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Moving Saudi Arabia's Role in the Global Methane Pledge Forward

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Instant Insight

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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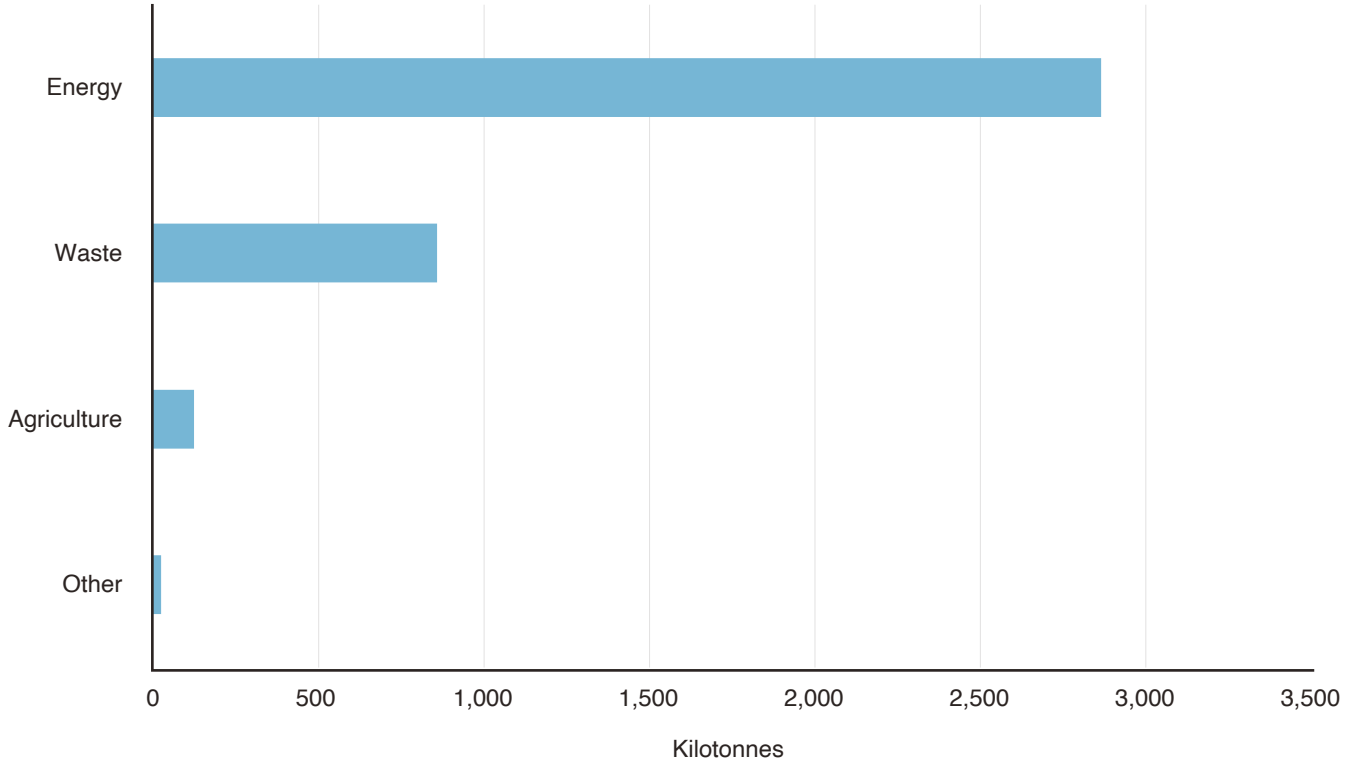
In our previous Instant Insight, “The Global Methane Pledge: What It Means for the Oil and Gas Industry Post-COP26,” we shed light on the increased momentum behind the issue of methane emissions and how it is taking center stage in major climate change forums (Shabaneh 2022). As of the time of writing, 111 countries have signed the Global Methane Pledge to collectively decrease global methane emissions by 30% by 2030 from 2020 levels (Global Methane Pledge n.d.). However, there are varying degrees of discrepancies in methane emissions data, and more accurate measurements are needed to back action to reduce methane emissions.

