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Looking ahead to COP27—from climate pledges to action

The Global Methane Pledge—opportunities and risks

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Abstract: The global energy transition is happening, but too slowly to limit climate change to acceptable levels, for diverse reasons. Carbon emissions policies and measures focus too little on absolute emission targets and too much on relative measures such as carbon intensity. Focus is needed on early emission reduction actions, while current efforts aim to for carbon neutrality at a distant date. High-profile listed companies disposing of high-carbon-emitting assets to unlisted organizations ('hand-me-down assets') is reducing transparency on emissions and emissions-reducing investments. Measuring emissions using satellite remote-sensing technologies can reduce reliance on self-reporting and should thus be a public good not subject to corporate confidentiality or other commercial restrictions. More integration of existing assets in decarbonization efforts is needed; the largest positive impact on climate and health now would come from having such assets emit less. More recognition is needed that measures suited to developed high-income countries/regions may not work as well in developing low- and middle-income countries.

Cutting methane emissions is the most immediate way to slow the rate of global warming, even as progress is made on decarbonizing energy systems. Any reprieve over the next decade from reaching a global temperature rise—and potential tipping point—of 1.5 °C is vital while more-challenging policy commitments are implemented. Reducing wasteful natural gas flaring would be an immediate way to cut methane emissions. It requires urgent co-ordinated action by oil- and gas-producing countries, donors, multilateral development banks, and countries hosting satellite data companies, with the International Monetary Fund taking a leadership role through its surveillance and capacity development work. Tackling methane emissions is especially significant since it contributes to meeting other development priorities, such as generating government revenue (by penalties and gas sales), improving health (by reducing air pollution), and helping to deliver greater energy access (by using rather than wasting the gas).

Key words: natural gas, methane, emissions, health, air pollution, technologies, transparency

JEL classification: I1, Q3, Q4, Q5

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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 avoiding methane emissions as a major opportunity in reducing the short-term emissions 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 Sustainable Development Goals (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 being 'short' in gas supplies, and the priority to reduce methane emissions is even greater than before, as it 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 to reducing greenhouse gas (GHG) 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, chaired by Professor Drew Shindell and published by the Climate and Clean Air Coalition (CCAC) and the UN Environment Programme (UNEP).[3]

These findings are also underscored by the 2021 DNV Group's Energy Transition Outlook (ETO).[4] It finds that global energy-related emissions are likely to fall by only 9 per cent by 2030 compared with 2019, and consequently the 1.5 °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 per cent of total energy supply by 2050, with only 3.6 per cent 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 per cent of 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 discuss the emergence of 'net zero gas' markets and the opportunities for new liquefied natural gas (LNG) producers to future-proof their greenfield assets. Section 8 concludes with recommendations for policy-makers in developing countries.

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[1] IEA, 'Global Methane Emissions from Oil and Gas: Insights from the Updated IEA Methane Tracker', available at: www.iea.org/articles/global-methane-emissions-from-oil-and-gas (accessed 31 March 2020).

[2] IPCC, *Climate Change 2022: Mitigation of Climate Change*, Working Group III contribution to the IPCC Sixth Assessment Report (Geneva: World Meteorological Organization, 2022).

[3] UNEP and CCAC, *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions* (Nairobi: UNEP, 2021).

[4] DNV, *Energy Transition Outlook 2020*, (Oslo: DNV, 2020).

2 Delivering on the global climate ambition

There are a number of key concerns that urgently need attention in order 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. There is 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 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 the decarbonization of existing assets into the 'just energy transition' terminology. The largest positive impact that can be had on climate and health now would be for existing emitting assets to emit less.
5. There is a lack of recognition that measures suited to developed high-income countries and regions may not work as well in developing low- and middle-income countries.

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 emissions 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.

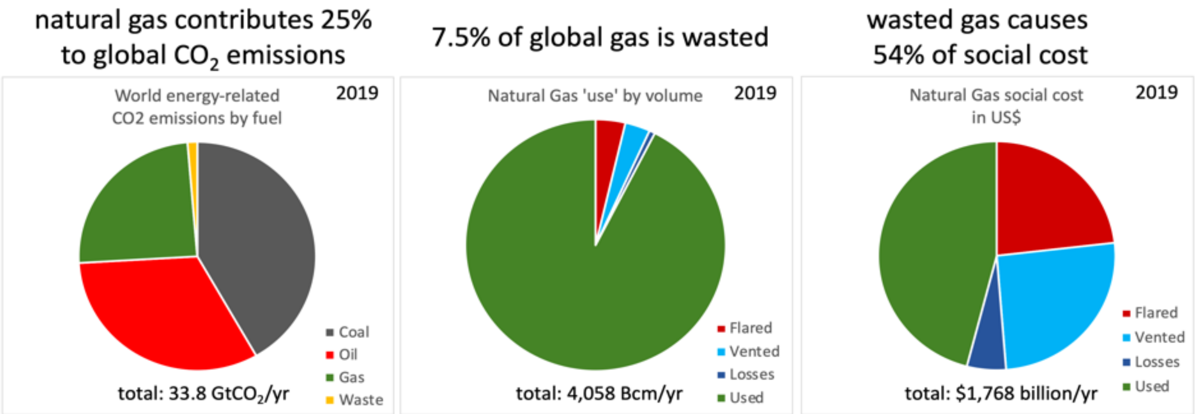
The integration of existing assets in decarbonization efforts will reduce the risk of stranded assets and avoid major disruptions in the workforce (jobs, skills). It also provides continuity of energy access and economic growth, while providing opportunities to reduce energy waste, improve energy efficiency,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

Transparency is needed to increase awareness among regulators and provide actionable information. Increased transparency and public (non-governmental organization, 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 at the same time their production life 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[5] find that a large number of low- and middle-income countries are dependent on oil and gas production. In 2018,[6] 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 account for more than 50 per cent of exports.

UNU-WIDER research set outs 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 around 300 billion cubic metres (bcm) annually, which is approximately 7.5 per cent of global gas production (Figure 1). Efforts since 2000 to reduce global flaring have 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.[7] However, due to the larger impact of methane on global warming, CO_2-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 the estimate of the US Environmental Protection Agency (EPA) for the Global Warming Potential (GWP) value for methane over a time horizon of 20 years.

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



Source: authors' construction based on Romsom and McPhail, 'Capturing Economic and Social Value from Hydrocarbon Gas Flaring and Venting: Evaluation of the Issues', WIDER Working Paper 2021/5 (Helsinki: UNU-WIDER), https://doi.org/10.35188/UNU-WIDER/2021/939-6; DNV, *Energy Transition Outlook 2020*.

