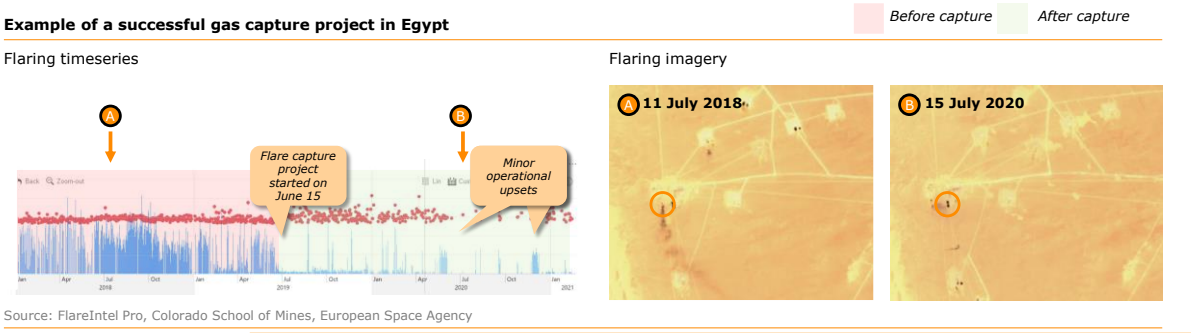
Leadership on flaring in Egypt: Recent successes and future opportunities in the lead-up to COP27



Above: illustration of a successful flare capture project, as verified by satellite data

A thought piece by

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4000 words, reading time 8 minutes

Executive summary

In November, Egypt will host the world at COP27 in Sharm El Sheikh. It will be a unique opportunity for Africa to showcase its leadership amid today's triple crises – an energy security crisis, a cost-of-living crisis, and a climate crisis. The dramatic rise in the price of natural gas has been driving governments to scramble for alternative gas supplies. Yet, amid this worldwide energy crisis, we have not been paying enough attention to the wasted gas in our global system. Globally, flaring, venting and leaking in the oil and gas industry results in the loss of 266 billion cubic meters (BCM) annually[1].

Encouragingly and quietly, gas flaring reduction is already an area where Egypt is driving change. Flaring is lower, by 26% compared to 2016, partly due to the specific projects we highlight below. Operators in Egypt have recently demonstrated that flare capture projects are commercially attractive at the scale of 10, 30, 50, and 150 million cubic metres per year.

But there is more to do. Egypt's flaring, venting and leaking could be further reduced, annually adding up to 3.7 BCM of gas, up to $7 billion per year to the economy, whilst reducing emissions by up to 88 million CO2-equivalent tonnes. Flare projects can be delivered relatively quickly (within 9-18 months, if fast-tracked), without additional drilling, by deploying proven technology, whilst delivering attractive commercial returns.

Building on the success of recent flare projects, the government can further accelerate action, supported by international offers of collaboration, capabilities and capital. In doing so, Egypt can bring additional supply to domestic and international markets, reduce emissions and support its economy. The extra gas can lower the need for the current electricity rationing, reverse gas-to-oil substitution in power stations, boost gas exports, and create jobs in Egypt. This model could also be replicated by other oil and gas-producing countries.

[1] Which also generates CO2-equivalent emissions of around 1 billion tonnes per year, and represents a revenue opportunity of $700 billion per year (that's $20,000 per second) at today's prices of $75 per mmbtu. For a compilation of the figures, see https://flareintel.com/insights/insights-from-energy-weeks-panel-on-flaring-venting-and-leaking.

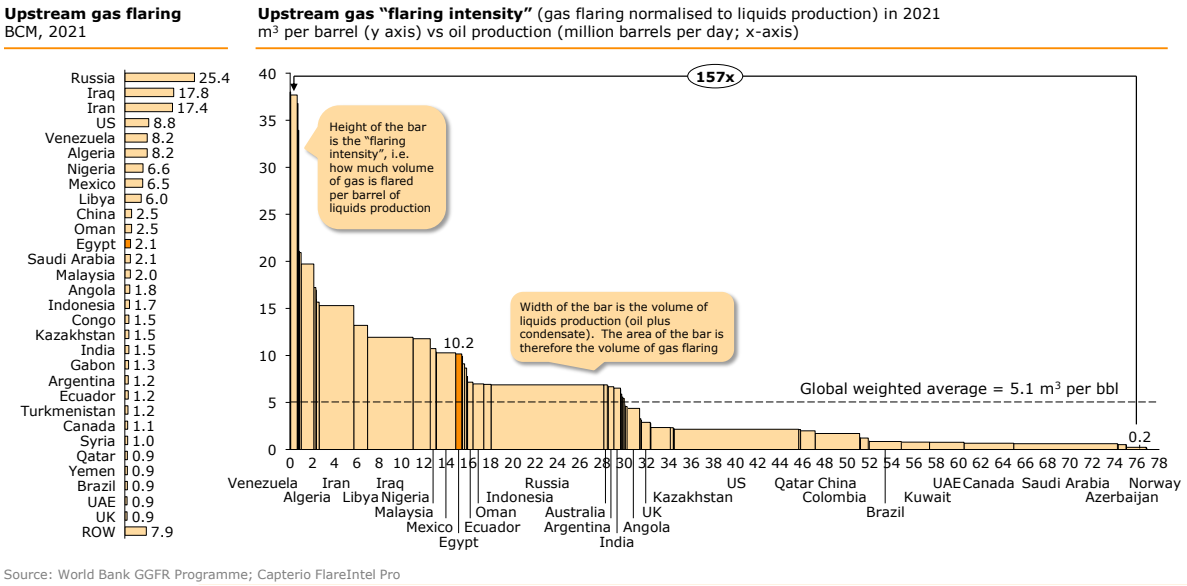
Overview of Egypt's gas flaring opportunity

