Looking ahead to COP27: from climate pledges to action
Global Methane Pledge – opportunities and risks
Etienne Romsom and Kathryn McPhail, EnergyCC

NOTE: This is the draft of a forthcoming WIDER working paper. Please do not circulate or cite without permission of the authors

Abstract

The global energy transition is happening, but at pace that is too slow to limit climate change within an acceptable outcome. The reasons for this slow pace are diverse. Carbon emission targets are insufficiently driven by policies and measures that focus on absolute emission targets and focus instead of relative measures, such as carbon intensity. Focus is needed on early emission reduction actions, while current efforts aim to establish carbon neutrality at a distant date. Disposal of high-carbon emitting assets by high-profile listed companies to unlisted companies and organizations (‘hand-me-down assets’) is negatively affecting transparency on emissions, and negatively impacting emissions-reducing investments. Satellite remote sensing technologies can reduce the reliance on self-reporting of emissions. Measurement of emissions by satellite data is to be established as a public good that is not subject to corporate confidentiality or other commercial restrictions. More focus is needed on the integration of existing assets in the decarbonization efforts. The largest positive impact that can be made for climate and health now, is for existing emitting assets to emit less. And, more recognition is needed that measures suitable and successful for developed and high-income countries or regions may be much less suitable and successful for developing and low-and middle-income countries.

Cutting methane emissions is the fastest opportunity to immediately slow the rate of global warming, even as progress is made on decarbonization of energy systems. Moreover, any reprieve over the next decade from reaching a global temperature rise—and potential tipping point—of 1.5 degrees Celsius is vital while more challenging policy commitments are implemented. Cutting methane emissions by reducing wasteful flaring of natural gas stands out as an immediate opportunity. Implementation requires urgent coordinated actions: by oil and gas producing countries, by donors and MDBs, by countries hosting satellite data companies, and by the IMF in taking a leadership role in its surveillance and capacity development work.

Tackling methane is especially significant since doing so meets other development priorities, such as generating government revenue (by taxing methane emissions), improving health (by reducing air pollution), and helping deliver greater energy access (by using rather than wasting the gas).

This study has been prepared within the UNU-WIDER project Extractives for development (E4D)—risks and opportunities, which is part of the Domestic Revenue Mobilization programme. The programme is financed through specific contributions by the Norwegian Agency for Development Cooperation (Norad).
1. Introduction

The 2021 Intergovernmental Panel on Climate Change (IPCC) report highlights the critical role of the energy sector – particularly oil and gas in methane abatement. In 2020, the International Energy Agency (IEA) highlighted methane emission avoidance as a major opportunity in reducing the short-term emission impact on global warming: ‘even with an oversupplied gas market, reducing methane emissions from oil and gas operations is amongst the lowest of low hanging fruit for mitigating climate change’\(^1\). Capturing these atmospheric emissions would support the UN SDGs: Climate Action (SDG13), Good Health and Well-being (SDG3), Affordable and Clean Energy (SDG7), Gender Equality (SDG5), and Sustainable Cities and Communities (SDG11). Since IEA’s statement, the gas market has radically altered from being ‘long’ to ‘short’ in gas supplies and the priority for reducing methane emissions is even greater than before, as this also supports global energy security.

In its April 2022 report on Mitigation of Climate Change, the IPCC prioritizes cutting methane emissions by one-third, so as to make a major contribution in reducing greenhouse gas emissions by half in this decade.\(^2\) The importance of early action to reduce methane emissions is also a key conclusion of the 2021 Global Methane Assessment, published by the Climate and Clean Air Coalition (CCAC) and UNEP, and chaired by Professor Drew Shindell.\(^3\)

These findings are also underscored by the 2021 DNV Group’s Energy Transition Outlook (ETO). It finds that global energy-related emissions are likely to fall by only 9% by 2030 compared to 2019, and consequently the \(1.5\) \(\degree\)C global carbon budget will be utilized by the end of this decade. It further expects fossil fuels (coal, oil, natural gas) to comprise 50% of total energy supply by 2050, with only 3.6% of fossil CO\(_2\) emissions abated through Carbon Capture and Storage (CCS). The ETO also expects natural gas to overtake oil as the world’s largest energy source in 2032, supplying 24% of the world energy by 2050.

This paper introduces priorities in delivering on the global climate ambition in Section 2. After highlighting the extent of global energy waste and inefficiencies from natural gas flaring and venting, Section 3 then discusses why reducing methane emissions in the energy sector is an attractive opportunity. Section 4 explains actions that can be taken to implement the Global Methane Pledge and benefit producing countries, while section 5 defines the methane-reducing opportunities for developing countries. Sections 6 and 7 subsequently discuss the emergence of ‘Net Zero gas’ markets and the opportunities for new LNG producers to future-proof their green-field assets. Section 8 concludes with recommendations for policy makers in developing countries.

---


\(^2\) Climate Change 2022: Mitigation of Climate Change. Working Group III Contribution to the IPCC Sixth Assessment Report

2. Delivering on the global climate ambition

There are a number of key concerns that urgently need attention, to get delivery on the global climate ambition back on track. This paper will discuss these concerns in more detail, including:

1) Carbon emission targets are often driven by policies and measures that focus on relative measures such as carbon intensity, instead of absolute emission targets.

2) A lack of recognition that climate impact is driven by cumulative emissions. Targeting carbon emissions milestones at future (distant) dates obscures what counts most - the emission performance every day from now onwards. Early reductions have much more positive impact than late reductions.

3) Disposal of high-carbon emitting assets by high-profile listed companies to unlisted companies and organizations (‘hand-me-down assets’) is negatively affecting transparency on emissions, and negatively impacting emissions-reducing investments. Satellite remote sensing technologies can reduce the reliance on self-reporting of emissions.

4) Indiscriminate adherence to EU sustainability taxonomy restricts progress on the energy transition. There is an urgent need to integrate decarbonization of existing assets into the ‘just energy transition’ terminology. The largest positive impact that can be made for climate and health now, is for existing emitting assets to emit less.

5) A lack of recognition that measures suitable and successful for certain countries or regions may be much less suitable and successful for others.

Asia is key for emissions reduction, given the scale and growth of its energy use. Asia’s rising population and fast-rising middle class, make emissions reductions in a scenario of rapidly growing energy demand, and much needed economic development, a particularly challenging problem. It is therefore no surprise that Asia is lagging on carbon emission reductions. Measures developed for Europe may not be applicable for Asia. The lack of local perspectives and local solutions for the global climate problem impedes mitigating actions.

The integration of existing assets in the decarbonization efforts will reduce the risk of stranded assets and avoid major disruptions in the workforce (jobs, skills). It also provides continuity for energy access and economic growth, while providing opportunity for reduced energy waste, improved energy efficiency and absolute lower emissions.

Transparency is needed to increase awareness among regulators and provide actionable information. Increased transparency and public (NGO, shareholder and political) pressure can result in reputable listed companies selling out of their assets to private unlisted companies (‘hand-me-down’ assets). This may result in a political win but a public loss, when the operational performance of these assets deteriorates because of lower standards and cost-cutting, while the production life of hand-me-down assets is extended because they remain profitable for longer. Proper asset abandonment and restoration may also suffer because the new owners do not carry the same reputational awareness, technical competence and
financial means to carry out these activities responsibly. Forever leaking oil and gas wells could be a final legacy of hand-me-down assets.

UNU-WIDER publications[^4] find that a large number of low- and middle-income countries are dependent on oil and gas production. In 2018[^5], 13 low- and lower-middle-income countries received more than 20 per cent of export revenues from oil and gas. For Angola, Cameroon, Chad, Nigeria, and Yemen, oil and gas accounts for more than 50 per cent of exports.

UNU-WIDER research sets out the extent of the opportunities for these lower income producing countries to capture significant benefits from their own efforts to reduce energy waste and inefficiencies from natural gas flaring and venting. Satellite data since 2005 show that 85 per cent of total gas flared is in developing countries. The volume of gas routinely flared and vented is large, estimated to be circa 300 billion cubic meters (Bcm) annually, which is approximately 7.5 per cent of global gas production (Figure 1). Efforts since 2000 to reduce global flaring has reduced its share in natural gas volumes wasted from 58 to 48 per cent, but an estimated increase in the volume of methane vented has caused the total volume of gas wasted to increase by 7 per cent.[^6] However, due to the larger impact of methane on global warming, CO₂-equivalent emissions from natural gas flared and vented increased from 2000 to 2019 by 27 per cent, i.e. from 5,500 to 7,000 million tonnes per annum (mtpa), based on a Global Warming Potential (GWP) for methane of 25 years.

