

Global Flaring and Venting Regulations: A Comparative Review of Policies

MAY 2022



A companion to 28 Case Studies from Around the World

GGFR
Global Gas Flaring Reduction Partnership

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Foreward

Climate change is the defining development challenge of our century. Rising temperatures are altering our ecosystem and endangering our livelihoods, while natural disasters push millions out of their homes and into migration. We must work urgently to decarbonize the global economy.

In 2020, almost three quarters of greenhouse gas emissions stemmed from energy supply and use, including oil, which supplied 34 percent of global energy demand. Clearly, accelerating the transition to cleaner sources of energy is fundamental to mitigating climate change. The World Bank Group's commitment to that mission is set forth in its Climate Change Action Plan for 2021–25.

Gas flaring and venting—the burning and release into the atmosphere of natural gas produced as a by-product of oil production—generated more than 400 million tons of CO₂-equivalent emissions in 2020, comparable to the amount emitted by 77 million automobiles. The pollution from the many thousand flaring and venting sites worldwide also affects nearby communities, which often face hazardous living conditions and heightened health risks.

Estimates by the World Bank's Global Gas Flaring Reduction Partnership show that global flaring volumes have dropped by a fifth from their 2003 peak of 175 billion cubic meters. But some countries still continue to burn off significant amounts of associated gas.

Our hope is this global regulatory review, which provides a systematic analysis of regulatory frameworks governing the flaring and venting of gas in 21 oil-producing countries, will raise awareness and spur action by identifying the most successful approaches to reducing a wasteful and environmentally damaging industry practice.

The framework for comparing regulations described in this report will help regulators and policymakers reach the goal of the Zero Routine Flaring by 2030 initiative. Meanwhile, the report can serve as a template for reducing methane emissions, which captured a great deal of attention at the UN Climate Change Conference of the Parties (COP26) in 2021.

Three key findings emerge from the review. First, global reduction of gas flaring and venting has been much slower than what is possible. Second, successful reduction requires strong financial and nonfinancial incentives, combined with robust monitoring and enforcement capacity. Third, if flared and vented gas could be made available for use in nearby communities, it could replace more-polluting fuels, thus cutting emissions and potentially expanding access to energy among those who need it most.

The World Bank Group, the largest source of multilateral finance for climate change mitigation in the developing world, provided more than US\$26 billion in fiscal year 2021 to decarbonize the energy sector, scale up the use of renewable energy, raise energy efficiency, and expand access to clean energy among the poor. This report is an integral part of that effort.

Demetrios Papathanasiou
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Notes to readers

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The flare data graphs in this report are based on estimates by the Global Gas Flaring Reduction Partnership (GGFR) using satellite data from the Colorado School of Mines. This approach is applied globally in a consistent manner. Deviations from other sources, based on reported flare gas volumes, are possible. No investment, policy, or other type of decision should therefore be based on this material without verifying the findings independently.

Abbreviations

| | |
|------------------------|--|
| CO₂ | carbon dioxide |
| CO₂e | carbon dioxide equivalent |
| GGFR | Global Gas Flaring Reduction Partnership |
| GHG | greenhouse gas |
| LNG | liquefied natural gas |
| NDC | Nationally Determined Contribution |

Acknowledgments

This study was carried out by a World Bank team led by Martin Oswald and Masami Kojima. The team included Paulo De Sa, Gurcan Salih Gulen, and Adam Pollard.

The report benefited from regional insights offered by Huw Martyn Howells and Alexander Johannes Huurdeman and helpful comments from Zubin Bamji, Carlos Lopez, Susana Moreira, and David John Santley, all of the World Bank.

The study team is also grateful to Harshit Agrawal, Oliver Braedt, Moez Cherif, Jane Olga Ebinger, Julia Komagaeva, Boris Nekrasov, and Yulia Rybakova, all of the World Bank, for providing assistance or points of contact for information on gas flaring and venting in their countries of responsibility or areas of expertise.

The report was prepared under the overall supervision of Demetrios Papathanasiou, Global Director for the Energy and Extractives Global Practice.

Financing was provided by the Global Gas Flaring Reduction (GGFR) Trust Fund. The study team thanks its GGFR partners—BP, Equinor, and Shell—which have supported this effort from its inception.

The study team is also grateful to the Colorado Oil and Gas Conservation Commission, the Petroleum Advisory Forum, and Numada for their support.

This document was edited by Steven Kennedy and designed by Mark Lindop.



Executive Summary

Eliminating routine gas flaring and venting is at the core of the growing imperative of minimizing greenhouse gas (GHG) emissions in oil and gas production.

Since the early 2000s, many jurisdictions have made significant efforts to eliminate this wasteful practice. This report pulls together the main findings of a review of the laws, regulations, decrees, standards, and other relevant government documents in 21 oil-producing countries—including analysis of subnational jurisdictions in Canada and the United States—through September 2021. The review takes the form of 28 case studies published in a companion volume (GGFR 2022). It draws lessons about the effectiveness of the legal and regulatory framework, fiscal incentives and disincentives, contractual arrangements, institutional governance, monitoring and enforcement practice, and public-private partnerships across a range of scenarios and operating environments. These lessons aim to provide guidance to jurisdictions planning to establish new, or improve on existing, laws and regulations to eliminate flaring and venting. Most of the principles and lessons learned from the effort will also apply to broader measures to reduce GHG emissions, particularly fugitive methane emissions.

Despite considerable progress, the global reduction of gas flaring and venting has been much slower than what is attainable and has fallen short of government commitments.

Global Gas Flaring Reduction (GGFR) partnership estimates that the total volume of natural gas flared globally decreased by 14 percent from 1996 levels to reach 144 billion cubic meters in 2021. Over the same period, oil production increased by a fifth. Despite these volumes, few oil-producing countries set specific gas flaring and venting reduction targets in their Nationally Determined Contributions (NDCs), made as part of their commitments to curtail overall emissions under the 2015 Paris Agreement on Climate Change.

Across the 28 case studies, there is significant variation in the legal and regulatory approaches applied.

All of the reviewed jurisdictions ensure that flaring and venting, though often not explicitly mentioned, fall under the responsibility of one or several dedicated authorities. Twenty-three jurisdictions have set measurement and reporting standards for the oil and gas sector that encompass flaring and venting, even if they are not always explicitly mentioned, as a core element of capturing relevant data that can be used to identify the need for corrective action. However, despite the increasing recognition of the need to eliminate flaring and venting, only 21 jurisdictions have put in place outright bans on routine flaring or venting. Just 14 of the 28 jurisdictions reviewed impose monetary fines or use market-based solutions, signaling reluctance to follow through with corrective action. The table at the end of this executive summary identifies the levers available for effective legal and regulatory framework to reduce flaring and venting.

About half of the 21 countries analyzed have reduced both flaring volumes and flaring intensity since 2012.

This finding indicates that legislative and regulatory approaches to combat routine flaring and venting can vary widely from one country to another but still be effective. The top performers deploy different regulatory instruments, but all of them use an array of strong monetary and nonmonetary incentives and disincentives, and all grant enforcement powers to their regulators. Poor performers typically lack (i) clearly defined and fit-for-purpose laws and regulations that impose material penalties or (ii) the willingness and capacity to enforce the rules effectively.

Flaring and venting regulations must consider the capabilities of and resources available to the authorities responsible for enforcing them.

Adequately resourced and trained institutions are key to ensuring effective reporting and enforcement. Where these capabilities are under-resourced, underdeveloped, or selectively applied, policy, legal, and regulatory commitments fail to achieve the desired reductions in flaring and venting. Countries with a national oil company often delegate de facto regulatory functions and responsibilities for controlling gas flaring and venting, constraining the regulator's authority and independence. It is good practice for regulators to consult with key public and private stakeholders on the development of new regulations.

Development of an effective regulatory framework requires monitoring, measuring, and enforcement capabilities that may need to be phased in over time.

Accurate and timely data are essential for designing efficient regulations. Absent monitoring and enforcement capacity, a comprehensive regulatory framework cannot achieve the desired results. Where such capacity is weak, setting different deadlines for bringing new projects and existing facilities into compliance with new regulations can be effective. Jurisdictions need to establish fit-for-purpose methods for measuring the volume of gas flared and vented (by metering or using engineering estimates) and to require reporting and disclosure. Except for Nigeria and countries in North America and Europe, few countries have provisions requiring producers to measure or estimate all flaring and venting volumes and submit the information to the regulator on a regular basis. The quality of public disclosure of data on flaring and venting volumes varies widely across jurisdictions, and relevant information is often missing. Disclosure of the requisite information can help strengthen existing regulations and build trust in the industry with the affected communities, civil society, and the public at large.

As part of the approval process for new projects, countries are advised to require plans for eliminating routine flaring and venting.

These plans should employ a thorough technical and economic evaluation of alternative uses of associated gas and include the costs of reducing flaring and venting in assessing the viability of new oil field developments. The application and approval procedures for intermittent flaring and venting of associated gas should be an integral part of the overall license (or contract) for upstream oil field development and subsequent production plans. Routine gas flaring and venting should be avoided by using or monetizing associated gas.

Penalties should be established at a sufficiently high level to make the alternative of investing in flaring and venting reduction more attractive than paying the penalty.

They should not be so high that ceasing oil production becomes the only viable option for many operators. Mandatory payments such as fines, penalties, and sanctions for noncompliance appear to have a limited effect on improving compliance mainly because they tend to be minor compared with the commercial value of oil production and are often not evenly enforced for fear of losing oil production. Few jurisdictions have explicit rules prescribing accurate gas flaring and venting records and regular reporting requirements. Few regulators have introduced detailed auditing procedures or enforce sanctions for noncompliance.

The carbon taxes, royalties, and fees imposed by some jurisdictions on gas flared and vented appear to be effective at curbing emissions—provided they are fully collected.

Governments are encouraged to levy these charges on all gas flared and vented, or at least on levels above certain limits or outside specific situations authorized by the regulator. An essential step is the collection of material payments from all producers, including national oil companies and small domestic companies. Market-based approaches (such as emissions trading systems and offset credit schemes) can also create incentives for the internal use or commercialization of associated gas. Several emissions trading schemes have been developed, but it is too early to assess their effectiveness at this time.

Regulatory and governance problems outside of the upstream oil sector may substantially affect the degree to which oil producers can reduce flaring and venting.

The regulator in charge of the midstream gas sector can take steps to facilitate the commercialization of gas, such as regulating nondiscriminatory third-party access to gas processing and transportation infrastructure. But even where the cost of gathering, treating, and transporting gas is “manageable” by the standards of well-functioning markets, oil producers may not be able to recover the investments made to commercialize gas if gas tariffs in the domestic market are kept artificially low or large volumes of gas “purchased” are not paid for on time or at all. A prime example is a financially nonviable power sector. It is typically the anchor customer for gas, but it may owe significant arrears to gas producers, and rectifying this situation is often outside the oversight of the ministry in charge of oil and gas. Balancing reforms in sectors outside oil and gas and imposing sensible regulations on gas flaring and venting requires policy alignment and coordination across several line ministries and different levels of government.

The elimination of routine flaring and venting should be a core component of the net-zero-emission and energy transition plans of oil-producing countries and companies.

Endorsement of the World Bank’s Zero Routine Flaring by 2030 initiative by 34 governments, 53 oil companies, and 15 institutions (as of April 2022) holds the promise of reducing this significant source of GHG emissions in oil-producing countries. The 2030 goal is also needed to meet the temperature goals of the Paris Agreement. Toward that end, clear and implementable national roadmaps for action are critical. Most countries have yet to develop workplans through 2030 to achieve zero routine flaring and adopt legislation to make new greenfield projects free of routine flaring and venting. Many international oil companies have announced net-zero emission goals and plans, launched initiatives to monitor and reduce routine flaring and methane emissions, set internal targets, and expanded emissions reporting in their sustainability reports. However, many national oil companies are struggling to raise the capital required to curb gas flaring and venting; they are falling behind in meeting the 2030 target. Increasing awareness among consumers regarding the carbon footprint not only of combustion of oil and gas but also of flaring and venting could put pressure on producers and resource holders to free up the required funding to remain competitive in global commodity markets.