Egypt has a significant flaring opportunity

Egypt has seen a gas renaissance in the last five to ten years. Significant discoveries in the onshore and the offshore (famously, the Zohr field), coupled with deeper ties with neighbouring countries, have put Egypt firmly on the map. Egypt has been a net gas exporter since 2018 and is already becoming a regional gas hub well-positioned to serve Asian and European markets. In parallel, Egypt has strongly stated its commitment to climate goals. In 2017 Egypt endorsed the World Bank's "Zero Routine Flaring" (by 2030) initiative, and, in June 2022, it joined the "Global Methane Pledge (which commits to a 30% reduction in methane by 2030).

But Egypt still has significant flaring (2.1 Billion Cubic Metres of gas per year, according to the World Bank[2][3][4], making Egypt the world's 12th largest flarer with a "flaring intensity" – flaring per barrel of produced liquids – of 10 m^3 per barrel (Figure 1). Whilst Egypt has considerably lower flaring than geographic peers Libya or Algeria, Egypt's flaring intensity is two times higher than the world average and is 20-50 times greater than the best-in-class countries of Norway and Saudi Arabia[5].

Egypt has high gas flaring – both in absolute and relative terms



Source: World Bank GGFR Programme; Capterio FlareIntel Pro

[2] Note that we measure the volume of *hydrocarbons* being flared, in methane-equivalent volumes. Any volumes of non-combustible gas (e.g. H2S or CO2) are excluded from our figures. So too are volumes of uncombusted hydrocarbons (due to inefficient burning at the flare tip), although these figures are included in Figure 2.
[3] According to the World Bank's 2022 report for 2021, see also FlareIntel Free at www.flareintel.com.
[4] As an aside, based on our calibration exercises in the region, we believe that this is probably moderately overstated, but in a sense, this point is not critical, as the problem is still material).
[5] Norway delivered its best-in-class performance through strong regulation (since 1971; see our article: https://flareintel.com/insights/tackling-flaring-lessons-from-the-north-sea), and Saudi Arabia built its petrochemicals business from previously flared gas. Both examples demonstrate what can be achieved by strong and committed leadership.

Figure 1: Overview of flaring in Egypt, a top 12 flarer globally, with a "flaring intensity" 2x the global average and 50x higher than the best-in-class country, Norway.

Flaring occurs mostly within the oil supply chain, either when critical gas-gathering infrastructure is absent, or when there are operational upsets. According to Capterio's real-time flare tracking tool (which combines real-time flaring data with detailed infrastructure mapping), in Egypt, 90% of all flaring is "routine" in nature (it happens most days). Also, 75% of flared volumes are within 20 km of an existing gas pipeline. These factors suggest that flaring in Egypt is a very fixable problem.

Fortunately, the World Bank data show an encouraging trend. Egypt has significantly reduced flaring, by an average of 6% *per year* over the last six. In part, this is due to a lower "flaring intensity" (a proxy for operational efficiency), coupled with a reduction in the underlying liquids production (Figure 2). Flare capture projects outlined below have significantly helped to lower Egypt's flaring intensity.

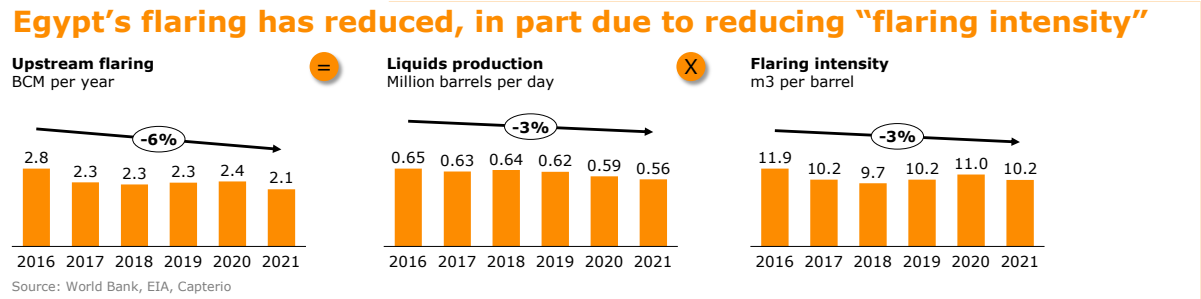


Figure 2: Flaring in Egypt (left chart) is broken down into its primary drivers (liquids production and flaring intensity) over time. Egypt's flaring is down by 6% per year, in part due to operational improvements driven by recently delivered flare capture projects.