The International Energy Agency (IEA) has updated its methane emissions database, the Global Methane Tracker 2022, to include country-level analyses of methane emissions from the coal and bioenergy sectors. This is in addition to its detailed coverage of the oil and gas sector. It has also incorporated non-energy-related emissions estimates from publicly available data, albeit from 2018 or 2019 base years. From the energy sector alone, the IEA has identified that governments underreported almost 70% of emissions (IEA 2022). As part of the Global Methane Pledge, participants are expected to use best practices to maintain their emission inventory methodologies and improve their accuracy, transparency and consistency (Global Methane Pledge n.d.).

Figure 1. Saudi Arabia methane emissions by sector, 2021.



Source: IEA Methane Tracker Data Explorer (IEA 2022).

To understand Saudi Arabia's participation in the Global Methane Pledge, Figure 1 provides the IEA's breakdown of emission estimates. In 2021, Saudi Arabia emitted 3,871 kilotonnes (kt) of methane, which accounted for 1.1% of global methane emissions. While the agricultural sector represents the largest source of global anthropogenic methane emissions, it is the energy sector that represents the largest share in Saudi Arabia (74% of the country's emissions). This is followed by waste such as that deposited in landfill sites. During the Saudi Green Initiative forum in October 2021, Saudi Arabia announced its commitment to reach net-zero greenhouse gas (GHG) emissions by 2060. This included a waste management initiative that involves composting 1.3 million tonnes of biodegradable waste by 2035 to reduce emissions from landfill sites (SGI n.d.).

Given how powerful methane gas is, and its 100-year global warming potential of 28 to 34 times that of carbon dioxide (CO_2) (EPA 2021), controlling methane emissions will be imperative for Saudi Arabia and the national oil company Saudi Aramco to reach their goals. Controlling methane emissions would also enhance the sustainability of Saudi Arabia's economic development, which would help it secure future sales of its hydrocarbon resources, its downstream products, and help it to meet its domestic energy needs more efficiently. Methane emissions abatement in Saudi Arabia serves the following three strategies:

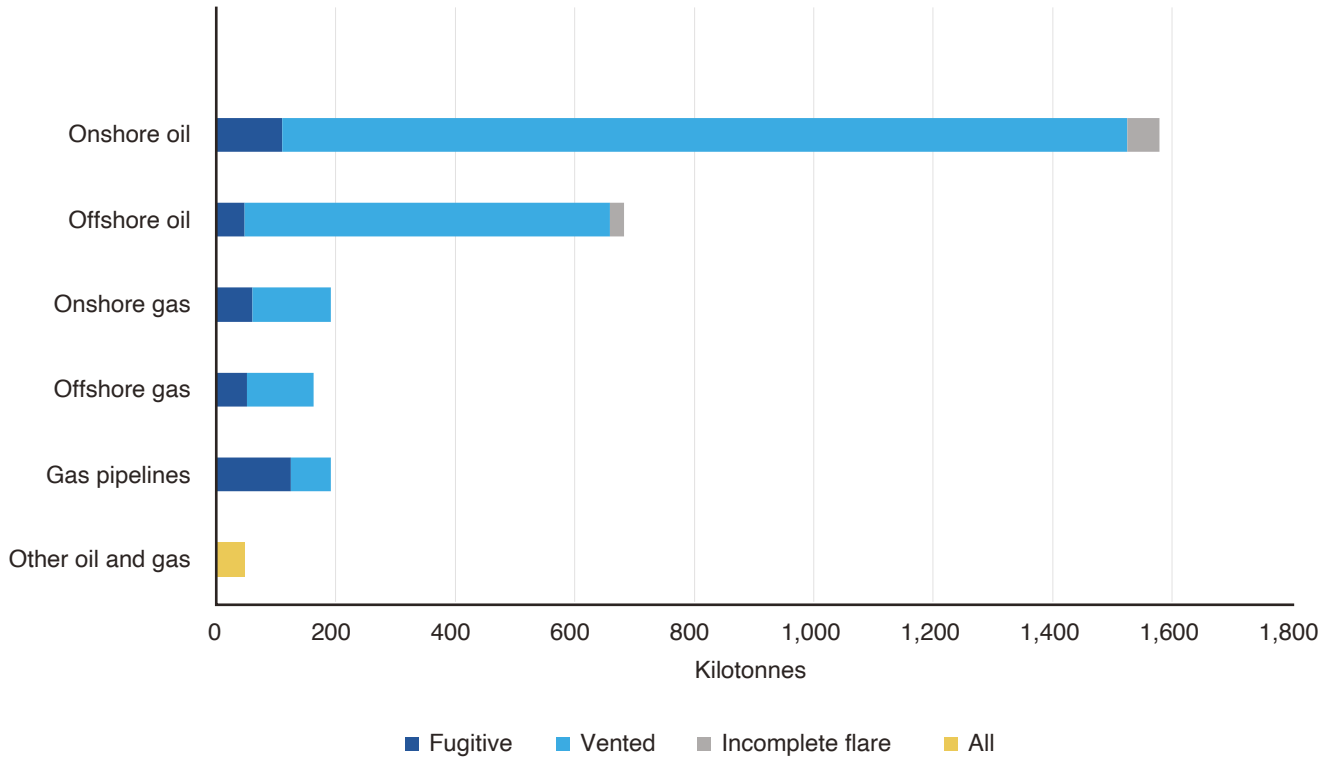
1. Maintain the Kingdom's status as a reliable, sustainable oil supplier with a low carbon intensity.