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 of capturing and utilizing upstream flared and vented natural gas in 2019 was US$48 billion, based on an assumed US$4 per

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[5] See UNU-WIDER, 'Extractives for Development (E4D): Risks and Opportunities', 2022, available at: www.wider.unu.edu/project/extractives-development-e4d-%E2%80%93-risks-and-opportunities (accessed May /June 2022).

[6] M. Ericsson and O. Löf, 'Extractive Dependency in Lower-Income Countries: Evolving Trends during the Transition to a Low Carbon Future', WIDER Working Paper 2020/120 (Helsinki: UNU-WIDER, 2020).

[7] E. Romsom and K. McPhail, 'Capturing Economic and Social Value from Hydrocarbon Gas Flaring: Evaluation of the Issues', WIDER Working Paper 2021/5, (Helsinki: UNU-WIDER, 2021), https://doi.org/10.35188/UNU-WIDER/2021/939-6.

million British thermal units (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 in light of 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 to reduce atmospheric emissions.[8] This event highlighted the critical point, not often addressed, that emissions affect public health as well as climate, and that these impacts are interdependent. In earlier published work,[9] 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 of 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 the contribution to reducing global warming, can now be calculated. Our estimates of the SCAR, based on methodology developed by Shindell,[10] show these 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_2O). 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.

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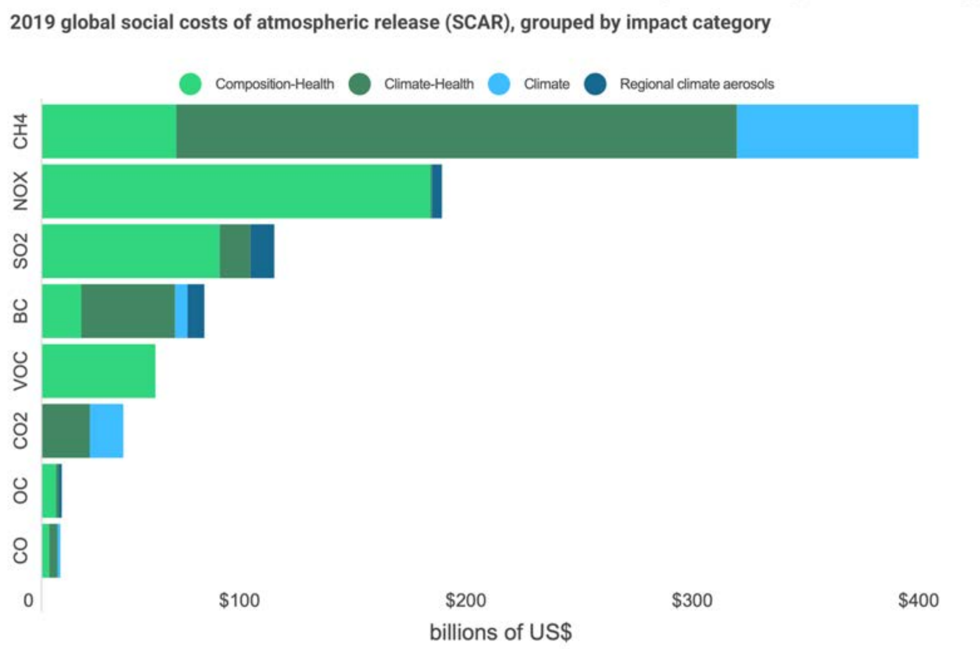
[8] UNU-WIDER, 'COP26: Are We Ready?', online panel discussion, 28 October 2021, available at: www.wider.unu.edu/event/cop26-are-we-ready (accessed May 2022).

[9] Romsom and McPhail, 'Capturing Economic and Social Value: Evaluation of the Issues'.

[10] D.T. Shindell, 'The Social Cost of Atmospheric Release', *Climatic Change*, 130 (2015): 313–26, https://doi.org/10.1007/s10584-015-1343-0.

Figure 2: Social and environmental costs of natural gas flaring and venting



Source: reproduced from McPhail and Romsom, 'Reducing Wasted Gas Emissions Is an Opportunity for Clean Air and Climate', UNU-WIDER blog, October 2021.

At the UNU-WIDER pre-COP-26 event, it was demonstrated how natural gas flaring impacts local communities (see Figure 3 for an 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 superimposing such data on local population density, or the presence of agriculture activities impacted by toxic atmospheric releases.

The scope for reducing methane emissions lies disproportionately within developing countries, which 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;[11] the World Bank estimates that 85 per cent of total gas flared since 2005 comes from developing countries.[12] 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.[13]

[11] A. Roe and S. Dodd, 'Dependence on Extractive Industries in Lower-Income Countries: The Statistical Tendencies', in T. Addison and A.R. Roe (eds), *Extractive Industries: The Management of Resources as a Driver of Sustainable Development* (Oxford: Oxford University Press, 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.

[12] World Bank, 'Zero Routine Flaring by 2030: Q&A', 2020, available at: www.worldbank.org/en/programs/zero-routine-flaring-by-2030#7 (accessed 30 October 2020).

[13] VIIRS Nightfire satellite data for 2017: see E. Romsom and K. McPhail, 'Capturing Economic and Social Value from Hydrocarbon Gas Flaring and Venting: Solutions and Actions', WIDER Working Paper 2021/6 (Helsinki: UNU-WIDER, 2021), https://doi.org/10.35188/UNU-WIDER/2021/940-2.

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

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-metre distance of this flare (indicated by the yellow circle), and a food store. The 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 monetized for local power generation and connected to the grid, as other Jambi small-scale electrification projects are underway.

Source: authors' illustration based on a combination of Visible Infrared Imaging Radiometer Suite (VIIRS) data, Payne Institute, 'VIIRS Nightfire (VNF)', available at: https://payneinstitute.mines.edu/eog/viirs-nightfire-vnf (accessed July 2022), with Google Earth; Images Landsat/Copernicus, © 2021 Maxar Technologies.