Recently-delivered flare capture projects have driven down flaring in Egypt

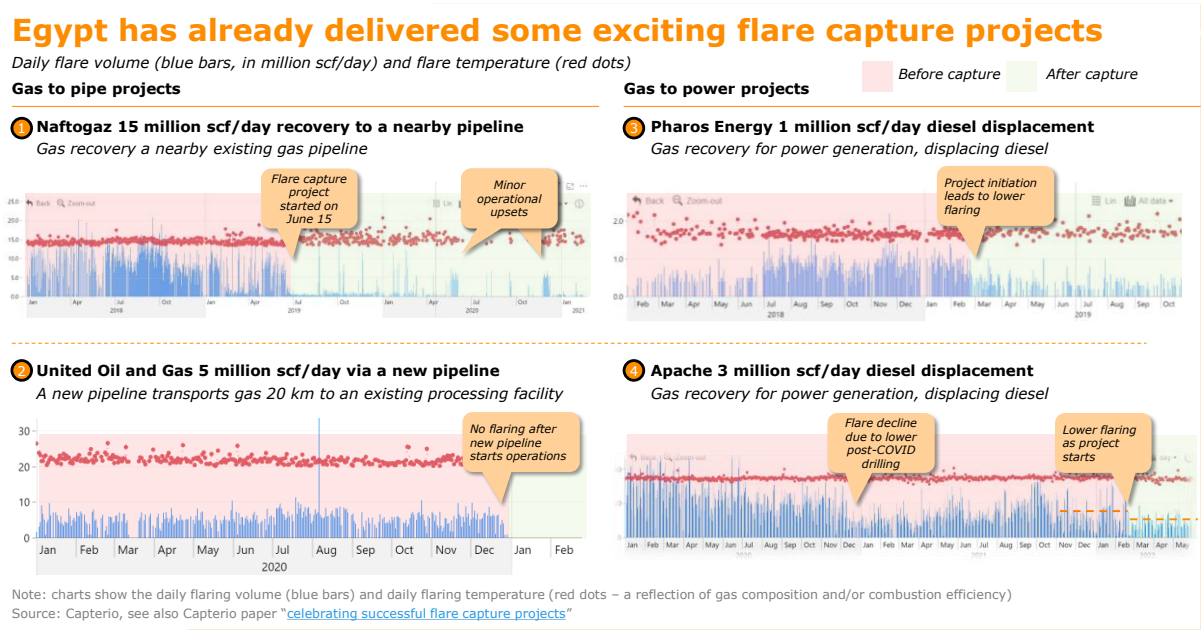
Egypt's success at reducing flaring is, in part, driven by the successful delivery of a number of flare capture projects. Indeed, such projects were highlighted a as strategic priority by a report commissioned by the EBRD (European Bank for Reconstruction and Development) in 2017[6].

For "routine" flaring (i.e., flaring that occurs on a majority of days), the potential solutions range from sending recovered gas to nearby pipelines, using it for power generation (for local operations, or for the grid), sending it to market in the form of CNG (Compressed Natural Gas) or LNG (Liquefied Natural Gas), or deploying more exotic solutions (including using the gas to synthesise alternative proteins or to generate graphene, etc.). Incidentally, for "upset" flaring (flaring that occurs on an infrequent basis, mostly due to operational problems), the solutions are normally focused on better operational management, improved maintenance, turnaround, restart practices and/or better operator training.

[6] https://www.ebrd.com/documents/admin/egypt-gas.pdf.

The examples we discuss below are compelling, not least because they can be "seen from space". Satellite data analytics tools such as *FlareIntel Pro*[7] (which tracks every flare for every asset, for every company, in every country, every day) can be used to independently demonstrate and verify the successful delivery of flare capture projects.

To prove the point, we highlight in Figure 3 flaring "before" and "after" the implementation of four key flare capture projects in Egypt that range in size from 10-150 MCM per year (1 to 15 million scf/day). Each project has successfully monetised otherwise wasted gas whilst also significantly reducing emissions. Collectively, these projects capture some 240 MCM per year (c. 24 million scf/day) and reduce emissions by 1.3 million CO2-equivalent tonnes per year.



