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Understanding Gas: Monetisation Options for Emerging and Future Global Gas Producers



Energy Research Paper

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Developing and bringing challenging gas resources to market has historically been a formidable endeavour. Commercial and technical advances have notably facilitated this process over the past two decades, and the loss of legacy supply creates the opportunity for new sales. Nevertheless, those in possession of substantial undeveloped gas resources face new and emerging challenges – political and environmental – in accessing markets.

From the East Mediterranean and Africa to Russia and Central Asia, how will gas monetisation targets and options evolve in a global gas market driven by climate change and the energy transition? How are resource-holding countries making the most of this opportunity? What is the long-term impact on global gas markets?

ENERGY RESEARCH PAPER

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The Eastern Mediterranean, Africa, and Russia-Central Asia are three of the key regions hosting large volumes of undeveloped gas. In each, a different combination of political, commercial, and technical factors poses challenges to the full development of these assets.

The following factors will affect a nation's ability to utilise and monetise these undeveloped gas reserves:

- **Technology:** new resources in deepwater, ultra-deep or sour fields, harsh Arctic conditions, or unconventional resources, each have their own challenges. Technology for these resources has greatly improved in the last twenty years, but such developments are never simple.
- **Infrastructure:** remote or undeveloped regions pose many infrastructural challenges. Floating LNG liquefaction, especially for smaller or far-offshore resources, is an emerging option, but early deployments have experienced some problems.
- **Politics:** cross-border pipelines are complex, especially where regional relationships are difficult.
- **Commercial:** the correct balance of long- and short-term contracts, flexible pricing mechanisms, and robust, mutually beneficial contracts, is important, and significantly different between LNG, pipeline exports and domestic gas.
- **Market:** access to large, reliable, attractively priced markets is as important as ever. The Chinese market has become the single most important global factor, but it is price-sensitive and demand is not

infinite. Chinese policymakers are acutely sensitive to energy security issues, even more so following Russia's invasion of Ukraine.

- **Environment:** new gas developments face increasing scepticism. They have at least to minimise operational emissions, including flaring, methane leakage, LNG plant energy consumption and contaminant CO₂.
- **Financing:** finance for new gas production and export projects is increasingly limited. Environmental excellence, and access to innovative sources of capital, including domestic funds in Africa, will become essential.

The required balance of these, though, is different in each of the broad regions considered here.



Eastern Mediterranean:

- The Eastern Mediterranean region is experiencing a surge in gas production due to significant discoveries in the deepwater basins of Israel, Cyprus, and Egypt. However, the high demand for gas within the region, particularly in Egypt, limits the available gas for export. Further exploration is crucial to augment gas reserves and meet export demand.
- In the Eastern Mediterranean, three groups of companies are notable. The first group includes NOC and sovereign wealth players, Mubadala, QatarEnergy and Rosneft, representing the UAE, Qatar and Russia respectively, with significant gas volumes in fields such as Egypt's Zohr and Israel's Tamar and Leviathan. The second group covers the major international Western oil companies, nearly all of whom are represented: Shell, BP, TotalEnergies, ENI, ExxonMobil and Chevron. QatarEnergy has become the new partner in the Lebanese blocks with TotalEnergies. The third group is locally-focussed players, notably Israeli companies at home, Energean in Israel, and Cheiron in Egypt.
- Recent gas discoveries in the Eastern Mediterranean region can be commercialised through exports to Europe with two main options: long-distance gas pipelines or LNG. The pipeline option could potentially accommodate future hydrogen transportation. LNG options include utilising existing LNG projects in Egypt, building a new project in Cyprus, or constructing a floating LNG facility in Israel or Cyprus. Another alternative is a subsea electricity line between Greece, Cyprus, and Egypt. These options face challenges but offer flexibility and potential for regional integration.

Africa:

- Egypt and Algeria are expected to remain the top gas-producing countries in North Africa, solidifying their position as Africa's primary gas producers. Other African countries cover:
 - o The established players – Nigeria and Angola
 - o Emerging exporters, with projects underway or just entering service – the Republic of Congo, Mauritania, Senegal, and Mozambique
 - o Future producers, with undeveloped discoveries, or where production today is only for domestic use – Ghana, South Africa, Côte d'Ivoire, Namibia, and Tanzania
 - o Exploration frontiers, including Zimbabwe and Ethiopia.
- African governments can play a key role in attracting financing for gas projects by adopting favourable fiscal policies. Independent and local players face challenges in obtaining funding due to limited options and stricter lending criteria. International lenders are increasingly ruling out financing new fossil fuel production.
- European buyers are welcoming plans to double African LNG supply in the next ten yearsⁱ. However, Africa faces challenges in commercialising its resources. Material risks often hamper exports, postpone start-up, and block financing and final investment decisions.