Some countries (including Nigeria, Angola, and 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 for gas flared, to be 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 and six other countries (Russia, Iraq, Iran, USA, Algeria, and Venezuela) together account for about 65 per cent of global gas flaring.[14] Nigeria exports a significant share of its natural gas as LNG to international markets (particularly to Europe and Asia). Despite its domestic gas demand and export opportunities, Nigeria contributed 4.7 per cent to all natural gas flared globally in 2020 (ranking seventh among the largest flaring countries). According to the Nigeria Extractive Industry Initiative's (NEITI's) 2020 oil and gas sector audit,[15] Nigeria flared 230 billion standard cubic feet (Bcf) of gas during 2020, around 8 per cent of its annual production of 3,013 Bcf or 12 per cent of its annual gas sales volume of 1,916 Bcf.[16] Data from the Earth Observation Group at Payne Institute for Public Policy[17] put the volume flared that year somewhat higher, at 254 Bcf (7,195 million m^3), with an equivalent sales value of US$835 million (based on an average international gas sales price of US$3.29/MMBtu in 2020).[18] In 2021, flaring in Nigeria reduced to 231 Bcf (6,548 million m^3), while the post-COVID19 recovery of global gas demand caused the international gas 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,[19] 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 is 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 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 two hundred super-emitters are located in Nigeria.

While the performance of methane-detecting satellites is rapidly improving, flare performance trends (measured by VIIRS satellites[20]) can now be used to determine the quality of oil and gas asset operations, which itself is a proxy for methane emissions. A joint Oxford Policy Management Ltd/EnergyCC study to analyse the quality of operations from flare data is ongoing for Nigeria. VIIRS satellite measurement data can identify operational performance issues, such as process upsets and equipment failures, and 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 is 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,

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[14] World Bank, 'Global Gas Flaring Tracker Report, 28 April 2021, available at: www.worldbank.org/en/topic/extractiveindustries/publication/global-gas-flaring-tracker-report (accessed April 2022).

[15] NEITI, *NEITI 2020: Oil and Gas Industry Report* (Abuja: NEITI, 2022), available at: https://extractive360.com/wp-content/uploads/2022/03/NEITI-OGA-2020-Report.pdf (accessed June 2022)

[16] Roughly one-third of Nigeria's production is used for power generation in the oil and gas sector or for reinjection to increase yields from oil reservoirs, or is unaccounted for.

[17] C.D. Elvidge, M. Zhizhin, F.-C. Hsu, and K.E. Baugh, 'VIIRS Nightfire: Satellite Pyrometry at Night', *Remote Sensing*, 5, no. 9 (2013): 4423–49, https://doi.org/10.3390/rs5094423.

[18] Gas prices can fluctuate strongly among global regions and over time. The average Japan/Korea Marker (JKM) (Asian gas) price in 2021 was US$15.16/MMBtu, well up on 2020's average JKM price of $3.85/MMBtu, while Europe's Title Transfer Facility (TTF) price averaged $15.20/MMBtu, up from an average of $3.29/MMBtu in 2020; J. Lewis, 'Gas Markets Expected to Remain Tight for Next Two Years following Surge in Prices in 2020: EnergyQuest', Upstream, 19 January 2022, available at: www.upstreamonline.com/lng/gas-markets-expected-to-remain-tight-for-next-two-years-following-surge-in-prices-in-2021-energyquest/2-1-1147621 (accessed July 2022).

[19] See for example Rédaction Africanews, 'Europe Turns to Nigeria to Fill the Gap in Gas Supply', Africanews, 12 April 2022, available at: www.africanews.com/2022/04/12/europe-turns-to-nigeria-to-fill-the-gap-in-gas-supply (accessed July 2022).

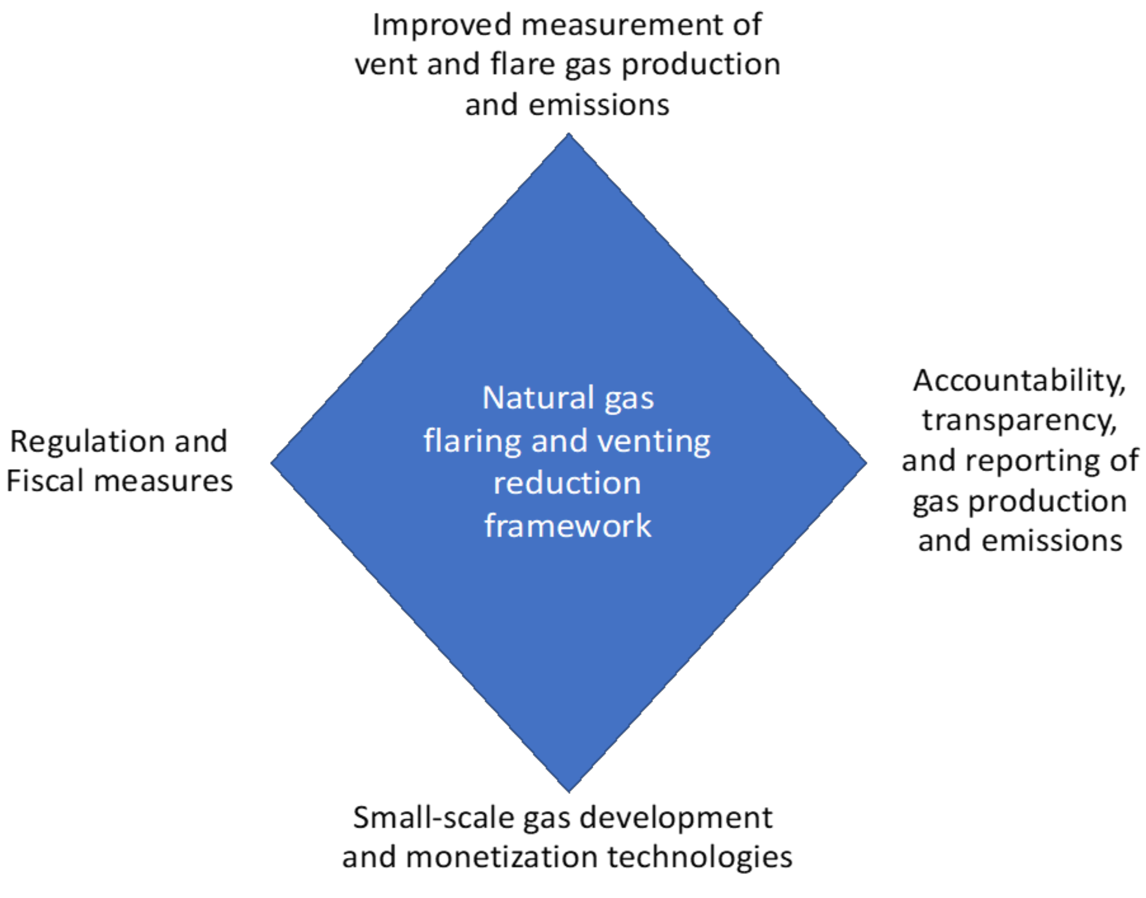
[20] VIIRS Nightfire (VNF), originally developed by NASA. Administration and updating of VNF data is now done by the Payne Institute of the Colorado School of Mines.

