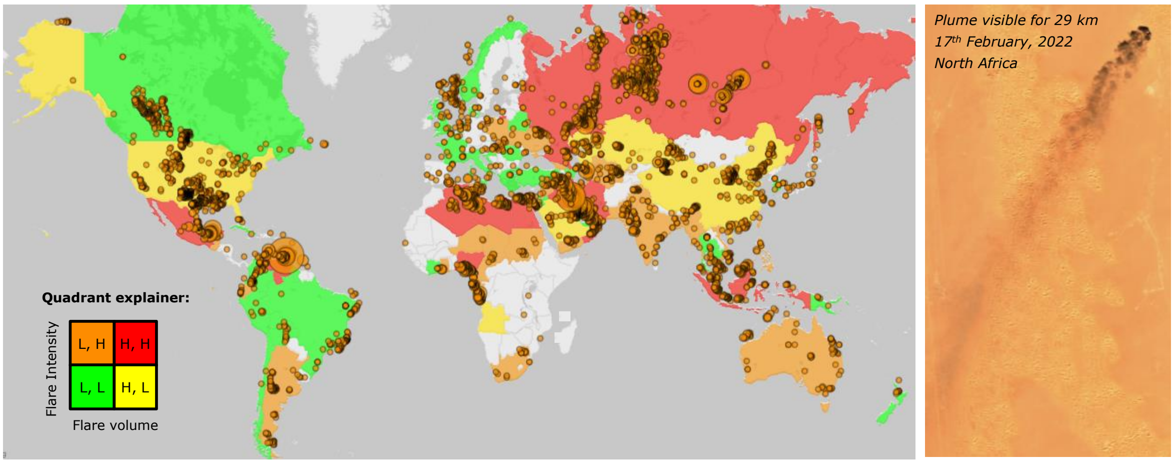
New flaring data shows unacceptable flatlining and boldens the imperative to act

Flare map set against a backdrop of country status on absolute flaring levels and relative flaring intensity | **Example flare**

Higher flaring, higher intensity · Higher flaring, lower intensity · Lower flaring, higher intensity · Lower flaring, lower intensity



Note: "higher flaring" identifies countries with flaring above 1.5 BCM per year. "higher flaring intensity" identifies countries with flaring intensities above 5.1 m3 per barrel
Source: World Bank (2022); EIA crude oil including lease condensate production (2022); Capterio FlareIntel Pro, which incorporates data from the Colorado School of Mines

A thought piece by capterio

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2800 words, reading time 11 minutes.

Executive summary

- **The latest upstream flaring data, published yesterday by the World Bank, highlights that gas flaring is marginally higher in 2021 than in 2020, driven by marginally higher oil production. At 143 BCM (or 93% of Europe's gas purchases from Russia), flaring accounts for $47 billion of lost revenues and 1 billion CO2-equivalent tonnes of greenhouse gas emissions. This waste is unacceptable, especially in today's world of energy insecurity, sky-high energy prices and a global climate crisis.**

- **Whilst there has been some good progress on flare reduction in a few countries (e.g. US, Algeria and Nigeria), these gains are usurped by dramatic increases in a few (e.g. Iran, Libya and Mexico). And whilst many listed companies are having impact (at least for their "operated" assets), flare reduction is minimal for many National Oil Companies (and for some of the non-operated assets of International Oil Companies).**

- **Of grave concern is that there is very little evidence to suggest that the world is remotely on track to dramatically reduce flaring to deliver so-called "zero routine flaring". Existing commitments are simply not being delivered on, which makes meeting "net zero" ambitions (even just for scope 1) very challenging for many.**

- **The status quo is increasingly becoming untenable and will soon start to materially undermine the industry's license to operate. The global industry needs to pull together to make good its commitments – offering a hand to countries in need by mobilising cash, capabilities and already-proven technologies.**

- **With the hottest temperatures ever recorded in India this week and an urgent political imperative to diversify away from Russian gas, the oil and gas industry cannot afford to miss out on the opportunities from its own "low hanging fruit" of gas flaring. We must act now to reduce flaring, lower emissions, reduce pollution, create value and accelerate the energy transition.**

The latest data confirms the world is off-track to eliminate gas flaring

Yesterday, the World Bank's Global Gas Flaring Reduction programme published its annual assessment of upstream gas flaring[1] and declared that 143 BCM *"was needlessly flared at upstream oil and gas facilities"* in 2021[2]. This paper – our third annual independent analysis of this data – explores the topic in detail[3].

The headline figure is a 0.6% increase in upstream flaring (from 142 to 143 BCM). Since oil + condensate production[4] increased by 1.4% over this period, the underlying "flaring intensity" (flaring per unit of oil production) is showing modest improvement (by 0.7%). Flaring intensity – a measure of operational performance – remains at a record high (of 5.1 m3 per barrel[5]) despite many stated initiatives to reduce gas flaring from a wide range of governments and producers.