Table E.1 Summary of key review findings

| | Targets or limits have been set | Authorities are empowered by legislation and regulation | Emergency flaring or venting is allowed without prior approval | Routine flaring or venting is prohibited | Development plans must include provisions for the use of associated gas | Associated gas projects require an economic evaluation | Measuring and reporting standards are prescribed | Monetary fines, penalties, and sanctions are imposed for violations | Nonmonetary sanctions are imposed for violations | Engineering performance requirements are set | Fiscal incentives are provided for reductions | Market-based incentives are provided for reductions | Mid- and downstream regulations encourage reductions |
|-----------------------|---------------------------------|---|--|--|---|--|--|---|--|--|---|---|--|
| Algeria | Y | Y | Y | Y | Y | Y | N | — | — | N | Y | N | Y |
| Angola | N | Y | N | Y | Y | Y | Y | Y | N | N | Y | N | N |
| Argentina | Y | Y | Y | Y | Y | Y | Y | — | — | N | Y | Y | Y |
| Brazil | Y | Y | Y | N | Y | Y | Y | Y | Y | N | Y | N | Y |
| Canada (federal) | Y | Y | Y | Y | Y | N | Y | — | — | N | — | Y | Y |
| Alberta | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| British Columbia | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y |
| Saskatchewan | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y |
| Colombia | Y | Y | Y | Y | Y | Y | Y | Y | Y | — | Y | Y | — |
| Ecuador | N | Y | — | Y | Y | Y | Y | — | — | Y | N | N | N |
| Egypt, Arab Rep. | N | Y | N | N | N | N | N | N | N | N | N | N | Y |
| Gabon | Y | Y | N | Y | Y | N | N | Y | — | N | N | N | N |
| Indonesia | Y | Y | Y | Y | Y | Y | Y | N | Y | N | — | Y | Y |
| Kazakhstan | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Libya | N | Y | N | N | Y | Y | — | N | — | N | N | N | N |
| Malaysia | — | Y | Y | Y | Y | N | Y | — | — | N | — | N | N |
| Mexico | Y | Y | Y | Y | Y | Y | Y | Y | — | Y | N | Y | Y |
| Nigeria | Y | Y | — | Y | Y | Y | Y | Y | Y | — | Y | Y | Y |
| Norway | N | Y | Y | Y | Y | Y | Y | Y | Y | — | Y | Y | Y |
| Oman | N | Y | N | N | N | — | Y | — | — | Y | Y | Y | Y |
| Russian Federation | Y | Y | N | — | N | — | Y | Y | — | — | Y | N | Y |
| United Kingdom | Y | Y | Y | Y | Y | Y | — | Y | Y | — | N | Y | Y |
| US (federal offshore) | Y | Y | Y | Y | Y | Y | Y | — | — | Y | Y | N | Y |
| US (federal onshore) | Y | Y | Y | Y | Y | Y | Y | — | — | Y | Y | N | Y |
| Colorado | Y | Y | Y | Y | Y | Y | Y | — | — | Y | N | N | Y |
| North Dakota | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Texas | Y | Y | Y | N | N | Y | Y | — | — | Y | — | N | Y |
| Venezuela, RB | N | Y | Y | N | N | Y | Y | N | — | N | Y | N | — |

Source: GGFR forthcoming.

Y Yes N No — No information available, n.a.: not applicable



Photo credit: © goutsight / World Bank.

Introduction

Data published by the World Bank's Global Gas Flaring Reduction Partnership (GGFR) show that global gas flaring in 2021 released about 400 million tonnes of carbon dioxide equivalent (CO₂e), including uncombusted methane and black carbon (soot). The Russian Federation, Iraq, the Islamic Republic of Iran, the United States, Algeria, República Bolivariana de Venezuela, and Nigeria have been the largest flaring countries by volume for nine years running, roughly in the order listed. These seven countries together produce 40 percent of the world's oil each year but account for about 65 percent of global gas flaring (GGFR 2021).

According to the International Energy Agency, the global oil and gas industry emitted an estimated 70 million tonnes of methane in 2020 along its entire value chain, accounting for 12.6 percent of global emissions, with upstream operations representing more than three-quarters of total sector emissions (IEA 2021b). Gas losses from flaring and venting were once thought to account for a small share of the volumes of natural gas recovered and processed. Advances in data collection and the use of new technologies (such as drones and infrared imagery) reveal that these losses are far greater than originally thought (BSEE 2017). Flaring and venting have long been known to be a leading source of emissions from the oil and gas sector, but fugitive methane emissions were only recently identified as another key pollutant and a severe source of short-term effects on climate. Measurement technologies to trace and quantify methane emissions, along with laws and regulations targeting their elimination, are still in their infancy. Given the similarity and partial overlap of the problem, as well as the accumulated experience in developing legal and regulatory approaches to flaring and venting, there is reason to hope that the findings of this report can help identify solutions to tackle fugitive methane emissions.

Eradication of routine gas flaring and venting is a cost-effective way for the oil and gas industry to reduce overall emissions from its operations and make an important contribution to the reduction of global GHG emissions. Voluntary initiatives, often industry led, have played a significant role in curbing emissions, but there are limits to what they can achieve. Many producers face financial constraints, and higher returns on investment for oil projects could reduce the incentives to search for alternative uses of associated gas. Although many abatement technologies are well known and may be "economic" on paper, capital expenditures in such projects are subject to a variety of risks, such as changes

in gas-market prices and the failure of off-takers to honor their contractual obligations. In addition, operators' incentives are not always aligned with these investments, because of internal competition for capital among a variety of projects in which flare reduction investments are viewed as having insufficiently high rates of return on investment. Where the cost of investing in flaring reduction equipment exceeds (or risks exceeding) the incremental revenue derivable from the recovered gas, regulations are crucial in ensuring that producers undertake appropriate abatement actions.

A small number of large flaring sites contribute significantly to global flaring. In 2020, 12 percent of sites accounted for 75 percent of the world's total flaring volume (GGFR 2021). Although these large sites could be easier to regulate from a technical point of view than smaller flare sites dispersed around hundreds or thousands of wells, political economy considerations (such as the imperative to maximize the government's oil revenues) often prevent meaningful abatement progress at many large sites. These considerations continue to deter progress, despite the fact that reducing routine gas flaring and putting valuable associated gas to productive use could contribute to economic development and create jobs.

Consistent high-level political leadership and commitment are crucial for the design and enforcement of gas flaring and venting regulations. Such regulations must be adapted to each jurisdiction's circumstances, including the country's policies and goals; the role of the oil and gas sector in the economy; the specific structure of the domestic oil and gas industry; the size, number, and location of emissions sources; and the quality and enforcement capabilities of regulatory institutions. Constructive interactions between the industry, the regulator, and, increasingly, civil society are also essential to make regulations effective, ensure enforcement, and achieve policy targets and goals.

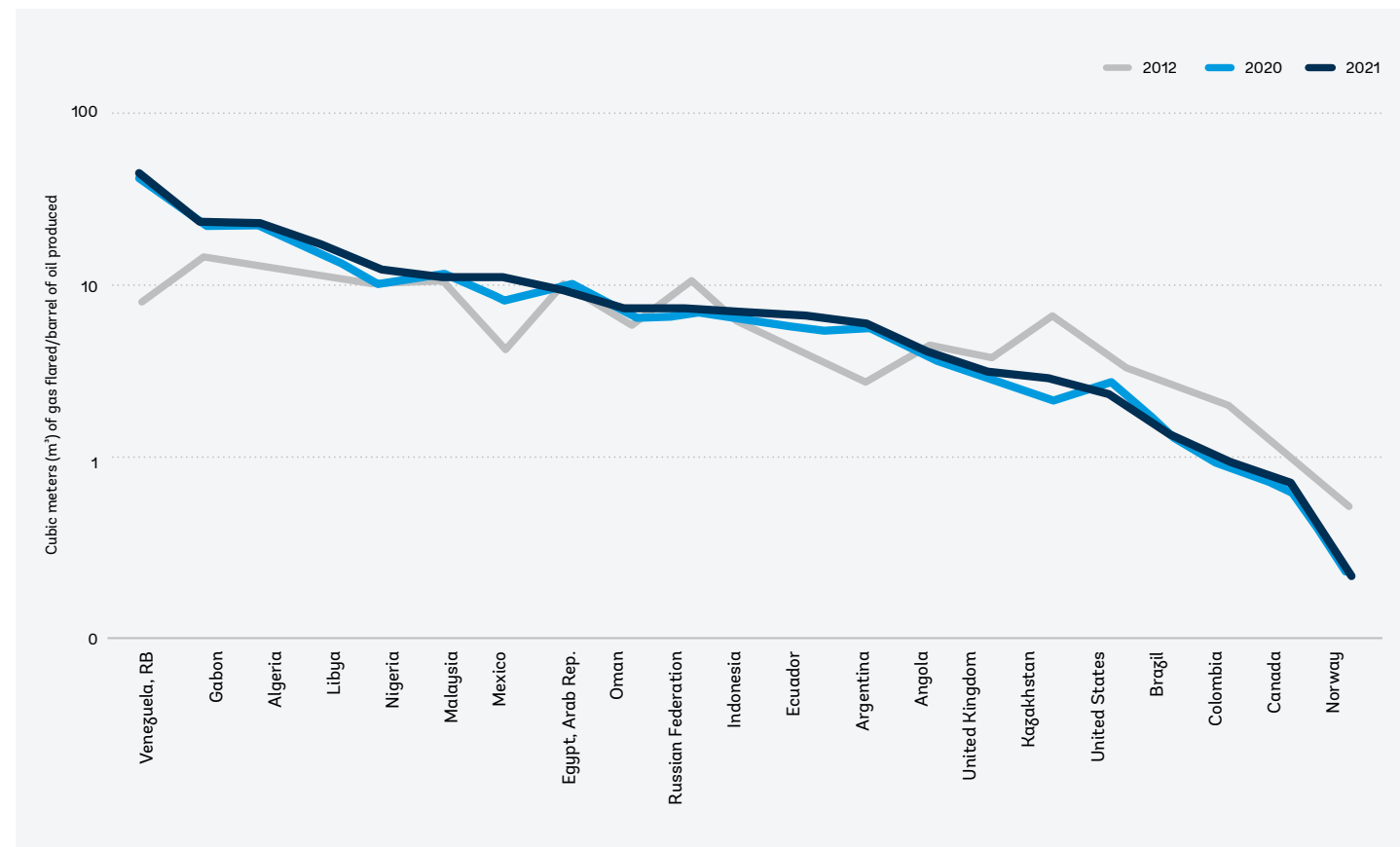
This report provides a general description of the associated gas flaring and venting regulations adopted in 21 oil-producing countries. It updates GGFR's 2004 review and captures relevant issues from GGFR's 2009 publication on policy and regulatory guidance, which focused on the implementation of regulatory frameworks. The present report summarizes information collected on gas flaring and venting, including laws, regulations, decrees, standards, and other relevant government documents, as well as

on monitoring and enforcement experiences, if available, through September 2021. It draws lessons about the effectiveness of the regulatory framework and institutional governance and about monitoring and enforcement by relevant regulatory institutions. A companion report consisting of 28 case studies provides a comprehensive legal and regulatory overview of the main oil- and gas-producing regions (GGFR 2022).

Country selection for the review was based on the availability of information on regulations governing gas flaring and venting and whether the jurisdiction is a major oil producer with significant production of associated gas today or in the recent past. The review includes an analysis of subnational jurisdictions in Canada and the United States, for a total of 28 case studies in the following regions:

- **Europe:** Norway, Russia, and United Kingdom.
- **North America:** Canada (federal and the provinces of Alberta, British Columbia, and Saskatchewan); Mexico; and the United States (federal onshore and offshore and the states of Colorado, North Dakota, and Texas).
- **Latin America:** Argentina, Brazil, Colombia, Ecuador, and República Bolivariana de Venezuela.
- **Sub-Saharan Africa:** Angola, Gabon, and Nigeria.
- **North Africa and the Middle East:** Algeria, the Arab Republic of Egypt, Libya, and Oman.
- **Asia:** Indonesia, Kazakhstan, and Malaysia.

Figure 1 Flaring intensity in countries reviewed, 2012, 2020 and 2021



Source: <https://www.worldbank.org/en/programs/gasflaringreduction/global-flaring-data>

For the countries surveyed in this report, the volume of gas flared globally decreased by 6 percent from 2012 to 2021, while oil production increased by 4 percent. Flaring intensity (the volume of gas flared per barrel of oil produced) is an indicator of the effectiveness of a country's gas utilization; it markedly decreased in 10 countries: Kazakhstan (67 percent), Brazil (60 percent), Colombia (57 percent), Norway (55 percent), United States (46 percent), Canada (40 percent), Indonesia (38 percent), United Kingdom (28 percent), Angola (12 percent) and Egypt (11 percent) (figure 1). It remained stable or increased for the other countries, with large upsurges in República Bolivariana de Venezuela (327 percent), Mexico (126 percent), Argentina (124 percent), Algeria (45 percent), Gabon (31 percent), and Libya (15 percent).