Figure 1: Natural gas flaring and venting has a disproportionally large impact on the social cost of the use of carbon energy.

The importance of natural gas flaring & venting in world energy emissions

<table>
<thead>
<tr>
<th>natural gas contributes 25% to global CO₂ emissions</th>
<th>7.5% of global gas is wasted</th>
<th>wasted gas causes 54% of social cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>World energy-related CO₂ emissions by fuel 2019</td>
<td>Natural Gas 'use' by volume 2019</td>
<td>Natural Gas social cost in US$ 2019</td>
</tr>
<tr>
<td>total: 33.8 GtCO₂/yr</td>
<td>total: 4,058 Bcm/yr</td>
<td>total: $1,768 billion/yr</td>
</tr>
</tbody>
</table>

*Source:* authors’ construction


Capturing and processing the natural gas associated with the exploitation of upstream hydrocarbon resources significantly reduces negative social impact and provides additional revenues that can be used to reduce poverty and contribute to the UN SDGs. The value from capturing and utilizing upstream flared and vented natural gas in 2019 was US$48 billion, based on an assumed US$4/MMBtu gas price. This volume of natural gas could supply annually more than the total South and Central America gas consumption, plus all of Africa’s power needs.

Reducing natural gas waste is essential to securing global energy security and, together with other energy efficiency measures, supports the rapid readjustment of global gas markets following Russia’s war in Ukraine. More non-Russian natural gas supplies are needed in the short to medium term and reducing the large volume of natural gas wasted by other super-emitting countries is a key mechanism to achieve improved global energy security.

3. Reducing methane emissions by reducing wasteful flaring and venting of natural gas is an unusually attractive opportunity

This section explores the implications of COP26 and subsequent policy and market developments for producers and consumers of natural gas, including the prospects for future revenues.

UNU-WIDER hosted a very successful COP26 Are we ready? online event which highlighted the importance of immediate action on reducing atmospheric emissions.7 This event highlighted a critical factor, not often addressed, that emissions affect public health as well as climate, and that these impacts are interdependent. In earlier published work8, the combined impact of emissions on health (air quality and toxicity), climate-health (e.g. vector-borne diseases), agriculture (regional hydrologic cycle changes) and climate (global temperature rises and extreme weather events) has been evaluated for oil and gas and expressed as a monetary value, the Social Cost of Atmospheric Releases (SCAR), see Figure 2.

The benefits to producing developing countries from reducing methane emissions go way beyond the gains from greater energy access and higher revenues; the social cost of emissions is also reduced sharply, with benefits especially for human health. The beneficial development impact of reduced emissions, beyond its contribution to the reduction of global warming, can now be calculated. Estimates of the social costs of atmospheric release (SCAR) by Romsom and McPhail, based on methodology developed by Shindell9 show these

---

7 UNU-WIDER, online panel discussion, “COP26: Are We Ready?”, 28 October 2021; https://www.wider.unu.edu/event/cop26-are-we-ready
8 Romsom and McPhail, Op Cit (n6)
atmospheric releases and their social impact in a consistent representation. Different emissions affect climate, air quality, health, and environment differently. These wider-ranging impacts from this broader spectrum of releases are captured in a multi-impact economic valuation framework of SCAR that assigns a social cost per ton for each individual release, including: carbon dioxide (CO$_2$), methane (CH$_4$), black carbon (BC), nitrogen and sulphur oxides (NO$_X$ and SO$_X$), volatile organic compounds (VOCs), organic carbon (OC), carbon monoxide (CO), ammonia (NH$_3$) and nitrous oxide (N$_2$O). Poor quality flaring operations, as evidenced regularly by remote sensing, dramatically worsen the impact, as the emission of toxic chemicals increases by orders of magnitude. The local benefits arise from improved air quality, given fewer damaging particulates and toxic chemical emissions; less toxic chemical absorption in the food chain; improved crop yields because of lower methane levels; and less ground water pollution. These benefits together make political support for emissions far more compelling than just contributing to global reduction targets.

At the UNU-WIDER pre-COP-26 event, it was demonstrated how natural gas flaring impacts local communities (see Figure 3 as example). The transparency now provided by satellite data, not only measures the amount of gas flared by individual installations, but also provides local context by super-imposing such data on local population density, or the presence of agriculture activities impacted by toxic atmospheric releases.

The scope for reducing methane lies disproportionately within developing countries, who also stand to benefit most from such reduction (see Box A). Most wasted gas from emissions occurs in the more than 30 low- and middle-income countries that are highly dependent on oil and gas production, and the World Bank estimates that 85 percent of total gas flared since 2005 comes from developing countries. Moreover, the 100 largest “super-emitter” flares that account for a quarter of total gas flares globally are all located in low- and middle-income countries.

10 Roe and Dodd, Chapter 2 in Addison and Roe (2018) for the data on dependence. The low- and middle-income countries in this list include Nigeria, Ghana, Bolivia, Chad, Congo, Cameroon, Egypt, and Sudan.
Figure 2: The social and environmental costs of natural gas flaring and venting
2019 global social costs of atmospheric release (SCAR), grouped by impact category

Source: authors’ illustration

Figure 3: Flare emission source in the middle of a city in Indonesia

Source: authors’ illustration based on a combination of Google Earth images with VIIRS data.

Note: example of satellite identification and measurement of a natural gas flare in Jambi City (population 600,000), Sumatra, Indonesia. Multiple houses are within 50-meter distance of this flare (indicated by the yellow circle), including a food store. This flare is operated by Pertamina, the national oil company. It burned 11.7 million m$^3$ in 2020, and was ranked among the world’s 25% largest flares. Jambi city is short of electrical power. This flare waste gas could be monetised for local power generation and connected to the grid, as other Jambi small-scale electrification projects are underway.
Some countries (including Nigeria, Angola, Gabon) have acted to reduce flaring and venting emissions through gas aggregation and development schemes to stop routine flaring. Satellite measurements of emissions has enabled other measures, including penalties on gas flared implemented by Nigeria. These efforts have resulted in reduced wasted gas emissions from these countries. Nevertheless, although Nigeria natural gas flaring has reduced over time, the remaining opportunity to create value from reducing Nigeria’s natural gas waste is highly substantial (see Box A and Section 5).

BOX A: NIGERIA Improving Operational performance and reducing methane emissions?

Nigeria, alongside six other countries (Russia, Iraq, Iran, USA, Algeria, Venezuela) accounts for about 65 percent of global gas flaring. Nigeria exports a significant share of its natural gas as Liquefied Natural Gas (LNG) to international markets (particularly to Europe and Asia). Despite its domestic gas demand and export opportunities, Nigeria contributed 4.7% to all natural gas flared globally in 2020 (ranking 7th among the largest flaring countries). According to the Nigeria Extractive Industry Initiative’s (NEITI) 2020 oil and gas sector audit, Nigeria flared 230 billion standard cubic feet (BCF) of gas during 2020, around 8% of its annual production of 3,013 BCF or 12% of its annual gas sales volume of 1,916 BCF. Data from Earth Observation Group, Payne Institute for Public Policy put the volume flared that year somewhat higher at 254 BCF (7,195 million m³) and this equates in an equivalent sales value of US$835 million (based on an average international gas sales price of US$3.29/ MMBTU in 2020). In 2021, Nigeria flaring reduced to 231 BCF (6,548 million m³), while the post-COVID19 recovery of global gas demand caused the gas international price to increase by a factor 4.6 to US$15.20/ MMBTU. Therefore, Nigeria is estimated to have lost a potential US$3.5 billion of revenue from gas sales as a result of flaring in 2021. Given the current war in Ukraine and Europe’s efforts to switch from Russian to other sources of gas supply, including Nigeria, the opportunity cost to Nigeria of continuing to flare, in financial terms alone, is huge.