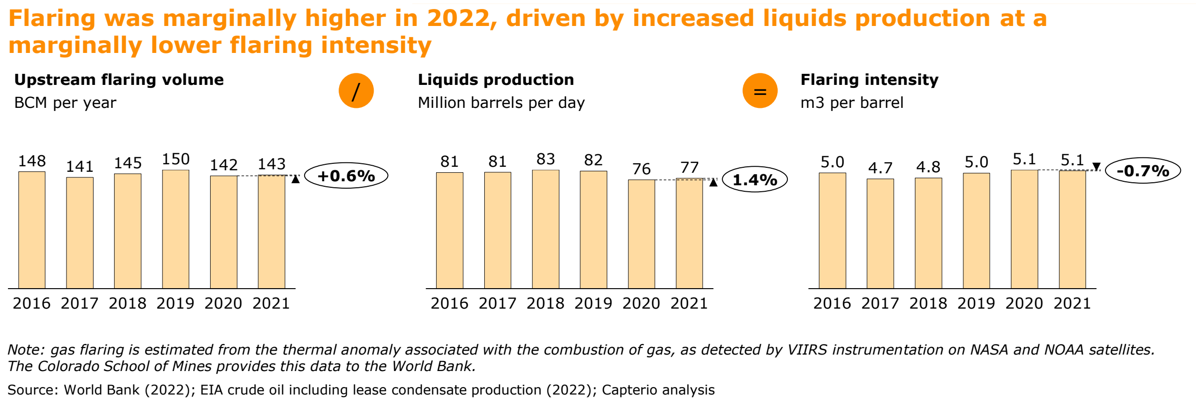

Figure 1: global gas flaring (derived by satellite), liquids production and calculated gas "flaring intensity". Gas flaring is marginally up in 2021 vs 2020, due to slightly higher liquids production, offset by a marginally lower flaring intensity.

These data are particularly disappointing given that 103 organisations[6] (including 53 producers, 34 governments and 15 development institutions) that cover over 100 BCM (70%) of flaring have committed to deliver "zero routine flaring" by 2030. Whilst many leading International Oil Companies and Independents are making progress on flaring reduction as part of their "net zero" plans (at least, for their "operated assets" – those that they control the day-to-day operations of), many National Oil Companies are not. Given

[1] See https://thedocs.worldbank.org/en/doc/1692f2ba2bd6408db82db9eb3894a789-0400072022/original/2022-Global-Gas-Flaring-Tracker-Report.pdf
[2] Gas flaring is estimated from the thermal anomaly associated with the combustion of gas, as detected by VIIRS instrumentation on NASA and NOAA satellites and processed by the Colorado School of Mines, part of the Payne Institute for Public Policy.
[3] Many more articles of interest on a wide range of flaring-related topics are at www.flareintel.com/insights
[4] Oil and condensate production is the most significant driver of gas flaring, so normalising flaring to production to calculate a "flaring intensity" metric is a useful indicator of performance.
[5] Assuming, for the purposes of this calculation, a 98% combustion efficiency – see discussion later.
[6] See https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/endorsers

that flaring has been flat for a decade we need to see a monumental fall in flaring to meet the targets (Figure 2).

To meet the IEA's "Sustainable Development Scenario", we need a 90% reduction in flaring by 2025, and to meet this would require a 44% reduction *every year* – and this is a truly immense cliff to descend. Without a dramatic step-change in analytics, commitment, leadership, political and economic reform, delivering "zero routine flaring" is unachievable. Yet not delivering zero routine flaring – especially when it clearly could have been achieved, whilst making money, with proven technology if the world had acted – will seriously negatively impact the oil and gas industry's license to operate as civil society and the investment community and others pile on the pressure.