Note: charts show the daily flaring volume (blue bars) and daily flaring temperature (red dots – a reflection of gas composition and/or combustion efficiency)
Source: Capterio, see also Capterio paper "celebrating successful flare capture projects"

Figure 3: Illustrations of the several flare reduction projects that have recently been delivered in Egypt. Data shows daily flaring from Capterio's satellite flare tracking tool FlareIntel Pro, which incorporates data from the Colorado School of Mines. The blue bars are the volume of gas being flared, and the red dots are the temperature of the flares (which is a function of gas composition and combustion efficiency). Red areas highlight the flaring before the flare capture project, green area shows flaring after delivery. The labels 1-4 are cross-referenced in the map below.

The examples above represent two of the flare solution archetypes:

Gas to pipeline projects: Two recent projects (by Naftogaz and United Oil and Gas/Kuwait Energy) are particularly interesting:

- Example 1: Naftogaz (the Ukrainian state oil and gas company) delivered a similar project, recovering a large (15 million scf/day) flare to an existing

[7] Which detects flares, by satellite, from the thermal anomaly derived from the combustion of gas. Capterio's tool FlareIntel Pro incorporates data from the Colorado School of Mines and other data providers to visualise the flares in context of key infrastructure (gas and power pipelines), licence blocks and oil and gas fields. A free version of FlareIntel is also available at https://flareintel.com/flareintel-free.

pipeline. Whilst a few operational upsets are clear in the data, the impact of this project is very clear.

- Example 2: United/Kuwait (example 1) installed a 20 km pipeline in record time – within 13 months – of their discovery at the Ash field. This pipeline recovers a modest 5 million scf/day to the nearby El Salmiya gas processing facility. This project is impressive not only because of the speed of its deployment, but also because it demonstrates that a moderate-length pipeline can be an attractive option, even for relatively small flares.

Gas to power projects: Pharos and Apache[8] have recently delivered flare-to-power projects (examples 3 and 4, respectively); so too has Shell (now Capricorn & Cheiron). In each case, the power is used to run the local oil and gas field operations instead of burning diesel (which itself is in short supply in Egypt). We estimate that these projects saved up to 3 million litres of diesel per month, lowering operating costs by several tens of million dollars per year whilst also reducing emissions and improving the safety of truck drivers and other road users.

Whilst these examples are important, the nationwide prize is more substantial

The above examples, whilst impressive in their own right, only talk to some of the significant potential within Egypt. Nationwide, the flare capture opportunity is significant, as Figure 4 illustrates.

[8] Apache's project alone generates 10 MW of power and saves 2.4 million litres per month, according to the contractor who delivered the project, Aggreko: https://www.worldoil.com/news/2022/9/7/aggreko-completes-africa-s-largest-flare-gas-to-power-project/.

