oil company. ALNG is one of the only major LNG facilities in the world developed to produce LNG exclusively using associated gas as a feed gas. Before ALNG's development, significant volumes of associated gas were wastefully flared at the upstream oil production facilities offshore. These facilities now feed associated gas into ALNG.

After starting operation in 2013, ALNG was shut down between April 2014 and June 2016 to repair design flaws. However, since its restart in 2016, the impact of ALNG on Angola's flare volumes and flaring intensity has been marked and demonstrates the tremendous progress and value that can be realized when the government, the national oil company and the private sector work together to deliver solutions to reduce gas flaring.

Figure 11 Schematic showing offshore blocks feeding associated gas into ALNG

Source: ANLG

Figure 12 Angola flare volume and oil production, 2012 to 2022



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Opportunities Remain

Spotlight: Egypt

During 2022, the EU also increased LNG imports from Egypt, a country which has experienced an increase in gas production and export over recent years, thanks to significant gas discoveries such as the offshore Zohr field in 2015 and, more recently, the Nagris block in late 2022. Egypt exports gas in the form of LNG from its Idku and Damietta liquefaction plants.

During this time of increased gas production, Egypt has also been successful in reducing its gas flaring, having achieved a reduction in annual flare volumes for the last three years. During 2022, Egypt successfully reduced flaring while also increasing oil production, leading to a reduction in Egypt's flaring intensity from 10.2 m^3/bbl in 2021 to 9.5 m^3/bbl in 2022.

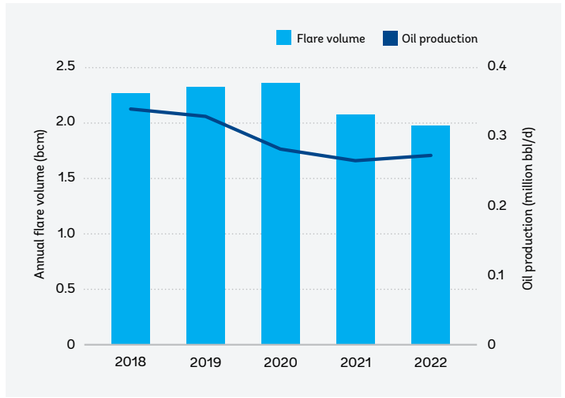
There have been several investments in infrastructure to both recover and utilize associated gas in Egypt. One example is at the Petrosannan-operated Alam El Shawish area of the Western Desert. Flaring has been dramatically reduced since 2018 due to investments in additional pipeline infrastructure (commissioned in June 2019) and the installation of a gas-boosting compressor at the HG field to recover additional associated gas in 2020.

Given Europe's increased and sustained demand for natural gas from countries other than Russia, Egypt has a tremendous opportunity to continue its success in reducing flare volumes and utilize its existing LNG infrastructure to commercialize associated gas.

Flare-to-power Activities

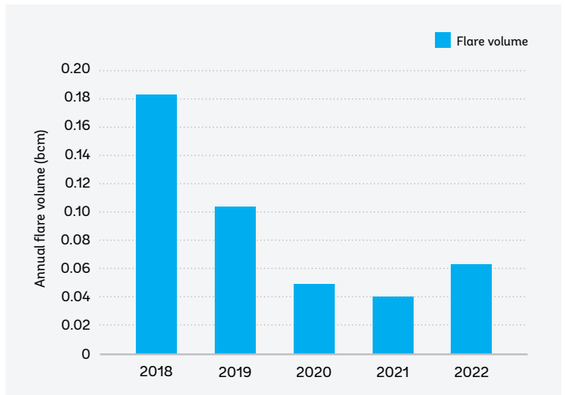
Additional flare reduction activities in Egypt include efforts by operators such as Petrosilah and Khalda Petroleum Company to implement gas-to-power projects. At the El Fayum and Kalabsha fields, respectively, flare gas has been recovered and used to generate electricity to supply both the production facilities and the local community. Not only have these projects reduced gas flaring but, by displacing a more carbon-intensive fuel such as diesel with gas, there is also an emission reduction benefit.

Figure 13 Egypt flare volume and oil production, 2018 to 2022.



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Figure 14 Evolution in flaring at PetroSannan-operated fields in the Western Desert region due to improved gas takeaway infrastructure, 2018 to 2022.