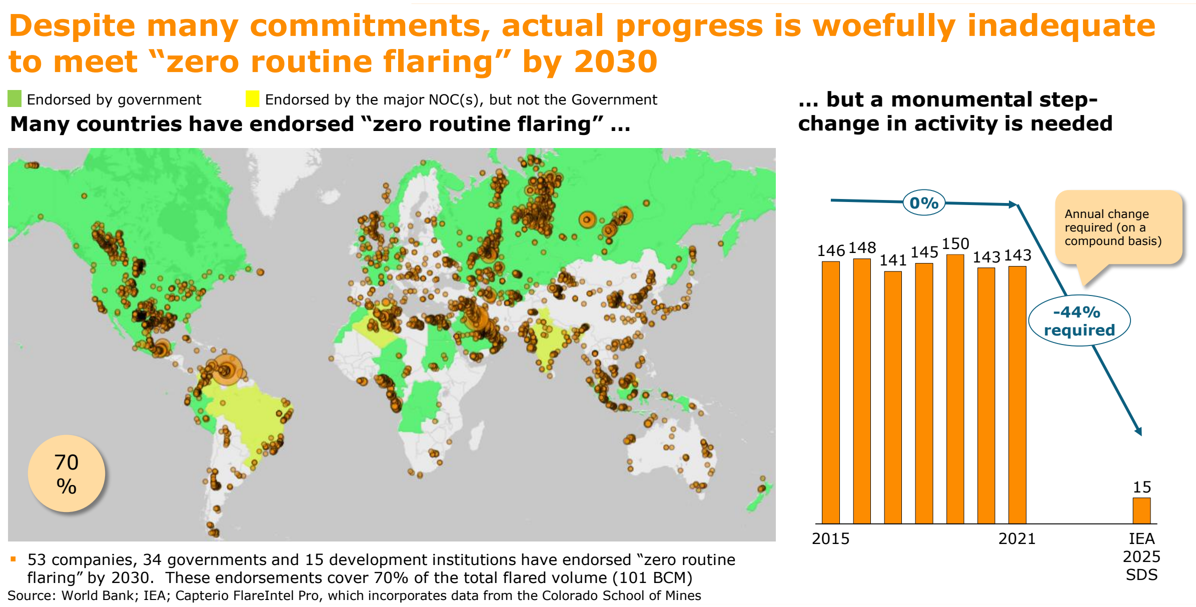

Figure 2: map showing the individual flare locations against the countries that have endorsed the World Bank's "zero routine flaring" (by 2030) initiative. Green colours indicate countries for whom governments have made this endorsement. Yellow colours indicate countries where the National Oil Companies have made this endorsement (but their government has not). By volume, 70% of all flaring (101 BCM) is covered by ZRF commitments. The flaring timeseries is, however, flat, and a 44% compound rate of flaring reduction is required to meet the IEA's Sustainable Development Scenario.

The new data confirms a wide performance gap between countries

Figure 3 shows the league table of upstream flaring by country on both an absolute basis (total volume flared) and a relative basis (flaring intensity). As the World Bank's report highlights, 75% of flared volumes come from the top ten countries, which include Russia, Iraq, Iran, US, Venezuela, Algeria, Nigeria, Mexico, Libya and China.

Normalising for liquids production, the flaring intensity data continues to show a very wide variation in performance between countries such as Saudi Arabia and Norway, which have very low flaring intensities and those with very high flaring intensities (Venezuela, Algeria, Iran, Libya and Iraq).

Venezuela's flaring intensity is a staggering 157x higher than Norway's, and whilst the "gassiness" of oils does vary, the difference is mainly attributable to operational practices. Indeed, countries with enduring policy, coupled with enforcement by credible and independent regulators (e.g. Saudi Arabia and Norway) do particularly well on this metric. Norway has an implicit carbon price embedded in its anti-flaring policy, and for good reason, as flared gas can be put to productive use that creates real economic value (and reduces emissions). Conversely, countries with very high flaring intensities are not always stable politically and/or often do not adopt strong processes or policies. Nigeria, for example, has a punitive flaring penalty equivalent to $38 per tonne, however, it is rarely enforced.