More projects to abate gas flaring and venting would help countries meet their climate-mitigation commitments. As pressure grows to decarbonize the world economy and reduce emissions from gas flaring and venting, such initiatives can help distinguish cleaner oil and gas in export markets and to investors, for whom the transition to a low-carbon future is becoming an increasingly important factor in capital allocation decisions. For example, as part of their climate policies, the European Union and some East Asian countries are considering imposing methane-intensity standards at the point of import or introducing carbon-related border adjustments on imports of certain goods. One example is the European Commission's methane strategy.

Oil importers are beginning to consider the GHG emissions in oil and gas production. Although the most recent announcement from the European Union did not include oil and gas, covering only manufactured goods, such as cement and steel, large consumers of natural gas are assessing the feasibility of establishing gas certification or grading systems for globally traded gas and demanding a supply chain with low leakages of methane (either flared or vented) as a basis for eligibility to bid or as a performance condition in a contract. These types of measures can significantly affect countries such as Algeria, Nigeria, Qatar, Russia, and the United States, which, together with Norway (where reported emissions are already below any limits that may be imposed), accounted for more than 95 percent of the European Union's crude oil imports in 2019. The GGFR's new metric, the Imported Flare Gas Index, estimates how crude oil-importing countries are

exposed to embedded gas flaring. Preliminary quantification of the index shows that many large European crude oil importers are indirectly exposed to gas flaring through their imports of crude oil from countries with large flaring intensities, such as Algeria, Iraq, Libya, and Nigeria.

The rest of this report is organized in two parts. The first deals with the methodologies for developing effective gas flaring and venting regulations, the economic evaluation of associated gas utilization, and stakeholder consultation. The two broad regulatory approaches considered are (i) the prescriptive approach, which focuses on specific and detailed laws and regulations that operators must meet, and (ii) the performance-based approach, which emphasizes collaborative agreement on realistic objectives and targets and having operators demonstrate that they have met them.

The second part of this report derives lessons, cites examples of what drives and hinders effective regulation on a country-by-country basis, draws conclusions, and provides recommendations.

Developing Effective Gas Flaring and Venting Regulations

The analysis of legal and regulatory frameworks demonstrates that the means to tackle routine flaring and venting are known and can produce results beyond what has been achieved to date. However, outdated legal and regulatory provisions, a lack of capacity to monitor and enforce existing regulations, an insufficiently integrated domestic gas value chain, and a lack of consideration of external drivers can reduce the impact of well-intentioned laws and regulations that might otherwise be effective. This section identifies key structural enablers and barriers and derives recommendations on developing effective gas flaring and venting laws and regulations.

Adjusting to the Specific Circumstances of the Industry

Because of its size, economic and political relevance, and broad-based impact on topics of national or regional importance—such as energy, the environment, and public finance—the oil and gas industry is subject to multiple external pressures. The long life cycle of assets poses a constant challenge to operators to stay up to date with the latest technologies and to regulators to develop and enforce standards that can withstand the test of time. Verification and enforcement of laws and regulations can be challenging and costly in jurisdictions with more than one agency involved in regulation. Large companies may be able to handle a multiplicity of regulations, but smaller firms may struggle. They may therefore oppose detailed regulations, viewing them as excessively burdensome.

In response to these challenges, regulators can prescribe broad, generally applicable standards for all regulated activities, setting the boundary conditions for predetermined categories, such as industry segment, age, type of facility, or type of technology or equipment used. This approach can be further adjusted to local circumstances by setting requirements on a case-by-case basis—through individualized permits, bidding rounds, concession terms, or contractual provisions—that may be crafted for each permit or contract, depending on the characteristics of the project. This approach may be particularly appropriate in jurisdictions with a few large international oil companies, where regulators can also negotiate specific terms for individual sites. Transparency concerns and the impression of favoritism—two related issues often arising in the context of individualized permits—can be

addressed through public disclosure of permits and flaring and venting data, which also tends to foster stricter compliance with regulations.

Oil-producing countries with national oil companies working with other firms often have a different regulatory regime from jurisdictions in which the industry is entirely market based, with equal treatment of all producers. Having a relatively weak agency regulate a strong national oil company raises the risk of regulatory capture. The national oil company can become a self-regulated entity or a state agent acting *de jure* or *de facto* as a co-regulator of investors operating in the country. The end result is a national oil company that is subject to different rules from all other producers. In some countries, national oil companies are *de facto* exempt from compliance. In addition, the national oil company may be required to meet certain production targets that do not align with the goal of abating gas flaring and venting or to redirect financial and human resources to projects that are outside the oil and gas sector but considered important by the government.

Efforts to regulate national oil companies have gained ground, notably in Latin America. Often, however, arm's-length relations between the regulator and the national oil company are difficult to enforce. For example, in 2017, Mexico's regulator set guidelines for the national oil company, Pemex, to reduce gas flaring and venting. However, a lack of financial resources and other investment priorities have prevented major gas abatement projects from being implemented. Ecuador convinced its national oil company, Petroecuador, to work toward the elimination of routine gas flaring by establishing an initiative that aims to increase the use of associated gas for electricity generation and the production of liquefied petroleum gas.

If laws and regulations governing flaring and venting are to be effective, implementable, and enforceable, prerequisites apply. Early engagement with all stakeholders—regulatory agencies, the national oil company (where it is an important player), producers, other industry players (for example, contractors, technology providers, and financial sponsors), affected communities, and other segments of civil society—can facilitate a greater understanding of the laws and regulations and create opportunities to seek assurances and adjust regulations. Some regulators have committees that represent different stakeholders and craft or recommend regulatory language through a

collaborative process. In Canada, for example, the Saskatchewan Petroleum Industry–Government Environment Committee was formed to facilitate the cooperative resolution of provincial environmental management issues, including climate change and gas flaring and venting. Brazil’s National Policy Energy Council, which is responsible for formulating energy sector policies, comprises government representatives, energy experts, and nongovernmental organizations.

In Alberta, Canada, operators must consult annually with, and address the concerns of, residents living within a prescribed distance from a gas flare. For communities not well versed in the safety risks posed by nearby flaring and venting, the outreach strategy may also include an educational component.

Recommendations

- When formulating new regulations, governments should capture both their own established good practices and experiences from other jurisdictions that are most applicable to their situations. The sharing of advice among oil- and gas-producing countries can enhance and drive the pace of implementation of abatement measures.
- Consultation of key public and private stakeholders on the development of flaring and venting regulations is an essential starting point for a functioning legal and regulatory framework. Boundaries should be established between the regulator and the national oil company, to avoid conflicts of interest.

Adopting a Multilayered Approach to Designing and Implementing Regulations

The availability and quality of gas flaring and venting volumes are key inputs to the design of the regulatory approach. Identifying a fit-for-purpose measuring method commensurate with the commercial potential of the available gas is essential for monitoring performance and enforcing procedures to ensure compliance. For regulations to be effective, both the operator and the regulator should be required to have adequate baseline data and establish reliable procedures to track progress. In countries lacking strong regulatory agencies, substantial efforts may be needed to estimate emissions and monitor compliance; otherwise,

the additional inspection protocols and reporting requirements needed to ensure compliance could become a financial and administrative burden.

A commonly used regulatory approach to restrict flaring and venting is based on command-and-control. It introduces standards related to items such as the gas volume; its characteristics (for example, gas composition); and emissions (for example, the height of discharge). These standards are often associated with regulations or contractual obligations for measuring flaring and venting volumes, as well as the measures deployed by the regulator for monitoring compliance. Regulators find this approach easy to implement, and producers find it easy to understand.

Promoting the utilization of otherwise flared or vented gas is significantly more challenging and dependent on a variety of factors often outside the regulator’s control (for example, available transport infrastructure or downstream customers willing and able to accept associated gas). Successful regulatory approaches are therefore often complex. A hybrid approach has proven to be an effective way of combining standards that place limits on fields, equipment, units, or other combinations without rigidly prescribing the method or restricting the way to achieve the desired results, allowing operators to prioritize investments as they see fit. This regulatory approach employs specific performance metrics (for example, minimum gas utilization rates or limits on the gas flared or vented as a percentage of the total gas production) or establishes performance requirements (for example, process or equipment standards, such as requiring 98 percent flare gas combustion efficiency). These metrics and requirements can be applied at the level of the company, facility, or piece of equipment.

Mexico has adopted this hybrid approach, with differing degrees of flexibility for the operator across the life cycle of a field. For exploration, the operator indicates the volumes of associated gas that can be utilized under given circumstances; the regulator then reviews the associated gas utilization program to establish the targets. For production, Mexico has established an annual utilization rate for associated gas of 98 percent, which must be reached within three years of the start of operations. The regulator and the operator are expected to work together to find the best solution for a particular field.

To allow for a smooth transition from previous flaring and venting regulations toward a more flexible approach, such as the hybrid model described above, some countries have adopted a phased approach to introducing new regulations, setting different compliance deadlines for new facilities and existing ones. The United Kingdom, for example, requires that all new developments be designed for zero routine flaring and venting, whereas existing facilities have until 2030 to comply. Phased implementation allows regulators to increase requirements and targets incrementally over time, giving producers more time to adapt. Enforcement of these requirements must be supported by measurement and reporting programs that can be strengthened over time. Toward that end, steadily improving and mainstreaming innovative detection methods—such as continuous monitoring systems, aerial surveillance, and satellite instruments—have facilitated monitoring and enforcement.

Recommendations

- Fit-for-purpose measurement methods (both metering and engineering estimates), reporting, and monitoring are essential to define regulatory priorities, starting with areas where abatement actions are likely to have the most impact.
- These priorities can be implemented in a phased manner by gradually introducing new laws and regulations.
- To optimize the functionality of the laws and regulations introduced, countries can use a hybrid approach to find a balance between prescriptive rules detailing what is required to reduce flared and vented volumes and performance-based standards aimed at reducing emissions across facilities without rigidly prescribing the method to achieve them.

Assessing the Economics of Associated Gas Utilization

Major economic barriers remain for associated gas utilization. In most countries, before being allowed to flare or vent associated gas, operators must demonstrate that the projects that recover gas cannot meet the hurdle rate of return (the threshold discounted cash flow or internal rate of return). In some jurisdictions, field development plans are not approved until operators conduct an economic evaluation of the return on investment in flaring and venting reduction, demonstrating that

they have investigated all reasonable options to use associated gas, including reinjection or gathering and treatment for sale in downstream markets. According to this “incremental” approach, operators are allowed to flare or vent only once they can prove that the incremental benefits of using associated gas are lower than the incremental costs.

Alberta requires each operator to make an economic evaluation of all available associated gas utilization options and utilize the gas whenever it is economic to do so. Gas may be flared or, if unavoidable, vented only if all options do not meet the required hurdle rate, specified as a net present value of less than C\$55,000 (about US\$44,000 as of August 2021). A decision-tree approach based on three principles is required for the economic analysis:

1. Flaring and venting are first evaluated for elimination.
2. If the emissions cannot be eliminated, flaring and venting are evaluated for reduction.
3. If the emissions cannot be reduced, the flaring and venting source must meet specified performance standards.

This incremental approach often leads to inaction. The financial return on flaring and venting reduction projects depends critically on the price paid for the gas captured and taken to market. If prices are too low—because of oversupply or market or regulatory distortions, for example—the financial return on investment will be too low or even negative (UNECE 2019), substantially reducing or even removing the incentive to capture associated gas. Equally limiting is poor payment discipline in the domestic market, whereby gas purchasers do not pay for gas fully or on time. This is a problem even when prices on paper seem sufficiently high; it is worse when the government keeps domestic gas prices artificially low. In either situation, because there is little or no incentive to sell gas in the domestic market, governments often impose a domestic supply obligation on gas producers—a response that is neither effective nor sustainable.

By contrast, in the “integrated” approach, the economics of associated gas use are determined as part of the overall project approval process, and flaring and venting are considered negative externalities, the cost of which must be included in assessing the viability of the oil field development. Pricing carbon or charging royalties or fees on gas flaring and venting are possible ways of integrating these externalities in the economic evaluation.