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Spotlight: Algeria

Perhaps surprisingly, Algerian LNG and pipeline exports to the EU experienced an overall decrease between 2021 and 2022. The reduction in pipeline exports was mainly due to the cessation of operations of the Gazoduc Maghreb Europe (GME) pipeline Q4 2021, which fed gas into Spain and Portugal with a capacity of 12 bcm/year.

Flare volumes in Algeria increased slightly during 2022. However, despite this, Algeria has had some success reducing flare volumes over recent years, having achieved a reduction in both flare volume and flaring intensity between 2020 and 2021 and a continued improvement in flaring intensity through 2022.

This reduction in flaring intensity is understood to be the result of several investments in associated gas recovery at key oil-producing sites in Algeria over the last few years. For example, in the oil-producing region of Hassi Messaoud, the largest in Algeria, the national oil company Sonatrach has made several facility upgrades and improvements to increase the recovery and reinjection of associated gas into the wells and debottleneck processing facilities. Satellite observations suggest a 44% decrease in gas flaring at Hassi Messaoud since 2020.

As is the case for Egypt, recovery of associated gas volumes and inclusion in gas export systems (both LNG and pipeline) presents a potential opportunity for Algeria to reduce its gas flare volumes and generate revenues from this otherwise wasted energy resource.

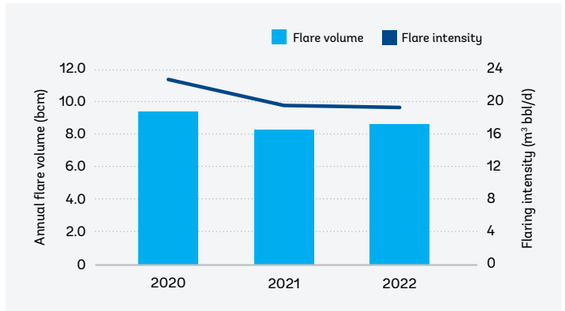
Promising Developments

During 2022, Sonatrach also signed agreements that include extensive investments in flare reduction at the In Salah/In Amenas fields (partners Eni and Equinor) and blocks 404 and 208 (partners Eni, Oxy, and TotalEnergies) to bring additional gas into the national gas infrastructure to supply both the domestic and export gas markets.

Figure 15 Algerian Gas Pipelines into Europe

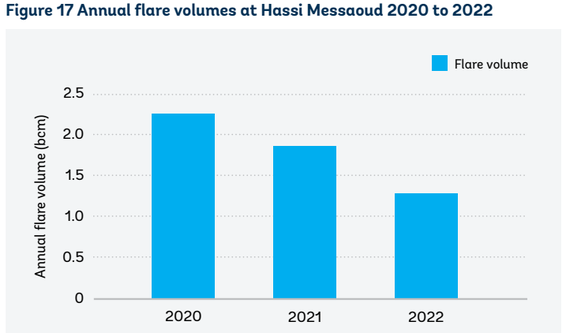
Source: S&P Global Platts Analytics

Figure 16 Algeria flare volume and flare intensity, 2018 to 2022.



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Figure 17 Annual flare volumes at Hassi Messaoud 2020 to 2022



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Photo credit: © Leonid Ikan / Shutterstock