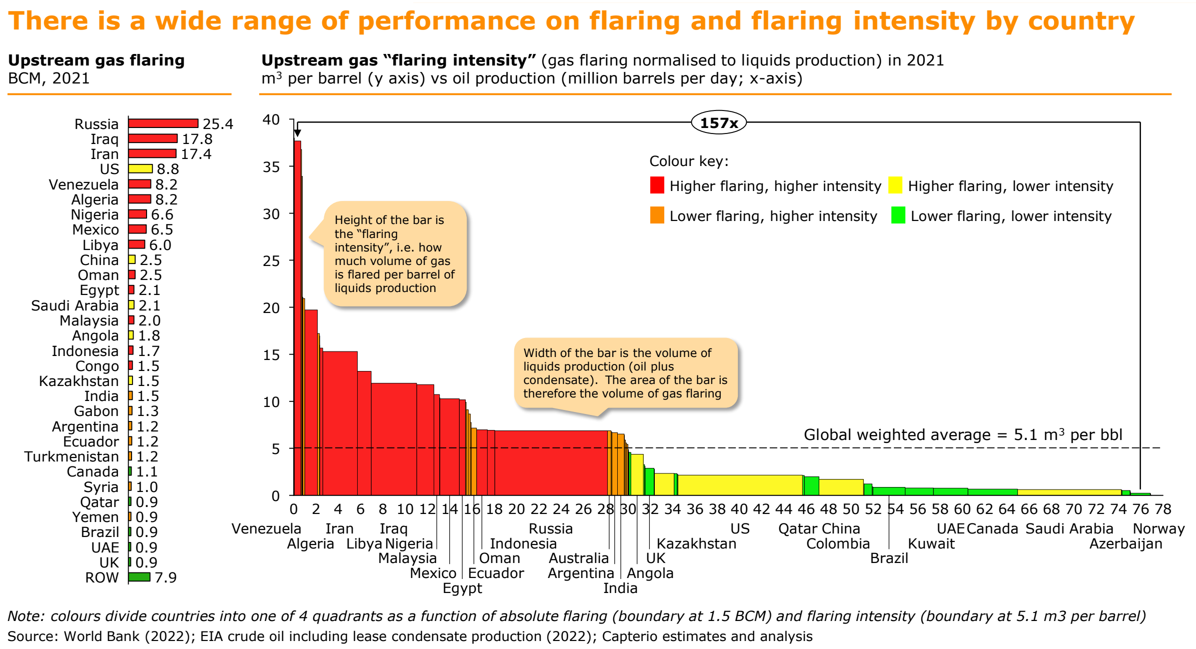

Figure 3: league table of upstream flaring by country, on an absolute (BCM) and relative (m3 per barrel) basis, showing a wide span of performance between countries. Norway, for example has a flaring intensity 12x lower than the UK despite similar geology/oil chemistry. Similarly, UAE has a flaring intensity 20x lower than Iran. Venezuela has a flaring intensity 157x that of Norway. Colours divide countries into one of 4 quadrants as a function of absolute flaring and flaring intensity (see Figure 4). Many countries have many opportunities to reduce flaring, and each should aspire to reach levels of performance of e.g. Norway (0.2 m3 per barrel) or UAE (0.8 m3 per barrel).

Figure 4 illustrates the span of flaring performance in map view, colour-coded into the four quadrants of "high absolute flaring and high flaring intensity" (red) to "low absolute flaring and low flaring intensity" (green). Red countries are an urgent priority, but so too are "orange" (those with high flaring intensities, but less than 1.5 BCM of absolute flaring, e.g. Egypt and Australia), and "yellow" (those with more than 1.5 BCM of flaring but at low rates, such as Saudi Arabia, US and China. Many "green" countries (such as the UK, Qatar and Brazil) also have significant room for improvement.

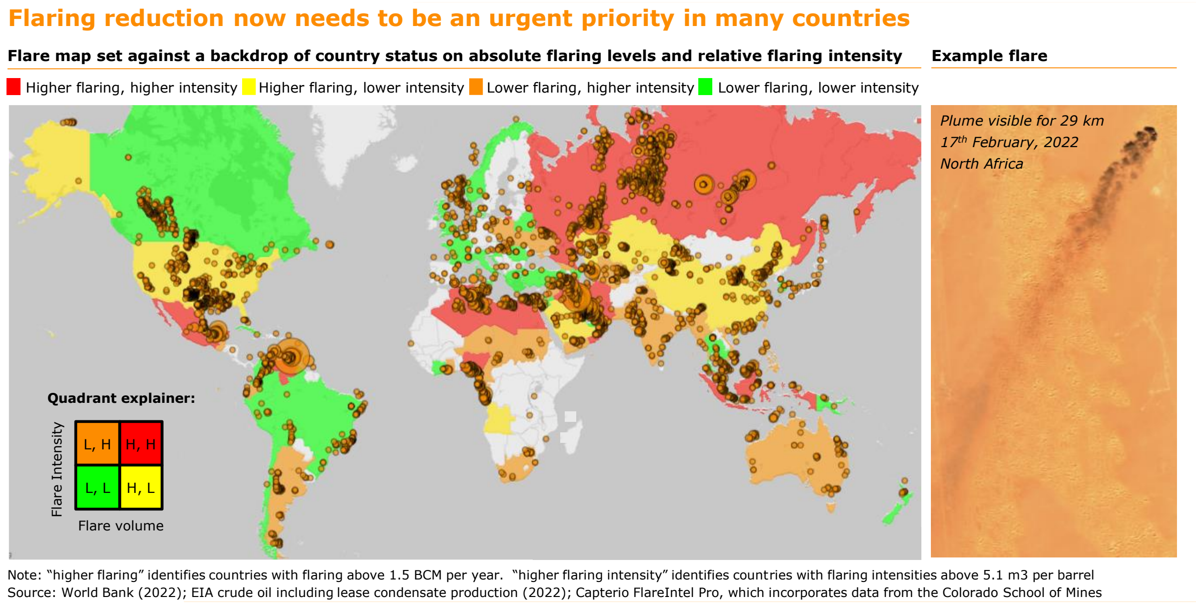

Figure 4: map of flaring by country, colour-coded by country based on the absolute flaring and the flaring intensity. "Higher" and "lower" references are with respect to other countries (as opposed to over time). "Higher flaring" countries are those with flaring above 1.5 BCM per year. "Higher flaring intensity" countries are those with flaring rates above 5.1 m3 per barrel (i.e. above the global weighted average flaring intensity).