Although flare estimates are quite consistent and satellite flare detection accurate, current estimates of methane emissions resulting from Nigeria’s oil and gas industry vary. One challenge with estimating methane emissions from the industry is that vented natural gas or fugitive emissions are not easily measurable if no accurate metering is installed. Although satellite technology is available now that can detect methane in the atmosphere, it is not always easy to trace it back to its origin, although progress is being made to improve the resolution of methane

---

15 Roughly one third of Nigeria’s production is used for power generation in the oil and gas sector, reinjection to increase yields from oil reservoirs, or is unaccounted for.
17 Gas prices can fluctuate strongly among global regions and over time. The average JKM (Asian gas) price in 2021 was US$15.16 per million Btu, well up on 2020’s average JKM price of US$3.85 per million Btu, while Europe’s TTF price averaged US$15.20 per million Btu, up from an average of US$3.29 per million Btu in 2020. https://www.upstreamonline.com/lng/gas-markets-expected-to-remain-tight-for-next-two-years-following-surge-in-prices-in-2021-energyquest/2-1-1147621
18 See for example: https://www.africanews.com/2022/04/12/europe-turns-to-nigeria-to-fill-the-gap-in-gas-supply//
measurements by satellite. The exception to this is when methane emissions come from flaring, where the flare point source is visible from space and where satellite measurements of methane should be possible to be directly linked to point sources of emissions. A scouting project to identify methane emissions from global super-emitter flares, using methane detecting satellites, is currently being planned. Fifteen of the global top 200 super-emitters are located in Nigeria.

While the performance of methane detecting satellites is rapidly improving, flare performance trends (measured by VIIRS satellites19) can now be used to determine the quality of oil and gas asset operations, which itself is a proxy for methane emissions. A joint OPM / EnergyCC study to analyse quality of operations from flare data is currently ongoing for Nigeria. VIIRS satellite measurement data can identify operational performance issues, such as process upsets and equipment failures, while they may also provide indications on flare quality. For example, a high variability in flare rates is indicative of oil and gas processing instabilities, and therefore expected to correlate with methane and other emissions. Operational upsets can further be identified when flare rates exceed continuous flare trends, or when peak flare rates exceed historical trends, or potentially also by investigating other data such as flare temperatures (all derived from satellite measurements). In the near future, it may be possible to compare these proxy values of methane emissions directly with methane measurements by satellite. This type of analysis for Nigeria will lay the groundwork to calibrate detailed flare performance observations with direct methane measurements.

Quality of oil production operations can have a significant impact on the combustion efficiency of flares and this may vary over time. Indeed, efficiency may on occasion dip well below the typical factors used to model methane emissions from flares, meaning that actual emissions of methane from flaring could sometimes be much higher than assumed. Given that methane has a much higher short- and medium-term warming effect than CO₂, this is problematical. Further work is ongoing to better understand the background, trends and opportunities for further flare rate reductions of super-emitters and other high-rate flares. The key learnings that arise from the evaluation can improve operational performance and further reduce flaring.

Earlier work by UNU-WIDER20 has highlighted that the most effective measures to reduce flaring and venting emissions deploy an integrated “Diamond” framework, combining public-private action on four key focus elements, as shown in Figure 4.

---

19 VIIRS Nightfire (VNF) originally developed by NASA. Administration and updating of VNF data is now done by the Payne Institute of the Colorado School of Mines. https://payneinstitute.mines.edu/eog/viirs-nightfire-vnf/

20 Romsom and McPhail, Op Cit (n12)
Generally, governments lack ‘decision-useful’ information on the exact location and actual volumes of gas being flared and vented. Technologies are key. Remote sensing technologies now make it possible to locate and measure the size of flares. This information can be used to identify the scale and location of potential investments, as well as to prioritise the options to aggregate, process, and utilise natural gas for local economic use that can stimulate further benefits for communities, such as local energy access and transportation fuel.

Technologies to capture and use gas instead of flaring and venting are available and affordable, but are often not adopted by oil and gas companies when this would dilute their commercial returns or result in projects with limited financial scale. However, public policies — regulation requiring measurement of emissions, together with fiscal measures — have changed the calculus for the companies involved (see next section). Public transparency facilitates not only public awareness, but also increases company awareness as their emission performance can be benchmarked and any natural gas leaks detected early. Furthermore, emission transparency also improves the ability of authorities and regulators to make informed data-driven decisions.

With appropriate public-source data on flares and vents available, it is far easier in any country to identify the specific producing assets and companies that are responsible for these and for what specific amounts. The key to this is to ensure that the necessary satellite data is indeed established as a public good and is not subject to corporate confidentiality or other commercial restrictions.
4. From pledge to immediate action on methane

This section sets out how public-private collaboration can be mobilized to achieve the action that is so urgently required.

As discussed above, natural gas is forecast to become the prime source of global energy with the next 10 years. However, estimates of methane emissions associated with natural gas production and utilization can undo much (if not all) of the reduced carbon intensity natural gas provides over the use of coal. If natural gas leakage rates are 3 to 5 percent or higher, its net benefits as fuel in electric power plants over coal are undone. Gas engines as a replacement for heavy-duty diesel vehicles have a methane emission threshold of 1 to 2 percent before its net emission benefits are undone. Current estimates of global methane emissions associated with the production and use natural gas are 3.9 per cent.21

With the successful launch of the COP26 Global Methane Pledge (GMP), and the U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s, together with the GMP Energy Pathway (June 2022), the door is now wide open for immediate action on emissions reduction from the energy sector.

Action can also be taken quickly, as explained in work with the Center for Global Development (CGD). This requires cooperation from several sources: oil- and gas- producing countries (as already set out in Box A on Nigeria and Box C on Norway); official donors and multilateral development banks (MDBs); countries that host satellite data companies; and the IMF that can play a leadership role through its surveillance work and advice to implement taxes that incentivize reductions in emissions.22

More than 100 countries have signed the Global Methane Pledge and committed to a collective goal of reducing global methane emissions by at least 30 percent from 2020 levels by 2030. This includes using best available inventory methodologies to quantify methane emissions, with a particular focus on high emission sources (our italics). The countries that have joined the Pledge represent all regions of the world and include representatives from developed and developing nations.

Fiscal innovations and technological advances now present attractive opportunities for all countries, including some high-income significant gas flaring countries, to measure, capture, and use the gas otherwise wasted. The 2021 Global Methane Assessment finds that a methane tax is effective in reducing emissions from the energy sector and leads to an immediate drop in the implementation year. Few countries have implemented a methane tax to date. Some countries impose a proxy-methane tax.

21 Romsom and McPhail Op Cit (n6)
The IMF has devised a novel way to tackle methane emissions in contexts where satellite-based measurements still need further improvement. In the absence of metering or remote measurement of emissions, taxes can be levied based on assumed default methane leakage rates, with rebates given to operators that demonstrate, via continuous monitoring, lower leakage. This creates disincentives for operators to conduct routine gas flaring and venting operations, as these erode their commercial returns, without the authorities having to prove how much methane was emitted. Conversely, the repurposing of waste gas for local use may now become commercially attractive if penalties for (deemed) methane emissions are set at the right level.

The IMF is the only global institution that requires each of its 190 members to engage in mandatory, usually, annual (Article IV) consultations; its membership includes all oil and gas producers. A key recommendation in the earlier CGD note, therefore is that the IMF include advice on implementing a default-methane tax as part of its Article IV consultations, and through its capacity development work.

Moreover, the IMF has recently established a new lending instrument that is both timely and relevant. The IMF’s newly established Resilience and Sustainability Trust (RST) allows at least US$45 billion from the recent special drawing rights (SDR) allocation to be channeled to 143 eligible low-income and vulnerable middle-income countries as well as small states. This can assist member countries to face their longer-term structural challenges, including climate change, thereby building resilience to external shocks and ensure sustainable growth, contributing to their long-term balance of payments (BoP) stability. The policy on conditionality associated with the long-term loans from the RST is being finalized. Reform measures would be a single policy action or set of closely related actions constituting a single reform and would need to be “objectively monitorable”, “clearly linked to addressing qualifying longer-term structural challenges” and make a “meaningful contribution toward strengthening the member’s prospective BoP stability”. The IMF has given specific examples of what could comprise these reform measures. In the context of climate mitigation, examples include issuing regulations on carbon pricing policy, applying the standard VAT rate for electricity and fossil fuels, and introducing/increasing excises on coal, natural gas, and petroleum products. A forthcoming CGD note argues that this list of reform measures as potential RST loan conditions should be expanded to include the introduction of a default tax on methane emissions.