Several regulators have applied this integrated approach, including the Norwegian Petroleum Directorate and the US Minerals Management Service. For the UK Oil and Gas Authority to approve field development plans for greenfield oil and gas projects, projects have to include zero routine flaring and venting and gas recovery systems as well as low-carbon electricity options, precision GHG measurements, and new technologies to reduce emissions. To lower the barriers to investment, the regulator can price environmental externalities to provide incentives for the use of captured gas or establish financial incentives for expenditures in abatement technologies.

The integrated approach tends to reduce gas flaring and venting more than the incremental one. However, the incremental approach can lead to effective results under certain preconditions. For example, some jurisdictions require producers to commit to gas evacuation infrastructure before project development, request an evaluation of opportunities for joint gas utilization projects with neighboring operators, or require gas to be handed over free of charge at the license boundary (which likely requires investments, because associated gas has to be separated, gathered, and transported to the license boundary). Traditional as well as more recent technologies, such as enhanced oil recovery and floating or small-scale liquefied natural gas (LNG) facilities, offer new uses that enable flaring or venting reduction at a competitive incremental cost.

Recommendations

- For the economic assessment of associated gas utilization, the integrated approach has proven effective, as it assumes that the utilization of associated gas is part of the overall development rather than a separate project. Flaring and venting are therefore considered negative externalities, and all related abatement costs become an integral part of the entire project expenditure.
- Consistent application of the integrated approach across the oil and gas sector is key to allowing comparability across different projects and approaches.

Addressing Barriers Outside the Upstream Petroleum Sector

Some significant barriers are located outside the upstream oil and gas industry and cannot be addressed in isolation, because they fall outside the authority of the governmental bodies in charge of oil and gas. Imprecise institutional arrangements and legal uncertainty regarding the definition of competencies at different levels of government (national and subnational) and across agencies within the central administration (for example, hydrocarbons, energy, and environment) can result in conflicting mandates and overlaps.

Such barriers make policy alignment and coordination among line ministries and levels of government essential, requiring the legal and regulatory framework for gas flaring and venting to cover the entire value chain (production, transportation, and consumption). The government needs to support an integrated energy sector strategy, ensure access to markets for the associated gas, establish rules for nondiscriminatory third-party access to existing transportation and processing infrastructure, facilitate the development of infrastructure needed to access export markets, prevent a single firm from controlling natural gas markets across the value chain, and ensure payment discipline among gas purchasers.

Recently, climate change considerations and growing recognition of the need to decarbonize global supply chains have led to an increasing role for North American and certain European environmental authorities in abating methane emissions. Regulations and voluntary commitments to control methane emissions have added another layer of complexity to the legal and regulatory framework governing gas flaring and venting and resulted in frequent updates to existing regulations.

In parallel with new legislation that further restricts flaring and venting, many international oil companies have announced net-zero plans and outlined new strategies to reduce the emission intensity of their operations. In addition to minimizing flaring and venting, some have diversified into the generation of clean energy (such as renewable energy and green or blue hydrogen). As a result, more oil and gas producers are expected to deploy monitoring

and reduction initiatives for routine flaring and venting, set their own internal targets, and expand emissions reporting in their sustainability reports.

A number of national oil companies lag behind this global trend and may struggle with the capital expenditure and investment required to meet these challenges. Although some of them have improved energy efficiency and reduced routine gas flaring from upstream operations, few have developed net-zero emission plans.¹ Some exceptions include Equinor's goal of a 40 percent reduction in emissions by 2030, Ecopetrol's target of reducing emissions from operations by 20 percent by 2030, and YPF's commitment to a 10 percent reduction in CO₂ emissions by 2023. As the primary fossil fuel suppliers and economic pillars in their home countries, national oil companies are being increasingly asked to play a critical role in the decarbonization of their domestic economies.

Recommendations

- Alignment of targets through legal and regulatory requirements and standards is important to provide clarity and direction to the oil and gas operators. Given the breadth of areas touched on by flaring and venting, interagency coordination is essential. It can be achieved through dedicated liaison officers.



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¹ See IDB (2020) for examples in Latin America.



Lessons from the Case Studies

The first part of the report highlighted some of the key structural elements and contextual circumstances enabling or preventing laws and regulations from living up to their full potential. Building on these findings and using the practical insights gained from the country case studies, this part of the report distills lessons on what drives or hinders effective regulation to eliminate routine gas flaring and venting.

It includes seven sections that follow the structure of the case studies contained in the companion volume (GGFR 2022):

1. **Policy and targets**
2. **Legal, regulatory framework, and contractual rights**
3. **Regulatory governance and organization**
4. **Licensing/process approval**
5. **Measurement and reporting**
6. **Fines, penalties, and sanctions**
7. **Enabling framework**

Policy and Targets

Targets to reduce GHG emissions can be set at the national and sectoral levels. Economywide targets tend to be more common; they may be sufficient if there is an economywide carbon price.

In its absence, a bottom-up approach to setting sector-specific targets may be needed. Abatement targets for gas flaring and venting are set to avoid resource wastage; reduce local air pollution and GHG emissions; and yield various co-benefits, such as fostering the development of a midstream gas sector, expanding access to electricity, and increasing the added value of extracted oil and gas resources.

Russia, for example, has set a sectorwide utilization target for its associated gas and developed regulations to achieve the reduction targets for gas flaring and venting. Other countries have imposed facility-specific targets on operators. Mexico's regulations specify the methodologies and criteria that should be used by operators to structure their proposals for associated gas utilization programs and targets. In Brazil, monthly flared volumes cannot exceed 15 percent of the gas-to-oil ratio defined in the approved production plan. In Argentina, wells and production facilities that exceed a specified gas-to-oil ratio are prohibited from flaring and

venting, although some exceptions have been granted. Canada has established both national and sectoral targets, and some provinces have adopted facility or company standards. For example, the Alberta Energy Regulator limits the total annual volume of gas flared or vented at all upstream facilities in the province. If those limits are exceeded in any year, the regulator can impose reduction limits for individual sites.

Including national emission reduction targets in the NDCs as part of climate change mitigation actions has become a widespread practice. To date, however, only eight of the oil-producing countries covered in this review have included reduction targets for gas flaring and venting in their NDCs. Algeria, Angola, Gabon, Nigeria, and República Bolivariana de Venezuela have set quantified targets. Ecuador, Egypt, Mexico, and Oman mention gas flaring and venting in their respective NDCs but without setting specific emissions reduction targets. Although gas flaring and venting reduction should be an essential part of the NDCs in oil-producing countries, not all countries that set flaring and venting reduction targets have adopted detailed and all-encompassing regulations to improve operational practices across the industry to meet those goals. Most countries have yet to come forward with workplans to achieve the goal of the Zero Routine Flaring by 2030 initiative, and few have adopted legislation to make new greenfield projects free of routine flaring and venting. (Exceptions are Nigeria, Norway, some parts of the United States, and more recently, the United Kingdom.) In addition, under the authority of the national oil company, Petronas, all new oil and gas developments in Malaysia are required to be designed for zero continuous flaring and venting.

Algeria's 2015 NDC adopted an unconditional target of less than 1 percent of total associated gas to be flared by 2030. Nigeria has set zero flaring by 2030 as a conditional contribution in its first NDC, updated in 2021. The responsible regulator in the United Kingdom issued guidance in June 2021 requiring all new oil and gas developments to incorporate zero routine flaring and venting and gave the industry until 2030 to comply. In the United States, since November 2020 the North Dakota Industrial Commission has required companies to capture 91 percent of the associated gas they produce.

An area related to flaring and venting that has received increasing attention recently is the reduction of fugitive methane emissions

from oil wells, pipes, valves, compressors, and other types of equipment. In 2016, Canada, Mexico, and the United States jointly called for a 40–45 percent decrease in methane emissions from their respective oil and gas sectors by 2025. Nigeria’s NDC foresees a 60 percent reduction in fugitive methane emissions by 2031 as a conditional contribution.

Recommendations

- Any environmental commitment should be accompanied by a clear and implementable national roadmap for action.
- Governments are advised to consider specifying the role of flaring and venting reductions in achieving local and global environmental objectives and to develop specific emission targets and regulations as part of the environmental targets or limits to which their country has committed.

Legal, Regulatory, Fiscal, and Contractual Frameworks

Gas flaring and venting regulations are anchored in legislation governing a jurisdiction’s oil and gas sector and environmental management. Primary sector legislation usually addresses such issues as jurisdiction over oil and gas, ownership, allocation of permits, contractual rights and obligations, the right to commercialize associated gas, fiscal regimes, sector institutional organizations, and the role and functions of the regulator. Many jurisdictions have laws prescribing natural resource management functions and environmental policies without explicitly referring to gas flaring and venting.

The legal and regulatory framework governing gas flaring and venting depends on what part of the government has jurisdiction over oil and gas resources. In unitary states, this is normally the prerogative of the national government. In federal states, two types of situations can occur. Where the federal government owns the resources in the ground, regulations for oil or gas production and gas flaring and venting are often prescribed at the federal level. Where subnational governments own the resources located within their borders, they typically regulate the flaring and venting of gas. In practice, the two modalities may coexist, as they do in Argentina, Canada, and the United States, where different segments are regulated by national or subnational levels of government.

In countries where the subnational authorities own the resources, the federal government often exercises other powers, such as regulating offshore production and coordinating and harmonizing certain roles among subnational agencies. In most cases, the federal government retains authority over environmental legislation, which focuses mainly on air quality and emissions abatement in the case of flaring and venting. For example, in the case of onshore oil and gas in the United States, states are responsible for sector regulation, whereas the (federal) Bureau of Land Management has the authority to regulate oil and gas production activities taking place on federal lands. The Environmental Protection Agency sets standards for air quality under the Clean Air Act but allows states in most circumstances to develop and implement the regulations necessary to meet the federal standards. The federal government owns the resources for offshore oil and is the sole regulator. In Canada, the federal Canadian Energy Regulator jointly regulates offshore resources with the Maritime Provinces (Labrador, Newfoundland, and Nova Scotia) and retains powers over so-called frontier areas (including the Northwest Territories, Nunavut, and Sable Island). In Argentina, the provinces own oil and gas resources, while legislative powers over general environmental matters are transferred to the federal government, which, through the General Environmental Law, applies minimum environmental standards throughout the country, including for the oil and gas industry.

Building on the main pillars established in primary legislation, secondary legislation aims to set standards and guidelines for oil and gas production to achieve environmental, safety, and health objectives and maximize oil and gas recovery, avoiding waste during production. Many jurisdictions have introduced detailed secondary legislation to reduce overall flaring and venting volumes, allowing for more flexibility and adaptability in response to the evolving conditions of the industry. Some measures adopted include the following:

- specifying equipment and operating processes to ensure efficient combustion
- limiting the maximum volume and duration of continuous flaring allowed
- restricting flaring locations to within safe distances of other facilities and populated areas
- setting upper limits on heat and noise generation
- imposing limits on smoke and noxious odors generated by flaring.

Some jurisdictions, especially in North America and Europe, have been updating their gas flaring and venting regulations to incorporate adjustments to environmental legislation restricting GHG emissions. In Canada, the provincial governments of Alberta, British Columbia, and Saskatchewan have established flaring and venting regulations as owners of the resources, while the federal ministry, Environment and Climate Change Canada, has issued methane pollution abatement standards for the whole country. Provinces can choose to adopt them or draft their own, as long as they meet or exceed the federal targets (referred to as “equivalent regulations”). This approach has led to the updating of gas flaring and venting regulations in Alberta and British Columbia to make them compatible with federal environmental legislation; Saskatchewan has yet to introduce additional regulatory measures to fulfill a new equivalency agreement before 2024.

Operational requirements for gas flaring and venting often have not been sufficiently established in secondary legislation or are not accompanied by the monitoring capacity needed to enforce them. In countries that do not have regulations specifically covering flaring and venting, confidential contractual or licensing arrangements between the government and the national oil company, on the one hand, and the operator, on the other, govern most relevant aspects. In Libya, for example, a committee composed of representatives of the national oil company and of the operator in the context of a production-sharing contract grapple with topics such as adherence to good oil field practices and the commercial assessment of associated gas.

Recommendations

- Primary legislation should explicitly address the treatment of associated gas so as to reduce flaring and venting and achieve environmental, safety, and health objectives while maximizing resource recovery and avoiding waste.
- Countries should adopt detailed secondary legislation empowering regulators to monitor and enforce the reduction of flared and vented volumes through operational standards and guidelines, regular recordkeeping and reporting, and site inspections. The Canadian provinces of Alberta, British Columbia, and Saskatchewan provide excellent examples of dedicated pieces of stand-alone legislation that offer valuable lessons to other jurisdictions.

