2022 Global Gas Flaring Tracker Report

GGFR
Global Gas Flaring Reduction Partnership

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Foreword

2021 was yet another turbulent year for the oil and gas industry, with rising oil prices, tight oil and gas markets, high energy prices, and the ongoing recovery from the Covid-19 pandemic. However, despite these challenges, the UN Climate Change Conference of the Parties (COP26) and Global Methane Pledge (GMP) underscored once again the growing urgency for governments, companies, and development organizations to accelerate decarbonizing the global economy. This is a pressing need, brought to the fore by the Russian invasion of Ukraine earlier this year and its dramatic impact on energy security across the world.

In 2021, 144 billion cubic meters (bcm) of gas was needlessly flared at upstream oil and gas facilities across the globe. We estimate that this gas flaring resulted in approximately 400 million tonnes of carbon dioxide (CO_2) equivalent emissions globally last year. Ending this polluting practice must be central to decarbonization efforts. Not only could the gas wasted displace dirtier fuels and increase energy access in some of the world's poorest countries, but by utilizing the gas that is currently being flared, the world could make significant progress towards much-needed energy security. For example, the volume of gas flared worldwide is greater than the European Union's 27 member states gas imports from Russia.

Flaring reduction also plays a critical role in mitigating methane emissions, by eliminating a direct source of methane released un-combusted from flares and enabling the gas successfully conserved through reductions in venting and fugitive emissions to be utilized rather than flared. This raises the often-overlooked importance of integrating the decarbonization of the oil and gas sector into wider climate initiatives and discussions.

With this in mind, we're keen to understand not only how much gas was flared in 2021, but where countries have made progress and where the greatest opportunities for flaring abatement remain. GGFR's 2022 Global Gas Flaring Tracker, a leading global and independent indicator of gas flaring, found that despite strong early progress, reductions in both absolute flare volumes and flaring intensity have plateaued over the last decade; impressive reductions in some countries have unfortunately been offset by concerning increases in others.

We explore several oil-producing countries where absolute flare volumes have decreased and some where they have increased, despite commitments and efforts to end flaring. Unfortunately, flaring increases are not limited to those countries highlighted in this report. We urge all governments and operators to carefully assess how they are producing oil and to identify and seize opportunities for effective decarbonization.

With less than a decade to go until the global ambition of Zero Routine Flaring by 2030, it is time for swift and determined action. Our team at the World Bank will continue to support this effort, especially in developing countries, and work closely with governments and oil companies to overcome the barriers to flaring reduction.

Zubin Bamji
Program Manager
Global Gas Flaring Reduction Partnership
World Bank

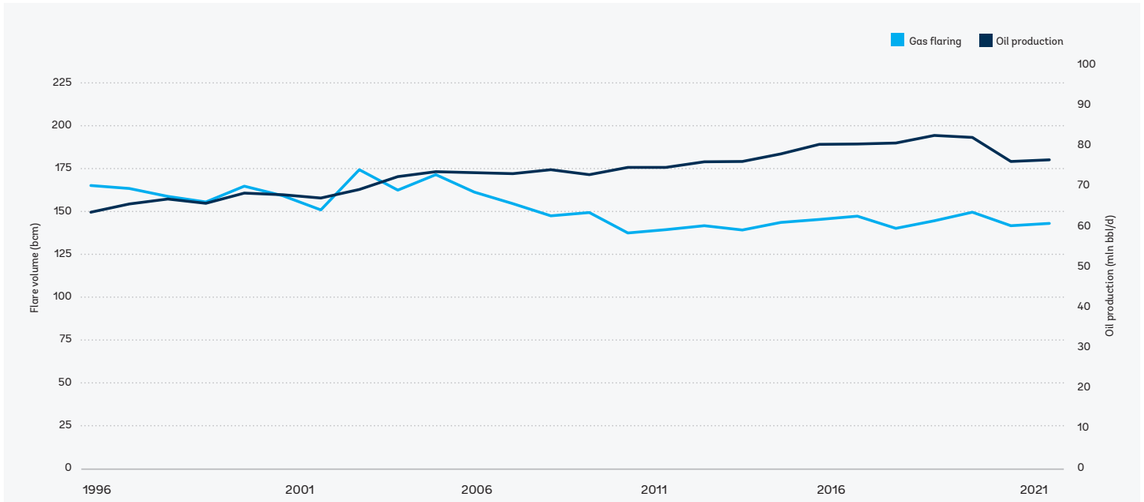
Plateau at a Time for Progress

Despite strong early progress since satellite observations began in 1996, reductions in flaring have plateaued over the last decade, marking a period of disappointing progress during a time of increased international focus on the urgency of greenhouse gas emissions reduction and the energy transition.

Global gas flaring volumes have remained largely static over the last 10 years, plateauing at around 144 bcm. During this same period, global oil production levels rose slightly before dropping in 2020 due to the impacts of the Covid pandemic, averaging around 80 million barrels of oil per day. However, the global perspective obscures the significant flare reduction progress made by some countries – with the reduction achieved only to be offset by increases in flaring by others.

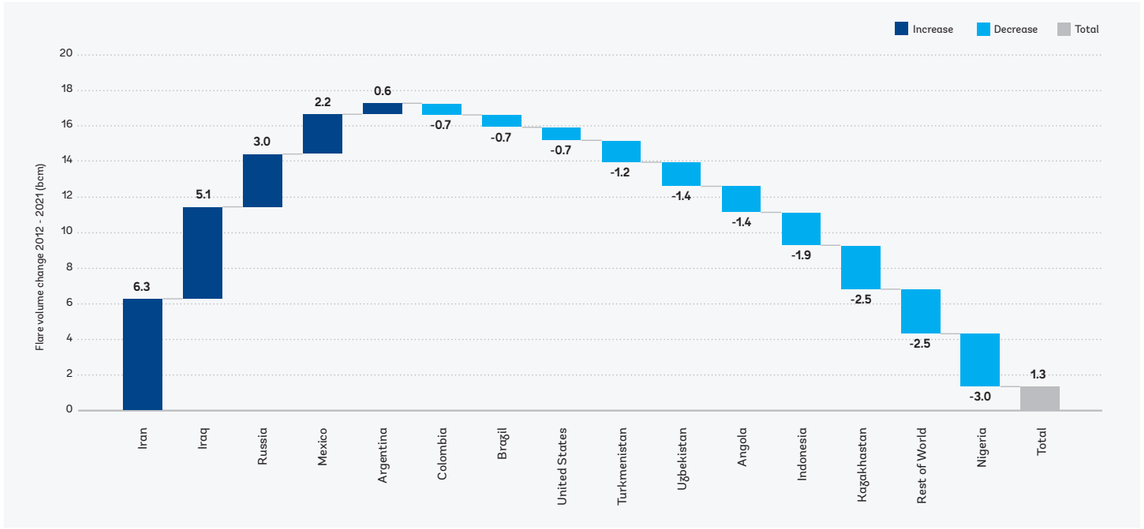
A similar story emerges when we consider flaring intensity, the volume of gas flared per barrel of oil produced; the initial improvements are evident, only to plateau again over the last decade.