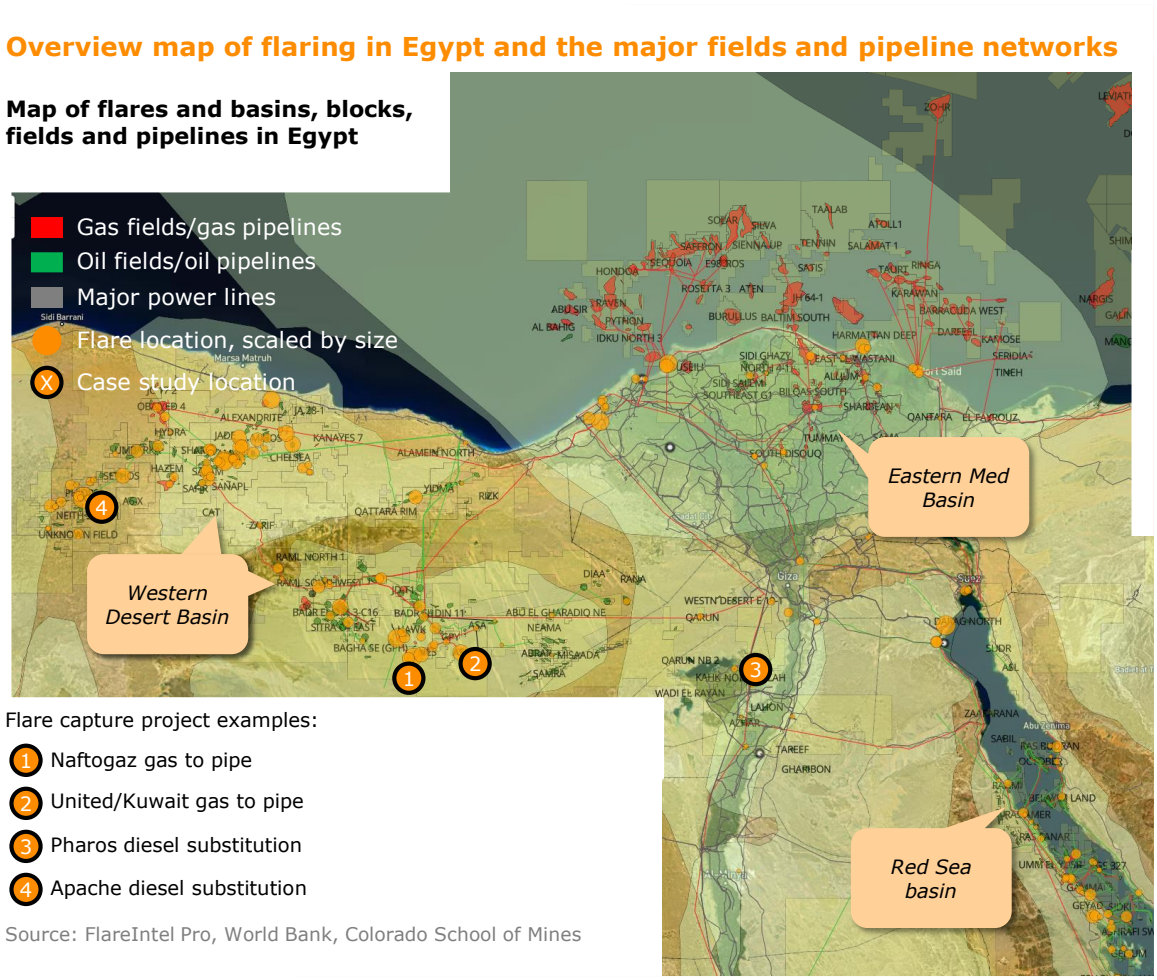


Figure 4: Overview of flaring in Egypt from FlareIntel pro, incorporating data from the Colorado School of Mines. The labels 1-4 are cross-referenced in the profiles in Figure 3.

When flaring data from the World Bank (2.1 BCM per year) is combined with both a reasonable estimate for "methane slip" from incomplete combustion (0.3 BCM per year) and data from the IEA's Methane Tracker[9] on vents (0.9 BCM year) and leaks (another 0.4 BCM per year), the total *potential* gas capture opportunity for Egypt rises to up to 3.7 BCM per year (5% of its gas production). That is the equivalent of up to $7 billion per year revenue upside (2% of Egypt's GDP), plus 90 million tonnes per year of CO2-equivalent emissions[10] (see Figure 5).

Whilst not all potential opportunities are likely to be realisable in the near-term, a significant share probably is. The reduced flaring we identify can be replicated in other similar projects within Egypt. For venting and leaking, a significant majority can be recovered at no net cost (a negative marginal abatement cost), according to the IEA. Key interventions that can reduce methane emissions from venting and leaking include installing vapour recovery units on storage tanks, switching out pneumatic

[9] According to the IEA's Methane Tracker, 2022: https://www.iea.org/reports/global-methane-tracker-2022.
[10] We use a gas price of $50 per mmbtu and consider the CO2-equivalence of gas on a 20-year basis, i.e. accounting for the fact that methane is 82.5x more potent than CO2 on a mass basis, according to the IPCC.

valves and pumps with electric alternatives and stepping up LDAR (Leak Detection and Repair) programmes, especially for ageing facilities and pipelines.

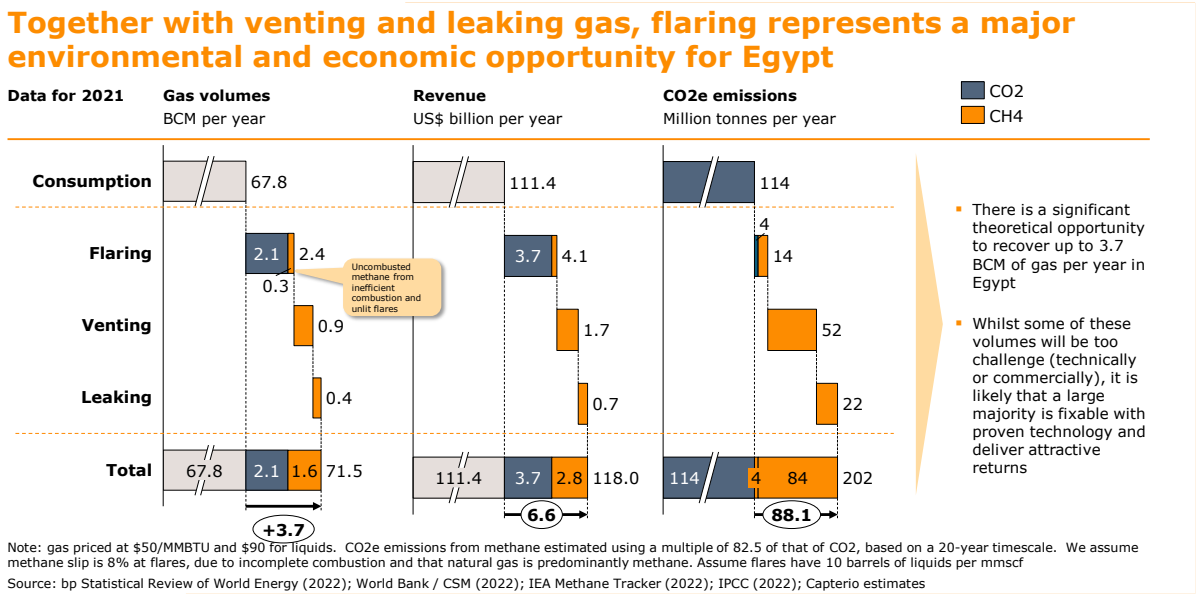


Figure 5: Overview of the opportunity from flaring, venting and leaking in Egypt in terms of volume, revenue potential and greenhouse gas emissions. We use a 20-year Global Warming Potential for methane, at 82.5x that of CO2 (on a mass basis).