---

24 Romsom and McPhail Op Cit (n6)
26 Ibid, see p25
27 CGD Note John Hicklin: How IMF Conditionality Can Help Countries Build Resilience, (forthcoming)
With public data from satellite measurements of emissions available for analysis, it is now possible to exert particular focus on high emission sources. The VIIRS satellite data resolution enables the detection, measurement and ranking of global super-emitter flares. Using the identified locations of these high-emission flare assets, data algorithms can be deployed to assess the associated methane emissions of these individual emission sources.

In 2017, more than 60% of all gas flared globally from 10,622 flares came from just 700 flares (6.6%). This insight means that the targeting of the largest flares would yield major reductions in greenhouse gas emissions. Most of the global top 200 super-emitters are in a few countries, thus easier to tackle than other emissions reduction initiatives. Of the 20 top countries with super-emitter flares, almost half are signatories of the GMP (Iraq, Nigeria, Mexico, Libya, Malaysia, Congo, Qatar, UAE and Saudi Arabia); a further three countries (Turkmenistan, Kazakhstan, Egypt) are countries of action for the EBRD and 15 are countries of the Green Climate Fund, including Iran, Venezuela, Algeria, Angola, Oman and China. Thus 18 of 20 countries with super-emitter flares are members of organizations pledged to provide technical assistance and project support to member countries.

The World Health Organization (WHO) has found that air pollution, defined as particulate matter (PM)\(^\text{28}\) is the leading environmental health risk that humans face. When small particulate matter is inhaled, it penetrates deeply into the lungs. One in eight premature deaths is caused by air pollution, largely a result of increased mortality from stroke, heart disease, lung disease, and cancers. This is particularly significant for people living in low- and middle-income countries. Of the 4.2 million premature deaths in 2016, 91 per cent occurred in low- and middle-income countries. The integration of climate and health impacts into a single SCAR measure (see Section 3) greatly enhances the ability to focus action on highly impacting super-emitter sources. The most affected are the WHO South-East Asia and Western Pacific regions.\(^\text{29}\) These are also the regions where world demand for energy is growing fastest (see Box B). This makes improving air quality in the drive to reduce natural gas emissions an important driver. Clean Air Asia shows that almost all cities have unhealthy levels of air quality. China’s successes over more than a decade are notable and were in part driven by local community pressure in cities such as Beijing and this experience could be shared with others.

MDBs such as the Asia International Investment Bank (AIIB) and the Asian Development Bank (ADB) can provide support to replicate these successes in air-quality improvement. For example, among the top 20 countries with super-emitter flares, almost half are regional members of AIIB: Australia, China, Iran, Kazakhstan, Malaysia, Oman, Qatar, Saudi Arabia, UAE. The ADB has operations in China, India, and Kazakhstan. The Climate and Clean Air Coalition, implementing partner for the GMP, has partner countries with super-emitter flares that include Ghana, Iraq, Mexico, Nigeria, UAE, Australia.

\(^{28}\) PM consists includes chemicals such as black carbon (BC), ozone (O\(_3\)), nitrogen dioxide (NO\(_2\)), and sulphur dioxide (SO\(_2\)).

\(^{29}\) Romsom and McPhail Op Cit (n6)
Box C highlights Norway as an example that opportunities to reduce the atmospheric emissions from flaring and venting are not restricted to lower- and middle-income countries.

BOX B: Opportunities from reduced Gas Flaring in ASEAN countries

IEA’s Southeast Asia Energy Outlook 2022⁴⁰ is calling for “major efforts”, including from international financing, to boost energy efficiency, renewable power and low-emissions fuels in South-East Asia. This will also support the region in meeting energy security and emissions goals.

There are significant opportunities to meet these ambitions as well as the potential for increased government revenues and contribution to the SDGs. In 2017, ASEAN countries had 366 active natural gas flares, combusting 7.5 billion cubic meters (Bcm) that year (731 million cubic feet per day, MMscfd). ASEAN countries contributed 5% to global flaring. Among the 10 ASEAN member countries, 8 have natural gas flares (only Laos and Cambodia do not). Indonesia is the country with most gas flares (202), while Malaysia flares the most gas (3.16 Bcm, 306 MMscfd), see Table 1.

Reducing natural gas emissions creates the following benefits for ASEAN countries:

- Prevent the loss of valuable energy resource: ASEAN countries include flares that are ranked in the top 50 of 10,000 flares in 2017 (Figure 5). The opportunity to recover this loss of energy resources is significant as set out elsewhere in this paper.
- Deliver on NDCs: many ASEAN countries include emissions reductions in their Nationally Determined Contributions (NDCs).
- Increase global competitiveness: Singapore has issued new measurement protocols for LNG cargos to ensure that these meet global targets for reduced carbon emissions. Reducing emissions from natural gas flaring and venting offers new areas of competitiveness for companies to strengthen their value proposition to customers, investors, and society. Oil and gas produced with low emissions are likely to be priced higher in the market.
- Improve human health and contribute to NDCs: Large flares at petrochemical complexes are located close to local communities and homes in Brunei (Figure 6) and somewhat further distanced in Bintulu in Sarawak. Even much closer to homes are upstream flares in Sumatra, such as in the Jambi City urban area (see Figure 3). Eradication of flares and vents ranked by volume emitted (as well as by pollutants and proximity to populated areas) would significantly benefit human health and contribute to Sustainable Development Goals.
- Enhance local energy access: for ASEAN countries seeking to enhance energy access for citizens, the scale of the opportunity is exemplified by the observations also set out elsewhere in this paper.

In short, as the world is now focused on COP27, there are opportunities for ASEAN countries to press forward with the urgent need to abate emissions substantially by reducing gas flaring and venting, using our Diamond model approach (Section 3). They would thereby achieve a win-win-win: gains in human health, climate and revenues for the governments of host countries.

---

Table 1: Overview of natural gas flares in 10 ASEAN countries and Timor Leste as observed by VIIRS satellite

<table>
<thead>
<tr>
<th>Country</th>
<th>Volume natural gas flared in 2017 (Bcm)</th>
<th>Average daily rate of natural gas flared in 2017 (MMscfd)</th>
<th>Number of active flares in 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>3.16</td>
<td>306</td>
<td>81</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.48</td>
<td>240</td>
<td>202</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.98</td>
<td>95</td>
<td>29</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.42</td>
<td>41</td>
<td>30</td>
</tr>
<tr>
<td>Brunei</td>
<td>0.31</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.14</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Myanmar</td>
<td>0.04</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.01</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Cambodia</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laos</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Timor Leste</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total ASEAN</strong></td>
<td><strong>7.54</strong></td>
<td><strong>731</strong></td>
<td><strong>366</strong></td>
</tr>
</tbody>
</table>

**Source:** authors’ representation based on 2017 VIIRS data.

**Figure 5:** Individual natural gas flares in ASEAN countries as observed by VIIRS satellite

**Source:** authors’ illustration based on a combination of Google Earth images with 2017 VIIRS data.

**Note:** each natural gas flare observed by VIIRS satellite in 2017 is represented by a red dot in the map above.
**Figure 6**: Example gas flare in Brunei, member of ASEAN, as observed by VIIRS satellite

**Source**: authors’ illustration based on a combination of Google Earth images with 2017 VIIRS data.

**Note**: The main gas flare at Brunei LNG was ranked as the 440th largest global flare in 2017 (global top 4 percent), consuming 0.077 Bcm of gas that year (7.5 MMscfd). Nearest houses are at 800m distance from the flare.

**Table 2**: Long-term gas flaring trends for Malaysia and Indonesia countries (in Bcm per year)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>1.7</td>
<td>1.9</td>
<td>1.8</td>
<td>1.9</td>
<td>1.5</td>
<td>1.6</td>
<td>1.5</td>
<td>2.8</td>
<td>3.4</td>
<td>3.7</td>
<td>3.2</td>
<td>2.8</td>
<td>2.2</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.8</td>
<td>3.1</td>
<td>2.6</td>
<td>2.5</td>
<td>2.9</td>
<td>2.2</td>
<td>2.2</td>
<td>2.4</td>
<td>3.1</td>
<td>3.1</td>
<td>2.9</td>
<td>2.8</td>
<td>2.3</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>4.5</td>
<td>5.0</td>
<td>4.4</td>
<td>4.4</td>
<td>4.8</td>
<td>3.7</td>
<td>3.8</td>
<td>3.9</td>
<td>5.9</td>
<td>6.5</td>
<td>6.6</td>
<td>6.0</td>
<td>5.1</td>
<td>4.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

**Source**: Authors’ representation based on data from World Bank Group, GGFR.

**Note**: Malaysia and Indonesia are both global top 30 flaring countries as per World Bank’s Global Gas Flaring Reduction Partnership (GGFR). Long term gas flaring trends for Malaysia and Indonesia show a rise for the former and a decline for the later. Both countries combined show similar levels of gas flaring in 2019 compared to 2005.