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 for calibrating detailed flare performance observations with direct methane measurements.

The 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 CO_2, this is problematic. 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 learning that arises from the evaluation could improve operational performance and further reduce flaring.

Earlier work by UNU-WIDER[21] 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.

Figure 4: Integrated framework to end routine flaring and venting



Source: authors' illustration based on Romsom and McPhail, 'Capturing Economic and Social Value from Hydrocarbon Gas Flaring and Venting: Solutions and Actions', WIDER Working Paper 2016/6 (Helsinki: UNU-WIDER, 2021), https://doi.org/10.35188/UNU-WIDER/2021/940-2.

[21] Romsom and McPhail, 'Capturing Economic and Social Value: Solutions and Actions'.

Generally, governments lack 'decision-useful' information on the exact location and 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 prioritize the options to aggregate, process, and utilize 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 they 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 not only facilitates public awareness but also increases company awareness, as a company's emissions performance can be benchmarked and any natural gas leaks detected early. Furthermore, emissions transparency 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.[22]

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 within the next ten years. However, estimates of methane emissions associated with natural gas production and utilization can undo much (if not all) of the reduced carbon intensity that natural gas provides over the use of coal. If natural gas leakage rates are 3 to 5 per cent or higher, its net benefits over coal as a fuel in electric power plants are undone. Gas engines as a replacement for heavy-duty diesel vehicles have a methane emission threshold of 1 to 2 per cent before the net emission benefits are undone. Current estimates of global methane emissions associated with the production and use of natural gas are 3.9 per cent.[23]

With the successful launch of the COP26 Global Methane Pledge (GMP) and the US–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 undertaken quickly, as explained in work with the Center for Global Development (CGD). This requires co-operation from several sources: oil- and gas-producing countries (as set out in Box A on Nigeria and Box C on Norway); official donors and multilateral

[22] A. Roe, K. McPhail, and E. Romsom, 'Gas and Oil Industry Emissions: What Could be Done Right Now?' Oxford Policy Management blog, October 2021, available at: www.opml.co.uk/public/index.php/blog/gas-oil-emissions-what-could-be-done-now ((accessed April 2022).

[23] Romsom and McPhail, 'Capturing Economic and Social Value: Evaluation of the Issues'.

development banks (MDBs); countries that host satellite data companies; and the International Monetary Fund (IMF), which can play a leadership role through its surveillance work and advice to implement taxes that incentivize reductions in emissions.[24]

More than 100 countries have signed the GMP and committed to a collective goal of reducing global methane emissions by at least 30 per cent from 2020 levels by 2030. This includes using best available inventory methodologies to quantify methane emissions, with a *particular focus on high-emission sources*. 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.

The IMF has devised a novel way to tackle methane emissions in contexts where satellite-based measurements still need further improvement.[25] 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 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.[26]

Moreover, the IMF has recently established a new lending instrument that is both timely and relevant. The 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, ensuring sustainable growth, and contributing to their long-term balance of payments (BoP) stability.[27] The policy on conditionality associated with the long-term loans from the RST is being developed. Reform measures would be a single policy action or set of closely related actions

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[24] J. Hicklin, K. McPhail, and E. Romsom, 'A Practical Proposal on Methane for 2022: From Climate Pledges to Action (Note), CGD, 15 February 2022, available at: www.cgdev.org/publication/practical-proposal-methane-2022-climate-pledges-action (accessed April 2022).

[25] IMF, 'Fiscal Policies for Paris Climate Strategies: From Principle to Practice', Policy Paper 19/010 (Washington, DC: IMF, 1 May 2019), available at: www.imf.org/en/Publications/Policy-Papers/Issues/2019/05/01/Fiscal-Policies-for-Paris-Climate-Strategies-from-Principle-to-Practice-46826 (accessed May 2022).

[26] Hicklin, McPhail, and Romsom, 'A Practical Proposal'; Romsom and McPhail, 'Capturing Economic and Social Value: Evaluation of the Issues'.

[27] IMF, 'Proposal to Establish a Resilience and Sustainability Trust', IMF Policy Paper (Washington, DC: 18 April 2022), available at: www.imf.org/en/Publications/Policy-Papers/Issues/2022/04/15/Proposal-To-Establish-A-Resilience-and-Sustainability-Trust-516692 (accessed April 2022).

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'.[28] The IMF has given specific examples of what these reform measures could comprise. 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.[29]

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 2020, 60 per cent of all gas flared globally from 10,389 active flares came from just 700 flares (6.7 per cent). This insight means that targeting the largest flares would yield major reductions in GHG emissions. Most of the global top 200 super-emitters are in a few countries and the issue is thus easier to tackle than other emissions reduction initiatives. Of the 20 top countries with super-emitter flares, almost half are signatories to the GMP (Iraq, Nigeria, Mexico, Libya, Malaysia, Congo, Qatar, UAE, and Saudi Arabia); a further three countries (Turkmenistan, Kazakhstan, and Egypt) are countries of action for the European Bank for Reconstruction and Development (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),[30] 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.[31] These are also the regions where world demand for energy is growing fastest (see Box B). This makes improving air quality an important driver for reducing natural gas emissions. 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; this experience could be shared with others.

[28] IMF, 'Proposal to Establish a Resilience and Sustainability Trust', 25.

[29] J. Hicklin, 'The IMF's RST: How Conditionality Can Help Countries Build Resilience', Note, CGD, (forthcoming).

[30] PM includes chemicals such as black carbon (BC), ozone (O_3), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2).

[31] Romsom and McPhail, 'Capturing Economic and Social Value: Evaluation of the Issues'.

BOX B: Opportunities from reduced gas flaring in ASEAN countries

IEA's Southeast Asia Energy Outlook 2022[32] 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 2020, ASEAN (Association of Southeast Asian Nations) countries had 373 active natural gas flares, combusting 6.17 Bcm that year (597 million standard cubic feet per day, MMscfd). ASEAN countries contributed 4 per cent to global flaring. Among the ten ASEAN member countries, eight 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 (2.75 Bcm, 266 MMscfd); see Tables B1 and B2.