2. Utilize captured methane to eliminate liquid fuels from its electric power generation sector.

3. Become a world leader in supplying low-carbon hydrogen from sustainably sourced methane.

As we outline in this insight, some of the largest methane emissions abatement can be achieved by the energy sector alone. As a valuable fuel and feedstock, methane can be more cost effective to capture and utilize than other GHGs as a pragmatic solution to reach net-zero targets. In Saudi Arabia's energy sector, most emissions originate from onshore and offshore oil and gas fields where the methane is intentionally vented into the atmosphere, as shown in Figure 2. The flaring of methane by the upstream sector comprises the lowest source of emissions. *Fugitive* emissions, or unintentional leakages, are also a significant source, mostly from downstream gas infrastructure, such as pipelines.

Figure 2. Estimated methane emissions from Saudi Arabia's energy sector, 2021.



Source: IEA Methane Tracker Database (IEA 2022).

Saudi Arabia's pathway to lowering methane emissions

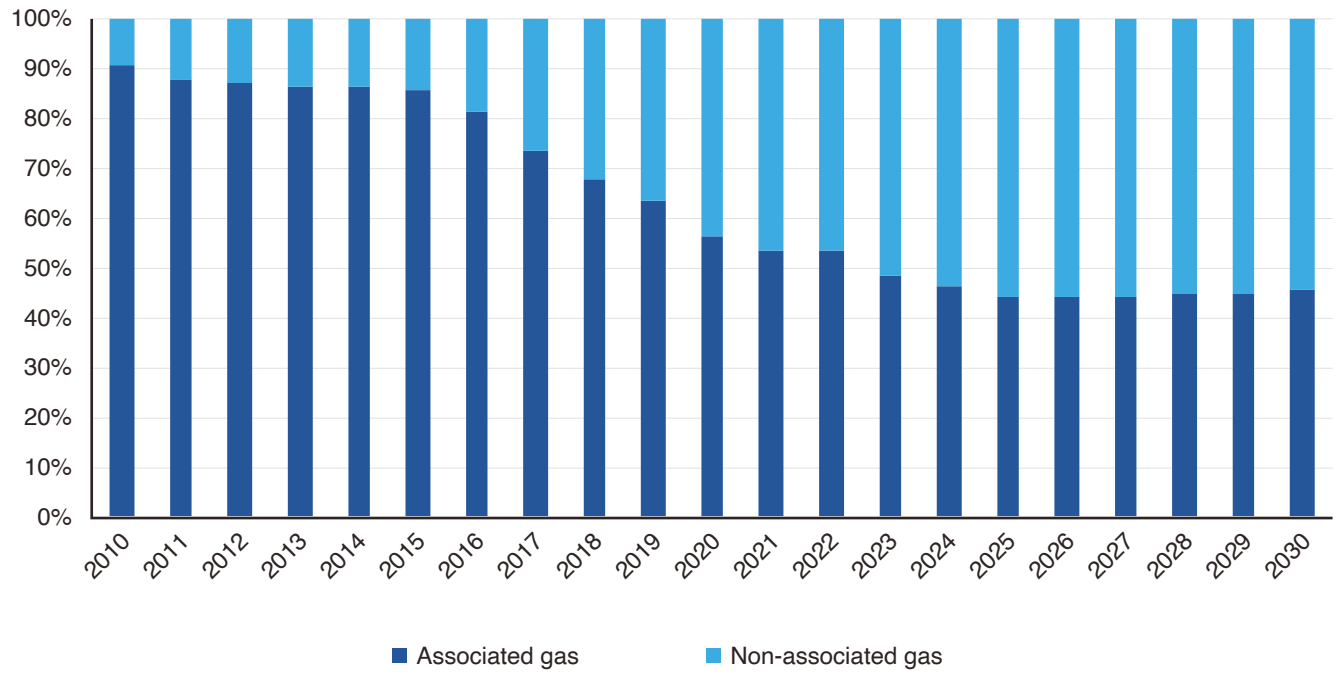
A paper published by Science that assessed the upstream carbon intensities of 8,966 oil-producing fields in 90 countries found that Saudi Arabia has the second-lowest upstream carbon intensity. It is reported at 4.7 grams of CO_2 equivalent (CO_2e) per megajoule of oil produced, close to half the global average (Masnadi et al. 2018).