Global gas flaring and oil production 1996 to 2021 (flaring only at upstream oil & gas and LNG plants)



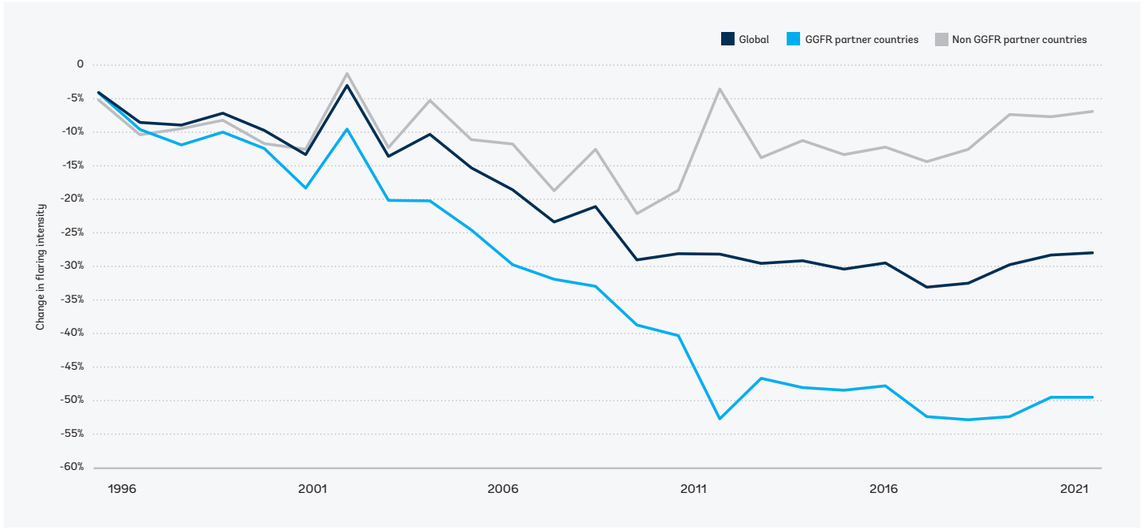
Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Change in flare volume between 2012 and 2021 (individual countries with most significant change (+ or – 0.6 bcm) indicated, rest of world combined, overall global change of +1.3 bcm)



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

Percentage reductions in flaring intensity 1996 to 2021: global average, GGFR and non-GGFR partner countries



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

Top Ten Countries Account for 75 percent of all Flaring

In 2021, the top 10 flaring countries (on an absolute volume basis) accounted for 75 percent of all gas flaring and 50 percent of global oil production.

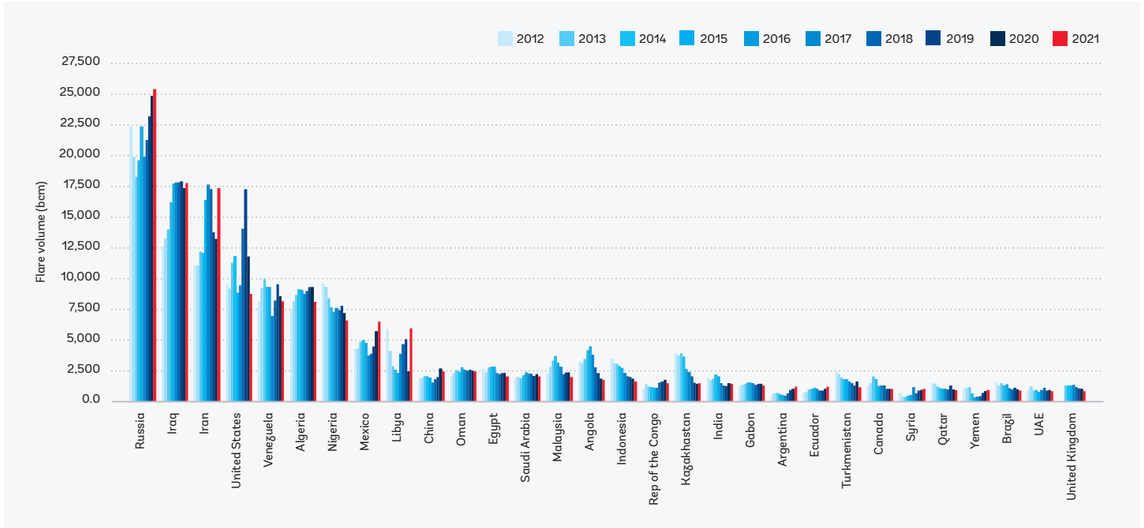
Seven of the top 10 flaring countries have held this position consistently for the last 10 years: Russia, Iraq, Iran, the United States, Venezuela, Algeria, and Nigeria. The remaining three; Mexico, Libya, and China, have shown significant flaring increases in recent years.

When we consider flaring intensity, fragile, conflict-affected, and insecure countries, such as Venezuela, Syria, and Yemen are among the worst performers, flaring more gas per barrel of oil produced than any other country. The intensity perspective also suggests there are opportunities to improve flaring performance in oil-producing countries such as Algeria, the Republic of the Congo, Gabon, and Turkmenistan.