**BOX C**: Opportunities to use satellite data to improve the operational performance of oil refineries: Norway

Opportunities to reduce the atmospheric emissions from flaring and venting are not restricted to lower- and middle-income countries. Even producer countries with high-quality regulations and capable regulators offer opportunities for improvement. In this section, we highlight the flaring emissions by Norway’s last remaining refinery Mongstad, which has been subject to operational incidents that resulted in emissions that were detected by satellite. Mongstad refinery is owned and operated by Equinor since 1975. It has a capacity of 12 mtpa of crude oil and 9.3 mtpa of product, and 73 percent of the refinery output is exported.
Detailed evaluation of flare rates of installations is important to determine trends in the quality of operations, whereby the amount flared over time is a key indicator of operational performance. Flare analysis can assist regulators in their supervision of operations. Flare rates may even provide diagnostic value in incident analysis. For example, high flaring activity was observed prior to Mongstad refinery shutdown, and may be indicative of a system upset or maintenance activity that led to a gas leak on 25 October 2016. Six such publicly reported refinery incidents can each be identified from VIIRS NightFire (VNF). High flaring activity prior to refinery shutdowns may be indicative of system upsets or maintenance activities.

As explained in Box A, flare quality indicators are as important as quantitative flare rate measurements. Poorly operated flares can cause SCARs that are orders of magnitude higher than under optimum flare combustion, i.e. 98% destruction efficiency. Consequently, efforts to measure flare quality should be given higher priority as these indicators relate directly to air quality.

Consistent flare evaluation methodologies, such as those developed by the authors, can also assist in benchmarking individual assets on their flaring performance. In this context, Mongstad refinery flare rates exceed those of Pernis, Galp Sines, Repsol Sines, are similar to Pertamina RU2, and are smaller than KNPC and a number of other refineries.

VNF is a powerful tool for monitoring gas wastage, emissions, and for verifying the quality of asset operations over time. The Mongstad refinery has a patchy track record of operational performance, and this is reflected in its profile of frequent flare gas emissions, as shown in figure 7 below.

**Figure 7:** Example gas flare in Norway, with refinery incidents observed by VIIRS satellite

**Mongstad publicly reported refinery flaring events detected by satellite**

**Source:** authors’ illustration based on a combination of Google Earth images with 2012-2021 VIIRS data.

**Note:** six individual incidents of the Mongstad refinery were detected by VIIRS.
Importantly, the GMP is supported by philanthropic aid and by MDBs such as the European Bank for Reconstruction and Development (EBRD) and the Green Climate Fund (GCF) which have each committed technical assistance and project finance. At the launch of the Pledge in Glasgow, Scotland, Larry Kramer, president of the Hewlett Foundation, said:

“The speed with which the pledge came together has been remarkable—something for which we must thank the extraordinary leadership of Presidents Biden and von der Leyen.

Now we must match that speed with similar speed in implementing and fulfilling it. ...More than 20 philanthropies...likewise came together quickly to compile a fund well in excess of $325 million to assist nations that have taken the pledge.

This flexible philanthropic aid can be used to provide technical assistance to countries that need it and to develop and deploy innovative new solutions....grant dollars can be moved quickly and nimbly for feasibility studies, project development, and other efforts needed to create the conditions to scale investment in methane reduction now.

We are, in this respect, keen to partner creatively with financial institutions, like EBRD, to help deploy the billions in investment that will be necessary to rapidly reduce methane.

We look forward, eagerly, to working with you”.

5. Implications for developing countries in reducing methane emissions from oil and gas operations

This section discusses the implications for developing countries that have signed the Pledge and how best they can move ahead on reducing methane emissions in oil and gas, and the implications for their revenues.

The energy transition priorities of developing countries often differ from those set by industrialized countries. OECD countries must therefore recognize that measures suitable and successful for them may be much less suitable and successful for other geographies. For example, the climate change taxonomy developed by and for Europe is causing confusion and obstacles for emissions reductions in developing countries. This is particularly pertinent for efforts to reduce emissions in the extractives sectors that are so critical to the development of low- and middle-income countries. These emission reduction initiatives would benefit

greatly from more practical support than by artificial determination if such steps are deemed ‘sufficiently-green’ by Europe’s taxonomists.

One of the challenges with methane abatement is to identify the specific sources of methane emissions. UNU-WIDER published papers indicate that natural gas flares that are accurately identified with VIIRS satellite, are also key sources for methane emissions. Work is currently ongoing to improve the resolution of satellites in detecting methane emissions from assets. Correlation of satellite measurements of methane with flare quality parameters derived from VNF, can assist in predicting SCARs of individual flare installations. Assets with large SCARs, particularly those near populations centres, should be prioritized for flare reductions and flare quality improvement.

Improvements in the availability in quantifiable emission data from oil and gas operations enables improvements in countries’ regulatory systems. It also supports validation of much needed mandatory reporting of flaring and methane emissions. The benefits of reduced flaring emissions include local energy access opportunities by repurposing waste gas, improved air quality and thus health, and the opportunity to raise significant additional fiscal revenues. In Nigeria, fiscal penalties are imposed on oil and gas operators based on flare measurements of its Flare Tracker and have resulted in estimated revenues of US$270 million in 202032. Capture of associated gas has furthermore enabled commercialization of Nigeria’s gas for export (Nigeria is the world’s fifth-largest LNG exporter), and domestic consumption. Other countries can benefit from a similar approach as deployed by Nigeria in a combination of emission measurement, transparency, regulation and fiscal measures and deployment of (small-scale) gas monetisation technologies.

Though some flaring is done for safety reasons, much of the observed flaring is an unnecessary part of routine operations. These routine flaring sites are easily identified and their priority for emissions reductions ranked. This in turn enables analysis of various options for monetizing some of the otherwise wasted gas. By combining this analysis with both the indicative unit costs of the technologies required, and the satellite measurement data, it is possible to identify the scale and location of the potential investments required to develop possible uses of that gas otherwise wasted.

Satellites provide additional information on the presence of local communities most impacted (via their health) by chemical emissions from flaring and venting and for whom capturing the gas would provide domestic economic opportunities. This facilitates prioritizing the options to aggregate, process, and utilize the gas for local economic use (e.g., compressed natural gas) that can stimulate further benefits for communities through clean fuel for agricultural equipment such as engines and irrigation pumps. Producing countries such as, Thailand, Vietnam, Pakistan, India, Indonesia, Chad, and Cameroon could benefit greatly from this sort of approach.

Other countries, such as Algeria, Angola, Brunei, Gabon, Malaysia (Sarawak), Nigeria, Qatar have opportunities to further reduce flaring and aggregate waste gas for their existing LNG export opportunities, as an alternative to domestic use. DNV’s ETO expects global LNG trade to more than double from 2018 to 2035. These emission reduction efforts will deliver more taxable revenue for governments in a post-COVID world. They also represent an important market opportunity for producers that can reduce their emissions and repurpose waste gas across the full value chain of gas production.

The critical importance of the extractive industries to the development prospects of low- and middle-income countries continues. This is also underscored in the mining sector, with a major World Bank study highlighting the growing demand for those metals required by the global energy transition to establish low carbon infrastructure.

Solutions that reduce emissions from extractive industries at source are more effective than import / consumer tax solutions and have greater benefit to natural gas producers that are often lower-and-middle income countries. For example, the proposed EU’s carbon border adjustment mechanism which penalizes producers lagging in decarbonization efforts, will result in a net value transfer from governments of oil and gas producing countries to those of consuming countries. Conversely, reducing emissions at source directly benefits producing countries in multiple ways. Examples exist of how to successfully manage the long-standing tension between the need to reduce emissions and the need to allow emerging economies to exploit oil and gas resources for national development. These solutions do not depend on climate finance. Instead, by focusing on measures to reduce emissions at source, producing countries benefit directly from their own emission reduction efforts. Solutions that incentivise emission reductions at source have the benefit that these affect all consuming markets, not only those that have carbon-border taxes. Not only does reduction-at-source result in a more effective abatement of climate impact, it also improves local air quality and agriculture in oil-and-gas producing areas. Tackling methane from natural gas flares meets other development priorities, including higher government revenues, and local community public benefits - better health and greater energy access.