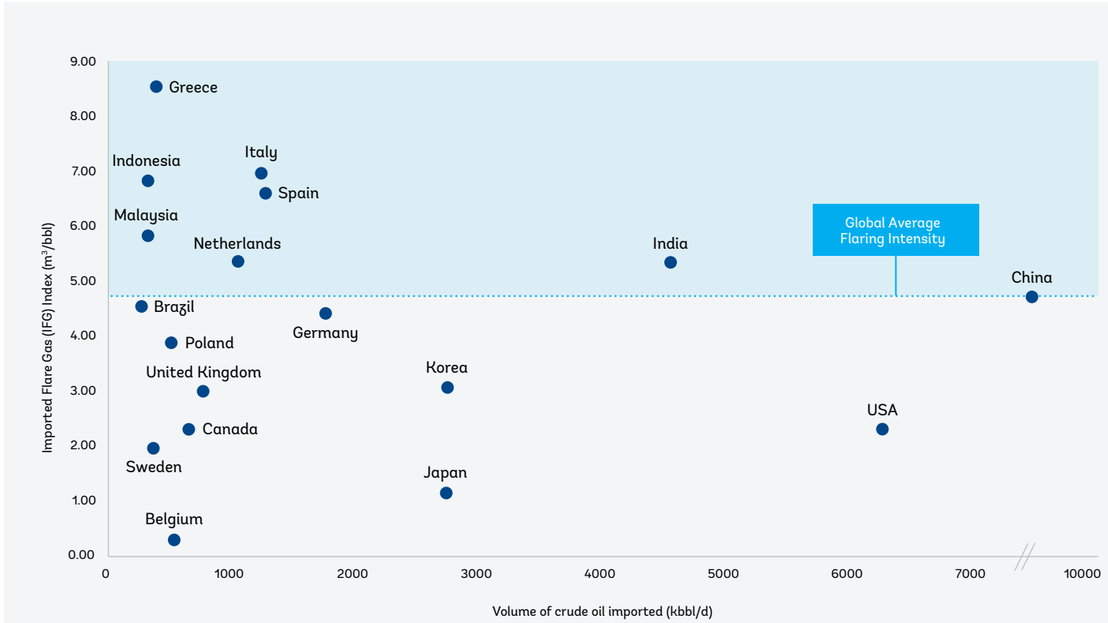
Imported Flare Gas Index

In addition to flare volume and flaring intensity, GGFR also tracks the Imported Flare Gas (IFG) Index of crude-importing countries. The IFG Index highlights the flaring consequences of crude oil imports, underscoring the burden of responsibility for flaring reduction between both countries that produce and the countries that import the crude oil. It is based on the premise that if a country is importing crude oil from producing countries, it is also importing the flaring intensity of these producing countries in proportion to the amount of crude oil imported.

Analysis of 2022 data indicates that, as with previous years, many countries that import significant volumes of crude oil, such as Greece, Italy, Spain, and the Netherlands, are 'exposed' to high levels of gas flaring as they import crude from countries with a high flaring intensity, such as Algeria, Libya, and Iraq.

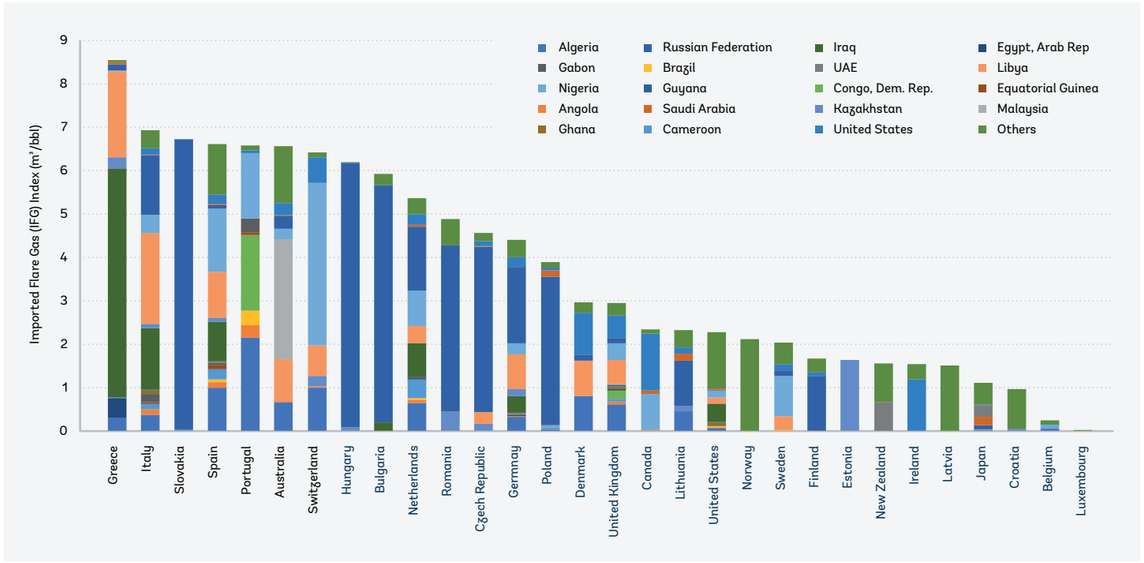
Photo credit: © Alejandro Solo / Shutterstock.