Table B1: Overview of natural gas flares in ten ASEAN countries and Timor Leste, as observed by VIIRS satellite

Country	Volume of natural gas flared in 2020 (Bcm)	Average daily rate of natural gas flared in 2020 (MMscfd)	Number of active flares in 2020
Malaysia	2.75	266	79
Indonesia	2.05	199	202
Vietnam	0.69	67	33
Thailand	0.36	35	37
Brunei	0.18	17	7
Philippines	0.09	9	6
Myanmar	0.03	3	4
Singapore	0.02	2	5
Cambodia	0	0	0
Laos	0	0	0
Timor Leste	0	0	0
Total ASEAN	**6.17**	**597**	**373**

Source: authors' construction based on 2020 VIIRS data.

Table B2: Long-term gas flaring trends for Malaysia and Indonesia (Bcm per year)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Malaysia	1.7	1.9	1.8	1.9	1.9	1.5	1.6	1.5	2.8	3.4	3.7	3.2	2.8	2.2	2.4	2.4	2.0
Indonesia	2.8	3.1	2.6	2.5	2.9	2.2	2.2	2.4	3.1	3.1	2.9	2.8	2.3	2.1	2.0	-	-
Total	4.5	5.0	4.4	4.4	4.8	3.7	3.8	3.9	5.9	6.5	6.6	6.0	5.1	4.3	4.4	-	-

Note: Malaysia and Indonesia are both global top 20 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 latter. The two countries combined showed similar levels of gas flaring in 2020 compared with 2005, while the recent decline in flaring observed in 2021 is promising.

Source: authors' construction based on GGFR data from World Bank Group.

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

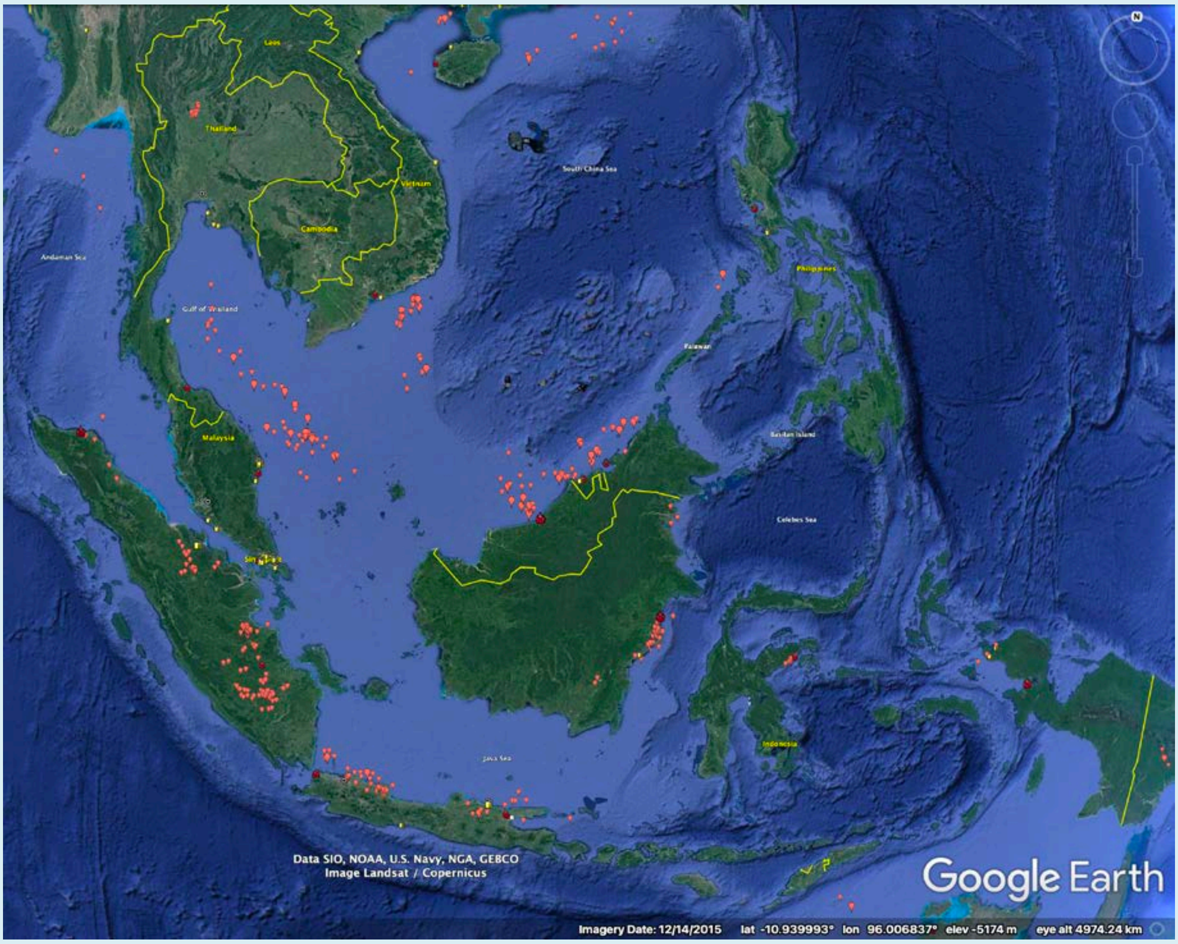
- Preventing the loss of valuable energy resource: ASEAN countries include 28 flares that are ranked in the top 700 of the global 10,000 flares in 2020 (Figure B1). The opportunity to recover this loss of energy resources is significant, as set out elsewhere in this paper.
- Delivering on Nationally Determined Contributions (NDCs): many ASEAN countries include emissions reductions in their NDCs.

[32] Renews.biz, 'South-East Asia "Must Accelerate Renewables"', 17 May 2022, available at: https://renews.biz/77912/south-east-asia-must-accelerate-renewables (accessed May 2022).

- Increasing 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.
- Improving human health and contributing to SDGs: large flares at petrochemical complexes are located close to local communities and homes in Brunei (Figure B2) and are somewhat further distanced in Bintulu in Sarawak. Even closer to homes are upstream flares in Sumatra, such as in the Jambi City urban area (see Figure 3). The 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 SDGs.
- Enhancing 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.

Figure B1: Individual natural gas flares in ASEAN countries as observed by VIIRS satellite



Note: each natural gas flare observed by VIIRS satellite in 2020 is represented by a red or yellow dot.

Source: authors' illustration based on a combination of 2020 VIIRS data with Google Earth; Data SIO, NOAA, U.S. Navy, NGA, GEBCO; Image Landsat/Copernicus.

Figure B2: Example gas flare in Brunei, member of ASEAN, as observed by VIIRS satellite

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

Source: authors' illustration based on a combination of 2017 VIIRS data with Google Earth; Images © 2021 CNES/Airbus, © 2020 Google, © 2021 Maxar Technologies, Landsat/Copernicus.