- When preparing legislation, a thorough public consultation and notification process with key stakeholders from the public and the private sector—such as enforcement agencies, civil society representatives, and recognized industry bodies—can add to the effectiveness of laws and regulations and create broad-based support, resulting in increased levels of compliance.

Regulatory Governance and Organization

Institutional responsibilities for regulating gas flaring and venting are divided in a wide variety of ways. There is no generally established practice for determining which of the agencies and ministries responsible for managing oil and gas should carry out which regulatory function. However, it is essential to clearly define which institutions have regulatory authority over the industry and the scope of their mandates. The final institutional arrangements depend on the ownership of the resource (federal, subnational, nonstate) and the nature of the regulation (oil and gas development and production; environmental; fiscal).

Despite the inherent risk of legal and regulatory overlaps, gas flaring and venting tend to be regulated by two line ministries—one in charge of oil and gas and the other in charge of the environment. The agencies responsible for oil and gas usually pursue abatement strategies from the perspective of waste prevention; some require the payment of royalties or fees for gas that is flared or vented rather than captured and used internally or marketed. The responsibilities of environmental authorities include assessing the environmental impact of gas flaring and venting and enforcing limits on emissions. In cases where both line ministries have regulatory power over gas flaring and venting, they often consult and cooperate before issuing flaring permits or approving oil field developments.

The responsibilities and powers of the regulator should be clearly defined in its enabling statutes, ideally allowing it to enforce compliance independently of the executive branch of the government and, if applicable, the national oil company. A framework that is widely accepted as being appropriate is one in which the minister in charge of oil and gas is responsible for formulating policies and regulations and delegates monitoring and enforcement of compliance to the regulator. The permutations of

the levels of delegation vary across countries, from empowering the regulator on a broad range of functions to limiting the regulator's role to a narrow set of technical and administrative activities, such as keeping the registry of concessions and collecting fines from time to time but with little public disclosure.

In Colombia, for example, the Ministry of Mines and Energy defines the sector policy and is responsible for issuing any technical rules and administrative decisions associated with the regulation and imposing applicable sanctions for noncompliance. The National Hydrocarbons Agency and the Ministry of Mines and Energy executed an interadministrative agreement that delegates certain inspection functions and regulatory activities to the National Hydrocarbons Agency, which is an autonomous entity under the Ministry of Mines and Energy with administrative and financial independence. The agency awards and negotiates exploration and production contracts and regulates any activities under them, including flaring authorizations, measuring standards, and compliance monitoring. Mexico, as part of an all-encompassing energy sector reform in 2014, strengthened the power of the sector regulator, the National Hydrocarbons Commission, and created a new environmental regulator that can impose conditions on gas flaring and venting when issuing an environmental license. Interinstitutional coordination rules are also provided for by law. In the United States, the Colorado Oil and Gas Conservation Commission has the authority to regulate and enforce the development and production of the state's oil and gas resources in a manner that protects public health, safety, welfare, the environment, and wildlife resources, while the Air Quality and Control Commission oversees the state's air quality and emission efforts. Both authorities have overlapping and shared authority over flaring and venting. To manage the interface, particularly with regard to the protection of public health, an energy liaison officer from the Department of Public Health is assigned to coordinate alignment.

The regulator's independence should not be limited to the executive branch of the government but should also cover the oil and gas producers they supervise, and operations should be guided by transparent and enforceable procedures. However, the financial resources and technical expertise of oil and gas producers often far exceed those of the regulator, presenting serious challenges to the authority and independence of the regulator. As a result, where national oil companies exist, they often become de facto

regulators for gas flaring and venting and assume enforcement responsibilities, especially where the national oil company signs production-sharing contracts on behalf of the state.

In Malaysia, for example, regulatory powers and responsibilities are vested in Petronas in its capacity as the custodian of Malaysia's oil and gas resources. Its regulatory suborganization, Malaysia Petroleum Management, performs its regulatory responsibilities. All oil and gas companies active in Malaysia must abide by the Petronas Procedures and Guidelines for Upstream Activities, which cover flaring and venting.

When formulating regulations for gas flaring and venting, policy makers need to consider the capacity of regulatory agencies to enforce regulations and standards. Even when regulators have clearly defined mandates and responsibilities, their institutional capacity, technical expertise, and financial resources tend to fluctuate over time, because they often depend on the level of political support the agencies enjoy. Regulatory procedures and operational processes are not always defined realistically with respect to the capacity of the regulator—which is often poorly staffed, underfunded, or both—to monitor and enforce the regulations. Standards and regulations that are unevenly or rarely enforced could do more harm than good, diminishing the credibility of the legal framework and posing the risk of creating an uneven playing field or even triggering a “race to the bottom,” as violations of environmental, safety, and health standards deliver financial gains with few or no adverse consequences.

The provincial oil and gas regulator of the Canadian province of Alberta, the Alberta Energy Regulator, is a good example of a capable independent agency with full responsibility for all upstream oil, gas, and oil sands activities in the province, including flaring and venting. In line with the applicable laws and regulations, the agency's operations cover regulatory applications and enhancements, compliance and liability management, geological surveys, and technical science and innovations. To ensure that its broad mandate can be fulfilled, the agency has about 1,000 employees, who work across 13 offices. Based on internal capability assessments, specialized employees are hired on the open market. Long-standing industry experience is one of the typical requirements.

Recommendations

- There is no generally established practice for identifying the institution best suited to regulate gas flaring and venting. Good practices do not necessarily require establishing a separate regulatory agency, but governments need to define the roles and responsibilities of the regulators clearly, without overlapping or conflicting mandates.
- When regulatory functions are split among different authorities (oil and gas, environment, finance), governments should put in place processes requiring the authorities to cooperate in cross-cutting areas, such as the issuance of flaring permits or the approval of oil field developments. The regulatory framework should consider the capabilities of and resources available to the authorities responsible for enforcing it. It is essential to staff and fund regulators to enable effective monitoring and enforcement.
- Independent regulators can help avoid conflicts of interest and ensure a level playing field for all market participants. They are particularly relevant in countries with national oil companies, which often report to the minister in charge of oil and gas operations.

Licensing and Process Approval

Gas flaring and venting regulations depend on how associated gas is treated and oil development rights granted in primary legislation. Uncertainty about the ownership of the associated gas and the right to commercialize it and laws that consider it a waste instead of a resource are significant barriers to its economic use.

Regardless of the applicable fiscal regime, the state typically owns underground resources (Canada and the United States are notable exceptions). Once hydrocarbons are extracted, producers own them under a tax-and-royalty concession system, although restrictions may be imposed for regulatory or contractual noncompliance. República Bolivariana de Venezuela, for example, mandates that operators take any reasonable measure, if economically justified, to use associated gas for the maintenance of reservoir pressure, any other internal use, or marketing to third parties. If the operator does not use the gas as prescribed in the Regulation for the Conservation of Hydrocarbons, the government may take it free of charge as it leaves the separator (i.e., the device that separates the well stream into gaseous and liquid components).

In production-sharing contracts, contractors are entitled to a portion of the production in the form of “cost and profit oil” (and gas if gas is included in the contract). Title to their share of the oil (and gas) is usually transferred at the outlet flanges. Unless clearly stated in the contract terms, in case of a commercial oil discovery, the contractor has the right to use associated gas without having to make any payments to the government for operational purposes, such as reinjection or for use as fuel. For any excess associated gas that may potentially be used commercially, the contractor must agree with the state on the handling of such gas and the sharing of costs and proceeds. If no such agreement can be reached, the contractor should allow the state to take the excess associated gas free of charge, usually with the state assuming the costs of separating gas and transporting it to the transfer point. Uncertainty about the right to commercialize associated gas or an outright prohibition on marketing gas is a barrier to investments in flaring and venting abatement. While contract terms for oil are, as a rule, clearly defined, terms for associated gas sometimes remain vague and subject to a potential side agreement. In Algeria and the Arab Republic of Egypt, firms investing in the upstream oil and gas sector must partner with national oil companies, which are entitled to their share of associated gas as specified in their agreements. In contrast, in Nigeria, only the national oil company can commercialize associated gas in production-sharing contracts.

Some jurisdictions require coordination with midstream operators to manage another barrier to flaring and venting reduction: the lack of adequate infrastructure to process associated gas or transport it to markets. In some cases, large volumes of gas are still flared in areas that already have gas-gathering pipelines because the production rate from new wells has outpaced the capacity of the infrastructure to transport or process the associated gas. Under these circumstances, operators must decide whether to shut or throttle the well, employ other technologies to use the gas, reinject the gas, or flare it. Inadequate planning and communication among operators, transporters, and gas purchasers often leads to flaring.

In North Dakota, where new oil production had led to large-scale flaring, operators are now required to provide an affidavit at the well-permitting stage stating that they had met with gathering companies and informed them of their expected well-development timing and production levels to ensure that a commercial outlet

can be identified in time. In Indonesia, SKK Migas, the country's special task force for upstream oil and gas, is authorized to sell gas that would otherwise be flared through a bidding mechanism. In Ecuador, the minister responsible for oil and gas may require fields with a high gas-to-oil ratio to deliver associated gas free of charge to the country's national oil company, Petroecuador, the only entity allowed to commercialize it. In Gabon, associated gas not allocated to self-consumption in oil operations remains the property of the state, which has the legal right to take over the commercialization of the gas in case of noncompliance with the legislation prohibiting routine flaring. Nigeria's new Petroleum Industry Act, enacted in August 2021, stipulates that, in addition to the state having the authority to take gas at the flare site free of charge, all gas in new production-sharing contracts, associated as well as nonassociated, will belong to the national oil company, which alone can commercialize it.

Regulatory restrictions may include banning routine flaring and venting, limiting total volumes flared or vented, limiting the duration of intermittent flaring and venting where prior authorizations are required, and specifying technology and equipment standards. Producers may also be required to use the gas on-site or pay royalties on gas flared or vented, as they do in Brazil.

The application and approval procedures for gas flaring and venting of associated gas can take several forms, and the right to flare and/or vent can be granted through three documents:

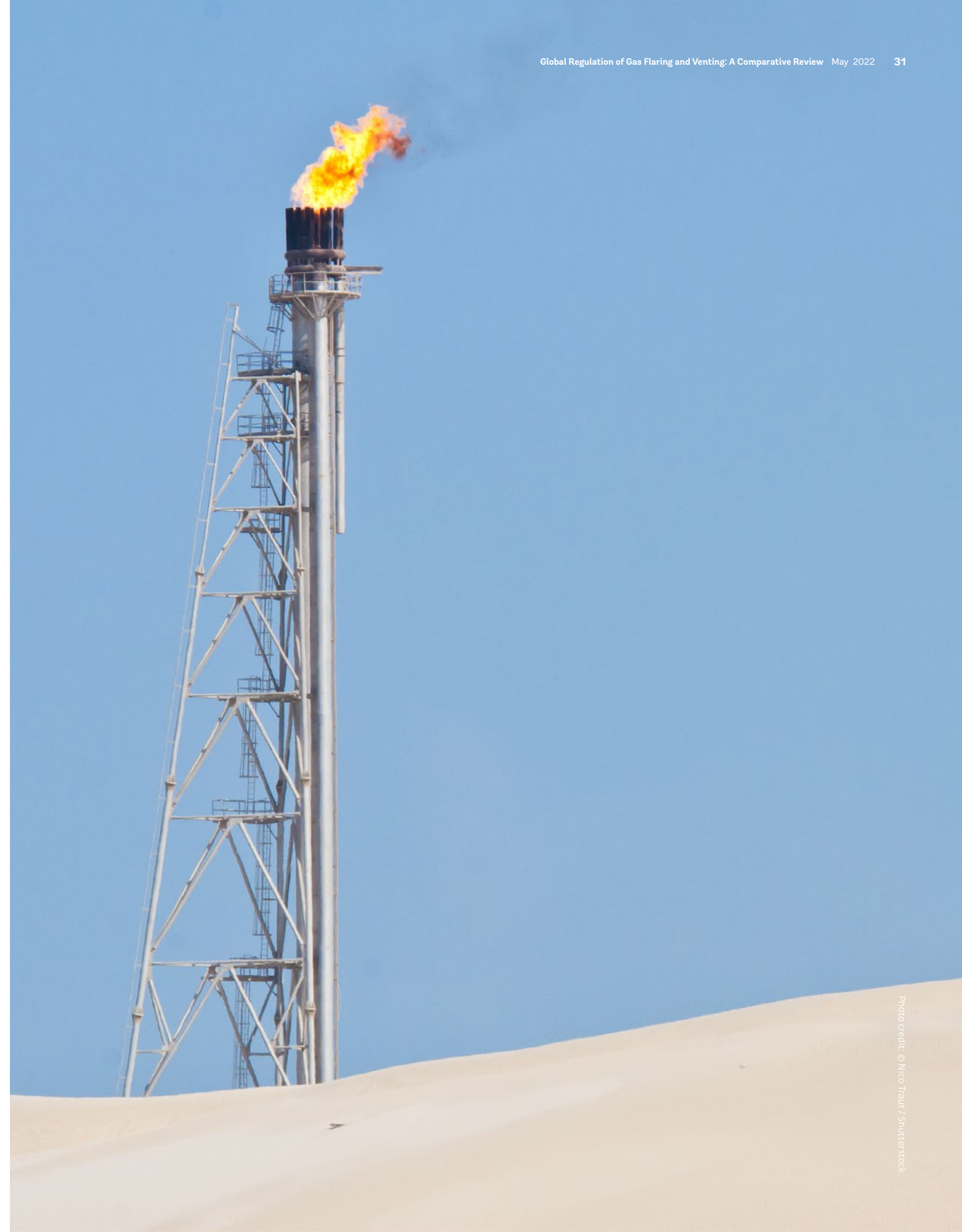
- 1. A separate flaring and venting permit.** Some countries require operators to obtain approval before flaring or venting, often for a limited duration. Oman, for example, requires large projects to secure a permit from the Climate Affairs Department, which authorizes GHG emissions. Upfront consent is typically not required for unforeseen events related to operational safety, but producers may have to inform the regulator afterward. In Algeria, if flaring occurs without prior authorization for safety reasons, a report must be submitted to the regulator within 10 days of the safety incident.
- 2. An overall field development plan for a license or contract.** Many governments do not explicitly require companies to include provisions for associated gas utilization in the approval process for oil field development plans. In the Arab Republic of Egypt and República Bolivariana de Venezuela, for example, field development approvals do not have operational requirements for limiting gas flaring and venting, and

regulators require operators only to follow "good practices for oil production." However, there are exceptions. In Mexico, the operator must submit an associated gas use program to the regulator as part of the development plan for each assignment and contract. The program must include month-by-month forecasts for associated gas use during the first three years and annually thereafter. In Colorado, flaring is allowed only with prior approval from the regulator, granted through an approved gas capture plan during the permitting process or in a subsequent application explaining why flaring is necessary. Brazil and Norway also use this approach.

- 3. An environmental license.** Regulators often require the operator to include the likely impact of flaring and venting on the environment in an environmental impact assessment as part of the flaring permit or field development application process. In Brazil, Colombia, and República Bolivariana de Venezuela, responsibility for authorizing flaring and venting lies either jointly or exclusively with the environmental authorities. Flaring and venting authorizations are provided on a case-by-case basis by virtue of an environmental license that often sets a variety of additional conditions, such as air emission limits for pollutants released to the atmosphere and operational safety restrictions. In some cases, compensation measures are defined before the start of operations. They can take the form of contributions to climate funds or the acquisition and liquidation of carbon credits.

Some countries permit the unauthorized flaring and venting of associated gas under certain circumstances and events, including for safety reasons or for unavoidable technical reasons, such as purge venting during well testing, at the start of operations, or in emergencies. Flaring and venting under these circumstances do not typically require additional regulatory approval other than the rights granted to operators under the three procedures mentioned above. However, not all developing countries clearly define these circumstances and events in their regulations.

To reduce intermittent flaring and venting, the regulator may ask the operator to seek approval if the duration of flaring or venting exceeds a threshold level. An example is the US Outer Continental Shelf, where the operator must seek approval if the duration of intermittent flaring or venting will exceed either 48 hours per event or 144 cumulative hours per month. Another option is to set up a volume-based threshold. An approach requiring the regulator's



prior approval to flare or vent at each installation may be practical if the number of installations is in the low hundreds, but it could become impractical if the number is markedly higher. The system of providing notification prior to intermittent flaring where the flaring has not been approved.

Recommendations

- Governments should clarify that associated gas is a valuable resource that must be recovered and either used or sold; accordingly, they must allow operators to commercialize it.
- Rules and procedures for approving gas flaring and venting, technology standards, and other regulatory measures should be clearly and transparently prescribed in regulations.
- The circumstances in which operators can flare and vent associated gas without prior regulatory approval should be clearly defined, with reporting requirements and sanctions for noncompliance.
- The application and approval procedures for intermittent flaring and venting of associated gas should be an integral part of the overall license (or contract) for upstream oil field development and subsequent production plans in new oil developments. Procedures and regulations should include sufficiently large incentives to avoid routine gas flaring and venting.
- Contractual terms for minimizing routine gas flaring and venting under production-sharing and service contracts should be clearly defined; should remain within the boundary conditions defined by the generally applicable laws and regulations; and should be disclosed to the public, provided no other confidential information is being revealed.
- The steps needed to coordinate action to avoid flaring should be identified before permits are granted in cases where inadequate midstream or downstream infrastructure capacity raises the risk of flaring.

Measurement and Reporting

Effective regulations prescribe measurement and reporting standards and procedures requiring companies to record, process, and submit the information specified by the regulator. Mandatory data collection and reporting on gas flaring and venting provide valuable information to regulators, allowing them to:

- monitor operators' compliance with approved objectives and targets and track progress toward achieving them
- compare the performance of similar types of assets and enable the operators of poorly performing assets to take steps to improve performance
- identify assets requiring site inspection.

Options for measuring gas flaring and venting volumes include direct metering, engineering estimates based on emissions factors, or a combination of the two. Regulators generally prefer accurate meter readings from calibrated installations, but these calibrated installations come with a significant price tag, making developments of minor volumes of associated gas uneconomic. In the United States, for example, only offshore facilities producing more than an average of 2,000 barrels of oil per day are required to install flare or vent meters. In some jurisdictions, such as Canada, meter installations are mandatory for certain hazardous types of flaring and venting and when certain volume thresholds are exceeded.

To ensure comparability across reports and data submitted by different parties, regulations should detail the methodology for measuring and reporting data, providing guidance, for example, on how to carry out measurements or specifications for calculating engineering estimates. In recent years, new technologies, such as continuous monitoring systems, which provide data in real-time; aerial surveillance (drone, aircraft, and satellite imaging); and satellite instruments that provide timely preliminary data have enhanced detection and improved measurement precision and accuracy while lowering costs. Engineering estimation is also increasingly accepted; it is particularly helpful for development plans for new fields when operators often have to estimate future flaring and venting volumes as part of their license application. Countries such as Brazil, Mexico, and Norway have suitable regulatory provisions for such estimation.

Cost considerations—often combined with technical challenges resulting from the highly volatile character of associated gas volumes—often prevent direct metering from being mandated. As a result, regulators do not specify how volumes are to be measured—through the installation of meters of a given type or through engineering estimates—instead requiring only that operators report flared and vented volumes accurately. For example, the Oil and Gas Authority, the UK regulator, recognizes

the challenges related to measuring flared and vented gas volumes. It has no specific metering requirement in place, accepting “operators' best estimates.” However, these engineering estimates are subject to detailed regulatory conversion guidance.

Reporting provisions require producers to maintain written records and regularly send information to the regulator on all flaring and venting volumes, regardless of size and duration; they must also submit emissions estimates or gas utilization ratios (the percentage of gas produced that was not flared or vented). Many jurisdictions require that reporting on flaring and venting be kept separate from other data submissions (such as production volumes), as prescribed recently in Texas. On the US Outer Continental Shelf, if any flaring or venting of gas requires prior approval, operators must report the location, dates, number of hours, and volumes of gas flared and vented to the regulator after the event.

Regulations may also provide guidelines regarding standards for the content and format of data; collection methods; base years; activity levels; a summary of significant occurrences (for example, major maintenance, accidents, or venting events); and a mechanism for recordkeeping and submission of the information. Regulators should build internal systems to receive and process this information, ideally on an electronic platform (IEA 2021a). An example is Nigeria's Guidelines for Flare Gas Measurement, Data Management and Reporting Obligations, which require producers to keep a daily log of gas flaring and venting based on metering (DPR 2018). Flaring reports documenting the composition of different gas streams, the gas-to-oil ratios, associated gas utilization ratios, and routine and nonroutine flaring quantities are to be submitted monthly and annually. The regulator, however, has not yet published these statistics. As of December 2021, the last year for which data were available was 2018.

The regulator has two complementary data sources for verifying compliance with gas flaring and venting targets and goals: (i) operators' reports and logs and (ii) ad hoc site inspections. Recordkeeping requirements set technical standards for written records that producers must file and maintain for a given period of time and make available for audit by the regulator upon request. Verification provisions prescribe the enforcement policy, authorize inspection, and specify sanctions and penalties. As a result of the technical and financial constraints on monitoring all flaring and

venting sites, few regulatory agencies have developed auditing procedures or defined consequences for failure to accurately report information or keep records. Exceptions include Canada, Norway, the United Kingdom, and the United States.

The quality of flaring and venting data disclosed to the public varies across jurisdictions, and relevant information is often missing or not released. Brazil, Canada, Mexico, and Norway regularly publish (at least annually) information on the government's external website, with a breakdown by operator. Alberta publishes an annual report with a summary of flared and vented volumes by industry segment, including a ranking of operators based on gas flared and vented and total oil and gas production. Colombia's regulator, the National Hydrocarbon Agency, publishes annual management reports on its website that include data on gas flaring and the authorizations granted. Nigeria's flaring payments go through a detailed reconciliation process and are published by the Nigeria Extractive Industries Transparency Initiative on its website with a time lag of less than two years. In the United States, state agencies collect data from producers, which they share with the Energy Information Administration for publication. In Algeria, Ecuador, Kazakhstan, Malaysia, and Oman, national oil companies publish data in their annual or sustainability reports. In many other cases, data are submitted voluntarily or on the basis of operating procedures in line with good industry practices, but there are no uniform reporting requirements.

Recommendations

- Methods and procedures for measuring gas flaring and venting are essential for monitoring regulatory compliance and should be detailed in the regulations.
- Engineering estimates should be accepted when measurement is difficult or too costly, provided that standardized estimation methods are specified and monitored. Regulators should consider new technologies such as continuous monitoring systems, aerial surveillance, and satellite instruments as independent sources of data.
- The nature and level of detail required for reporting flaring and venting should be set, considering the total number of sites in the country and the capacity of the regulator to monitor effectively.

- Operators should maintain daily logs of all flaring and venting volumes and occurrences, with intermittent events and continuous flaring and venting reported separately. Regular (for instance, monthly) reporting to the regulator should be mandatory, but logs should also be available to the regulator upon request and be kept, preferably on-site, for an extended period to support long-term trend analysis.
- The quality of data disclosure is uneven and needs to be enhanced. The industry could work with regulators to make reporting more accurate, detailed, and regular and to improve standards for public disclosure of flaring and venting data.
- Publication of the terms and conditions of licensing contracts can lead to better monitoring of gas flaring and venting reductions and encourage regulatory compliance.

Fines, Penalties, and Sanctions

Most jurisdictions, legislation, and contractual provisions impose sanctions, mandatory payments, or other means of enforcement for noncompliance with regulations. The sanctions typically take the form of progressive penalties, fines, or fees, with more severe sanctions for repeated violations or serious offenses. Violations may lead to suspension or withdrawal of the production license, imprisonment, and other forms of harsh punishment.

With regard to flaring and venting, very few jurisdictions have mandatory payments or sanctions specific to noncompliance with regulations. In Brazil, Colombia, Gabon, the United Kingdom, and certain jurisdictions in Canada and the United States, regulations indicate the situations in which penalties and sanctions should apply and the amounts due. In Mexico, operators must have financial resources sufficient to cover any environmental damages caused by flaring. In Gabon, any contractor that violates the ban on gas flaring is liable to a penalty that can be as high as US\$4.5 million. In Nigeria, all gas flared or vented—whether or not flaring or venting is avoidable and whether or not the oil producer has the right to commercialize associated gas—is subject to a substantial payment at all times and under all circumstances: US\$2.00 per thousand cubic feet where daily oil production is 10,000 barrels or more, and \$0.50 otherwise, making the impact of the payment comparable to that of a carbon tax.