There is a long-standing commitment by the Organisation for Economic Co-operation and Development (OECD) countries to provide US$100 billion climate finance for developing countries, beginning in 2009. Latest estimates are that this amount may be reached in 2022 and more likely by 2023. This represents an under-delivery in real terms since 2020. With the slow pace at which climate finance is being pledged for developing countries, the small initial costs and effort to implement methane reduction by wasting less gas make it an attractive investment for the private sector. Any gas repurposed from ‘waste’-to-‘resource’

---

has economic value, while regulatory and fiscal measures can positively influence the commerciality of investing in such local natural gas projects.

More generally, the Nigerian example can be shared with more countries with commensurate benefits in terms of achieving the SDGs and increased fiscal revenues. This fits well with OECD priorities: “the important role of natural gas in developing countries as a transition fuel to facilitate development of an affordable and resilient energy mix and to support the achievement of industrialisation objectives......(through) deployment of best available technology for methane emissions reduction, zero routine flaring”.

Countries often think that to meet their targets for emissions reductions they need to increase expenditures on new investments and on innovations, and to compensate those who may see a consequent loss in real incomes. However, in this case, countries can gain fiscal revenues from the innovation while making a significant contribution to reducing emissions, increasing local energy supply as well as improving health outcomes. This in turn shows how the dilemma between reduced emissions and development needs can be reconciled.

6. The emergence of ‘Net Zero gas’ markets

This section elaborates on the implications for producers of efforts to create markets for ‘Net Zero gas’ (in Singapore and other trading hubs) as an incentive to contain or reduce emissions.

Integrating emissions into LNG trade\(^{34}\) can be done in two ways: the “offset approach” and the “attribute approach.” To date, the less than 20 trades, out of, for example, over 5,000 cargoes of LNG delivered globally in 2020, have followed either approach – but most focus on offsets. This is due to the efforts required to measure the GHG emissions associated with an LNG cargo’s upstream, midstream, and consumption value chain. However, as Blanton and Mosis point out, ‘in the attribute approach to carbon-neutral commodity trade, producers with a lower carbon intensity will find themselves advantaged on a price basis, which can incentivize suppliers to reduce the carbon footprint of their entire value chain. Similarly, buyers would seek out supply with the lowest carbon intensity to reduce both potential cost as well as the GHG footprint of their own energy supply’. One example of this is in Singapore (see below).

In parallel, Jonathan Stern\(^{35}\) consistently argues that there is an urgency for sellers of natural gas and LNG to provide credible measurement, reporting and verification of emissions,

---


\(^{35}\) Jonathan Stern, “Methane Emissions from Natural Gas and LNG Imports: an increasingly urgent issue for the future of gas in Europe”, OEIS 2020; “Measurement, Reporting, and Verification of Methane Emissions from
including for imports to Europe, given the driver of the EU’s Methane Strategy. He considers that this is likely to spread to other major gas and particularly Asian LNG importing countries as it becomes increasingly necessary for companies and governments to account precisely for their emissions. At present, there is no consistent standard to determine emission offsets that typically fall into two categories: a lower emission-reporting standard where the objective is to meet minimum compliance, and a higher standard where parties see commercial price benefit in demonstrating robust emissions abatement. A globally accepted standard on what are considered to be ‘blue’-fuels as opposed to ‘grey’ fuels would facilitate developments that focus on offsets and/or carbon-sequestration as abatement options.

Of increased focus is the emissions of exported gas that is being processed, transported and sold as LNG. The carbon intensity of LNG is generally higher than for pipeline gas due to the energy required to liquefy the gas. Also, there are potentially additional leakage paths for methane emissions along the LNG value chain. However, the industry has made much progress in the re-use of LNG boil-off gas and to minimize methane slip. This serves also commercial interests as any gas wasted during and after costly liquefaction directly affects the commercial bottom line.

Asia is key to reducing greenhouse gas emissions from the LNG trade:

- In 2020, Asian countries imported 71 percent (i.e. 254 of 356 mtpa) of global LNG.\textsuperscript{36}
- Asia is home to a growing population that is already more than half the global population of almost 8 billion people.
- By 2030, two thirds of the global middle class will be in the Asia-Pacific region. The strongly rising Asian middle class is expected to disproportionally affect energy demand growth.
- Clean Air Asia: 463 of 465 Asian cities have PM2.5 levels above WHO Guidelines.
- The rising (and vocal) middle class see clean air as an important quality-of-life issue.
- Asia contains countries most impacted by climate and environmental risks.

To date, efforts to contribute to greater transparency in GHG-neutral LNG transactions comprise the ‘Statement of Greenhouse Gas Emissions’ (SGE) methodology and the International Group of Liquefied Natural Gas Importers (GIIGNL) Framework. Singapore, currently the world’s largest bunkering port and Asia’s largest oil trading hub, is now positioning to become an LNG trading hub with a carbon trading system. In 2020, it signed three contracts which include developing an SGE methodology with GHG-neutral LNG supply to commence in 2023.\textsuperscript{37} These long-term sale and purchase agreements cover GHG emissions for producing, transporting and delivering these LNG cargoes. However, they do not require either seller or buyer to offset all the emissions – in other words, they are not (necessarily)

\footnotesize{\textsuperscript{36} International Gas Union, “2021 World LNG Report”; \url{https://www.igu.org/resources/world-lng-report-2021/}

\textsuperscript{37} Blanton and Mosis Op cit (n35) The contracts ranged between: a 10-year LNG contract for up to 1.8 mtpa with Qatar Petroleum Trading; a six-year contract for 0.5 mtpa with Chevron, and a 10-year contract for 0.8 mtpa with BP; all with delivery to Singapore. The first two contracts start in 2023 and the third in 2024}
In November 2021, GIIGNL launched its “Monitoring, Reporting, and Verification (MRV) and GHG Neutral Framework”. This was developed by Cheniere Energy, CNOOC, Engie, JERA, Shell, Tokyo Gas, TotalEnergies, and Pavilion Energy. It is designed to provide industry-wide standards across the entire LNG value chain.

Gas buyers are increasingly looking to reward producers with greenhouse gas verified LNG cargoes, for example, with price premia and preferential offtake status. Financiers and ESG investors are driving capital towards companies that work with governments to achieve transparency on their low carbon targets. Transparency measures on emissions provide critical input to establishing carbon offset levels. Global institutional investors can work with others to ensure that the necessary satellite data frameworks to verify emissions are established and maintained as a public good. This can support the implementation of measures recommended by Task Force on Climate related Financial Disclosures (TCFD). Such transparency measures facilitate not only public awareness, but also increase companies’ awareness as their emission performance can be benchmarked and any natural gas leaks detected early.

The SIPA paper by Blanton and Mosis concludes that policy makers both in LNG producing and consuming countries can have an active role in the development of a ‘carbon-neutral’ LNG market. Policy makers can create tax incentives such as production tax credits or investment tax credits for sellers producing carbon-neutral LNG. They can also offer (tax) incentives to buyers of low carbon LNG or set low carbon fuel standards within their countries. Two such examples are set out below.

In February 2022, Singapore’s Minister for Finance, announced further measures in support of the Green Plan 2030 (Singapore’s Green Plan). Singapore was the first country in South-East Asia to introduce a carbon tax, starting from 2019, at S$5 tCO2e. It covers the six greenhouse gases currently covered by the UNFCCC/Kyoto Protocol. The rate was to be reviewed in 2023, with plans to increase it to S$10-15 tCO2e by 2023. In February 2022, the Government announced a significant increase to S$25 tCO2e in 2024; S$45 per tCO2e by 2026; and increasing to between S$50 and S$80 per tCO2e by 2030. This is in line with the

---

38 The Methodology is to ‘create a consistent, verified Statement of Greenhouse Gas Emissions (SGE) for each delivered LNG cargo’, from production to the delivery point at the import terminal. The methodology covers all operational emissions associated with these life cycle stages for carbon dioxide, methane, and nitrous oxide.