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, and 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, and Australia.

Box C highlights Norway as an example demonstrating that opportunities to reduce the atmospheric emissions from flaring and venting are not restricted to lower- and middle-income countries.

BOX C: Norway—opportunities to use satellite data to improve the operational performance of oil refineries

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 of Norway's last remaining refinery Mongstad, which has been subject to operational incidents that resulted in emissions detected by satellite. Mongstad refinery has been 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 per cent of the refinery output is exported.

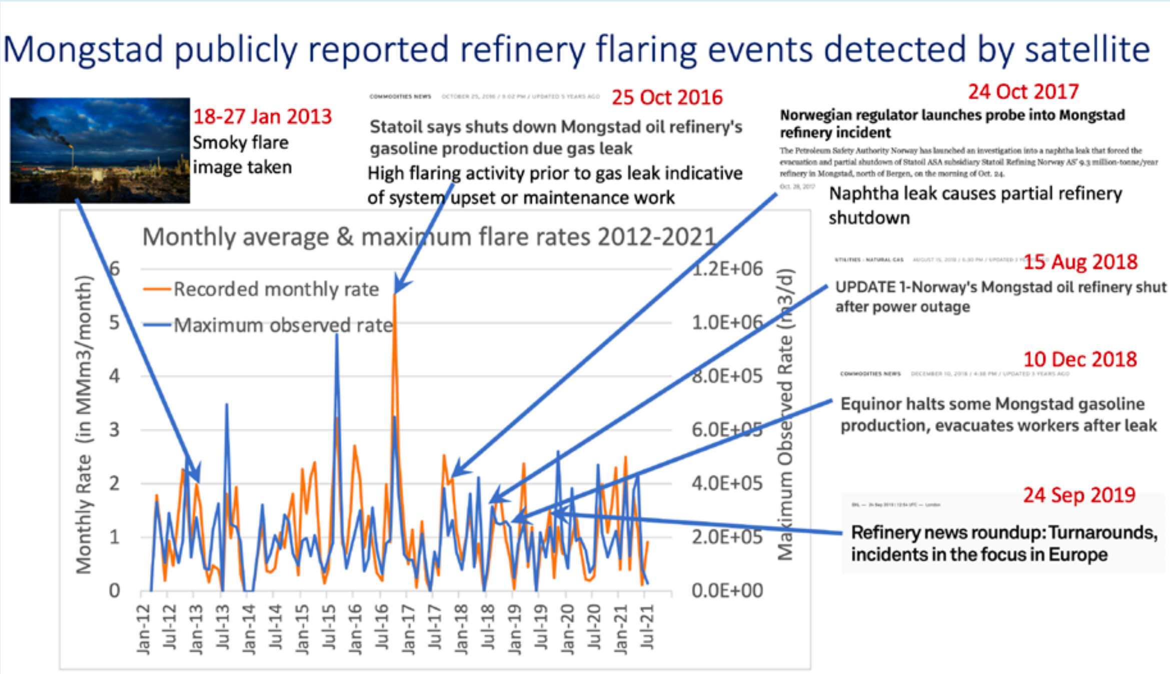
Detailed evaluation of flare rates of installations is important to determine trends in the quality of operations, whereby the amount flared over time is a key indicator of operational performance. Flare analysis can assist regulators in their supervision of operations. Flare rates may even provide diagnostic value in incident analysis. For example, high flaring activity was observed prior to the Mongstad refinery shutdown, and may be indicative of a system upset or maintenance activity that led to a gas leak on 25 October 2016 that caused the shutdown. 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 per cent 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, and Repsol Sines, are similar to those of Pertamina RU2, and are smaller than those of KNPC and a number of other refineries.

VNF is a powerful tool for monitoring gas wastage and 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 C1.

Figure C1: Example gas flare in Norway, with refinery incidents observed by VIIRS satellite



Note: six individual incidents at the Mongstad refinery were detected by VIIRS.

Source: authors' illustration based on 2012–21 VIIRS data.

Importantly, the GMP is supported by philanthropic aid and by MDBs such as the 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 Issues for developing countries in reducing methane emissions from oil and gas operations

This section discusses the issues for developing countries that have signed the pledge, 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.[33] Organisation for Economic Co-operation and Development (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 to 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[34] indicate that natural gas flares that are accurately identified with VIIRS satellite are also key sources for methane emissions. Work is ongoing to improve the resolution of satellites in detecting methane emissions from assets. The 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 population centres, should be prioritized for flare reduction and flare quality improvement.

Improvements in the availability in quantifiable emissions 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. For example, many companies currently do not report emissions from assets in which they have a participating interest, but that are operated by others.[35] Satellite data can validate these emissions and close this gap in transparency.

The benefits of reduced flaring emissions include local energy access opportunities from 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 from the country's flare tracker and resulted in estimated revenues of

[33] E. Romsom and K. McPhail, 'The Energy Transition in Asia: Country Priorities, Fuel Types, and Energy Decisions', WIDER Working Paper 2020/48, Helsinki: UNU-WIDER, 2020), https://doi.org/10.35188/UNU-WIDER/2020/805-4.

[34] Romsom and McPhail, 'Capturing Economic and Social Value: Evaluation of the Issues' and 'Capturing Economic and Social Value: Solutions and Actions'.

[35] E. Stallard, O. Pinnell, and J. Kelly, 'Revealed: Huge Gas Flaring Emissions Never Reported', BBC News, 29 September 2021, available at: www.bbc.com/news/science-environment-62917498 (accessed October 2022).

US$270 million in 2020.[36] The capture of associated gas has furthermore enabled the 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 to that deployed by Nigeria in a combination of emissions measurement, transparency, regulation, fiscal measures, and the deployment of (small-scale) gas monetization 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 can be 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 gas that would otherwise be 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 the prioritization of 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, and 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[37] 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 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 incentivize emissions reductions at source have the

[36] T. Hedley, 'Nigeria Takes Aim against Gas Flaring in 2020', Energy Capital & Power, 4 September 2020, available at: https://energycapitalpower.com/nigeria-takes-aim-against-gas-flaring-in-2020 (accessed 17 November 2020).

[37] World Bank, *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition* (Washington, DC: World Bank, 2020).

benefit that they 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, but 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, such as better health and greater energy access.