This tremendous opportunity outlined above (of up to 3.7 BCM per year) is extremely relevant today. Driven by the global gas crisis, European governments are scrambling to secure gas supplies. Amid the current restructuring of gas supply chains, several recent delegations to Cairo (including the European Commission's President, Ursula van der Leyen, and Russia's Foreign Minister, Sergey Lavrov) were focused on securing investment for new gas supplies.

Whilst these are positive developments, securing new gas supplies does not necessarily need new drilling – after all, the flares demonstrate that the gas is not only discovered, but is already on "production". And compared to other forms of investment within the gas supply chain, these flared gas projects need no exploration capital expenditure and, often, require only relatively modest development capital[11].

Many gas capture projects can be monetised with proven technologies and deliver attractive returns whilst simultaneously decarbonising by reducing emissions of CO2, methane and particulates. The Clean Air Task Force has shown that some 65% of gas that is leaked or vented from equipment in the US can be recovered within 2-3 years based on simple extensions of policies already implemented in some US states. Based on Capterio's experience in the region, we assess that many significant flare capture projects could deliver a material reduction in flaring within a 9-18 month time

[11] For a specific example, please see an Algeria opportunity where we illustrate how a 30-50 million scf/day flare can be recovered with a capital spend of $50 million, delivering a payback at "old" prices within a year on a pre-tax basis (and much more rapidly at today's prices): https://flareintel.com/insights/eliminating-flaring-and-accelerating-the-transition-a-practical-roadmap-for-algeria.

period. Furthermore, we estimate that a programme of multiple flare capture projects could collectively reduce flaring by at least 50% in a 3-4 year time period, should commitment and funding be rapidly unlocked.

However, to focus mitigation efforts, governments and operators need to inventorise and prioritise their interventions using a data-led approach.

Independent real-time data is key to prioritising intervention and improving operations

Data can frequently be a game-changing role, especially if (as we have often found), it helps to move conversations from "we don't flare" to "flare reduction is an urgent priority". As an example, Capterio's flare-tracking tool *FlareIntel Pro* enables companies, governments and regulators to get a better understanding of flaring.

FlareIntel Pro tracks flare worldwide on a daily basis, and in doing so, it helps companies firstly to get better visibility of flaring (especially for their non-operated assets), secondly to identify operational challenges (such as upset flaring resulting from equipment failures) and, thirdly to find investment opportunities (and track their successful delivery). Data can be particularly useful in screening for investment opportunities in at least three dimensions, including: (i) flare size, (ii) flare proximity (to other flares and/or existing infrastructure), and (iii) flare characteristics (e.g. variability or continuity).

One particularly interesting use case for this data is to identify when flares unexpectedly stop (or start). In many cases, this behaviour (deliberate or otherwise) results from a shift from flaring to venting (i.e. where gas is sent to an unlit flare, as was recently reported in Mexico[12], leading to very high emissions of uncombusted methane). Since this tool automatically detects these dramatic flaring reductions, it can also send real-time alerts to operators. Similar alerts can be established for sites that suddenly increase flaring beyond normal limits, as frequently happens during turnarounds and restarts, when control systems fail, key equipment falters, or during operator error.

By addressing flaring, we can also reduce methane emissions

Given that most flares not only produce CO2 (from combustion), plus particulates, plus methane (from inefficient combustion), there is another compelling case to improve flare operations: reducing methane emissions. After all, methane is 82.5x more potent as a greenhouse gas than CO2 (on a mass basis, over 20 years, according to the IPCC's AR6 of 2021).

A "large" sized flare of 10 million scf/day that operates at, say, 85% combustion efficiency today[13] produces emissions of 1.2 million CO2-equivalent tonnes per year.

[12] See https://www.reuters.com/business/environment/exclusive-scientists-detect-second-vast-methane-leak-pemex-oil-field-mexico-2022-09-02/.
[13] The current knowledge base on flare efficiency is not very strong, especially in the MENA region. However, based on many conversations and observations, we think that this figure is probably quite representative of many flares in Egypt - partly because many are known to contain significant quantities of liquids.

Yet if improved to 98% combustion efficiency (through active flare assist and monitoring), the emissions could be reduced by 70% to 0.4 million CO2-equivalent tonnes (saving close to 0.9 million CO2-equivalent tonnes per year)[14] – see Figure 6.