Considering again the top 10 flaring countries on a volume basis, Russia, Iraq, the United States, Nigeria, and Mexico have all committed to the World Bank's Zero Routine Flaring by 2030 (ZRF) Initiative, which commits governments and companies to (a) not routinely flare gas in any new oil field development, and (b) to end routine flaring in existing oil fields as soon as possible and no later than 2030. However, over the past decade, only the United States has successfully improved the flaring intensity of its oil production.

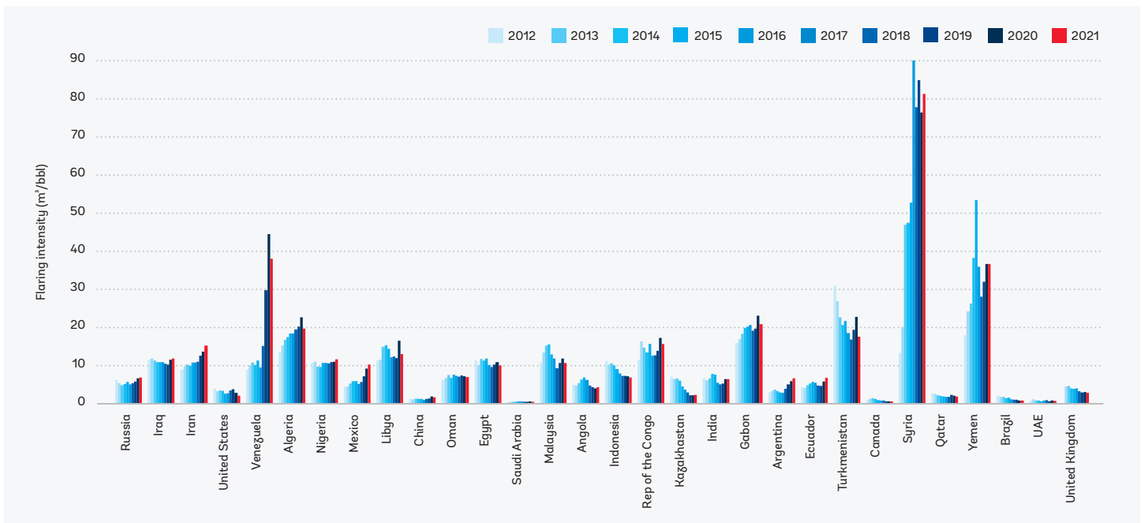
Photo credit: © Opsorman / Shutterstock

Flare volumes for the top 30 flaring countries from 2012 to 2021 (sorted by 2021 volume, shown in red)



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

Flaring intensity for the top 30 flaring countries from 2012 to 2021 (sorted by 2021 volume, shown in red)



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

Key Trends

In this report, we explore promising progress in a few case study countries and connect those findings to those of our Global Flaring and Venting Regulations: A Comparative Review of Policies study where relevant. We also share some worrying trends in two countries. It should be noted that these case studies are not intended to present a comprehensive analysis of progress (or lack thereof) in flaring reduction.

Promising Reductions

Kazakhstan

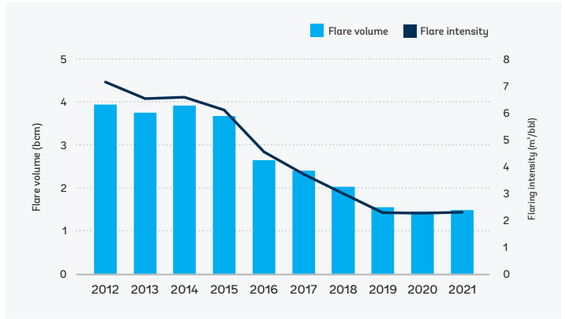
2021 Flare volume rank: 18th

2012-2021
62%
reduction in flaring

2012-2021
67%
reduction in flaring intensity

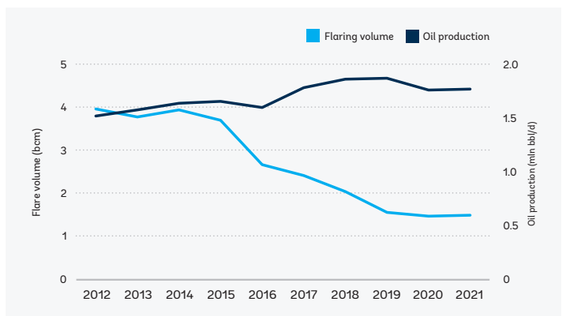
Kazakhstan has achieved the largest overall flare reduction of all countries during the last 10 years, reducing absolute flaring from 4 bcm in 2012 to 1.5 bcm in 2021. In addition to reducing routine flaring over these years, anecdotal evidence suggests there have also been improvements in equipment reliability and production efficiency leading to a reduction in non-routine flaring. This progress has been enabled by strictly enforced regulations that apply financial penalties for gas flaring, coupled with a well-established domestic gas market and integrated gas value chain to incentivize flare gas recovery. The case study for Kazakhstan in *Global Flaring and Venting Regulations: A Comparative Review of Policies* provides more details on the regulatory frameworks in the country.

Kazakhstan flare volume versus flare intensity, 2012 to 2021



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

Kazakhstan flare volume versus oil production, 2012 to 2021



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

The United States

2021 Flare volume rank: 4th

2012-2021
8%*
reduction in flaring

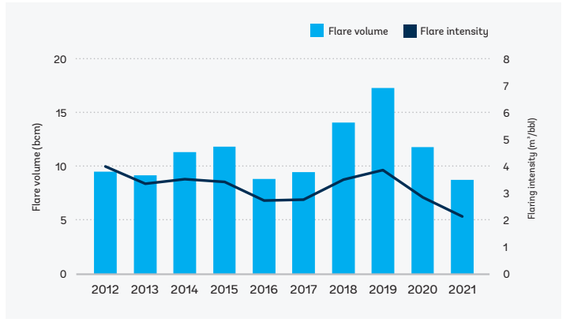
2012-2021
46%
reduction in flaring intensity

*51 percent reduction in Shale oil basins between 2019 and 2021 alone

The United States is the only one of the top 10 flaring countries to have successfully reduced absolute flare volumes while increasing production over the last decade—decreasing its flaring intensity by 46 percent. However, in terms of absolute volume reductions, the United States achieved an 8 percent reduction over the last decade, which somewhat masks the recent progress made to reduce flaring in the shale oil basins of the Permian, Bakken, and Eagleford. These fields represented 89 percent of all US flaring in 2021, and flaring has reduced by 51 percent since 2019, when oil production from these regions peaked. This reduction appears to have been achieved by increasing domestic gas utilization and the export of natural gas in the form of liquefied natural gas (LNG), enabled by increased pipeline infrastructure and capacity.