Persistent noncompliance with regulations or license conditions—including rules on flaring and venting, such as reduction plans or thresholds—can be subject to additional nonmonetary sanctions, eventually leading to the concession’s suspension or termination. Generic laws and regulations (not necessarily specific to flaring and venting) are relatively widespread, but the lack of monitoring and enforcement of regulations in most jurisdictions means that there is little chance that a license will be revoked for noncompliance.

Mandatory payments and sanctions generally have a limited impact on compliance with regulations because payments are not material, are not collected, or both. The imposition of payments for noncompliance often does not incentivize operators sufficiently to comply if the mandated monetary value is inconsequential in relation to the commercial value of oil production, measurement and reporting systems and procedures are ineffective, or regulators fail to enforce them for fear of losing oil production.

Countries with mandatory payments defined in the legislation rarely publish detailed information on them. There are two exceptions. The first is Alberta’s Compliance Dashboard, which provides a compliance history of companies and enforcement decisions since 2014, including fines for gas flaring and venting. The second is the annual oil and gas industry audit published by the Nigeria Extractive Industries Transparency Initiative, which reconciles payments by companies and those the federal government receives every year.² Data on fines charged for violations in gas flaring and venting regulations from other jurisdictions are extremely difficult to find. Data on fines imposed by Brazil are available for download on the regulator’s website, but specific information for flaring and venting has been missing for several years. In most cases, information is limited to anecdotal cases of fines being imposed on national oil companies or high-profile international oil companies.

Recommendations

- Any type of mandatory payment (penalty, fine, fee) should be established at a sufficiently high level to make the alternative of investing in flaring and venting reduction more attractive than paying the penalty. However, the payment should not be

so high that shutting down oil production becomes the only viable option. The monetary value of the required payment should be pegged to some indicator—adjusting for the country’s GDP deflator or the US dollar equivalent adjusted for the US GDP deflator, for example—that allows it to retain its real value and remain an incentive to the operator.

- Mandatory payments and sanctions should be applied evenly across all producers. Not enforcing them on national oil companies and small local producers with the same force could create a lop-sided playing field with, for example, only international oil companies making the payments. Such an uneven enforcement practice would be particularly problematic where small local producers and national oil companies are responsible for a disproportionate share of gas flaring and venting.
- Governments are advised to evaluate the trade-off between the enforcement of stepwise penalties and other payments on flared or vented gas, on the one hand, and incentives to reduce emissions or market mechanisms that create means and incentives for the commercialization of associated gas, on the other.

Enabling Framework

A range of economic instruments can be introduced to encourage producer-specific gas flaring and venting abatement programs. These instruments typically take the form of fiscal or market-based incentives. Under the first type, the fiscal burden is reduced by lowering taxes for associated gas and lowering or even eliminating royalties for capturing and using or marketing it. An alternative is to increase the fiscal burden of flaring and venting, by levying royalties on gas flared or vented without the regulator’s prior approval and imposing carbon taxes on all GHG emissions.

Examples of market-based approaches include (i) emission trading systems and offset credit schemes that allow producers to sell carbon credits by reducing flaring and venting; (ii) green investment funds; and (iii) financial grants for specific emission abatement investments. Gas pricing reforms can also be considered part of this category (UNECE 2019).

The distinction between penalties and fiscal incentives is not sharp. Paying royalties for unauthorized flared gas has the

same effect as paying a penalty on flaring; both are intended to encourage flaring reductions to avoid these expenses. Royalty payments are typically tax-deductible, reducing their effects compared with fines of the same magnitude. An example of a broader incentive is consolidating costs across oil and gas operations and allowing oil producers to claim investments in gas flaring and venting reduction as tax-deductible costs against oil revenue.

The broad array of fiscal terms in place for oil and gas allows fiscal disincentives for flaring and venting to be structured in multiple ways. In Brazil, natural gas that is flared or vented must be included in the total production volume to be calculated for the purpose of paying royalties to the government. The royalty is 5–10 percent of the oil and gas production reference price in concessions and 15 percent of the volume of produced oil in production-sharing contracts. In Colombia, any gas flared or vented in contravention of the regulations is subject to the payment of royalties.

For onshore oil fields in the United States, the federal Bureau of Land Management charges royalties for excessive flaring and wasting of natural gas. It imposes royalty payments on flared or vented associated gas that the regulator determines could have been utilized and on gas flared or vented without prior approval. Wellhead royalties are generally levied at a rate of 12.5–30 percent (based on the lease or contract) of the gross wellhead value for all petroleum produced. On the Outer Continental Shelf, if flaring or venting occurs without the required approval of the Bureau of Safety and Environmental Enforcement, if the regulator determines that the operator was negligent, or if flaring and venting could have been avoided, the associated gas is considered avoidably lost or wasted and subject to royalties (12.5 percent in old leases, 16.67 percent in shallow waters, and 18.75 percent in deep water). North Dakota modified its gas capture rules in 2014 to reduce the amount of flaring allowed from 26 percent to 9 percent after 2020. Operators may apply for a flaring exemption if connecting a well to a natural gas gathering line is not economically viable. Without an exemption, violators will pay taxes and royalties on flared gas. Gas is exempt from taxes and royalties for 2 years and 30 days (25 months) from the first day of production if at least 75 percent of it is used at the well site to generate electricity or collected to produce petrochemicals or fertilizers.

² <https://neiti.gov.ng/index.php/neiti-audits/oil-and-gas> (last accessed October 20, 2021).



Russia uses a formula to calculate flaring and venting fees, with automatic increases for factors such as volume increases and lack of meters. In Kazakhstan, emission taxes are calculated on the basis of base levies for various emissions, including from flaring. Base tax rates for emissions from flaring are 20 to 278 times as large as the same emissions from other stationary sources.

Operators of cash-strapped companies and new high-cost oil developments in areas lacking infrastructure may find it challenging to comply with gas flaring and venting requirements without further incentives to encourage associated gas utilization investments. Incentives could include reduced royalties, tax rebates, accelerated depreciation, and investment credits for reducing flaring and venting. However, royalties are typically applied only to oil and gas sold, not that consumed in operations. Kazakhstan provides tax relief to facilities that obtain an integrated environmental permit by adopting the best available techniques. Russia recognizes financial efforts to increase the use of associated gas by allowing an offset of the investment against the fee charged for gas flaring and venting.

In 1991, Norway became one of the first countries to introduce a carbon tax. The CO₂ Tax Act on Petroleum Activities levies a tax on the combustion of all gas, oil, and diesel in petroleum operations on the continental shelf and on CO₂ and natural gas releases. Oil and gas companies currently pay Nkr800 (approximately US\$94 as of August 2021) per tonne of CO₂ emitted from production on the Norwegian continental shelf. This amount comprises payments for EU Allowances under the block's Emissions Trading System and Norway's own carbon taxes. The Norwegian government intends to gradually raise the total cost of carbon to Nkr 2,000 (about US\$230 as of September 2021) per tonne by 2030. As a result of these efforts, Norway has the lowest flaring intensity of all the countries reviewed in this report (figure 1). Part of its success with robust reporting and regulation through carbon pricing may reflect the relatively small number of industry players and their large size (IEA 2021a).

In 2008, British Columbia implemented Canada's first broad-based carbon tax regulation. With a current value of Can\$25.60 per tonne of CO₂e (approximately US\$20 as of August 2021), the tax applies to the purchase and use of fossil fuels burned for transportation, home heating, and electricity. The regulation does not include legal requirements for the oil and gas industry. The

federal government decided not to apply a carbon tax on flaring or methane emissions in oil and gas operations because doing so could threaten the competitiveness of hundreds of small oil and gas producers.

Regulated facilities in Alberta must undertake one of several measures under the Technology Innovation and Emissions Reduction System: reduce their emissions, redeem credits from facilities that have exceeded their reduction targets, purchase offsets from unregulated entities, or pay into a compliance fund. In British Columbia, the CleanBC Industry Fund supports projects using commercially proven technologies that reduce GHG emissions from large industrial operations that emit more than 10,000 tonnes of CO₂e per year. In Saskatchewan, the Oil and Gas Processing Investment Incentive offers transferable royalty or freehold production tax credits at a rate of 15 percent of eligible program costs to value-added projects in the oil and gas sector, such as gas-gathering transportation infrastructure and methane gathering projects.

Fiscal ring-fencing rules allowing midstream and upstream activities to be consolidated for tax purposes are another way to incentivize flaring and venting abatement. In Russia, for example, a single legal entity can offset losses from one project with profits from another, regardless of whether the projects are upstream, midstream, or downstream.

In terms of market-based approaches, emissions trading schemes typically define limits and allocate allowances among the regulated companies that can then be traded. Where these schemes are operative, producers who fulfill and surpass regulatory requirements can have their certified reduction credits accredited as voluntary decreases and may choose to trade these credits. For example, in Norway and the United Kingdom, CO₂ emissions from the petroleum sector have been covered by the EU Emission Trading System since 2008. In 2012, the United Kingdom established Greenhouse Gas Emissions Trading System Regulations, which affected flaring because of its associated CO₂ emissions. Kazakhstan established the first GHG emissions trading system in Asia in 2013. Oil and gas installations with GHG emissions of more than 20,000 tonnes of CO₂e per year must obtain quotas. In 2021, the penalty for noncompliance was about US\$35 per tonne of CO₂e.

Negotiated agreements between the regulator and the national oil company (and sometimes with other producers) can range from a loosely defined arrangement with voluntary targets to formal accords that include penalties or sanctions if specific quantitative targets are not met. In Latin America, negotiated agreements appear to have produced better results than poorly enforced top-down regulations. To be effective, they must include procedures for monitoring, reporting, verification of compliance, and sanctioning (UNECE 2019). For example, the Brazilian regulator has signed terms of commitment with Petrobras, the national oil company, and Chevron. These agreements aim to reduce volumes flared and contain targets for the use of associated gas and action plans to ensure compliance. The Gas Optimization Program of Petrobras, developed in 2009 under the second term of the commitment, reduced emissions by more than 40 percent between 2009 and 2019, even though production increased during the period. Ecuador's most significant flaring abatement initiative—conducted since 2009 by Petroamazonas, the upstream branch of Ecuador's national oil company—has redirected associated gas to electricity generation and the production of liquified petroleum gas.

Agreements negotiated between the regulator and international oil companies have also produced results. The US\$12 billion Angola LNG Project—with a capacity to process 1.1 billion cubic feet of associated natural gas per day produced by Sonangol, Chevron, BP, Eni, and Total—reduced flared volumes by about 60 percent between 2016 and 2020. According to Angola's model production-sharing agreement, companies have the right to use any associated gas produced in their oil activities and separate any liquids from it. Any surplus gas must be given to the national oil company, Sonangol, free of charge. All capital expenditures borne by the operators for the storage and delivery of gas to Sonangol are cost-recoverable against oil revenues. Through the development of the LNG plant, Sonangol has taken several measures to enhance the country's use of associated gas and promote a de facto policy of no routine flaring. However, in Gabon, several government requests to all oil companies operating in the country to submit individual plans detailing how they will reduce gas flaring at their facilities have not produced tangible results. Although oil companies implemented several flare-reduction

projects from 2011 to 2015, flared volumes did not decline any faster than oil production; if anything, flaring intensity appears to have risen since 2012.³

Public-private partnerships between national oil companies and private investors can lead to investments in transportation and processing infrastructure that enable gas flaring abatement. Examples include the Angola LNG Project and the El Merk Central Processing Facility in Algeria. Well-intentioned and executed projects, such as those mentioned above, allow parties to pool resources and avoid imposing the full burden of overcoming the infrastructure challenges on individual companies. This cooperative approach can enable flaring reduction projects. However, negotiating joint infrastructure agreements between license holders, national oil companies, and infrastructure investors with differing objectives and financial and technical capabilities often comes with alignment challenges that are difficult to overcome. As a result, the industry still does not have a strong track record of joint ventures for pipeline and gas processing infrastructure to commercialize gas.