40 Jonathan Stern has pointed out that a better definition than ‘carbon neutral’ LNG would be ‘greenhouse gas verified’ LNG using, for example, the SGE and GIIGNL methodologies.

recommendations of the High-Level Commission on Carbon Pricing. It concluded that an ‘explicit carbon-price level consistent with achieving the Paris global warming target is at least US$40–80/tCO2 by 2020 and US$50–100/tCO2 by 2030, provided a supportive policy environment is in place’. Few countries are in this range. The IMF finds that comprehensive carbon taxes can also raise a significant amount of revenue—depending on the country’s energy mix, but typically 1–2 per cent of GDP for a US$35/tCO2 tax in 2030.42

In August 2021, the Government of Korea, keen to become a regional LNG bunkering hub, provides fiscal incentives for the midstream. The Government offered tax rebates by abolishing the import surcharge for LNG fueled ships starting January 1, 2022.43 In its report, S&P Global mentions that the abolition of the import surcharge for LNG-fueled vessels is expected to help boost the country’s efforts to develop LNG bunkering and cope with marine fuel regulations. The government is also pushing for cutting the LNG consumption tax to around Won 12/kg to help encourage the production of hydrogen and reduce coal consumption for power generation blamed for worsening air pollution.

7. Competitive opportunities for new LNG producers to future-proof their green-field assets

This section summarizes likely trends in global gas markets and the implications for new producers.

Given the market trends described above, new emerging LNG producers may be commercially advantaged as carbon and methane emission prevention and abatement can be designed into new (greenfield) projects. This may result in these new producers to be first in their ability to deliver ‘low-emissions’ LNG. For existing LNG plants that are commonly project financed, it is both technically as well as commercially more complex to retrofit carbon-abatement investments (other than offsets). It is noteworthy that offsets are often seen by customers to be of lower quality and more exposed than elimination of emissions at source. For example, trees planted as an abatement mechanism are potentially exposed delivery failures due to climate-related droughts or fires. Also, avoiding emissions in the first place (i.e. ‘green’ instead of ‘blue’ fuels) may catch higher prices in the market for consumers that are particularly sensitive to supply-chain emissions.

Newly built assets that are future-proofed against future regulations, (global carbon) taxes and customer demands are likely to have an advantage in the marketing of their natural gas


(as LNG). Not only can unnecessary emissions be engineered out through design, also emission monitoring and accounting can be designed in from the start, including third party assessment and validation by reputable organizations.

Early marketing efforts of new producers can focus on those customers that require the highest standards (such as Singapore as described above) and thereby create competitive differentiation against existing players that may have less flexibility to upgrade their performance standards to the higher accepted emissions standards.

Existing assets that find themselves less competitive are exposed to become ‘hand-me down’ assets. It is important that existing asset owners that can decarbonize their assets do so and not solely deflect these requirements through asset divestment processes. Insufficient attention is given to encourage existing asset owners to integrate their assets in the decarbonization efforts. The largest positive impact that can be made for climate and health now, is for existing emitting assets to emit less. Asset divestment as the alternative way out to decarbonization will most likely result in more emissions for longer (see Box D).

**BOX D: Real decarbonization or portfolio decarbonization?**

Company strategies to decarbonize are not always the best way to reduce climate change and may even increase global emissions. One common practice for a company is to dilute carbon emissions across a larger base of activities. This strategy includes the growth of lower carbon activities, for example through asset or company acquisitions, while keeping high carbon assets on the books. Although the total carbon footprint of the company increases, its carbon intensity is reduced, and it is the latter that is being publicly reported. Rather than decarbonizing existing coal-power plants, for example through co-fueling with biofuels or zero-emission ‘green’ fuels, coal-plant owners will invest in renewable power facilities that complement, but do not decarbonize their existing assets.

Another common strategy for companies that are under the watchful eyes of stock-exchange regulators, fund managers, activist shareholders and NGOs is to divest their high carbon activities. Such transactions are almost always completed based on perceived value differences between seller and buyer. Such differences include differences in company overheads (a large company selling to a leaner and smaller company), as well as differences in company standards (where the buyer has lower cost of operations than the seller). Typically for the oil and gas industry, it is possible for late-life production assets to have a negative Minimum Acceptable Sale Price (MASP), i.e. the selling company is in principle willing to pay the buyer for taking the assets of its hands. This happens when the forecast abandonment and restoration costs exceed the forward production revenues. However, the buyer is usually willing to pay a positive price, because it sees opportunities to create incremental commercial value, due the mechanisms described next.

The date for an asset to turn cash negative (costs exceed revenues) is more near-term for large, listed companies because of higher corporate overheads. Companies that run a leaner business model are able to run late-life assets for longer and squeeze out positive cashflow for longer. This benefits the asset economics enormously in relative terms (i.e. return on capital, profitability margins etc.), although the forward cashflow will generally be marginal in an absolute sense. Most
importantly, any positive cashflow defers the abandonment timing and its related costs. In most regulatory regimes, abandonment costs are treated as non-capitalized operational expenses and can therefore be kept out of the company books until the date of abandonment.

Perhaps even more important than lower operational costs, any abandonment deferment ‘creates’ significant commercial value. This benefit is amplified when the smaller buying company has a higher cost of capital and therefore applies a higher economic discount rate. This means that the asset net present value improves significantly for the longer-producing asset, even if the operations run exactly as before.

Differences in company standards can help to drive operational costs lower and therefore add commercial value to the new owner. With the larger and more conservative oil and gas companies, integrity assessments are regularly made to determine whether further delay in abandonment is prudent from a view of technical risk. The longer abandonment is deferred, the higher the risk of technical complications that need costly repairs and the higher the risk that the abandonment outcome does not comply with company standards (e.g., a zero-leakage rate forever). For leaner companies, abandonment means ‘setting a plug’, i.e., executing a certain activity. For more conservative companies, abandonment means full restoration, i.e., the well will never leak again, and the area will be restored to its original condition (including soil decontamination if necessary). The ‘zero-leakage rate forever’ requires for example that the remaining casing strings in the abandoned well must have sufficient remaining technical integrity and are not corroded to such degree that these leak oil and gas to the surface (seabed or subsurface aquifers), now or in the future. Indiscriminately deferring abandonment creates an environmental and climate time-bomb: when abandonment finally takes place, plugged wells will leak forever and there will be no longer a viable technical restoration method possible.

There are companies that make it their business model to take old oil and gas assets off the hands of asset owners, so that these pass on their abandonment obligations to the less discerning new owners. According to an example reported by Bloomberg: 44

‘Diversified Energy Co. has amassed about 69,000 wells, eclipsing Exxon Mobil Corp. to become the largest well owner in the country. Investors love [CEO Rusty Hutson]. Since listing shares in 2017, Hutson’s company has outperformed almost every other U.S. oil and gas stock, swelling his personal stake to more than $30 million.... Hutson says there’s no cause for worry. He claims to be able to squeeze more gas out of old wells than other companies can and keep them going longer. On average, he figures his wells have an additional 50 years in them, which means there’s no hurry to start socking away money to plug them... In 2018 the company bought a portfolio of wells from CNX Resources Corp. CNX had pegged its cleanup liability at $197 million. Diversified put the liability for the same wells at only $14 million. This may explain why Diversified frequently determines the wells it’s buying are worth far more than what it paid—so much so that it books the difference as profit upfront. Since 2014 the amount Diversified has made from these accounting gains is more than its cumulative reported profit.’

Diversified Energy’s business model is worrying as many of the old oil and gas wells leak and keep on leaking until it is too late to stop them from leaking. Then the final cost is for the community in terms of polluted soil and air emissions. Abandonment standards need to be strengthened based

---

on the ‘zero-leak forever’ principle. Companies should not be rewarded for delaying abandonment beyond the point of minimum technical integrity of the asset. Companies must make a reservation for future abandonment (i.e. as an independent retirement fund) on the basis of a combination of initial capital costs, cumulative production and asset age, so that indefinite abandonment deferral is no longer a commercial proposition. To ensure proper abandonment execution at the right standards, an independent executor (government appointed or independently certified companies) for this work is strongly recommended. Leak rates should be measured instead of based on theoretical formulas that take no account of age or condition of the asset.