Russia and Central Asia:

- The sharp reduction in Russia's gas exports to Europe, and the EU's decision to phase out Russian gas imports entirely by 2027, has severely affected Gazprom's upstream strategy and developments. Delays are expected in several projects. The Chayandinskoye and Kovyktinskoye fields in East Siberia aim to increase gas exports to China. The Power of Siberia 2 pipeline's commissioning is uncertain. By 2026, Russian gas production is estimated to be 677 BCM / yearⁱⁱ.
- Turkmenistan's gas production has evolved with the operational Galkynysh field and increased output from CNPC's Bagtyarlyk and Petronas's Caspian projects. Galkynysh, in its third development phase, could yield 200 BCM / year if fully developedⁱⁱⁱ. China is now the main destination for Turkmen gas exports, currently at 35 BCM / year^{iv}.

Implications: Long-Term Gas Outlook

- Russia and Central Asia rank as the second largest gas-producing region globally (after North America), with Russia accounting for over half of the region's projected increase in production by 2050^v. The Middle East is the third-largest gas-producing region, with Iran, Qatar, and Saudi Arabia being key players. Qatar is expected to lead in gas production growth.
- Therefore, Africa, the Eastern Mediterranean, and Central Asia need to find market opportunities between these giant, highly-competitive incumbents. Africa is projected to more than double its gas production by 2050, with Nigeria and Mozambique driving the growth.

- Global gas trade will continue to increase by 2050, with LNG trade surpassing long-distance pipeline trade by 2026^{vi}. European gas imports are projected to decrease by 80 BCM / year by 2050, with a focus on reducing reliance on Russia^{vii}. Global liquefaction capacity is set to surpass 1 billion tonnes / year by 2050, with the Asia-Pacific region witnessing the largest additions to regasification capacity^{viii}. Russia plans to expand its LNG export capacity, while Africa has the potential to become a more significant player in LNG exports.
- In order to achieve Africa's long-term gas supply goal by 2050, a total investment of US\$ 1.7 trillion is needed, with a focus on countries like Algeria, Egypt, Southern Africa, and Nigeria^x. Deepwater developments will receive the majority of investments in sub-Saharan Africa. Midstream investment will be driven by projects in Mozambique, Tanzania, Mauritania, Nigeria, Egypt, and Senegal. In the Russian and Central Asia region, a significant investment of US\$ 2.5 trillion is required to enhance gas production, particularly in challenging basins^x.
- The success of Africa in achieving its gas production potential depends on its ability to sustain attractive investment conditions; access finance; minimise the carbon footprint of its upstream; and access markets competitively against competition from the US, Qatar and Russia in particular.

BACKGROUND

Developing gas resources in the Eastern Mediterranean, Africa, Russia, and Central Asia has historically been challenging. However, advances in commercial and technical aspects over the past two decades have made this process more feasible. This includes in particular improvements in deepwater production and increasing experience with floating LNG systems both for production and regasification.

However, monetising gas resources faces the increasing challenge of accessing finance and markets, in the face of scepticism over gas's long-term role in a decarbonising world. This affects new entrant producers more than incumbents, and is particularly problematic for those targeting Europe as a market. The loss of Russian gas supplies to Europe opens a window, but one that will be open only in the short term, to around 2030.

Those holding major gas reserves must account for various additional factors beyond technical issues, notably as market dynamics, geopolitical considerations, environmental impacts, and evolving energy policies. By addressing these factors head-on, gas producers can effectively adapt to the changing landscape and secure a sustainable future for their gas supply in both the medium and long-term.

The interest in the gas potential of the Eastern Mediterranean region was boosted in 2015 with the emergence of Egypt's Zohr gas field and the subsequent successful development of Israel's Leviathan field, which was discovered in 2010 and commenced gas production in late 2019. However, exporting these hydrocarbon resources poses considerable challenges, beyond the geopolitical complexities in the region.

The Eastern Mediterranean gas projects, with their lengthy development timelines, must carefully consider long-term trends, as the current high gas prices may benefit suppliers. Their proximity to Europe would have been helpful in the past. However, these projects now encounter a decline in export opportunities as potential markets, particularly in Europe, are increasingly seeking to phase out gas in favour of renewables, electrically-driven heat pumps, and hydrogen. This means there is little political appetite or financing for long-distance subsea pipelines, even more those crossing difficult geopolitical boundaries.

Still, Eastern Mediterranean gas projects can still play an important role due to the shift away from coal in Asian countries, Europe's desire to replace Russian gas, and the recognition by many (though not all) countries of the importance of gas in a low-carbon energy mix.

However, the region's geopolitical conflicts have hindered the full realisation of its potential for developing and exporting natural gas. The border dispute between Cyprus, the Turkish-based Republic of Northern Cyprus, and Turkey itself, is one problem. The Israel-Palestinian conflict is another, with the important Tamar field shut down briefly in October 2023 as a precaution due to the

fighting in Gaza. The border demarcation deal between Israel and Lebanon of October 2022^{xi} was positive, but unfortunately the first well in Lebanon's Block 9 was unsuccessful, and the war in Gaza and possible escalation with Hezbollah has now overshadowed it.

Beyond political conflicts, the high demand for gas within the region, particularly in Egypt, poses limitations on the available gas for export. Therefore, further exploration is crucial to augment gas reserves and meet the growing export demand.