To enhance efficiency in the market, regulators should prevent anticompetitive behavior by the owners of transmission networks and ensure that all gas producers have nondiscriminatory third-party access to infrastructure, such as gas processing and transmission facilities. In Canada and the United States, the primary reason the industry cites for gas flaring and venting is the lack of transportation infrastructure (Kah 2020). Certain segments of the gas value chain, such as gas pipelines, are natural monopolies and could invite anticompetitive behavior in the absence of well-enforced regulations permitting third-party access. Vertically integrated oil and gas companies in some Latin American countries have engaged in anticompetitive behavior to discriminate against competitors for access to pipelines, hindering efforts to bring associated gas to the market. Although third-party access can often be secured through contractual negotiations, the substantial bargaining power held by the transmission network's owners may require regulatory intervention (CCSI 2016). In Russia, owners and operators of transmission and distribution facilities are required to give associated gas volumes preferential access to free capacities. In Alberta, when operators and network controllers cannot

reach agreement, the Energy Resources Conservation Board can unilaterally establish the conditions necessary for the transmission of associated gas.

In many developing countries with rapidly growing demand for electricity, the power sector is an important anchor customer for domestic gas. However, where the power sector is financially weak, large payment arrears (often aggravated by tariff subsidies) and large system losses that compound financial difficulties can pose major obstacles to ending routine flaring. When electricity generation companies do not have the resources to pay for gas “purchased” or where gas prices are kept too low to make the marketing of associated gas commercially viable, the only alternative to flaring may be gas exports. However, artificially low gas prices tend to be paired with domestic gas supply obligations, forbidding gas producers from exporting gas unless notified gas volumes are delivered to the domestic market first. This vicious cycle has deterred flaring reduction in several developing countries.

To be effective, investments in abatement of flaring and venting require gas pricing reforms and competitive downstream energy markets with efficient and transparent legal and regulatory frameworks that provide fair and nondiscriminatory access to markets. Abatement investments also require the right of oil producers to monetize associated gas, including through exports, and market-based domestic gas pricing and payment discipline in the power sector and other anchor points. These features are lacking in many developing countries, and resolution of these challenges lies outside the control of the ministry in charge of oil and gas. Absent an integrated energy sector strategy that is implemented and ensures market reforms, reducing gas flaring and venting will continue to present a challenge.

Recommendations

- Carbon taxes, royalties, and fees payable on emissions appear to be an effective means of curbing flaring and venting. Governments are encouraged to levy these charges on all gas flared and vented, or at least above certain limits or outside specific situations authorized by the regulator.
- Robust verification systems should support all incentives provided to investments in the abatement of gas flaring and venting.
- Negotiated agreements between the regulator and oil producers can reduce gas flaring and venting when they include procedures for monitoring, reporting, and verifying compliance. Latin America's experience provides lessons for other countries.
- Reforming gas tariffs that keep prices artificially low is an important enabler to incentivize flaring and venting abatements. Governments can encourage and enable associated gas utilization by (i) giving oil producers the right to monetize associated gas, including through gas exports; (ii) ensuring open and nondiscriminatory access to gas processing and transmission facilities; and (iii) establishing market-based energy pricing and ensuring payment discipline for gas purchase.
- Some essential steps for reducing flaring and venting, such as power tariff reforms and the restructuring of bankrupt power utilities, lie outside the control of the ministry in charge of upstream oil and gas. In such circumstances, interministerial coordination is paramount for the success of gas flaring and venting abatement strategies.

³ <https://www.worldbank.org/en/programs/gasflaringreduction/global-flaring-data> (accessed September 26, 2021).

Concluding Remarks

About half of the countries analyzed have reduced both flaring volumes and flaring intensity since 2012, demonstrating the effectiveness of a wide range of legislative and regulatory approaches. To provide further insights on what it took to achieve this from a regulatory perspective and where there is still scope for improvement, table 1 summarizes the findings of the review of approaches and tools in the 28 jurisdictions examined.

All 28 jurisdictions have put in place structures for environmental management of upstream oil and gas production, thereby ensuring that flaring and venting, although often not explicitly mentioned, fall under the responsibility of one or more dedicated authorities. Twenty-three jurisdictions have recognized the importance of capturing data of public interest, including flaring and venting volumes, underscoring the use of data as the basis for corrective

action. Despite growing attention to the need to eliminate flaring and venting, however, only 21 jurisdictions have banned routine flaring or venting; most of these jurisdictions also recognize that emergency flaring and venting requires swift action and therefore cannot easily be subject to prior authorization. Only 14 of 28 jurisdictions reviewed impose monetary penalties or use market-based solutions, signaling reluctance to follow through with corrective action. Monetary payments and bans on flaring and venting overlap in most cases, but exceptions occur, in particular when a general payment requirement is in place, regardless of trigger points such as volume thresholds. Only 12 jurisdictions have set performance requirements, mostly for the flaring equipment deployed; half of them also ban flaring and venting, indicating that installation of equipment but not its optimal functioning is a priority. The lack of attention to performance requirements raises concerns, particularly for unflared methane, the global warming potential of which is an order of magnitude greater than that of CO₂ from flaring gas.

Jurisdictions that have reduced flare gas volume and flaring intensity have adopted different regulatory approaches and tools, but they share one common thread: They tend to combine prescriptive and performance-based regulatory approaches, using strong monetary incentives and disincentives and giving their regulators the powers to monitor and enforce them. Their examples illustrate how different legal and regulatory approaches and tools can be combined into a successful package.

- Among the major oil and gas producers, Norway is the global leader on gas flaring intensity, with only 0.24 cubic meters of gas flared per barrel of oil produced. The country's flaring and venting laws and regulations started in the early 1970s and have built on a long environmental tradition. Norway's approach, which aims to internalize global externalities, consists of a bundle of measures that include flaring and venting permits with detailed specifications, a carbon tax, and an emissions trading scheme.
- For Colombia, Ecopetrol's 2010 climate change strategy was a major factor in kickstarting activities to reduce flaring and venting. It resulted in a reduction of flaring intensity from 2.86 cubic meters of gas per barrel of oil produced in 2012 to 1.22 in 2021. The tools deployed to achieve this reduction include a strict monetary penalty system and government support in

establishing a domestic gas market for the local gas production.

- Kazakhstan significantly reduced its flaring intensity, from 6.12 cubic meters per barrel of oil produced in 2015 to 2.34 in 2021. This remarkable reduction reflected decisive legislative efforts starting in 2015 that introduced both a strict monetary penalty system and an emission trading scheme. The government also established a domestic market for the gas produced and assigned the preferential right to purchase the gas to a state-owned company, which enabled an integrated domestic gas value chain extending from upstream to downstream.

Countries that have not consistently reduced routine flaring and venting typically lack clearly defined and fit-for-purpose laws and regulations that impose material penalties. Their enforcement capabilities are often weakened by a lack of focus and resources or by unwillingness to act in an equitable manner. A detailed assessment of the flaring and venting laws and regulations deployed across key oil-producing countries and regions can be found in the case-study companion to this report (GGFR 2022).

Table 1 Summary of regulatory status in the 28 jurisdictions reviewed

| Measure | Adopted | Not adopted | No information available |
|---|---------|-------------|--------------------------|
| Targets or limits are set | 19 | 8 | 1 |
| Authorities are empowered by legislation and regulation | 28 | 0 | 0 |
| Emergency flaring or venting is allowed without prior approval | 20 | 6 | 2 |
| Routine flaring or venting is prohibited | 21 | 6 | 1 |
| Development plans must include provisions for the utilization of associated gas | 21 | 7 | 0 |
| Associated gas projects require an economic evaluation | 22 | 4 | 2 |
| Measuring and reporting standards are prescribed | 23 | 3 | 2 |
| Monetary fines, penalties, and sanctions are imposed for violations | 14 | 4 | 10 |
| Nonmonetary sanctions are imposed for violations | 11 | 2 | 15 |
| Engineering performance requirements are set | 12 | 11 | 5 |
| Fiscal incentives are provided for reductions | 17 | 7 | 4 |
| Market-based incentives are provided for reductions | 14 | 14 | 0 |
| Mid- and downstream regulations encourage reductions | 21 | 5 | 2 |

References

- BSEE (Bureau of Safety and Environmental Enforcement). 2017.** *Analysis of Potential Opportunities to Reduce Venting and Flaring on the OCS.* Venting and Flaring Research Study Report prepared by Argonne Venting and Flaring Research Team. <https://www.bsee.gov/sites/bsee.gov/files/5007aa.pdf>.
- CCSI (Columbia Center on Sustainable Investment). 2016.** *A Policy Framework to Approach the Use of Associated Petroleum Gas.* Report prepared by Shayan Banerjee and Perrine Toledano, Columbia University, New York. https://scholarship.law.columbia.edu/sustainable-investment_staffpubs/19/.
- DPR (Department of Petroleum Resources). 2018.** *Guidelines for Flare Gas Measurement, Data Management and Reporting Obligations.* Lagos. <https://ngfcp.dpr.gov.ng/media/1129/guidelines-2-guidelines-for-flare-gas-measurement-data-management-reporting-obligations.pdf>.
- GGFR (Global Gas Flaring Reduction Partnership). 2004.** *Regulation of Associated Gas Flaring and Venting: A Global Overview and Lessons from International Experience.* Report prepared by Franz Gerner and Bent Svensson. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/590561468765565919/regulation-of-associated-gas-flaring-and-venting-a-global-overview-and-lessons-from-international-experience>.
- . **2009.** *Guidance on Upstream Flaring and Venting Policy and Regulation.* World Bank, Washington, DC. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/200701468344636937/guidance-on-upstream-flaring-and-venting-policy-and-regulation>.
- . **2021.** *Global Gas Flaring Tracker Report*, April. World Bank, Washington, DC. <https://thedocs.worldbank.org/en/doc/1f7221545bf1b7c89b850dd85cb409b0-0400072021/original/WB-GGFR-Report-Design-05a.pdf>.
- . **2022.** *Regulation of Gas Flaring and Venting: 28 Case Studies from around the World.* World Bank, Washington, DC. <https://flaringventingregulations.worldbank.org/>.
- IDB (Inter-American Development Bank) 2020.** *Latin American State Oil Companies and Climate Change: Decarbonization Strategies and Role in the Energy Transition.* Report prepared by Lisa Viscidi, Sarah Phillips, Paola Carvajal, and Carlos Sucre. <https://www.thedialogue.org/wp-content/uploads/2020/05/Latin-American-State-Oil-Companies-and-Climate-Change.pdf>.
- IEA (International Energy Agency). 2021a.** *Driving Down Methane Leaks from the Oil and Gas Industry: A Regulatory Roadmap and Toolkit.* Report prepared by K.C. Michaels, Tomás de Oliveira Bredariol and Katherine Konschnik. <https://www.iea.org/reports/driving-down-methane-leaks-from-the-oil-and-gas-industry>.
- IEA (International Energy Agency). 2021b.** *Methane Tracker 2021.* January. Paris. <https://www.iea.org/reports/methane-tracker-2021>.
- Kah, Marianne. 2020.** *Natural Gas Flaring Workshop Summary.* April. School of International and Public Affairs, Columbia University, New York. https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/NaturalGasFlaringWorkshoppSummary_CGEP_042920-2.pdf.
- Nigeria, Federal Government. 2018.** *National Action Plan (NAP) to Reduce Short-Lived Climate Pollutants (SLCPs).* <https://climatechange.gov.ng/wp-content/uploads/2020/09/nigeria-s-national-action-plan-nap-to-reduce-short-lived-climate-pollutants-slcp-.pdf/>.
- Nigeria, Federal Ministry of Environment. 2021.** *Nigeria's First Nationally Determined Contribution 2021 Update.* <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Nigeria%20First/NIGERIA%202021%20NDC-FINAL.pdf>.
- UNECE (United Nations Economic Commission for Europe). 2019.** *Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector.* Document prepared by Torleif Haugland, Carbon Limits. https://unece.org/DAM/energy/images/CMM/CMM_CE/Best_Practice_Guidance_for_Effective_Methane_Management_in_the_Oil_and_Gas_Sector_Monitoring_Reporting_and_Verification_MRV_and_Mitigation_FINAL_with_covers.pdf.

The World Bank's role in gas flaring reduction

The World Bank's Global Gas Flaring Reduction Partnership (GGFR) is a trust fund composed of governments, oil companies, and multilateral organizations committed to ending routine gas flaring and venting at oil production sites across the world. The Partnership helps identify solutions to the array of technical, financial, and regulatory barriers to flaring and venting reduction by developing country-specific flaring reduction programs, conducting research, sharing best practices, raising awareness, securing commitments to end routine flaring through the 'Zero Routine Flaring by 2030' global initiative, and advancing flare measurements and reporting.



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