Disposal of high-carbon emitting assets by high-profile listed companies to unlisted companies and organizations (‘hand-me-down assets’) is negatively affecting transparency on emissions, and negatively impacting emissions-reducing investments. Satellite remote sensing technologies can reduce the reliance on self-reporting of emissions. However, perhaps the more important root cause is societal pressure on reputable companies to get rid of “hand-me-down” assets, which may seem a win for the activists opposing publicly-listed firms, but is to become a major loss for society at large. This point is reinforced by Mark Carney UN Special Envoy on Climate and Finance:

‘Transition means transition. Financial institutions must go to where the emissions are and back companies—including in heavy-emitting sectors like steel, cement, transportation—that have credible plans to transform their businesses for a net zero world. They will also finance traditional energy projects consistent with the climate transition, including helping to phase out stranded assets transparently and responsibly through clear frameworks... GFANZ ⁴⁶ is committed to the imperative of real world decarbonization not the false comfort of portfolio decarbonization.’

8. Recommendations for policy makers in developing countries

This section provides recommendations for policy makers in developing countries as to how they can best navigate global gas markets to take the largest advantage of the opportunities as the world moves to Net Zero as well as the market risks they may face.

Restricting global climate change to below 1.5°C is not on track. Abatement of atmospheric emissions, including methane, are insufficient to date. In our review, the root causes for failing actions have been discussed and exemplified.

1) **Carbon emission targets and reporting should be based on absolute measures** and avoid relative measures such as emission intensity, as the global capacity to contain climate change is based on an absolute and not a relative carbon budget. NDCs as well as corporate emissions targets should be based on such absolute measures. Moreover, different pollutants should not be aggregated in a CO₂-equivalent measure, as this obscures the negative impact these pollutants have on health as well as

---

⁴⁵ Financing the Net Zero Revolution Net Zero Delivery Summit, 11 May 2022 Mark Carney

⁴⁶ Founded in April 2021 with 160 members responsible for US$70 trillion of assets
agriculture. The SCAR methodology applied to oil and gas emissions from flaring and venting is an example of a more holistic approach to impact assessment.

Previous UNU WIDER research discussed how currently there is no consistent and fair approach to utilize the global carbon budget based on countries’ opportunities, abilities, social impact and cost. No one global institution is responsible and accountable for all aspects. While the UNFCCC analyzes and encourages contributions to global abatement consistent with particular global warming goals, the IMF – in its role of global economic surveillance – could help bring clarity to the overall implications of country contributions. The IMF could analyze projections of global energy demand and supply, incorporating both the analysis of the IPCC and that by the IEA. This could form the basis for discussions with IMF member countries. The IMF could then ascertain whether there is consistency between their current economic policy settings and stated decarbonization goals. The IMF could assess whether – in aggregate – a country’s macroeconomic policies are on track to deliver the UNFCCC targets that are deemed sufficient to achieve the 1.5°C limit on global warming.

2) **There is a declining window of opportunity to reduce emissions** more determinedly from now onwards. The window of opportunity is in part determined by the rate at which the global carbon budget is receding.

*Developing countries’* Heads of State speaking at the UN Secretary General’s first ever High level Global Dialogue on Extractives and Development, highlighted their anxieties about prospects for the 81 countries which are highly dependent on extractives. These economies account for a quarter of global GDP, half of the world’s population and nearly 70 per cent of those living in extreme poverty. For these countries, reducing losses of natural resources, such as from natural gas flaring and venting, provides opportunities for improved energy access domestically and increased access to foreign currency through exports.

Oil and gas producing countries could volunteer to apply remote sensing (satellite) technology to measure—and fiscal policies to disincentivize—methane emissions from wasteful gas flaring (following Nigeria’s example) and venting, and also volunteer to implement existing gas monetization technologies (following the example of Norway). Egypt (COP 27 chair) and Indonesia (G20 chair) could take leadership roles in these initiatives. Reducing emissions at source, i.e., by oil and gas producing countries, has win-win-win benefits: gains in human health, climate, and revenues for the governments of host countries. The World Health Organization finds that air pollution (PM) is the leading environmental health risk that humans face.

3) **Transparency on emissions and verifiable operational standards are key instruments** against the consequences of ‘hand-me-down assets’ that occur when high-profile

---

47 Romsom and McPhail Op cit (n31)
listed companies offload their high-carbon assets to unlisted private companies. As Mark Carney concluded, financial institutions must go to where the emissions are and invest in companies in heavy-emitting sectors and traditional energy projects. The objective should be ‘the imperative of real world decarbonization not the false comfort of portfolio decarbonization’.

For developing countries there is a significant opportunity to improve quality of operations from their domestic companies by knowledge transfer by reputable international companies operating at transparent global standards. New emerging LNG producers may be commercially advantaged as carbon and methane emission prevention and abatement can be designed into new (greenfield) projects. This may result in these new producers to be first in their ability to deliver ‘low-emissions’ LNG. Existing LNG plants that are often project financed, are technically and commercially more complex to retrofit carbon-abatement investments (other than through offsets).

Governments and regulators can protect themselves against a potential deterioration of asset performance, in particular for late-life assets, by setting proper performance standards, maintaining technical integrity (e.g., through independent inspections), and prudent accounting, where companies are required to set aside financial reserves for future abandonment activities that are based on restoration and managing risk, instead of indiscriminate activity-based minimum efforts. This prevents future incurable emissions from late-life and abandoned assets. Satellite measurements of operations and pre-existing assets can provide continuous monitoring of emissions.

4) **There is a need to integrate decarbonization of existing assets into the ‘just energy transition’ terminology.** The largest positive impact that can be made for climate and health now, is for existing emitting assets to emit less.

Many developing countries have a social and economic need to hold on to existing carbon-emitting assets. This is particularly true in Asia where population growth, the fast rise of the middle-class and limited application or opportunity for renewable energy to date limit opportunities for and energy growth and carbon reduction. However, there are opportunities to reduce emissions in existing assets by exchanging dirtier fuels with cleaner ones, following examples in China where coal-fired boilers that caused most of the air pollution were replaced by natural gas. Co-firing of coal plants with renewable bio-fuels or green zero-carbon fuels also offer opportunities to reduce emissions from the largest polluters in terms of air quality. The mobilization of the middle class that demand clean air is a key force for emission reduction. Multilateral development banks (MDBs) supporting the Global Methane Pledge and other donors should help developing producer countries take advantage of the new technology in pursuit of country objectives to support the just energy transition.48 For example, standards for emission limits for new coal fired power plants in South-East

---

48 as discussed in a series of high-level UN Roundtables in 2021
Asia are five to ten times more lenient than those in China, the EU, or the US. China has the most stringent emission standards.

5) **OECD countries must recognize that measures suitable and successful for them may be much less suitable and successful for other geographies.** The climate change taxonomy developed by and for Europe is causing confusion and obstacles for emissions reductions in developing countries, that benefit more from practical implementation of emission reduction efforts than by artificial determination if such steps are deemed ‘sufficiently-green’ by Europe’s taxonomists.

President Jokowi of Indonesia, Chair of the G20, said that many developing countries need additional funding and access to technologies to enable the energy transition and not to create an ‘excess burden’ on people and national budgets.49

****

Different studies calculate when the absolute carbon budget will expire. The Mercator Institute used this 2018 IPCC report and developed an interactive online carbon clock [https://www.mcc-berlin.net/en/research/co2-budget.html](https://www.mcc-berlin.net/en/research/co2-budget.html). With emissions at a constant level, the budget for 1.5°C is expected to be fully utilized in 7 years from now. The budget for staying below the 2°C threshold would be exhausted in about 24 years.

For the purposes of this paper, the emphasis is on developing countries. It has demonstrated that reducing emissions at source directly benefits producing countries in multiple ways. It has set out actions that can be taken immediately based on public and private collaboration involving oil- and gas-producing countries; multilateral development banks and other donors to help developing countries take advantage of the available technologies. It has highlighted the importance of transparency of satellite data. Hence the importance for countries hosting satellite data companies to ensure that data on emissions is placed in the public domain on a timely basis, and not kept private. This data should be meaningful and usable by the public, following Nigeria’s gas flare tracker example. Transparency and accountability open the window to improved regulation and fiscal arrangements. The IMF that can play a leadership role through its surveillance work and advice to implement taxes and other schemes that incentivize reductions in emissions.

Although these action steps were published in February 2022, little has happened so far. Yet the case for speedy action has dramatically increased: the Russia-Ukrainian war has generated a scramble for scarce global gas resources. This makes the existing waste of 7.5 percent of all natural gas an even larger opportunity in terms of energy security, reducing the harmful health effects as well as reaching climate objectives.

---