In 2021, Egypt emerged as the leading gas producer in the Eastern Mediterranean, generating a substantial 68 BCM / year^{xii}. However, it faces the challenge of rapid decline rates in gas production. From 2009 – 2016, there were limited instances of new production startups, resulting in an average annual decline rate of 5.6%^{viii}. The discovery of the giant (30 Tcf) Zohr field in 2015 boosted Egyptian output substantially, but the field has not managed to produce to its 33 BCM/y annual capacity due to water breakthrough in the wells. Current production is around 22-23 BCM on an annualised basis. Projected figures indicate a decline of overall Egyptian production from 56 BCM in 2023 to 42 BCM by 2035, assuming no significant discoveries comparable to Zohr and no substantial increase in unconventional gas output onshore^{xiv}.

In 2021, Israel's gas production from the East Mediterranean reached 20 BCM / year and grew further to 21.9 BCM in 2022. The start-up of the 8 BCM/y Karish field in October 2022 will further boost the 2023 average. This figure is set to increase significantly, reaching 43 BCM / year by 2027^{xv}. Growth will be driven by planned expansions of the Leviathan field in 2022, 2027, and 2029, alongside the further development of

the Tamar field in 2025 and 2026. Moreover, the Energean-operated fields, which include Karish and satellites Tanin, Athena, Hermes, and others, will also come into operation, contributing to the overall increase in gas supply. Potential exploration achievements by Energean might further contribute to the volume of gas available. However, it is expected that any discoveries made by Energean in its current blocks will likely be relatively modest in size. BP, ENI and SOCAR won blocks in the exploration licensing round in October 2023, with potential for future finds.

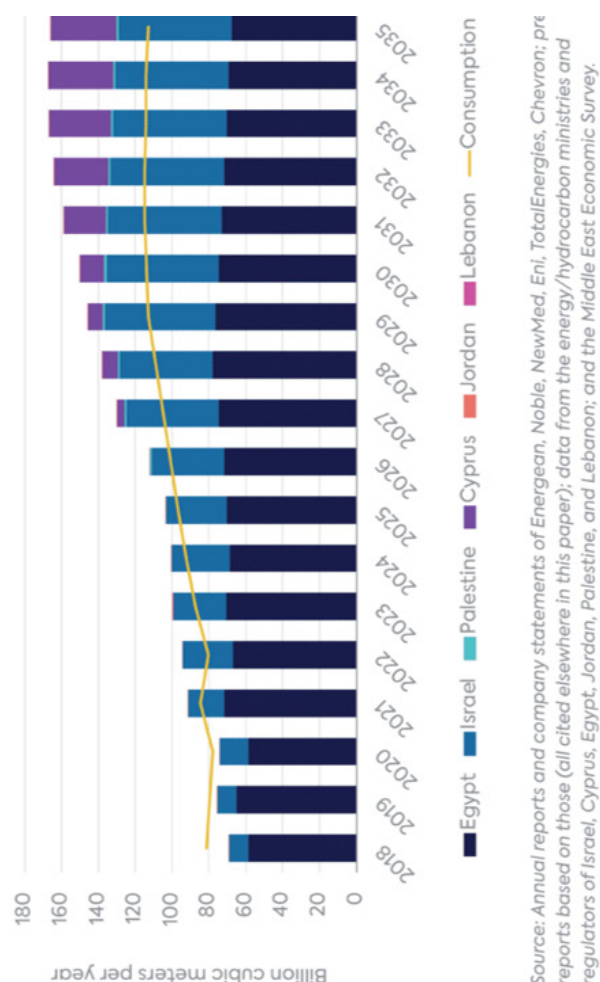
Cyprus is poised for substantial production growth with the planned development of several key projects. The Aphrodite project, anticipated to commence in 2027, will be followed by Glaucus in 2030, Calypso in 2031, Cronos in 2032, and Zeus in 2033. Collectively, these initiatives are expected to contribute to a significant increase in production to 32 BCM / year^{xvi}.

This estimate does not account for potential future exploration successes, which are inherently uncertain and challenging to reliably predict. Additionally, it is crucial to consider the potential impact of delays experienced thus far, as well as political and commercial obstacles that may result in a more cautious pace of development. The finds in Cyprus so far are scattered around several medium-sized deepwater fields, far apart from each other, and with different operating companies, making it difficult to arrive at a coherent development plan.

Production at Palestine's Gaza Marine field had been scheduled to begin in 2026, with an annual output capacity of 1 BCM^{xvii}. However, the conflict in Gaza makes it very unlikely this will proceed in the medium-term.

Jordan's onshore tight gas production is projected to decline gradually after a boost from current infill drilling. No substantial finds are predicted in Lebanon or Syria, although there is the prospect of further drilling offshore Lebanon.



Figure 1: Gas Production in the Eastern Mediterranean^{xviii}

The lack of coordination between various companies within different countries remains a significant hurdle in expediting the commercialisation of deepwater gas discoveries in the Eastern Mediterranean region.