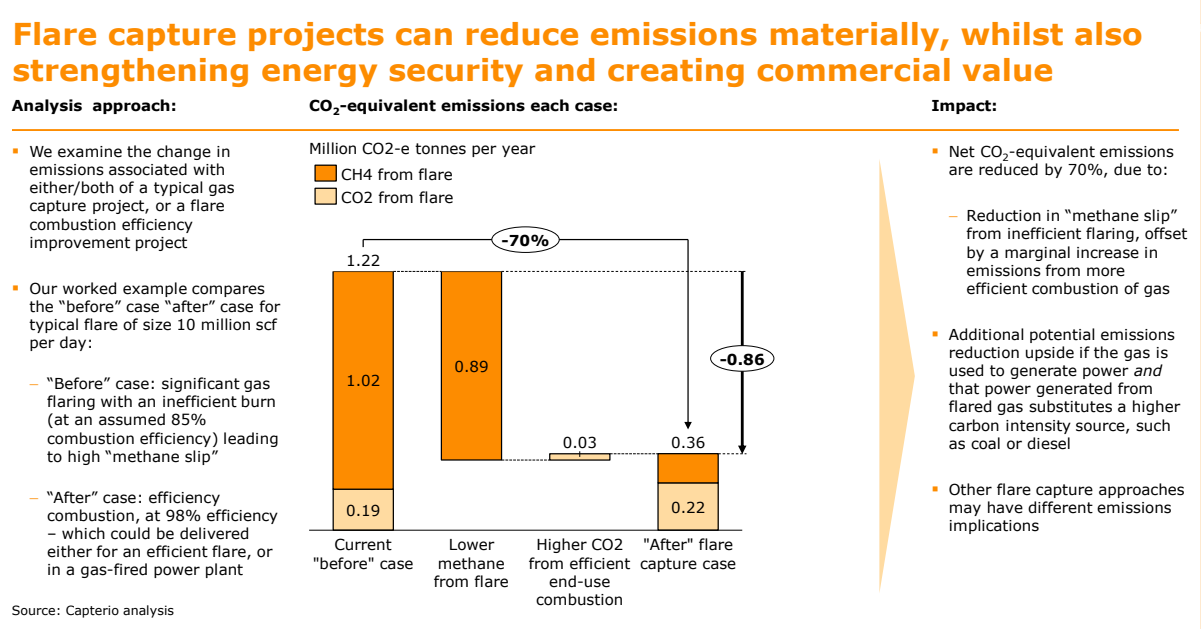


Figure 6: Potential impact of a flare reduction project which not only captures the flare but also reduces the volume of "methane slip" from incomplete combustion of gas. The net emissions impact is similar in the situation where the gas is not captured but simply the combustion efficiency is improved by an active flare assist. Should the flared gas however be captured and used to generate power which substitutes a more carbon-intensive source of power (e.g. coal or diesel), then there is an additional emissions-reduction upside.

Capturing the flare (and sending the gas to market) or improving combustion efficiency both deliver equivalent and significant decarbonisation (e.g. up to 70%, Figure 6). If the flare capture leads to the substitution of more carbon-intensive energy supplies (for example, coal or diesel), the greenhouse gas impact can be even greater. It is encouraging to see that Baker Hughes (a services company) is close to deploying its "FlareIQ" tool in Egypt specifically to improve flaring combustion efficiency[15].

Helpfully, flare reduction projects may also (should they be proven to meet additionality requirements) qualify for financial support from international carbon credit markets. There are a range of carbon market mechanisms, including UERs (Upstream Emission Reduction), which enable projects that reduce upstream emissions to generate credits which can then be sold to fuel suppliers to help them to meet their obligations under the EU Fuel Quality Directive (FQD). The German and UK schemes can be particularly attractive, offering credits well above EUR 100 per

[14] See also our paper which outlines the emissions prize further: https://flareintel.com/insights/why-flare-capture-projects-make-sound-esg-investments.
[15] See https://www.bakerhughes.com/company/news/baker-hughes-collaborates-egyptian-general-petroleum-corporation-flare-recovery.

tonne of CO2 – although these markets do not currently count reductions in methane slip through incomplete combustion.

How can countries strengthen their leadership and accelerate flare reduction?

We urgently need to promote and support Egypt's clear ambition to eliminate routine flaring because flare capture projects reduce emissions, create value and accelerate the energy transition. COP27 provides the perfect platform to profile Egypt's progressive practices, learn from its successes, and support other countries in achieving similar reductions.

Governments, of course, have a key role in accelerating the pace. Governments must facilitate collaboration between players by taking a "big picture" view (as opposed to waiting for individual producers to identify flare-capture projects individually, asset-by-asset or operator-by-operator) and force collaboration across organisational and contractual boundaries.