Figure 18 IFG Index versus volume of crude oil imported for countries importing more than 250 kbbl/d)



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, UN Comtrade, JODI, GGFR

Figure 19 IFG Index of Annex 1 countries



Source: NOAA, Payne Institute and Colorado School of Mines,, EIA, UN Comtrade, GGFR

However, during 2022 many of the Annex 1 countries[2] that import crude oil experienced a decrease in their IFG Index due to importing a larger share of crude oil from countries with lower flaring intensities during 2022. For example, Australia decreased its IFG Index from 9.1 m^3/bbl in 2021 to 6.6 m^3/bbl in 2022, a decrease of 2.5 m^3/bbl. This decrease can be attributed mainly to a decrease in crude oil imports from Malaysia, which has a relatively high flaring intensity (8.8 m^3/bbl in 2022), and an increase in imports from the United States, which has a relatively low flaring intensity (1.8 m^3/bbl in 2022).

Conversely, Portugal experienced the largest IFG Index increase, with values rising from 4.8 m^3/bbl in 2021 to 6.5 m^3/bbl in 2022. This was due to a decrease in crude oil imports from Nigeria and the United States (flaring intensities 11.1 and 1.8 m^3/bbl respectively in 2022) and an increase in imports from Algeria and the Democratic Republic of Congo (19.5 and 25.6 m^3/bbl respectively in 2022).

The IFG Index can help oil-importing countries assess flaring hotspots in their fossil fuel supply chain. This should lead to a dialogue with the countries from which they import oil and potentially to collaborate in implementing flaring reduction initiatives, thereby significantly improving the carbon emissions intensity of the oil they import.

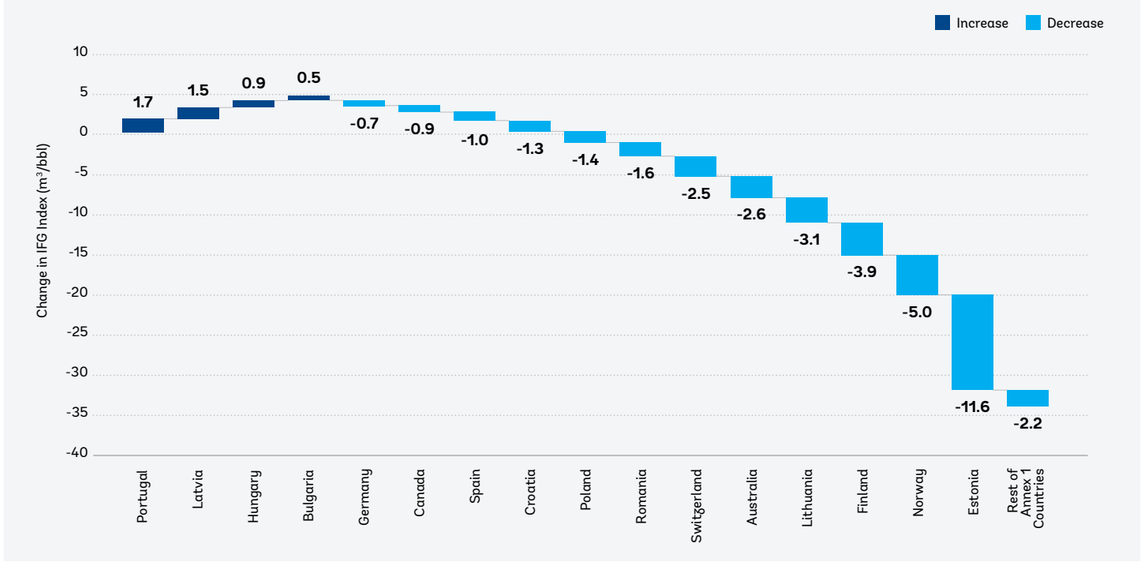
IFG Index Formula

The IFG Index of a crude-importing country is calculated using the formula below:

IFG Index of crude importing country X (m^3/bbl) = Σ fraction of crude imports from country Y * flaring intensity of country Y