Country flaring performance tends to be dictated by operational practices

The headline marginal increase in flaring, however, masks some important trends. As shown in Figure 5, several countries have materially reduced flaring (e.g. US, Algeria and Nigeria), however these gains have largely been offset by several countries with materially increased flaring (e.g. Iran, Libya and Mexico). Over a longer period, as highlighted by the World Bank, there have been promising reductions (over the period 2012-2021) in Kazakhstan, US, Columbia and Nigeria, but worrying increases in Mexico and Iraq.

To understand these trends more deeply, we break down the 2020-2021 data to explore how the *change in flaring* is driven by the *change in underlying liquids production* and the *change in flaring intensity*. Flaring intensity is a proxy for underlying operational performance[7].

The results are stark and highlight how changes in country performance is largely controlled by changes in operational practices (or changes in the mix of operational activities). Apart from Nigeria, all of the countries that have reduced their flaring have done so by reducing their flaring intensity (i.e. improving their operational

[7] Strictly, flaring intensity is driven by 3 factors: the "gassiness" of the liquids (its GOR or gas-oil-ratio), the percentage of associated gas that is put to productive use (or captured), and the combustion efficiency of the flare system. At a country level, the overall flaring intensity can also be influenced by the mix of assets and event without changing operational performance at an asset level.

fundamentals). Some have also boosted their flaring reduction by lower production (which may be related to an OPEC-led response to COVID demand destruction).

The converse is also true: with the exception of Libya and Russia, the countries with higher flaring have also seen higher flaring intensities (aka poorer operational intrinsics.

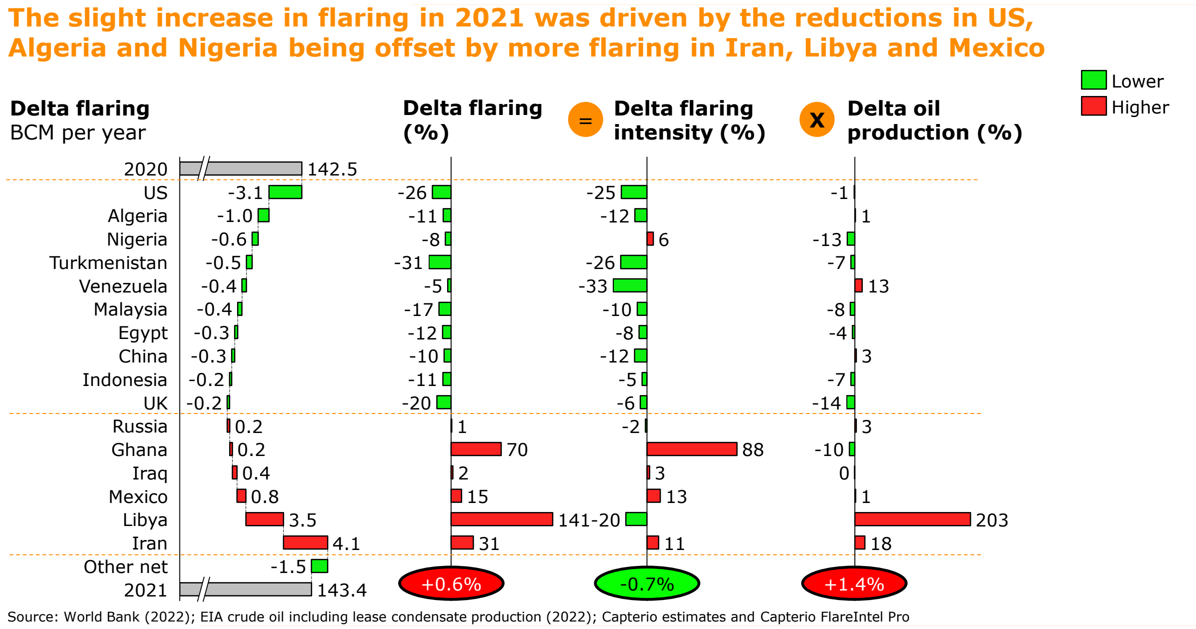

Figure 5: analysis of the key countries with lower and higher flaring in 2021, plus a decomposition of the change in flaring into a change in flaring intensity and a change in liquids production. Strikingly, most countries' flaring can be explained by changes to flaring intensity – which itself is a proxy for operational performance.