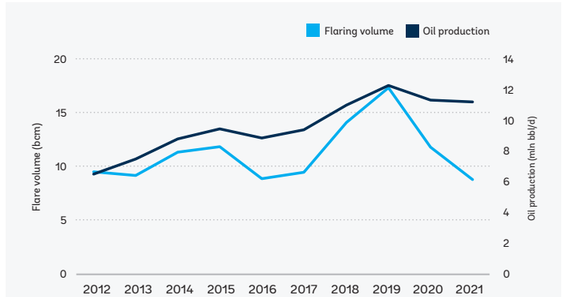
Our just-released *Global Flaring and Venting Regulations: A Comparative Review of Policies* study explores the regulatory context in the main flaring regions, specifically Texas (Permian, Eagleford) and North Dakota (Bakken). In Texas, in particular, there has been significantly increased pressure by multiple stakeholders to reduce flaring over recent years. While regulators made flaring and venting regulation more stringent in 2020, there is evidence that application and enforcement of the regulations could be more rigorous to support the positive trend in reduced flaring.

United States flare volume versus flare intensity, 2012 to 2021



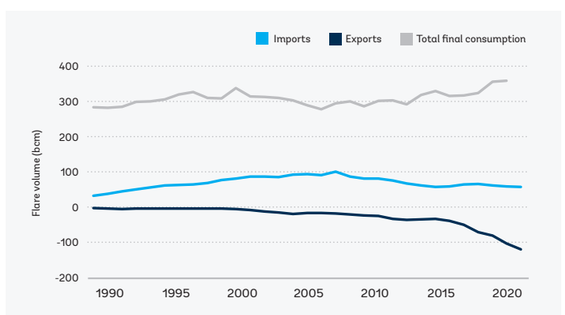
Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

United States flare volume versus oil production, 2012 to 2021



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

United States gas import, export and total final consumption indicting increase in both export and total final consumption over last decade
(modified data, taken from IEA, 2021)



Source: IEA

Promising Reductions

Colombia

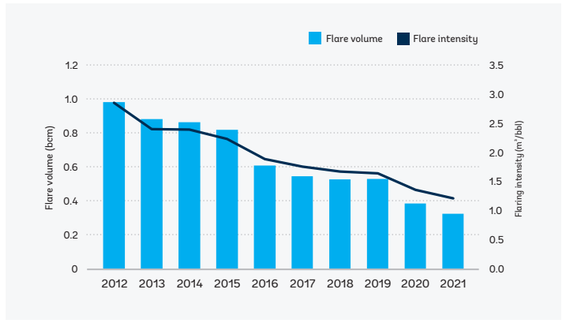
2021 Flare volume rank: 37th

2012-2021
67%
reduction in flaring

2012-2021
57%
reduction in flaring intensity

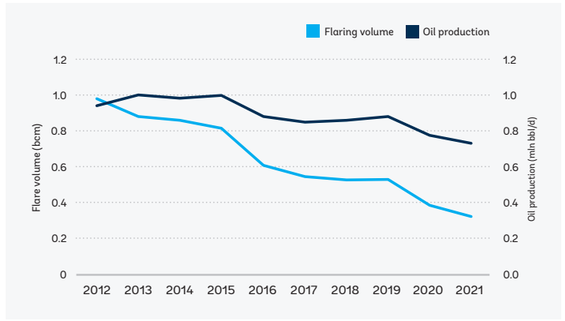
Despite not being a significant contributor to overall global flare volumes, Colombia's progress in flare reduction and its recent leadership in developing regulation on methane emissions make it worthy of mention. Flare volumes in Colombia reduced from 1 bcm in 2012 to 0.3 bcm in 2021, enabled by a well-established domestic gas market for local gas utilization and strong regulations which strictly prohibit and monetarily penalize any unauthorized gas flaring and wasting of gas. In February of this year, Colombia was one of the first countries worldwide to pass regulation on flaring, venting and fugitive methane emissions, following its signing of the GMP during COP26. In addition to government action, the national oil company, Ecopetrol, is a ZRF endorser and has an interim target to reduce flaring by 77 percent by 2022 from 2017 levels. Ecopetrol has linked its targets to Colombia's Nationally Determined Contribution (NDC) to the Paris Agreement, which specifically calls out gas utilization as an opportunity. In parallel, Ecopetrol has recently initiated an aerial survey of methane emissions from its oil and gas production facilities.

Colombia flare volume versus flare intensity, 2012 to 2021



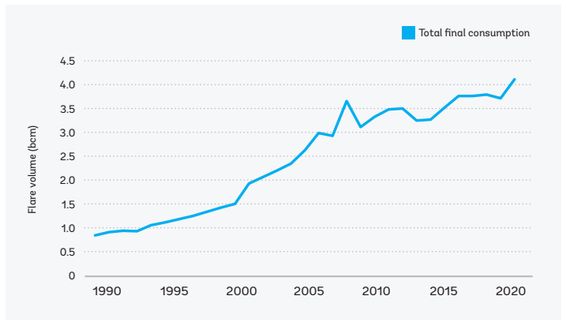
Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Colombia flare volume versus oil production, 2012 to 2021



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

Colombia total final gas consumption indicating increase in domestic gas consumption as Colombia does not import gas (data taken from IEA, values in petajoules (PJ) converted to bcm assuming an average natural gas heating value of 45 cubic meters per megajoule)