Eni and Chevron currently hold the largest share of discovered gas resources in the Eastern Mediterranean region, specifically in Egypt, Israel, and Cyprus. These two companies possess over 368 BCM of gas volumes through their working interests in these fields, establishing their dominant positions^{xix}. Chevron's gas volume control stands at 1,116 BCM, while Eni possesses 934 BCM, significantly surpassing ExxonMobil's 184 BCM^{xx}.

Energean operates smaller gas fields in Israel, holding 127 BCM designated for domestic consumption^{xxi}. However, Energean has the potential to become a significant gas exporter if its ongoing exploration program yields substantial gas discoveries in the near future and if is granted permission to export.

In the Eastern Mediterranean, among the more than 20 involved companies, there are two notable groups of companies. One group includes state players: Mubadala (UAE), QatarEnergy, representing the UAE and Qatar, and Rosneft (Russia) with significant gas volumes in fields such as Egypt's Zohr and Israel's Tamar. QatarEnergy has become TotalEnergies' new partner in the Lebanese blocks, while Israeli companies also hold substantial gas reserves.

The first noteworthy group comprises Mubadala and QatarEnergy, representing the UAE and Qatar, respectively. Mubadala holds significant gas volumes of 156 BCM in both Egypt's Zohr field and Israel's Tamar and Dalit fields^{xxii}. On the other hand, QatarEnergy possesses a 40% stake (equivalent to 74 BCM) in ExxonMobil's Glaucus discovery in Cyprus and has recently joined forces with TotalEnergies-Eni for exploration in Lebanon^{xxiii}.

It is crucial to highlight the improved relationships between Israel and Gulf countries, through the Abraham Accords in 2020, and the normalisation of ties with the UAE and Bahrain, which significantly influence the energy geopolitics of the region. Notably, the UAE is currently working towards improving its relations with Turkey. While Qatar, a longstanding Turkish ally, has not officially normalised ties with Israel, its interactions with the country are intricate and somewhat ambiguous.

Nonetheless, Qatar maintains lower-level contacts and plays a crucial role as a mediator between Israel and the Hamas-led administration in Gaza. As a prominent global player in the gas industry, Qatar may have strategic motives for its interest in Eastern Mediterranean gas, aligning with QatarEnergy's exploration-driven international growth strategy in collaboration with major IOC partners. Lastly, it is important to acknowledge that the ongoing Israeli offensive in Gaza may create strains in these relationships.

The second notable group includes Russia's Rosneft, which holds the fourth-largest volume in the Eastern Mediterranean gas industry with a 30% working interest in Zohr^{xxiv}. On the other hand, Novatek, another major player in the Russian gas industry, previously held a 20% stake in exploration blocks 4 and 9 in Lebanon, alongside TotalEnergies (40%) and Eni (40%) as operators^{xxv}. However, no discoveries have been made in those blocks.

In 2022, it was announced that Novatek would withdraw from the project, leading to QatarEnergy becoming the new third partner^{xxvi}. According to the terms of the Lebanon-Israel border demarcation, previously disputed Block 9 does not allow Israeli or Lebanese companies to hold a stake^{xxvii}. Consequently, QatarEnergy acquired a 30% stake in 2023, while TotalEnergies and Eni each became 35% equity owners^{xxviii}.

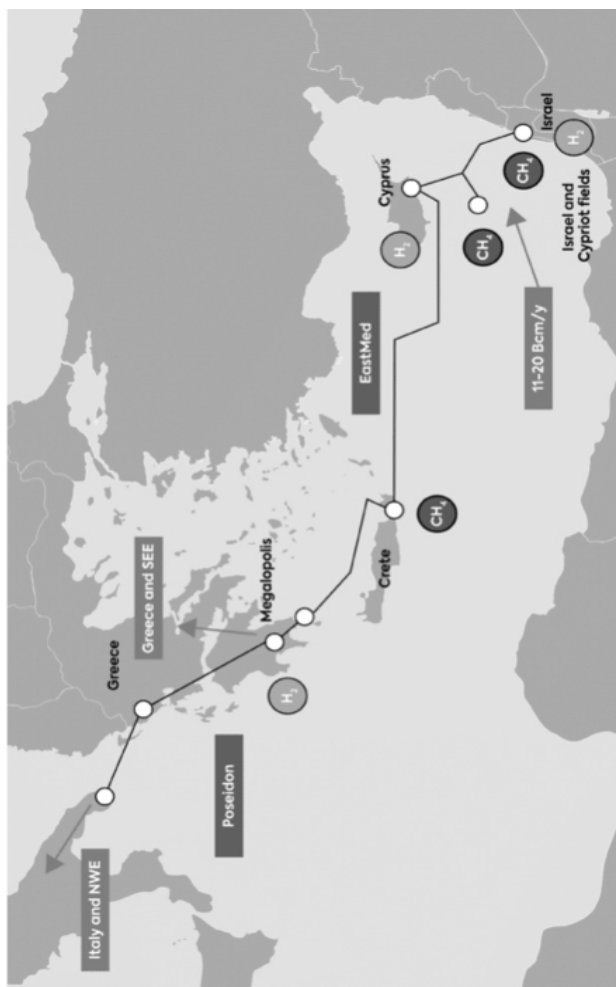
Israeli companies, namely NewMed Energy, Isramco, and Ratio, possess gas reserves exceeding 56 BCM^{xxix}. Notably, NewMed Energy participates in projects in both Israel and Cyprus. As the paths for commercialising these Eastern Mediterranean fields become more defined, there is a potential for these companies to become attractive targets for acquisition.