To comment on a few countries:

- **US**: flaring has substantially reduced in the onshore shale regions, especially in the Bakken and Permian. Here not only has gas gathering infrastructure been developed, gas compression facilities have been installed and facilities been optimised, but also operational best practices pioneered by larger players have become more widely adopted by the industry. Unfortunately only some of these practices are easily replicable in other geographies, meaning that the notion of transferring learnings across geographies is not always easy.

  Both bp[8] and Shell have committed to eliminate routine flaring by 2025 (and Shell has brough forward its global commitment to the same period[9]) using greater electrification and automation and Apache[10] has reached this standard

[8] https://www.bp.com/en_us/united-states/home/news/features-and-highlights/bp-aims-for-zero-routine-flaring-in-us-onshore-operations-by-2025.html
[9] https://www.shell.co.uk/about-us/powering-progress/achieving-net-zero-emissions.html
[10] https://www.globenewswire.com/news-release/2021/10/11/2311768/0/en/APA-Corporation-Achieves-Goal-to-Eliminate-Routine-Flaring-Onshore-US.html

in October 2021. These operational improvements have underpinned the massive expansion in LNG exports over the last few months.

- **Algeria**: flaring has reduced primarily in the three fields of Rhourde Chegga, Alrar and Hassi Messaoud due to the determined action and leadership of the National Oil Company. Each field saw substantial reductions in flaring from February, March and July, respectively. Flaring in Hassi Messaoud during 2020 was also anomalously high due to a blowout on a gas reinjection well that lasted for 134 days from January and reached a peak of around 70 million scf/day (according to FlareIntel Pro).

- **Libya**: flaring has dramatically increased following the restarting of oil production after the cessation of the military activity[11] initiated by the self-styled Libyan National Army (see Figure 6, incorporating data from Capterio's FlareIntel Pro tool[12], which tracks every flare for every asset, every company, worldwide and every day). Several western operators have seen substantially lower flaring in Libya in 2020. Similar shutdowns have recently caused dramatic drops in oil production (leading to substantial revenue losses to Libya[13]) and substantially lower gas flaring.

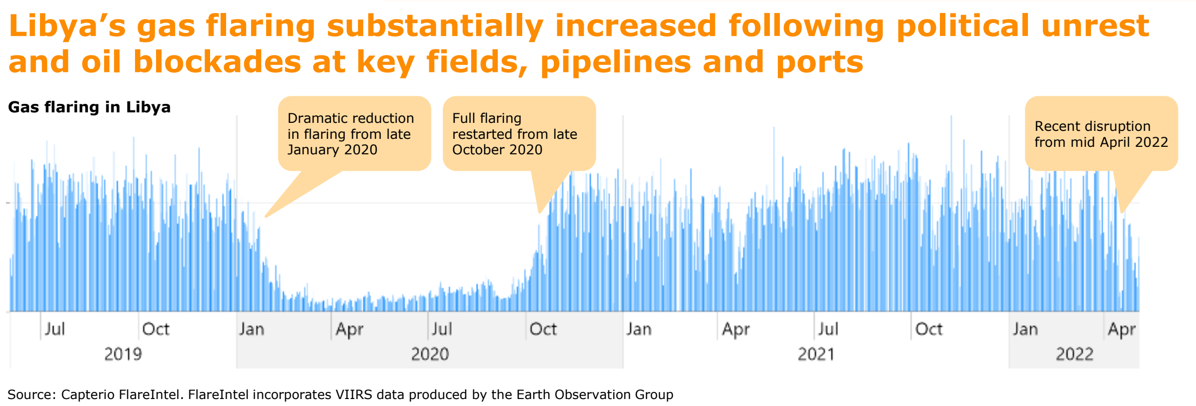

Figure 6: profile of flaring within Libya – illustrated on a daily basis – highlighting the substantial reduction of flaring associated with military disruption throughout most of 2020. Data from Capterio's FlareIntel Pro tool.

- **Iran**: flaring has increased (from routinely under 50 million scf/day to routinely over 100 million scf/day) in the Gachsaran and Aghajari fields in the Zagros basin, each of which was discovered in the 1930s. It is possible that flaring is increased in part due to increased production and/or delays in the planned gas capture projects in the area. It is also ironic that despite Iran's

[11] https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/oil/011722-libyan-oil-output-rebounds-but-disruption-risks-remain-very-high
[12] FlareIntel Pro is Capterio's flare-tracking tool that helps operators to (a) improve their visibility into gas flaring, (b) improve operational performance, and (c) facilitate investment programmes. FlareIntel incorporates VIIRS data produced by the Earth Observation Group.
[13] https://www.aljazeera.com/economy/2022/4/29/libya-is-losing-60m-a-day-in-oil-shutdown-oil-minister

high level of flaring, it exports gas (and power) to Iraq (at great expense to Iraq), which itself flares at extremely high rates.