Source: IEA

Nigeria

2021 Flare volume rank: 7th

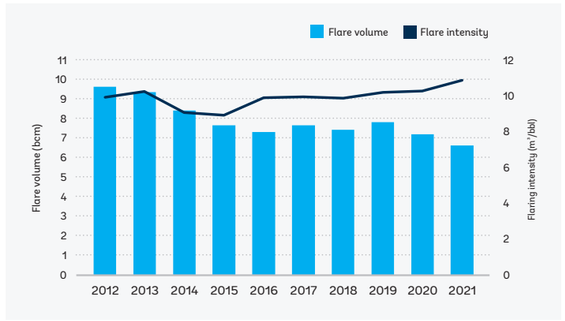
2012-2021
31%
reduction in flaring

2012-2021
10%*
increase in flaring intensity

*68% reduction since 1996

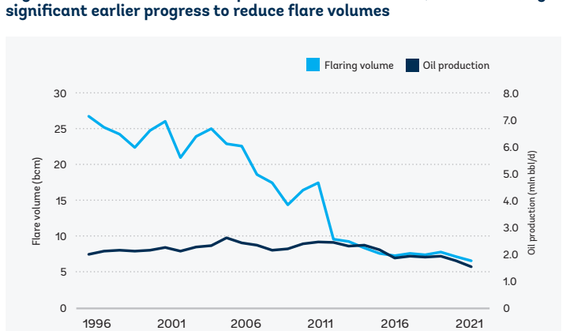
Nigeria has made significant progress in flare reduction since observations began, in no small part due to the commissioning and startup of several major projects to recover and export associated gas, including associated gas processing and export via the Bonny liquefied natural gas plant. However, flaring intensity has increased as production has declined over the last 10 years. The satellite data suggests that, while the largest flaring fields have been addressed, there remain many smaller, more disparate fields where flare elimination and gas utilization is more challenging. This issue is not unique to Nigeria and is likely to be experienced by many other oil-producing countries as they advance efforts to eliminate routine flaring.

Nigeria flare volume versus flare intensity, 2012 to 2021



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

Nigeria flare volume versus oil production 1996 to 2021, demonstrating significant earlier progress to reduce flare volumes



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

Worrying Increases

Mexico

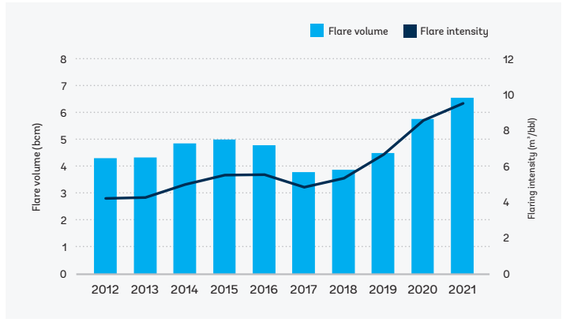
2021 Flare volume rank: 8th

2012-2021
53%
increase in flaring

2012-2021
126%
increase in flaring intensity

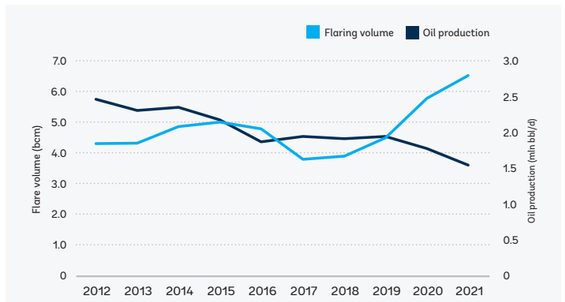
Despite oil production declining over the last 10 years, Mexico has increased flaring by over 50 percent, with a sharp uptick since 2018, rising from 3.8 bcm to 6.5 bcm in 2021. This increase suggests oil production is occurring at wells with higher gas-to-oil ratios and, with no outlet for the gas, the additional gas produced is flared. Additionally, in the Marine Region, where the highest gas volumes are flared, the use of nitrogen for artificial lift results in the production of gas with a high nitrogen content, which cannot be accepted in the domestic gas network. As a result, a large amount of this gas is flared both offshore and at onshore gas processing plants. Mexico's focus over the last few years has been on energy security, however the increase in gas flaring has occurred while Mexico has also steadily increased natural gas imports, highlighting the potential flare gas recovery could play in its energy independence.

Mexico flare volume versus flare intensity, 2012 to 2021



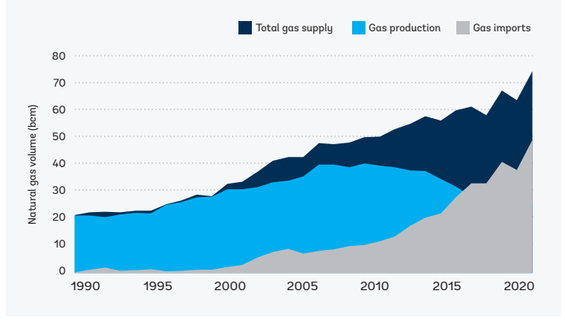
Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Mexico flare volume versus oil production, 2012 to 2021



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

Mexico domestic gas production, import and total final consumption 1990 to 2020, indicating increase in gas export and decrease in production (data taken from IEA, values in petajoules (PJ) converted to bcm assuming an average natural gas heating value of 45 cubic meters per megajoule, 2020 values provisional)



Source: IEA

Iraq

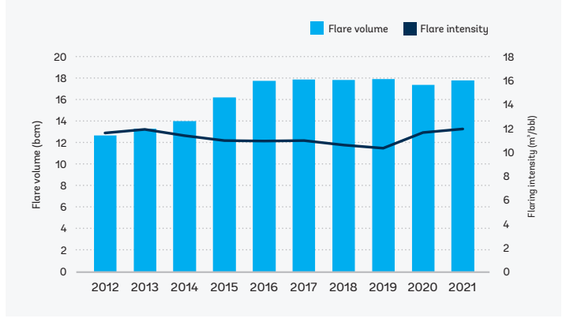
2021 Flare volume rank: 2nd

2012-2021
41%
increase in flaring

2012-2021
3%
increase in flaring intensity

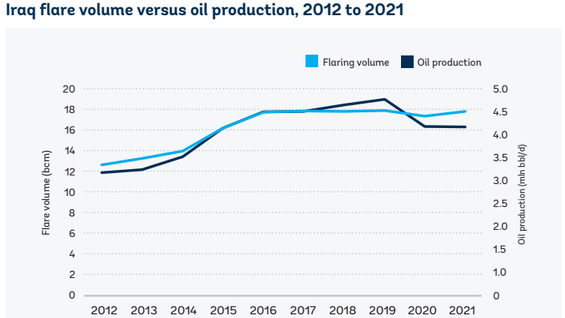
Over the last decade, flaring has steadily increased in Iraq, with volumes rising from 13 bcm in 2012 to almost 18 bcm in 2021, accounting for around 12 percent of total global flaring. At the same time, Iraq is importing natural gas; about 10 bcm in 2020. Flare gas recovery and associated gas utilization are significant opportunities for Iraq, which is both a GGFR partner and endorser of the ZRF initiative and has gas utilization reduction cited in its NDC.