Indeed, we have identified many flare capture projects which will best be delivered if companies share data, business plans and operational parameters (such as pressure, temperature, composition, and spare capacity). To take an example from Egypt, the BABETCO-operated Obaiyed export infrastructure could be leveraged by the Khalda joint venture to rapidly reduce flaring in the Western Desert, thereby suddenly unlocking a commercial opportunity – especially if commercial innovation (such as adjusting incentives, tariffs or fiscal terms) is also deployed

The international community and consumers also have some shared responsibility to act. After all, Egypt's oil and gas exports are bought by countries in the European Union, Asia and beyond, most of which have their own "net zero" commitments. Initial progress has been made in 2022 with the announcement of the Global Methane Pledge Energy Pathway, and the announcement of the "You Collect, We Buy" scheme in the RepowerEU plan, but neither project has resulted yet in allocated funding.

But now that Europe has declared gas a "green" fuel, perhaps it is time to find ways for European institutions – such as the European Investment Bank[16] – to *selectively* invest capital into flare capture projects which not only improve energy security, but also significantly decarbonise the industry. After all, flares will generally not be fixed without investment, and often it is the countries with the lowest cost of oil supply that will not only be producing oil for the longest, but also need the most flaring investment.

The imperative to act will be even more compelling if/when tools such as the EU's proposed Carbon Border Adjustment Mechanism[17] (CBAM) – or other regulatory import standards – apply to imported energy, we can expect the incentive to be even clearer for producing countries to decarbonise their supply chains.

[16] Which was the first international finance institution (in 2019) to end financing for fossil fuel projects.
[17] See our paper https://flareintel.com/insights/how-the-eus-cbam-will-impact-energy-imports-from-countries-that-flare-gas.

Some clear actions for regulators, governments and operators

To accelerate progress (and move from ambition to action) in Egypt and beyond, we identify a few clear activities that operators and governments can take:

Regulators and governments in production countries should:

- **Develop a national flaring task force** with an appropriate mandate and resources that reports monthly to the responsible ministers to assess progress toward country goals and the World Bank's Zero Routine Flaring initiative. The task force should identify barriers to implementation of flaring reduction project (and problem-solve their resolution) and help streamline funding opportunities to shovel-ready projects, as needed. The task force should take the "big picture" view and ensure that the right data is available to evaluate opportunities properly, especially where they require coordination between different parties and/or across contractual boundaries. This work should be coupled with more stringent enforcement of anti-flaring policies, including financial penalties, with a strong and independent regulator.

- **Drive a step-change in data transparency and reporting** utilising new tools, such as real-time satellite data, to – on a national level – identify, scope and prioritise opportunities based on their size, characteristics and proximity to pipelines and/or power infrastructure, and track their progress.

- **Demonstrate the delivery of successful flare capture projects** and share the learnings within countries and internationally through forums like the Climate and Clean Air Coalition, the Global Methane Initiative, and industry-led programmes and initiatives including the recently released "*Methane from Flaring Tool kit*"[18]. Delivered "pilots" can hopefully be an inspiration to act at scale, with the development of concrete case studies that illustrate actual returns on investments

- **Incentivise much better coordination/collaboration** between industry players, especially in "complex" cases where capturing gas from flares of one operator requires access to critical processing facilities and/or pipelines of another operator. In some cases, this will require commercial innovation and agile thinking.

Operators, funders, and multilateral organisations should:

- **Mobilise and deliver timely capital** from projects such as the Global Methane Pledge Energy Pathway as well as international development banks – noting that flare capture projects are probably the best possible climate investment on a capital-spend-per-tonne-of-CO2-abated basis. Whilst sizeable funding resources were announced at the Major Economies Forum, a plan for unlocking

[18] Released in summer 2022, available at: https://flaringmethanetoolkit.com/.

that financing and converting them into "quick-win" projects, has yet to materialise. The World Bank has recently published a book: "*Financing Solutions to Reduce Natural Gas Flaring and Methane Emissions*"[19] which details many options.

- **Accelerate the delivery of projects**, dramatically reducing the time for negotiation, contracting and approvals from years to months. Egypt has shown that a number of "pilot" projects can be delivered in about a year. Now is the time to scale up for deeper impact and to avoid another winter of discontent in 2023.

Egypt should be congratulated for its leadership on flare reduction, and it is right that this progress is highlighted at COP27. But now is the time to go further and faster on gas flaring as it can make a meaningful contribution to addressing the crisis of our time.

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The authors would like to thank many staff at EGPC, the Ministry of Petroleum and Mineral Resources and many of the companies mentioned above for constructive discussions. We also acknowledge multinational organisations, including the IEA, the World Bank, the African Development Bank and the European Bank for Reconstruction and Development, for their many insights and ideas. The opinions here (errors and omissions) are, however, our own.

We intend to host an event in Egypt at COP27 on the topic of flaring, venting and leaking. Please get in touch with us if you wish to attend and/or contribute.

[19] Published in March 2022, available at https://openknowledge.worldbank.org/handle/10986/37177