There has been a long-standing commitment by the OECD countries to provide US$100 billion in climate finance for developing countries, beginning in 2009. The latest estimates are that this amount may be reached in 2022 and more likely by 2023.[38] 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 and recognition of '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'.[39]

'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.'[40] 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[41] can be done in two ways: the 'offset approach' and the 'attribute approach'. To date, fewer than 20 trades, out of, for example, over 5,000 cargos of LNG delivered globally in 2020, have followed either approach—but more focus on offsets. This is due

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[38] H. Edwardes-Evans, 'UK COP26 Presidency Admits Defeat On meeting $100 Billion Finance Goal This Year', S&P Global Commodity Insights, 25 October 2021, available at: www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/102521-uk-cop26-presidency-admits-defeat-on-meeting-100-billion-finance-goal-this-year (accessed May 2022)

[39] Seventeenth Plenary Meeting of the Policy Dialogue on Natural Resource-Based Development (14 December – 15 December 2021, virtual format): Key Outcomes.

[40] Roe, McPhail, and Romsom, 'Gas and Oil Industry Emissions'.

[41] E. Blanton and S. Mosis, 'The Carbon-Neutral LNG Market: Creating a Framework for Real Emissions Reductions', Columbia SIPA Center on Global Energy Policy, 8 July 2021, available at: https://www.energypolicy.columbia.edu/research/commentary/carbon-neutral-lng-market-creating-framework-real-emissions-reductions (accessed 24 July 2022).

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'.[42] One example of this is in Singapore (see below).

In parallel, Jonathan Stern[43] consistently argues that there is an urgency for sellers of natural gas and LNG to provide credible measurement, reporting, and verification of emissions, 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 are the emissions of exported gas that is processed, transported, and sold as LNG. The carbon intensity of LNG is generally higher than that of pipeline gas due to the energy required to liquefy the gas. Also, there are potentially additional leakage paths along the LNG value chain for methane emissions. However, the industry has made much progress in the reuse of LNG boil-off gas and in minimizing methane slip. This also serves commercial interests, as any gas wasted during and after costly liquefaction directly affects the commercial bottom line.

Asia is key to reducing GHG from the LNG trade:

- In 2020, Asian countries imported 71 per cent (254 of 356 mtpa) of global LNG.[44]
- 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.[45] 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.[46]
- The rising (and vocal) middle class see clean air as an important quality-of-life issue.

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[42] Blanton and Mosis, 'The Carbon-Neutral LNG Market'.

[43] J. Stern, *Methane Emissions from Natural Gas and LNG Imports: An Increasingly Urgent issue for the Future of Gas in Europe* (Oxford: Oxford Institute for Energy Studies/OEIS, 2020); *Measurement, Reporting, and Verification of Methane Emissions from Natural Gas and LNG Trade: Creating Transparent and Credible Frameworks* (Oxford: OEIS, 2022); *Key Themes for the Global Energy Economy in 2022* (Oxford: OEIS, 2022).

[44] IGU (International Gas Union), *2021 World LNG Report* (London: IGU, 2021), available at: www.igu.org/resources/world-lng-report-2021 (accessed June 2022).

[45] H. Kharas (2017). 'The Unprecedented Expansion of the Global Middle Class: An Update', Global Working Papers 100 (Washington, DC: Brookings Institution, 2017), available at: www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global- iddle-class.pdf (accessed October 2019).

[46] Romsom and McPhail, The Energy Transition in Asia'.

- Asia contains many of the 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 itself 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.[47] These long-term sale and purchase agreements cover GHG emissions for producing, transporting, and delivering these LNG cargos. However, they do not require either seller or buyer to offset all of the emissions—in other words, they are not (necessarily) GHG neutral.[48] 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[49] are increasingly looking to reward producers with GHG-verified LNG cargos, for example with price premiums and preferential offtake status. Financiers and ESG (environmental, social, and governance) 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 the Task Force on Climate-related Financial Disclosures (TCFD). Such transparency measures not only facilitate public awareness but also increase companies' awareness, as their emission performance can be benchmarked and any natural gas leaks detected early.

The paper by Blanton and Mosis concludes that policy-makers in both LNG-producing and consuming countries can have an active role in the development of a 'carbon-neutral'[50] 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.

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[47] Blanton and Mosis, 'The Carbon-Neutral LNG Market'. The contracts include a ten-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 ten-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.

[48] 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 lifecycle stages for carbon dioxide, methane, and nitrous oxide.

[49] Japanese and South Korean utilities seek to purchase carbon-neutral or carbon-offset LNG, due in part to downstream commitments to supply carbon-neutral gas to customers and government commitments to net zero targets. Japan, the world's second-largest LNG importer, established the Carbon Neutral LNG Buyers Alliance in 2021 to 'increase the recognition of carbon-neutral LNG'. B. Roach, N. Kendrick, and Z. Wong, 'Carbon-Neutral LNG', Gibson Dunn, 16 March 2022, available at:

www.gibsondunn.com/wp-content/uploads/2022/03/Carbon-Neutral-LNG-March-2022.pdf (accessed 15 July 2022).

[50] Blanton and Mosis, 'The Carbon-Neutral LNG Market'; 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.

In February 2022, Singapore's Minister for Finance announced further measures in support of the Singapore Green Plan 2030.[51] Singapore was the first country in South-East Asia to introduce a carbon tax, starting from 2019, at S$5 per tCO2e (tonne of carbon dioxide equivalent)—approximately US$3.50. It covers the six GHGs currently covered by the UN Framework Convention on Climate Change/the 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, then S$45/tCO2e by 2026, increasing to S$50–80/tCO2e by 2030. This is in line with the recommendations of the High-Level Commission on Carbon Pricing.[52] 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.[53]

In August 2021, the Government of Korea, keen to become a regional LNG bunkering hub, provided fiscal incentives for the midstream. The government offered tax rebates by abolishing the import surcharge for LNG-fuelled ships, starting from 1 January 2022.[54] In its report on this, S&P Global mentions that the abolition of the import surcharge for LNG-fuelled 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 the LNG consumption tax to be cut to around 12 won/kg (less than 1 US cent) 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 greenfield assets

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

Given the market trends described above, newly 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 being first to be able to deliver 'low-emissions' LNG. For existing LNG plants that are commonly project financed, it is both technically and 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,

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[51] Singapore Green Plan 2030, February 2021. This comprises five pillars: City in Nature; Sustainable Living; Energy Reset; Green Economy; and Resilient Future. Government initiatives to support these pillars are: (1) green finance: for Singapore to be a leading centre for green finance in Asia and globally; (2) sustainability; (3) solar; (4) electric vehicles; and (5) innovation; see www.greenplan.gov.sg.