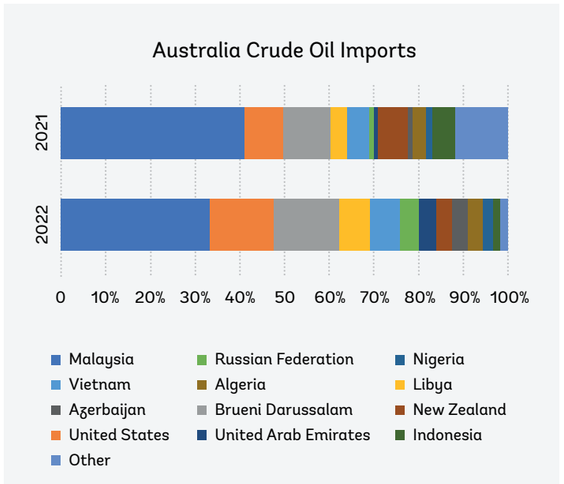
2 Annex 1 countries are the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) that are listed in Annex 1 of that framework. They are classed as 'industrialized (developed) countries and economies in transition'. IFG Index analysis uses latest available data on crude oil imports from UN Comtrade. At the time of writing, data was not available for Austria, Belarus, France and Russia. These four countries are consequently missing from our analysis.

Figure 20 Change in Imported Flare Gas (IFG) Index for Annex 1 Countries between 2021 and 2022



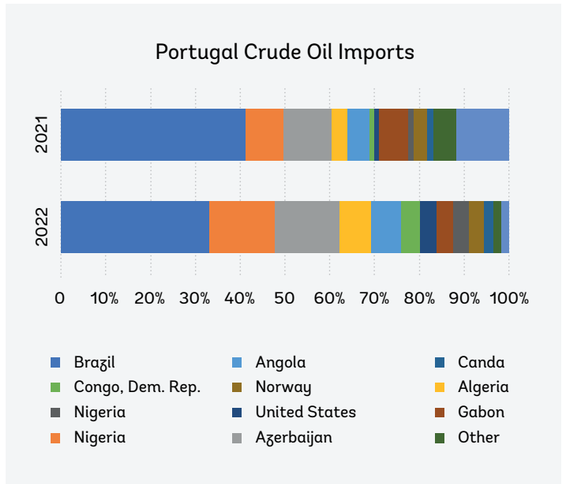
Source: NOAA, Payne Institute and Colorado School of Mines, EIA, UN Comtrade, GGFR

Figure 21 Relative share of crude oil imports to Australia during 2021 and 2022



Source: UN Comtrade

Figure 22 Relative share of crude oil imports to Portugal during 2021 and 2022



Source: UN Comtrade

Flaring & Methane: The Ongoing Challenge

Flares are a direct source of methane emissions, but by how much is not well understood.

Typically, greenhouse gas (GHG) estimates of gas flaring emissions are based on two core assumptions:

1) that flares have a methane destruction efficiency of 98%, resulting in 2% of the methane in the flare gas stream being emitted to the atmosphere un-combusted; and

2) that flares are lit and operating properly 100% of the time.

These assumptions, used widely for decades across the oil and gas industry, have formed the foundation of estimates of GHG emissions from flaring. However, until recently, neither of these assumptions had been rigorously tested in real-world operational environments.

The 98% value for flare destruction efficiency is attributed to controlled studies conducted on behalf of the United States EPA as far back as the 1980s. To date, flare destruction efficiency has not been widely field-tested because direct measurement in real-world environments is highly complex and problematic. However, given its importance in understanding the methane emissions associated with flaring, it has become a critical area of research.

In September 2022, a paper[3] was published in Science detailing the findings of a field campaign in the United States to measure flare destruction efficiency. Over several months, researchers sampled the emissions from over 300 flares at onshore oil and gas production facilities in the Permian, Eagle Ford, and Bakken basins. They found that the flares sampled had an average destruction efficiency of 95.2%, considerably lower than the default 98% commonly used.

In a complementary study, the researchers also found that 3.2% of the flares assessed in the Bakken were operating unlit, i.e., directly venting gas, including methane, to the atmosphere. Using these findings and building on an earlier study[4] in the Permian that found that 5% of the flare assessed were unlit, the study estimates an average of 4.1% of flares may typically be unlit across all three basins.

Bringing together the measured destruction efficiency of 95.2% and the prevalence of unlit flares, the researchers suggest that flares in the Permian, Eagle Ford, and Bakken actually operate with an 'effective' destruction efficiency of 91.1%.