There are many factors that contribute to upstream carbon intensity, including the energy required to lift and separate oil. The low carbon intensity of Saudi oil production is due mostly to its low methane emissions intensity, particularly from natural gas flaring. Saudi Arabia started to rein in gas flaring in the mid-1970s when it peaked at around 4.2 billion cubic feet of gas per day (bcf/d) (Al-Suwailem 2020). With the construction and expansion of the Master Gas System (MGS), Saudi Arabia's network of natural gas gathering stations, processing plants, and pipelines, flaring has been reduced significantly. In 2020, gas flaring in Saudi Arabia averaged only 0.22 bcf/d (GGFR n.d.).

The largest use of methane in Saudi Arabia is for electric power generation, followed by non-energy inputs for manufacturing chemicals such as ammonia and methanol. By 2030, Saudi Arabia plans to generate approximately half its power from natural gas and the remaining half from renewable energy, freeing valuable liquid barrels for export (Saudi Arabia Ministry of Energy 2021). In 2020, gas accounted for about 61% of Saudi Arabia's power mix, renewable energy was only 0.3%, while liquid fuels, which include crude oil, heavy fuel oil, and diesel, occupied 39% (BP 2021).

To achieve its natural gas targets for its power sector, Saudi Arabia will expand its gas production capacity. As a result, non-associated gas developments are expected to overtake associated gas production. According to Rystad Energy, the latter will still make up 46% of gas supplies by 2030, as Figure 3 shows. The increase in associated, and total, gas production will require Saudi Arabia to invest in methane capture to reduce both intentional venting and other fugitive emissions outlined in Figure 2.

Figure 3. Saudi Arabia's annual natural gas production ratio by type, 2010 - 2030.



Source: Rystad Energy Cube Browser.

The development of new gas supplies will mostly be used to meet domestic demand. However, Saudi Arabia also aspires to monetize surpluses for hydrogen exports. Blue hydrogen, which is made from extracting hydrogen from methane while capturing the CO_2, is expected to play a large role in its low-carbon hydrogen plans. Saudi Arabia successfully shipped its first cargo of blue ammonia to Japan in September 2020 (Shabaneh, Al-Suwailem, and Roychoudhury 2020).

For hydrogen to be certified and accepted as low carbon, the associated GHG emissions, including upstream methane emissions, need to be mitigated and managed. The IEA estimates Saudi Arabia's methane intensity at around 0.11 kilogram per gigajoule (kg/GJ), one of the lowest in world (IEA 2022). That is half of the methane intensity currently estimated for the United States (U.S.) and almost a third of Iran's. Similar or lower intensities will need to be achieved with the development of the giant Jafurah gas field, which would be the source of future blue hydrogen production (Saudi Aramco 2021).