[52] Romsom and McPhail, 'Capturing Economic and Social Value: Solutions and Actions'.

[53] See I. Parry, *Putting a Price on Pollution: Carbon-Pricing Strategies Could Hold the Key to Meeting the World's Climate Stabilization Goals* (Washington, DC: IMF, 2019), chart 2, available at: www.imf.org/en/Publications/fandd/issues/2019/12/the-case-for-carbon-taxation-and-putting-a-price-on-pollution-parry (accessed May 2022).

[54] C. Lee, 'South Korea to Offer Tax Rebates for Bunkering of LNG-Fuelled Ships', S&P Global Commodity Insights, August 2021, available at: www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/081021-south-korea-to-offer-tax-rebates-for-bunkering-of-lng-fueled-s (accessed May 2022).

avoiding emissions in the first place (i.e. 'green' instead of 'blue' fuels) may attract 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, but emission monitoring and accounting can be designed in from the start, including third-party assessment and validation by reputable organizations.

Tanzania LNG is an example of a greenfield LNG project that has the potential to have the lowest CO_2 footprint of any LNG project currently under development.[55] Not only does Tanzanian natural gas have very low CO_2 content but the development is also planning to integrate renewable sources of energy (such as hydroelectricity and solar) into the project design. Lower-carbon-intensive LNG, conserving natural gas for increased LNG export volumes, and lower liquefaction costs can all contribute to a more competitive and sustainable LNG project. Shell and Pavilion Energy are participants in Tanzania LNG and have the opportunity to apply their MRV and GHG Neutral LNG Framework (see Section 6) for this project.

Early marketing efforts by new LNG 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 do not solely deflect these requirements through asset divestment processes. Insufficient attention is given to encourage existing asset owners to integrate their assets into decarbonization efforts. The largest positive impact that can be achieved 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-fuelling 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 non-governmental organizations 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.

[55] Shell Tanzania, 'Tanzania Gas & LNG Project', 2020, available at: www.shell.co.tz/about-us/what-we-do/_jcr_content/par/relatedtopics_4b07_c.stream/1647327326382/58f9b5a965fdf3f4f6aab31dfeaa00dffef16a5e/tanzania-gas-and-lng-project.pdf (accessed November 2022).

However, the buyer is usually willing to pay a positive price, because they see 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 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 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 for 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 the point of 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 they 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.

There are companies that make it their business model to take old oil and gas assets off the hands of asset owners, so that they pass on their abandonment obligations to the less discerning new owners. According to an example reported by Bloomberg: [56]

> 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 US 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 the age or condition of the asset.

[56] Z.R. Mider and R. Adams-Heard, 'An Empire of Dying Wells', Bloomberg, 12 October 2021, available at: www.bloomberg.com/features/diversified-energy-natural-gas-wells-methane-leaks-2021 (accessed October 2021).

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 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:[57]

> 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 58 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. The abatement of atmospheric emissions, including methane, is 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 not solely on 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 and corporate emissions targets should be based on such absolute measures, while relative measures can be useful for benchmarking emissions performance. Moreover, different pollutants should not be aggregated into a CO_2-equivalent measure, as this obscures the negative impact these pollutants have on health and 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 utilizing the global carbon budget based on countries' opportunities, abilities, social impact, and cost.[59] No one global institution is responsible and accountable for all aspects. While the UNFCCC analyses 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 about the overall implications of country contributions. It could analyse projections of global energy demand and supply, incorporating the analysis of the IPCC, the IEA, and other partners. The IMF could then discuss with member countries their own projections of energy demand and supply and the consistency between their current economic policy settings and stated decarbonization and other goals. In turn, these discussions would help with assessments of whether—in

[57] M. Carney, 'Financing the Net Zero Revolution', Net Zero Delivery Summit, London, 11 May 2022.

[58] Founded in April 2021 with 160 members responsible for US$70 trillion of assets.

[59] Romsom and McPhail, 'The Energy Transition in Asia'.

aggregate—countries' macroeconomic policies were 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,[60] 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) technologies 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 (the COP 27 chair) and Indonesia (the 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 WHO 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 listed companies offload their high-carbon assets to unlisted private companies. As Mark Carney concluded,[61] financial institutions must go to where the emissions are and invest in emissions-reducing activities by companies in heavily 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 the quality of operations of their domestic companies through knowledge transfer from reputable international companies operating to transparent global standards. Newly 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 being the first to be able to deliver 'low-emissions' LNG. Existing LNG plants that are often project financed are technically and commercially more complex to retrofit with 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.

[60] UNSG, 'High-Level Global Roundtable on Extractive Industries as an Engine for Sustainable Development', 25 May 2021 (online).

[61] Carney, 'Financing the Net Zero Revolution'.

4. **There is a need to integrate decarbonization of existing assets into the 'just energy transition' terminology.** The largest positive impact that can be achieved 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 of or opportunity for renewable energy to date limit opportunities for 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 biofuels 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, who demand clean air, is a key force for emission reduction. MDBs supporting the Global Methane Pledge and other donors should help developing producer countries to take advantage of the new technologies in pursuit of country objectives to support the just energy transition.[62] For example, standards for emission limits for new coal-fired power plants in South-East 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, which 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, has said that many developing countries need additional funding and access to technologies to enable the energy transition and to avoid creating an 'excess burden' on people and national budgets.[63]

Different studies calculate when the absolute carbon budget will expire. The Mercator Institute used this 2018 IPCC report[64] and developed an interactive online carbon clock.[65] With emissions at a constant level, the budget for 1.5 °C is expected to be fully utilized seven 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 and for countries hosting satellite data companies to ensure that data on emissions are placed in the public domain on a timely basis and not kept private. These 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.

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[62] As discussed in a series of high-level UN roundtables in 2021.

[63] J. Widodo, 'Davos Agenda 2022: Special Address by Joko Widodo, President of Indonesia', 20 January 2022, available at: www.weforum.org/videos/davos-agenda-2022-special-address-by-joko-widodo-president-of-indonesia-indonesian (accessed April 2022).

[64] 'Summary for Policymakers', in IPCC, *Global Warming of 1.5°C* (Cambridge, UK, and New York: Cambridge University Press, 2022), https://doi.org/10.1017/9781009157940.001.

[65] See www.mcc-berlin.net/en/research/co2-budget.html.

The IMF 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–Ukraine war has generated a scramble for scarce global gas resources. This makes the existing waste of 7.5 per cent of all natural gas an even larger opportunity in terms of energy security and reducing harmful health effects as well as reaching climate objectives.