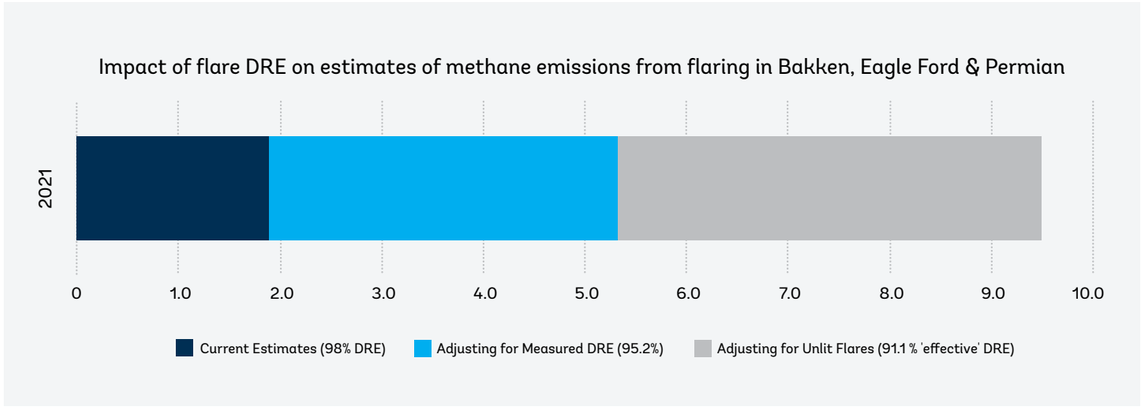
If the findings of these studies are typical for all gas flaring in the United States, it would have significant implications. The study shows it would increase estimates of methane from flaring by as much as five times current estimates reported under the United States Greenhouse Gas Reporting Program (GHGRP) using the default 98% destruction efficiency.

The research also raises important questions about the operation of flares globally. If these findings are widespread across industry, the true scale of the contribution of gas flaring to methane emissions could be grossly underestimated. In its annual methane tracker report, IEA suggests that, globally, flares operate with a methane destruction efficiency of closer to 92% when factors such as operation and maintenance of flare systems are taken into account. The IEA estimate is similar to the findings of the United States study above. Further research is needed to test both the destruction efficiency and the prevalence of unlit flares globally.

Methane

Methane, the primary component of natural gas, is a potent but short-lived greenhouse gas, with a warming potential up to 84 times that of carbon dioxide on a 20-year basis. Reducing methane emissions is one of the most important climate actions we can undertake in the short term. The oil and gas industry is a significant source of methane emissions globally. Emissions arise due to fugitive losses from equipment, venting of gas during both normal operations and upset conditions, and due to incomplete combustion during gas flaring.

Figure 23 Increase in 2021 estimates of methane emissions from flaring in the Bakken, Eagle Ford and Permian if both the measured destruction efficiency (DRE) and estimated percentage of unlit flares are applied



Source: Plant et al., GGFR

Reducing Methane Emissions from Flaring

At any given time, flares may be:

- lit and operating effectively;
- lit and operating ineffectively, with incomplete combustion of methane;
- unlit and active, venting methane directly to the atmosphere; or
- unlit and inactive, with no associated emissions.

Research has revealed that the destruction efficiency of a flare is likely to be a product of many factors, including flare gas composition, flow rate, flare system design, operation and maintenance and local environmental factors such as wind speed.

While research into this important topic continues, there are three critical steps operators can take now to reduce methane emissions from flaring:

1. Ensure flares are always lit and have automatic systems to re-ignite if they should go out.
2. Ensure flares are operating effectively and optimize flare destruction efficiency.
3. Reduce and ultimately eliminate the gas going to the flare, which should be the end goal.

On effective flare operation, GGFR and partners in the Methane Guiding Principles initiative recently published a Methane Flaring Toolkit, which seeks to provide important technologies and solutions to reduce methane emissions from flaring.

We continue to encourage all operators and governments to commit to the World Bank's Zero Routine Flaring (ZRF) initiative, which aims to end the 160-year-old industry practice. We have also published several important knowledge products to support flaring and venting reduction, including our comprehensive review of Global Flaring and Venting Regulations, Financing Solutions to Reduce Natural Gas Flaring and Methane Emissions and, in partnership with IPIECA and IOGP, the Flaring Management Guidance for the O&G Industry.

3 Plant et al., Science 377, 1566-1571 (2022)

4 Lyon et al, Atmos. Chem. Phys. 21, 6605-6626 (2021)

Concluding Reflections

While global flare volumes fell over the last year, greater efforts are needed to sustain flare reductions and reduce methane emissions.