There are two main monetising options for commercialising recent gas discoveries in the Eastern Mediterranean region to Europe and the world: by long-distance gas pipeline or by LNG tankers. The pipeline option could potentially accommodate hydrogen transportation. LNG options include utilising existing LNG projects in Egypt, building a new project in Cyprus, or constructing a floating LNG facility in Israel. Another alternative is a subsea electricity line between Greece, Cyprus, and Egypt. These options face challenges but offer flexibility and potential for regional integration and decarbonisation.

IGI Poseidon, a joint venture of DEPA (Greece) and Edison (Italy), is currently developing a gas pipeline spanning approximately 2,000 km. This pipeline will stretch from Israel, through Cyprus, to Crete, mainland Greece, and has the potential to extend to southeast Europe via the new Greece-Bulgaria interconnector or to Italy via the Trans-Adriatic Pipeline. Initially, the pipeline will have a capacity of 10 BCM / year, and the estimated cost of the project is US\$ 6.8 billion^{xxx}. Notably, the pipeline will encounter a maximum water depth of 3,000 meters, a depth comparable to other ultra-deepwater pipelines installed globally. Furthermore, the pipeline can be designed to accommodate hydrogen, considering Egypt's emerging significance as a future producer.

The construction of a 600 km subsea pipeline near Ceyhan, Turkey is expected to require an investment of US\$ 2.5 billion^{xxxi}. The advantageous proximity of an LNG terminal in the area, along with existing pipeline connections, will enable the efficient distribution of gas within Turkey. Additionally, this infrastructure presents the opportunity to re-export an equivalent volume of other Turkish imports into southeast Europe.

Figure 2: Proposed Pipeline Route from the Eastern Mediterranean^{xxxii}



The pipeline options offer the potential to be converted for hydrogen transportation, ensuring long-term sustainability. However, they face significant challenges such as political and border complexities, as well as the drawback of tying sellers to a single market. Additionally, successful implementation requires cooperation among multiple companies and countries to consolidate sufficient gas resources. The uncertain nature of Israel-Turkey relations, despite their recent restoration of full diplomatic ties in 2022 after a four-year hiatus, acts as an additional disincentive for pursuing the direct route to Turkey, despite its economic benefits.

There are three main alternatives for the LNG option. First, utilising the two currently underutilised LNG plants in Egypt, which would require the construction or expansion of connecting pipelines to link the Israel-Cypriot gas fields with these terminals. Second, the option of building a new floating or land-based LNG plant in Cyprus. Lastly, the possibility of constructing a new LNG liquefaction plant in Israel, most likely in a floating manner.



LNG offers greater flexibility in choosing the destination market and eliminates border-related challenges, although it comes at a higher cost. Utilising modular FLNG facilities can be considered if there are new gas resources available. This approach mitigates the need to consolidate resources from multiple companies and consortia to meet commercial viability criteria. Additionally, compared to surveying and obtaining permits for a pipeline route, the development of FLNG facilities may allow for a quicker entry into the market.

An alternative, though not directly comparable to the pipeline and LNG plant options, is the establishment of a subsea electricity line. This option involves a collaboration agreement among Greece, Cyprus, and Egypt. Funding of US\$ 698 million from the EU has been secured for a 1 GW link between Israel, Cyprus, and Greece, with the potential to expand it to 2 GW^{xxxiii}. The estimated cost for the Cyprus-Greece section alone is US\$ 1.7 billion^{xxxiv}. In addition to facilitating the transmission of electricity generated from renewable sources, this electricity line can be developed independently of any decision regarding gas exports. Notably, construction of the EuroAsia connector from Cyprus began in October 2022.

The HVDC electricity cable shares similar drawbacks with pipelines, such as the significant initial investment costs, challenges related to borders, and the need for market commitment. It solely transmits electricity and does not facilitate the transportation of gas or potentially hydrogen, which can have applications in industries and home heating. Nevertheless, it offers the advantages of bi-directionality and the capability to transport electricity from any source, including renewable energy. This aligns well with Europe's decarbonisation objectives and agenda.

NORTH AFRICA

Egypt and Algeria are expected to remain the top gas-producing countries in North Africa, solidifying their position as Africa's primary gas producers. Both countries are collaborating with international energy companies to pursue gas and hydrogen projects. Morocco is set to expand its domestic gas industry by 2030, driven by recent discoveries and a commitment to reducing coal consumption.

Egypt and Algeria are anticipated to maintain their positions as the foremost gas-producing nations in North Africa, consequently solidifying their status as Africa's primary gas producers alongside Nigeria. Notably, both countries made significant strides in collaborating with international energy companies in 2022, demonstrating their dedication to pursuing additional gas and hydrogen initiatives.