The economic and environmental impact of supply chain emissions

The economic and environmental impact of gas flaring is substantial. With gas prices today around \$9 and \$32 per mmbtu in US and Europe, respectively, the revenue opportunity resulting from flare reduction is enormous. Assuming a conservative \$7.5 per mmbtu, flaring wastes \$47 billion per year (equivalent to the GDP of Turkmenistan or Jordan).

The emissions resulting from gas flaring amount to around 1 billion CO2-equivalent tonnes (see Figure 7). Note to calculate the CO2-equivalent emissions we have accounted for: (i) the “methane slip” from incomplete combustion (which the IEA estimated in its latest World Energy Outlook at 8%), and: (ii) the enhanced potency of methane as a greenhouse gas (using a “Global Warming Potential of CH4 of 82.5, over a 20-year period[14]).

Figure 7 brings the flaring data together with that of venting and leaking, using data from the IEA’s 2022 Methane Tracker[15].

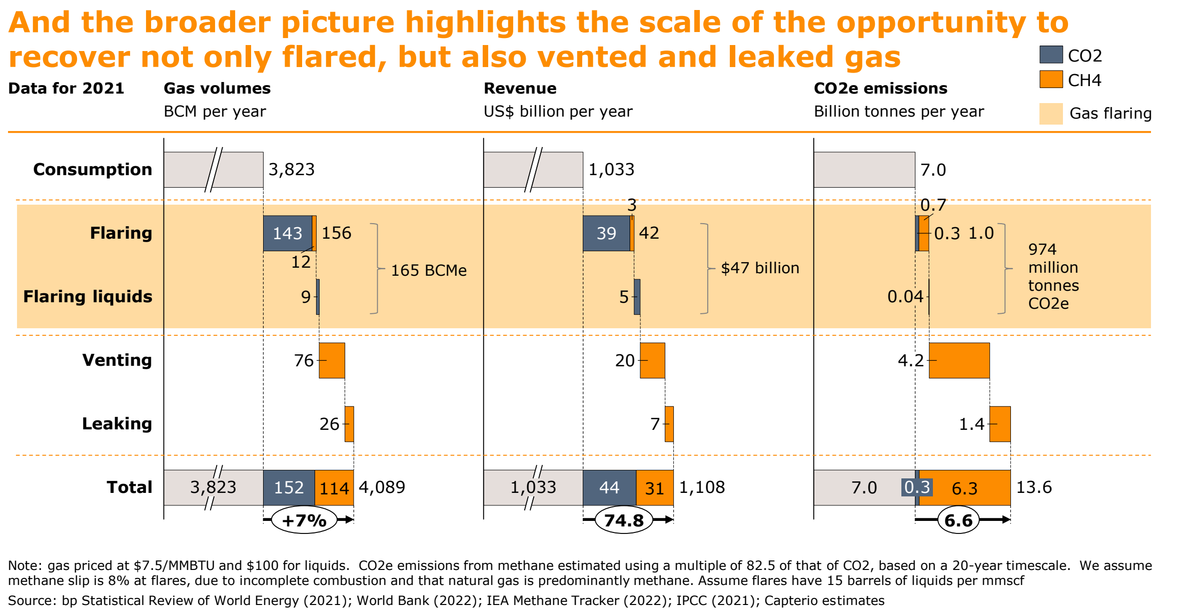

Figure 7: overview of the magnitude of volume, revenue and emissions resulting from flared, vented and leaked gas, in context of the consumption. We augment the 143 BCM of flared gas by an additional 8% (as per the IEA's World Energy Outlook, 2021) to account for the likely "methane slip" associated with inefficient combustion, plus also the entrained NGL (Natural Gas Liquids). We calculate the CO2-equivalent emissions by accounting for the combusted gas plus also the uncombusted methane, which

[14] According to the IPCC AR6 report: https://www.ipcc.ch/assessment-report/ar6/

[15] https://www.iea.org/reports/global-methane-tracker-2022

we equate to a CO2-equivalent figure using a GWP (Global Warming Potential) of 82.5x CO2 on a mass basin, over a 20-year period.

Our figure for CO2-equivalent emissions is 2.5x higher than the 400 million tonnes quoted by the World Bank in their 2022 Global Gas Flaring Tracker Report. This is due to (a) their highly conservative assumption that the weighted average combustion efficiency of flares is 98%, and: (b) arguably, a very optimistic view that a 100-year time period is an appropriate period on which to compare the climate forcing impact of methane versus CO2. Our figure is also over 3.5x higher than the 276 million tonnes quoted in a report by Rystad Energy late last month[16] which appears to ignore the issue of "methane slip" altogether.