At a global level, the resumption of the longstanding decoupling of gas flaring and oil production is welcome. Still, oil and gas producers need to rapidly accelerate the decline in global flare volumes if we are to end routine flaring by 2030. Two countries spotlighted in this year's report – Angola and the United States – provide evidence of the reductions in flaring that can be achieved when operators and governments work together to develop an integrated gas value chain to commercialize associated gas.

On energy security, the shift by European countries away from importing Russian oil and gas during 2022 has not resulted in an increase in Russian flaring. Despite this, oil importers need to be mindful that alternative sources of oil may be associated with higher gas flaring, as reflected through GGFR's IFG Index. It is critical that all countries reconsider their energy sources to ensure the oil they import is produced in the cleanest manner possible.

On methane, it is increasingly clear that flaring reduction and tackling methane emissions are inseparably interconnected challenges. While gas flaring continues, every step must be taken to ensure that methane emissions are minimized by ensuring flares are lit and operating effectively. However, ultimately, eliminating routine gas flaring (and reducing non-routine flare volumes to as low as possible) is essential to reducing global methane emissions from the oil and gas industry. Recovering flare gas will allow a previously wasted energy source to be conserved or utilized, thereby reducing both methane emissions associated with flaring and bolstering much-needed energy security.

While there are certainly barriers and constraints, ending routine gas flaring and reducing non-routine flare volumes represents a big "win" for climate action, energy access in developing nations, and energy security across the world. We hope this report, tracking progress towards our shared goal of ending routine flaring, serves as a reminder and catalyst to governments and companies to kickstart projects, prioritize investments in flaring and venting reduction, and contribute to the decarbonization of global energy sources.

Photo credit: © think4photop

Photo credit: © Ed Kashi / GGFR

The World Bank's role in gas flaring reduction

The World Bank's GGFR works closely with governments and oil companies to help assess technologies, develop policies and regulations, and build capacity to end routine flaring by 2030. We are also continuing to secure commitments for the Zero Routine Flaring by 2030 initiative, Zero Routine Flaring by 2030 initiative, building upon the 89 government and oil company endorsers that, together, account for close to 60 percent of global flaring. Ending routine gas flaring is critical if governments and companies are to deliver their products in the cleanest manner possible, meet net-zero targets, and maintain their license to operate, especially in developing countries where millions lack access to energy.

To do this, we must test and scale innovative approaches, while considering new solutions that treat associated gas as an asset, not a waste product. Such approaches must also be tailored to the unique circumstances and context of a particular country, or even a specific oil production site. We need to work collaboratively with governments and oil companies to develop holistic policies, considering a range of incentives and penalties, to finally put an end to this practice.

Methodology

The 2023 Global Gas Flaring Tracker Report is produced on an annual basis by the World Bank's GGFR, comprised of governments, oil companies, and international institutions working to end routine gas flaring at oil production sites around the world. GGFR, in partnership with the US NOAA and The Payne Institute for Public Policy at the Colorado School of Mines, has developed global gas flaring estimates based upon observations from satellites launched in 2012 and 2017. The advanced sensors of this satellite detect the heat emitted by gas flares as infrared emissions at global upstream oil and gas facilities.

The Colorado School of Mines and GGFR quantify these infrared emissions and calibrate them using country-level data collected by a third-party data supplier, Cedigaz, to produce robust estimates of global gas flaring volumes. The satellite data for estimating flare gas volumes is collected by NOAA's satellite-mounted Visual and Infrared Radiometer Suite of detectors (VIIRS).

VIIRS has a multispectral set of infrared detectors which:

- at nighttime respond only to heat emissions and hence are not affected by sunlight, moonlight or other light sources
- respond to wavelengths where emissions from flares are at a maximum
- overfly every flare several times per night
- have excellent spatial resolution.

The ability of VIIRS to detect and discriminate hot sources, such as gas flares, enables flares to be detected automatically with minimal manual intervention. Emissions from non-flare hot sources (e.g. biomass burning) can be removed from the data by selecting only emissions with temperatures above 1100C; other hot sources burn at lower temperatures. Indeed, flares burn hotter than any other terrestrial hot sources, including volcanos. Since the first year of year of operation in 2012, VIIRS has automatically detected ~10,000 flares annually around the globe.

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Global Gas Flaring Reduction Partnership (GGFR) Multi-Donor Trust Fund
1850 I Street NW, Washington, DC 20006
ggfr@worldbank.org