Iraq flare volume versus flare intensity, 2012 to 2021



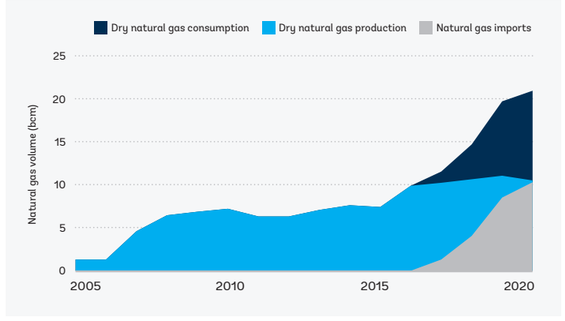
Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Iraq flare volume versus oil production, 2012 to 2021



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

Iraq natural gas production, import and total consumption
(data taken from bp Statistical Review of World Energy, July 2021)



Source: IEA, bp Statistical Review of World Energy, July 2021

Photo credit: © Leonid Ikan / Shutterstock

A Wasteful Practice, Crucial to Tackling Methane Emissions

Gas flaring is a wasteful practice that burns a valuable energy source that could be used to enhance economic development, provide increased energy security, and potentially displace dirtier energy sources. The 144 bcm of natural gas flared in 2021 could have potentially generated some 1,800 Terawatt hours (TWh) of energy, almost two-thirds of the European Union's net domestic electricity generation.

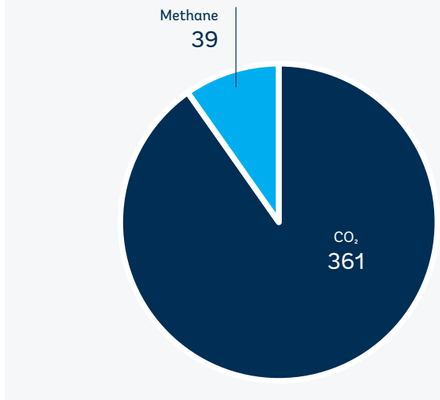
Tackling gas flaring is also critical, given its role in global methane emissions. Methane is a more potent greenhouse gas than CO_2 but has a shorter atmospheric lifetime. Therefore, reducing methane emissions is one of the fastest, most effective ways to slow the rate of climate change.

Gas flaring is a direct source of methane (see box below) and efforts to eliminate flaring also eliminate the associated methane emissions.

However, flare elimination efforts also support methane reductions from other sources, such as venting and fugitive releases. Without an outlet to export or utilize the gas, any methane conserved from these sources will ultimately be sent to flare and while there may be an overall emissions reduction, methane is still released, and this valuable energy source is still wasted.

This highlights the importance of flare reduction and gas management to overall oil and gas decarbonization strategies.

Estimated emissions from gas flaring in 2021 in million tonnes of CO_2 equivalants



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

Why is flaring a source of methane?

Methane is emitted from flares as flares do not completely combust all the hydrocarbons in the gas stream.

In our estimates, we assume:

- A flare destruction efficiency of 98 percent, assuming 2 percent methane is released uncombusted.
- The gas flared has a composition comprising 81 percent methane, with the remaining comprising heavier hydrocarbons (e.g. ethane, propane, butane).
- Methane has a global warming potential 25 times greater than CO_2on a 100-year basis, consistent with the IPCC Fourth Assessment Report.

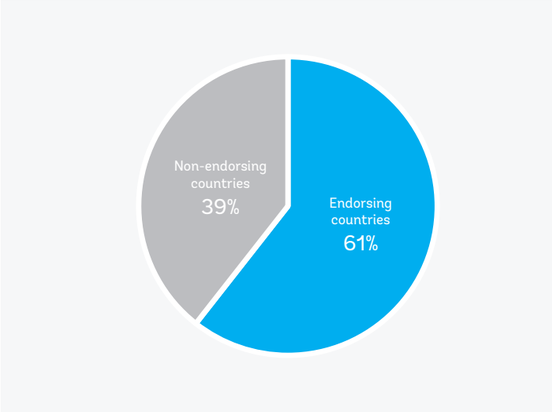
With these assumptions, we estimate that 2021 flaring resulted in 400 million tonnes of CO_2 equivalent emissions ($MMtCO_2e$), of which 361 $MMtCO_2e$ was in the form of CO_2 and 39 $MMtCO_2e$ was in the form of uncombusted methane.

Mixed Progress Towards Zero Routine Flaring

In 2015, the World Bank launched the ZRF initiative, which commits endorsing governments and companies to end routine flaring by 2030. 2022 marks an important mid-point on this journey, so we take an opportunity to reflect on progress to date.

Although 34 governments have endorsed the ZRF initiative, and committed to creating an enabling environment for flare reduction investments, there has been mixed progress to date. Some endorsing governments have successfully achieved both a reduction in absolute flare volume and flaring intensity since 2016, which indicates that flare reductions are not solely due to a decline in production. However, tremendous opportunities for improvement remain for some of the largest flaring countries, such as Russia, Iraq, and Mexico, all of whom were endorsers of the initiative in 2016 and have since experienced an increase in absolute flare volumes and flaring intensity.