Driven by recent onshore and offshore discoveries, as well as a commitment to reduce coal consumption, Morocco is poised to significantly expand domestic output by 2030. Gas will play a modest but crucial role in supplying thermal power stations, facilitating the transition away from coal, and presenting an opportunity for decarbonisation in transportation and various industries.

Morocco and Algeria are actively engaged in ambitious multi-billion-dollar transnational gas pipeline projects. These projects, namely the Nigeria-Morocco Gas Pipeline (NMGP) and the Trans-Saharan Gas Pipeline (TSGP), aim to facilitate the distribution of gas across West Africa and eventually supply European

markets. Both pipelines have a planned capacity of 30 BCM / year^{xxxv}. The NMGP will involve offshore infrastructure connecting Nigeria and Morocco, while the TSGP will focus on establishing an onshore pipeline network. These projects look highly speculative and unlikely to proceed in the current economic and environmental situation, and given the political complexities of crossing numerous borders.

SUB-SAHARAN AFRICA

Sub-Saharan Africa's gas industry shows promise compared to its oil industry, thanks to a string of significant discoveries in the past decade. Africa alone accounted for 40% of all global gas discoveries between 2010 – 2020^{xxxvi}. Activity in Africa outside North Africa focusses on four main areas:

- North-west Africa: Mauritania and Senegal
- The Gulf of Guinea – notably Ghana, Côte d'Ivoire, Nigeria, Equatorial Guinea and Congo
- South-west Africa: Angola, Namibia and South Africa
- East Africa: Mozambique and Tanzania

Nigeria began exporting LNG in 1999 and Angola in 2013. In both cases, these were secondary to the countries' major oil industries, and were supplied primarily by associated gas. Nigeria exported 19.6 BCM in 2022 of which 12 BCM went to Europe, and Angola 4.1 BCM (2.9 BCM to Europe), making them key suppliers.

Equatorial Guinea began exports in 2007, and the Republic of Congo is expected to start in December 2023^{xxxvii}; both are smaller players. The major deepwater oil find Baleine by Eni in Côte d'Ivoire began production in August 2023 and also produces some gas for domestic consumption.

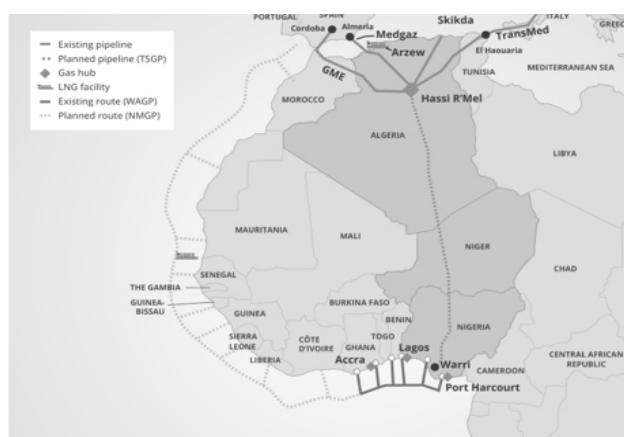
In the early 2010s, discoveries in Mozambique and Tanzania marked the beginning of Africa's ascent in the global gas industry. Subsequently, Senegal and Mauritania made significant offshore finds in the late 2010s. Adding to the momentum, in 2019, notable gas-condensate resources have been found off the southern coast of South Africa in the Luiperd and Brulpadda fields^{xxxviii}, and very large, ultra-deepwater oil fields apparently with associated gas in Namibia by Shell and TotalEnergies.

The increased gas production in the 2010s, particularly in sub-Saharan Africa, played a significant role in bringing African gas supplies to the global market. Moreover, this surge led to the initiation of several large-scale LNG projects focused on exports. Notably, final investment decisions for Coral South LNG in Mozambique and Greater Tortue Ahmeyim (GTA) LNG in Senegal and Mauritania were successfully made in the late 2010s. Subsequently, more extensive projects such as Mozambique LNG and Nigeria Train 7 were also approved.

Several upcoming projects have been proposed, including the GTA Phase 2, Rovuma LNG in Mozambique, Cameroon Phase 2, Nigeria Floating LNG (FLNG), and Congo-Brazzaville (Republic of Congo) FLNG. Though the Trans-Saharan Gas Pipeline, between Nigeria, Niger, and Algeria, looks very unlikely to progress, there is some regional trade using the West African Gas Pipeline.

West and North-west Africa are poised for substantial growth as a prominent gas-producing region, with the inclusion of Mauritania and Senegal alongside Nigeria and Ghana as gas exporters. These countries anticipate that the domestic allocation from their export initiatives will not only bolster gas-fired electricity generation but also facilitate the displacement of coal and diesel consumption. By prioritising these initiatives, both countries aim to advance their energy transition efforts and promote cleaner and more sustainable energy sources within their respective economies.