Bringing these three key sources of supply-chain waste together we get a sense of the scale of the opportunity not only to reduce waste, lower emissions, but also to create value for economies and society, improve animal and human health, and accelerate the energy transition. The figures are simply staggering. In total, the 264 BCM of waste (equivalent to 7% of all gas consumed globally) amounts to 1.7x the gas that Europe imported from Russia in 2021, $75 billion of lost revenue, and the equivalent of the emissions from up to 1.5 billion light passenger vehicles[17].

Where there is a will, there *is* a way

Fortunately, there is increasing international attention on this issue. Indeed, in early March 2022, the Oil and Gas Climate Initiative said: "*virtually all methane emissions can and should be avoided*". Equally, its members have committed to putting in place "*all reasonable means to avoid methane venting and flaring*"[18].

As Capterio outlined in a paper last month titled "*North Africa can reduce Europe's dependence on Russian gas by transporting wasted gas through existing infrastructure*"[19], significant volumes of this wasted gas is close to existing markets and can be captured with proven technology, can dramatically reduce greenhouse gas emissions (by up to 72%[20]) and deliver very attractive commercial returns.

With today's high gas prices and the political imperative to diversify away from Russian gas, there is a tremendous window of opportunity to accelerate work on reducing gas flaring.

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[16] https://www.rystadenergy.com/newsevents/news/press-releases/carbon-flaring-emissions-drop-to-10-year-low-but-a-rebound-may-be-on-the-horizon/
[17] https://flareintel.com/insights/insights-from-energy-weeks-panel-on-flaring-venting-and-leaking
[18] https://www.ogci.com/ogci-members-aim-to-eliminate-methane-emissions-from-oil-and-gas-operations-around-2030/
[19] https://flareintel.com/insights/north-africa-can-reduce-europes-dependence-on-russian-gas-by-transporting-wasted-gas-through-existing-infrastructure
[20] https://flareintel.com/insights/how-a-focus-on-gas-flaring-at-cop26-can-accelerate-decarbonisation

Solutions to capture the gas range from gas reinjection (for disposal, storage or Enhanced Oil Recovery), gas to pipe, gas to "virtual pipeline" (e.g. as Compressed Natural Gas or Liquefied Natural Gas), gas to power (for local oilfield operations, or for the grid) and as to other "exotic" solutions (such as vertical farming or cryptocurrency mining). Strikingly, over 54% of all flared volumes are within 20 km of an existing gas pipeline[21].

Indeed, there are several excellent case studies that prove that commercial-viable solutions for assets with a legacy flaring problem can be found (see our case study article "*celebrating successful flare capture projects with data-driven evidence*"[22]. Much support is also provided to operators by a range of new resources including the World Bank's "*Report on Small-scale Technologies for Utilization of Associated Gas*"[23], plus its new book "*Financing solutions to reduce natural gas flaring and methane emissions*"[24]. IPIECA also recently published a "Flaring Management Guidance" documentation[25] which may guide operators, and the Methane Guiding Principles group has just released a "methane toolkit"[26].

Reducing flaring, however, will inevitably require collaboration across multiple parties in this complex ecosystem which includes politicians, regulators, governments, operators, service companies, equipment manufacturers, consultants, funding bodies and consumers. It is likely that dramatic reform of political systems (to reduce corruption, remove subsidies, and create incentives, build capacity and leadership) will also be required.

But above all, this challenge requires us to reform how we think about this topic and be creative about innovating quickly and working together across boundaries to share best practices and help out underperforming companies and countries with reform, cash and capabilities as required.

The invasion of Ukraine has created unprecedented energy security concerns. Coupled with the COVID hangover, climate action understandably looks like a second-order priority. But with the hottest temperatures ever recorded in India this week and increasing investment in fossil fuels, we cannot afford to miss quick wins. One of the lowest-hanging fruit is reducing methane emissions. And one of the best ways to do that is to tackle gas flaring. Now is the time to act.

[21] https://capterio.com/insights/minimising-flaring-near-existing-demand-centres
[22] https://capterio.com/insights/celebrating-successful-flare-capture-projects-with-independent-data-driven-evidence
[23] https://documents1.worldbank.org/curated/en/305891644478108245/pdf/Report-on-Small-scale-Technologies-for-Utilization-of-Associated-Gas.pdf
[24] https://openknowledge.worldbank.org/handle/10986/37177
[25] https://www.ipieca.org/our-work/climate/emissions-management/flaring-management-guidance/
[26] https://methaneguidingprinciples.org/best-practice-guides/flaring/