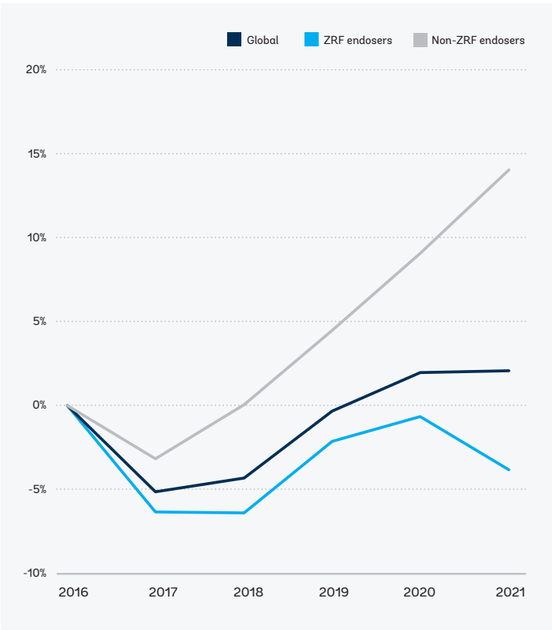
Percentage of 2021 flare volumes occurring in ZRF endorsing countries



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

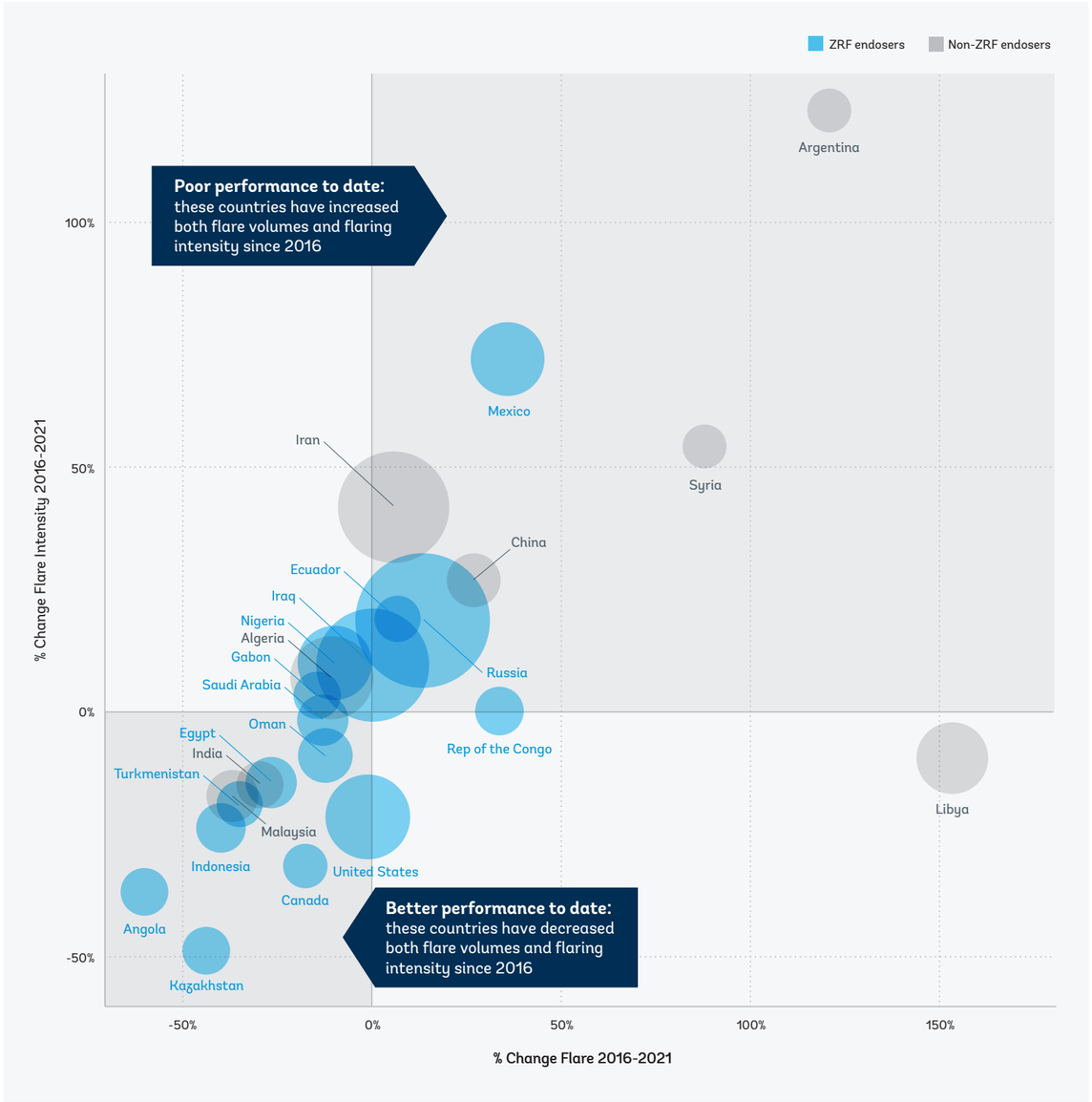
Photo credit: © Opsorman / Shutterstock

Change in flaring intensity 2016 to 2021: global average, ZRF endorsing countries and non-ZRF endorsing countries



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

Percentage change in flare volume versus flaring intensity between 2016 and 2021, top 30 flaring countries only, ZRF endorsing countries indicated. Bubble size is 2021 flare volume