Figure 3: Current Gas Infrastructure Developments in West Africa



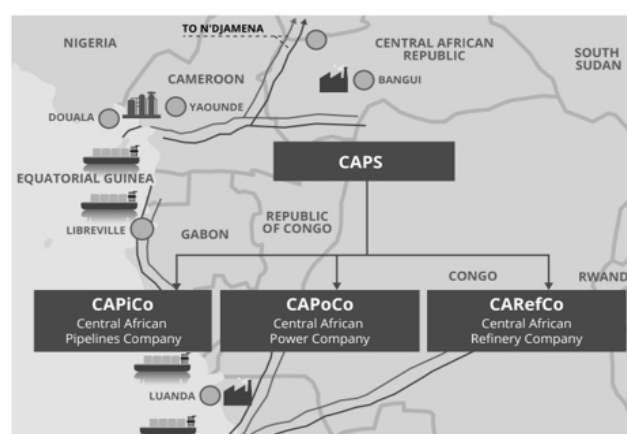
Meanwhile, Nigeria is trying to position itself as a regional export hub more actively. NNPC is promoting two export pipeline projects, the TSGP and the NMGP, while the private sector has proposed new onshore terminals and floating LNG projects. From the Nigerian perspective, the success of these ventures will now rely on the provision of an enabling business environment and the improvement of the security situation in the Niger Delta.

Côte d'Ivoire and Ghana are taking decisive measures to strengthen their domestic gas value

chains, as demonstrated by the proactive efforts of operators Eni and Tullow Oil to commercialise associated gas and eliminate flaring. As a result, a substantial increase in gas-to-power capacity is anticipated in the region, primarily in Senegal and Côte d'Ivoire.

Central African markets have accomplished the establishment of export facilities in Equatorial Guinea and Cameroon, despite possessing comparatively smaller gas reserves. Moreover, ongoing efforts are underway to construct additional export facilities in the Republic of Congo and Gabon.

Figure 4: Central African Pipeline System

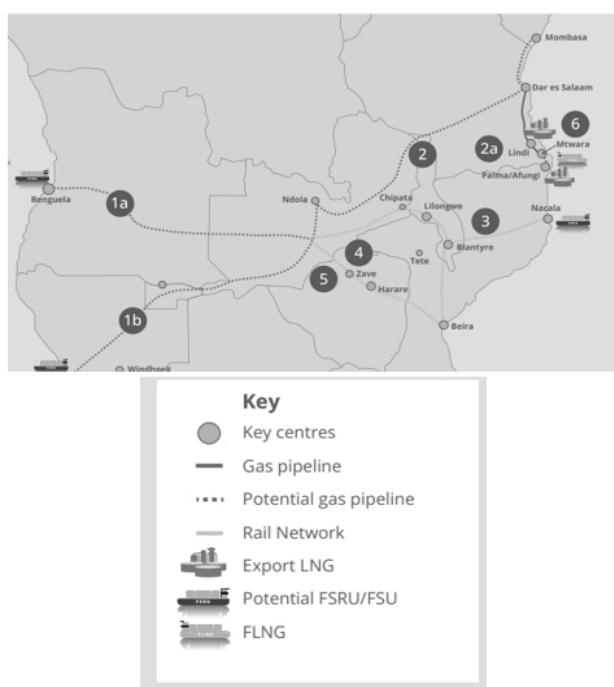


In order to fully capitalise on the gas potential in the Gulf of Guinea, particularly in the context of Equatorial Guinea's ambitions to become a regional gas hub, collaboration, and cooperation will be vital. Equatorial Guinea is actively seeking to revive the Fortuna FLNG project and establish its gas processing facilities at Punta Europa on Bioko Island as a central hub for processing stranded gas in the region^{xxxix}. While the country already enjoys strong regional leadership, its success in becoming a true gas hub will hinge on the enhancement of its business environment.

As noted, Congo is set to begin LNG exports in December 2023, with Eni's commissioning of the first floating LNG unit on its Marine XII block^{xli}. Additionally, the country heavily relies on gas for its power generation, with plans for a few more units underway. In a similar vein, Gabon aims to commence LNG exports by 2026 through the 0.7 MT / year Cap Lopez project proposed by independent operator Perenco^{xlii}.

South-western Africa is undergoing significant changes that will profoundly impact its energy future. For years, Angola has been a dominant force in gas production and exports in the region.

Figure 5: Current Gas Infrastructure Developments in Southern and Eastern Africa



From being a vital gas supplier to South Africa for the past twenty years, Mozambique has now transitioned into a role of exporting LNG since 2022. With ambitious intentions, Mozambique aims to substantially increase its LNG export capacity by 2030. As export facilities are being constructed in the northern

region, there is also a possibility of the country's capital in the south becoming an LNG import hub for the sub-region. Mozambique is also actively prioritising its domestic economy by undertaking various gas-to-power projects and bolstering its domestic liquified petroleum gas supply. However, although the Coral FLNG project is operating, construction of Mozambique LNG onshore has been held up by Islamist insurgent groups.