International cooperation plays an important role in advancing efforts to support the lowering of GHG emissions. It enables countries to share key lessons and technological advancements, while also advancing transparency on reporting and certification schemes. On a governmental level, Saudi Arabia is currently a member in many leading organizations and platforms, such as Mission Innovation, Clean Energy Ministerial, the Net-Zero Producers Forum, and the Global Methane Initiative. Saudi Aramco is also part of the World Bank's *Zero-routine flaring by 2030* initiative and a founding member of the Oil and Gas Climate Initiative. In the following sections, we discuss how Saudi Arabia can maintain and further reduce its methane emissions.

Technologies to detect and mitigate methane emissions

Venting and flaring methane is done both for safety reasons (non-routine) and for the routine disposal of gas when processing and distribution infrastructure is not available. Aramco deploys methane leakage detection and repair programs to minimize venting operations and flaring. This includes maintaining optimal combustion conditions in the flare stack, such as the temperature, to ensure a high conversion rate of methane to CO_2.

A range of satellite-based measurement systems has emerged that independently verify global gas flaring operations (Faruolo et al. 2020), which are otherwise measured at the facility level using onsite sensors and smart meters. These measurement systems report estimates of gas flaring volumes and the temperatures of the flame. These data help verify flare combustion efficiency to identify methane leaks and venting.

However, as shown in Figure 2, Saudi Arabia's contribution to the Global Methane Pledge will require it to target direct venting and fugitive emissions, rather than improving flaring operations. Venting is often performed in remote well pads where the infrastructure to capture and send gas to a flare stack or processing facility is unavailable. Reducing the harder to access venting sites will require an understanding of the technoeconomic constraints at the well sites and designing feasible mitigation solutions.

The IEA (2022) provides estimated methane abatement costs for Saudi Arabia through conventional methane capture systems. These include replacing existing devices (e.g., pumps, compressors and motors), installing new devices (e.g., vapor recovery, lowdown capture and flare stacks), and finally, leak detection and recovery systems (LDAR). The IEA estimates suggest that up to 70% of oil and gas sector methane emissions can be abated using these technologies. This corresponds to about half of the country's total and 0.5% of global methane emissions. Thus, the abatement by Saudi Arabia's energy sector positions the country well to contribute to the Global Methane Pledge.

While flaring is one strategy to reduce venting, an even better approach is to monetize emissions. The IEA suggests that up to 32% of the abatement potential can be done at no additional cost by increasing total gas sales. Additional investments to monetize wasted methane could be incentivized by putting a price on the associated emissions. This could be achieved by simply introducing an internal value to direct methane emissions within Aramco, reflecting the discounted value of investing in new equipment.

Alternatively, the government could explicitly price the waste emissions, adjusting the internal transfer of revenues made by Saudi Aramco. The decline in rents from oil exports caused by the emission price is transferred internally from Aramco to the government. Since the volumes of flared and vented methane are well below the oil sold, a price on emissions will be much less than the rents from oil exports.

The standard infrastructure to monetize methane is to connect into a master gas system used by large industrial facilities. However, this may not be feasible for remote or stranded oil fields. Therefore, a more distributed and decentralized approach could help minimize the need to vent and flare methane. This would involve developing smaller scale modular technologies that may be easier to deliver to remote areas, dismantle and relocate.

An alternative pathway to monetize gas is to convert natural gas to higher value liquid fuels (GTL) or chemicals (GTC) that can be transported without a pipeline. This includes the production of methanol (liquid) and ammonia (chemical). However, both are capital-intensive industries where economies of scale have been critical for project success.

The conversion process for GTL is traditionally known as the Fischer-Tropsch process. It has been researched for more than five decades and has seen serious commercialization by oil operators such as Shell and Sasol (Saunier, Bergauer, and Isakova 2019). The Lurgi MegaSyn reactor has introduced innovation to optimize gas reforming and improve economies of scale, targeting larger facilities (Ahlers and Liebner 2005).

Other innovation is being developed for smaller and modular plants that allow process intensification and skid mounting at the wellhead. Innovation has also focused on developing a higher tolerance to impurities in the GTC process, specifically in the gas feed, and on using less energy-intensive techniques than Fisher Tropsch. A report by Carbon Limits SA (Pederstad, Gallardo, and Saunier 2015) lists more than 10 companies that improve the utilization of associated gas by converting it to higher value chemicals. The latter are easier to transport, they reduce the carbon footprint of production, and they can be mobilized to tap into the gas feed at the vent outlet or before the flare stack.