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

Imported Flare Gas Index

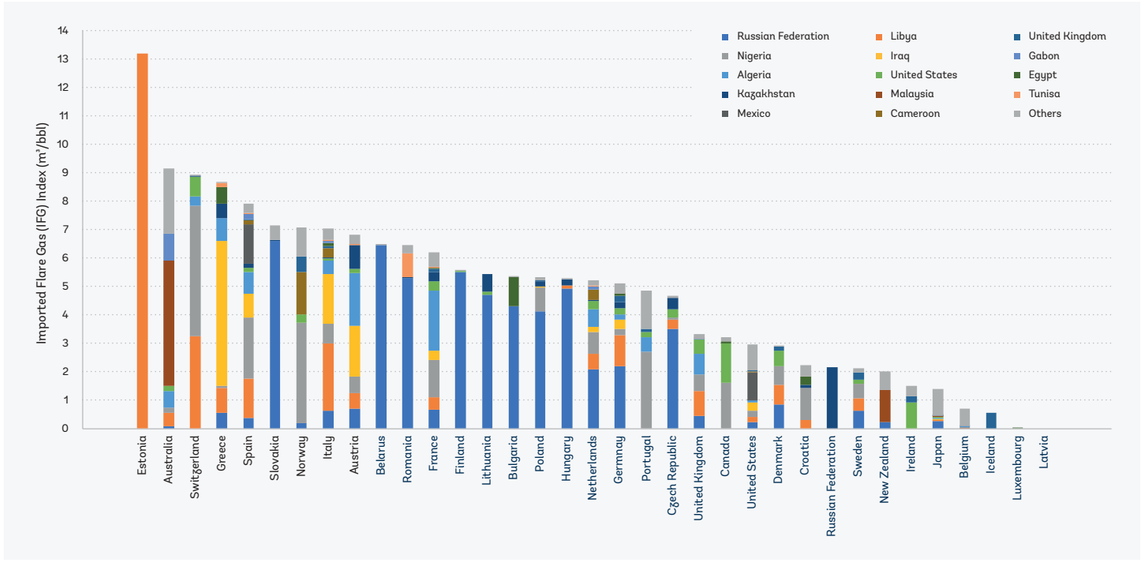
Photo credit: © Red Shadow / Shutterstock

In last year's report, we introduced a new metric, the Imported Flare Gas (IFG) Index, to infer the flaring associated with the crude oil imported by various countries around the world. This new metric highlights the flaring consequences of certain crude imports and shares 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.

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

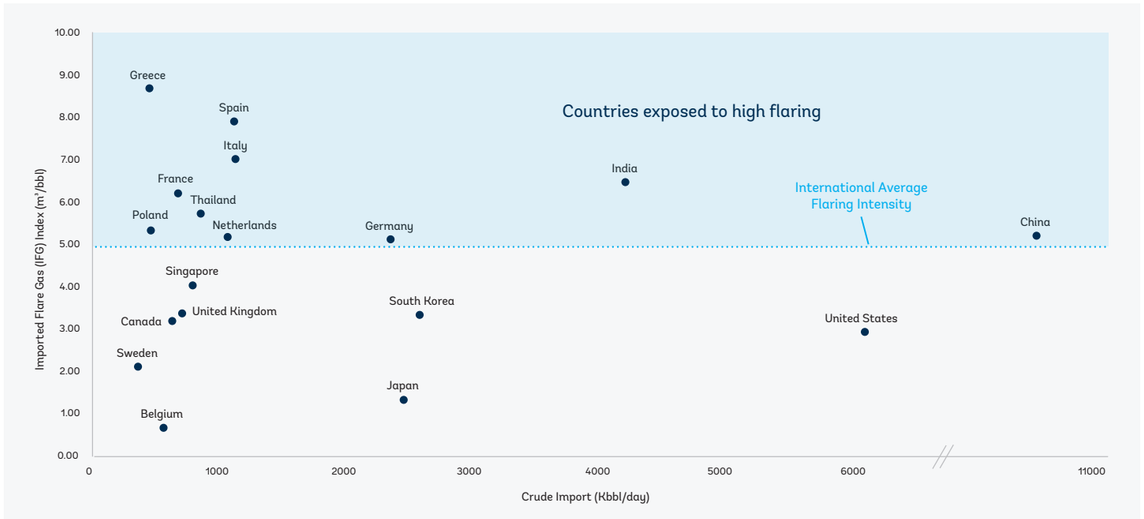
Analysis of 2021 data suggests that many large crude oil-importing countries, such as Spain, Italy, and the Netherlands, are 'exposed' to high levels of gas flaring as they import crude from countries with a high flaring intensity, such as Russia, Libya, Algeria, Iraq, and Mexico.

2021 IFG Index Results



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

IFG Index of Largest Crude Importing Countries (> 250 K bbl/day)



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

Concluding Reflections

While global flare volumes have remained largely static over the last decade, the very significant reductions achieved by some countries are encouraging and set an example for others.

Given the growing international focus on methane emissions and acknowledging the important role the oil and gas industry could play towards achieving climate goals, we call on governments and companies to increase their focus and accelerate their commitment to ending this wasteful industry practice by 2030.

On technology: while technology and innovation have an important role to play, it is important to note that most flaring is not due to a lack of available technology; it is due to a lack of political will and leadership in developing appropriate markets and infrastructure to recover and utilize the gas.

On regulation: effective regulation and strong enforcement are paramount; our *Global Flaring and Venting Regulations: A Comparative Review of Policies* study explores the many, and varied, policy mechanisms that can be leveraged to both penalize gas flaring and incentivize gas utilization.

On methane: eliminating routine flaring can offer a double win in the shared endeavor to reduce global methane emissions by:

- eliminating a direct source of methane released un-combusted from flares; and
- enabling the gas successfully conserved through reductions in venting and fugitive emissions to be utilized rather than flared.

On decarbonization: the utilization of flared gas presents an opportunity to put a valuable, wasted energy source to beneficial use. Natural gas can help reduce the carbon intensity of the global energy mix, with the ability to replace coal and liquid fuels quickly, allowing time for the development and implementation of low and no carbon sources such as renewables and green hydrogen.

On timing: Infrastructure projects needed to connect flares to markets can take years to be developed and operational. If Zero Routine Flaring by 2030 is to be achieved, action must be swift and determined.

Despite the 10-year plateau in flaring, we remain hopeful that significant progress on flaring can be made over the next few years, but this will require strong regulation and effective collaboration between the public and private sectors.

Photo credit: © Essam al-Sudani / Shutterstock.

Photo credit: © eleonimages / Shutterstock.

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 87 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 2022 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.

References:
Elvidge, C.D.; Zhizhin, M.; Hsu, F.-C.; Baugh, K.E. VIIRS Nightfire: Satellite Pyrometry at Night. Remote Sens. 2013, 5, 4423-4449. https://doi.org/10.3390/rs5094423
Elvidge, C.D.; Zhizhin, M.; Baugh, K.; Hsu, F.-C.; Ghosh, T. Methods for Global Survey of Natural Gas Flaring from Visible Infrared Imaging Radiometer Suite Data. Energies 2016, 9, 14. https://doi.org/10.3390/en9010014

GGFR
Global Gas Flaring Reduction Partnership

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

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