Digital flare mitigation

A term coined by Crusoe Energy, a pioneer in mitigating waste emission from methane. The company's business model is to convert stranded natural gas to electricity used to power advanced on-site computation systems and data centers. The company has eight operational sites across the U.S., with an additional 30 sites announced in the year 2020. It has a novel approach to monetize the natural gas onsite:

sending methane to gas turbine units installed in portable shipping containers. The electricity is used to power cryptocurrency mining equipment, mainly bitcoin. The advent of cryptocurrency and blockchain technology has provided Crusoe Energy and more than a dozen other companies in the U.S., Canada, the United Kingdom and Brazil the opportunity to tap into the flare source. The methane that would otherwise be wasted provides a low cost fuel to supply electricity at a much lower marginal cost than utility prices. As a result, these companies can generate higher returns without significant investment in pipelines or transportation to market (Bedolla et al. 2020).

The question is whether there is an opportunity for larger national oil companies, like Aramco, to adapt the innovative rent-seeking opportunities exploited by smaller independent companies. The legal and regulatory environment around cryptocurrency mining may be difficult to navigate. However, there may be a case for Aramco to explore remote data center operations to raise funds to further reduce its carbon footprint. For example, linking data or crypto mining operations to the development of renewable projects to help close the methane emissions cycle.

Performance certification and pricing methane emissions abatement

Maintaining emission inventories is a crucial first step in certifying and valuing efforts to mitigate upstream emissions by the oil and gas industry. In 2020 Saudi Aramco started publishing total direct (scope 1) and indirect (scope 2) emissions data for its domestic, wholly owned and operated assets in 2018 and 2019 (Saudi Aramco 2020). Aramco also started publishing carbon intensity metrics on flaring and upstream methane intensity (emissions per unit of produced gas).

Constructing detailed emission inventories is an important step to creating product-specific performance certificates for oil and gas commodities supplied by companies like Aramco. Selling these certificates to companies looking to reduce their carbon footprint can provide an additional source of revenue for an energy producer. However, this requires introducing standard-setting bodies to verify claims and markets where they can be traded.

Such sustainable commodity market offerings are starting to be introduced in other countries, such as in the U.S., where companies are selling certificates linked to fuel produced with low methane emissions. In 2021, S&P Platts and Xpansiv, a major sustainable commodity exchange, set up the Methane Performance Certificate (MPC) used in the trade of natural gas. Xpansiv applies recognized standards to issue digital natural gas units that characterize fugitive methane emissions during production. Producers are granted MPCs when their emissions are verified to be below a given threshold. In October 2021, S&P Platts issued the first price benchmark for MPCs at $6.29 per metric tonne of CO_2e avoided (PRNewswire 2021).

While Aramco does report the upstream carbon intensity of its oil production, participating in additional methane verification and certification programs could help advance its Global Methane Pledge. The methane performance certification of Aramco's fuel products could also play a role in establishing voluntary markets for certified methane reductions. The Public Investment Fund of Saudi Arabia and the Saudi stock exchange Tadawul have announced their intent to set up the Riyadh Voluntary Exchange Platform for offsets and carbon credits (SPA 2021).

Conclusion

Multilateral cooperation and voluntary commitments to the Global Methane Pledge present an opportunity for Saudi Arabia to share its success in reducing the methane intensity of its energy sector. It will need to explore the suite of technologies and methodologies available to manage its remaining emissions, primarily from upstream oil and gas extraction, but also from waste landfill gases. By implementing methane abatement technologies in its oil and gas sector, Saudi Arabia could reduce its methane emissions by up to 50%, providing a measurable contribution to the pledge to reduce global emissions by 30%. In addition, a significant part of this abatement can be done at no additional cost by monetizing the capture of methane gas.

By participating in the Global Methane Pledge and the corresponding international forums, Saudi Arabia continues to develop its institutional and technical capacities and maintains its commitment to report its reduction efforts. Saudi Aramco has taken important first steps to establish a company-wide emissions inventory. However, the country has room to develop its domestic markets, including internally pricing emissions, and voluntary efforts to promote emission reductions through methane performance certification. These efforts need to be complemented with a governmental roadmap, a list of action plans, and the proper regulatory framework and focused policies to signal concrete actions to lower emissions.

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