Meanwhile, South Africa considers gas as a viable alternative to coal and is making plans for LNG import terminals along its coastline to transition several gigawatts of coal-based power generation capacity. Notably, recent discoveries onshore and offshore are laying the groundwork for expanding the gas value chain, catering to established manufacturing and transport industries. Moreover, having entered the small LNG production sphere in 2022, the country aims to further exploit its domestic reserves to provide for industrial facilities and drive the decarbonisation of its transport sector.

The Venus, Graaf, Lesedi and Jonker deepwater fields in Namibia, discovered by TotalEnergies and Shell respectively, are estimated to hold 11 billion barrels of oil and 8.7 trillion cubic feet of gas^{xliii}. Oil production is intended to begin by 2030, while the scale of the gas resources could allow exports to South Africa and/or an FLNG project.

East African economies have traditionally relied on hydropower as their primary source of baseload power, resulting in a limited presence of gas. However, Tanzania is taking steps to change this by establishing a strong domestic gas value chain and exploring its extensive offshore reserves in the south, with plans to export LNG.



It already has a significant domestic gas supply, but the LNG project, involving Shell, ExxonMobil and Equinor, was held up for several years by political problems, until it was given approval to move ahead in May 2023. This development positions Tanzania not only as a potential strategic hub for the region but also as a potential supplier of gas to Kenya, where a significant portion of electricity generation hinges on heavy fuel oil and diesel. By replacing these sources with gas imports, Tanzania's aspirations for regional supply growth can be further supported. In addition, domestic projects like Ntorya in Tanzania have the potential to increase gas availability within the country and promote further integration of gas into the economy.

Ethiopia has the potential to establish itself as a significant player in the gas market in the coming years, but it is dependent on finding a new investor to develop its substantial gas reserves of 113 BCM in the Ogaden Basin, primarily located within the Calub and Hilala fields^{xliii}.

The initial plan was to construct a pipeline to Djibouti for LNG exports; however, this arrangement with a Chinese operator was terminated in 2022^{xlii}. In December, a small Australian company, Invictus, announced that it had found gas in Zimbabwe, which could help to replace coal in the country^{xlii}.

African governments can play a key role in securing financing for gas projects by adopting favourable fiscal policies. Independent and local players face challenges in obtaining funding due to limited options and stricter lending criteria.

The role of African governments is paramount in securing financing for gas projects. Many African nations have adopted progressive sliding-scale profit share, royalty, and tax rates, which facilitate swift cost recovery and are of significant interest to financiers. Implementing terms that allow for accelerated depreciation of capital for both cost recovery and tax

purposes, as well as expanding ring fences to enable producers to consolidate investments in new areas with revenues from existing areas, will further contribute to this effort.

Ongoing initiatives are underway in two key resource-rich countries in Africa to attract funding. Nigeria has made clear signals towards an impactful shift in fiscal and monetary policies, aimed at enhancing investment opportunities in the oil & gas industry^{xlvi}. Similarly, Angola has successfully negotiated improved terms in the upstream segment for multiple licenses, leading to increased exploration and development expenditure^{xlvii}.

Independent and local players in Africa face significant challenges due to limited funding options resulting from smaller balance sheets and stricter lending criteria imposed by African banks. This entails reducing costs, enhancing project delivery timelines, and establishing robust environmental, social, and governance credentials, including effective management of carbon emissions. Failing to meet these requirements will continue to deter potential lenders from providing financial support.

Most seriously, international banks, export credit agencies and multilateral financial institutions have increasingly ruled out investing in new fossil fuel production projects. Smaller international oil companies have also scaled back their activities, while even the large Western IOCs are very selective in new projects. Given Africa's shortage of domestic capital, this is a severe hindrance to major new projects.

European buyers are welcoming plans to double African LNG supply in the next ten years^{xlviii}. However, Africa faces challenges in commercialising its resources. Material risks often hamper exports, postpone start-up, and block financing and final investment decisions for projects.

Africa has three viable options for financing the upcoming phase of its gas industry. As international banks withdraw, Africa-focused / based banks will step in to assume the role, given their capacity to finance up to a third of the necessary investment in oil & gas projects across the continent. This transition promises enhanced liquidity in local currency lending, ensuring a more reliable source of funding.

The significance of traders providing production-based financing is on the rise. Recognising a market gap nearly a decade ago, these traders are now assuming substantial debt obligations for indigenous Nigerian players at a pace that commercial banks are unable to match. However, traders must also fulfil their own debt obligations, consequently leading to higher lending costs for third parties.

Multilateral lenders and development finance institutions have an opportunity to finance projects in Africa that align with local infrastructure and industrial development. Yet, at present, many of these institutions exhibit reluctance to finance directly upstream supply. On a more positive note, the African Export-Import Bank showcased its commitment last year by reaching an agreement with the African Petroleum Producers Organization to establish the African Energy Bank^{xlix}. This initiative reflects Africa's determination to secure funding for its oil & gas projects.

RUSSIA AND CENTRAL ASIA

The EU's decision to phase out Russian gas imports has affected Gazprom's upstream strategy and developments. Delays are expected in several projects. The Chayandinskoye and Kovyktinskoye fields aim to increase China's gas exports. Gazprom has a 25-year agreement with China's CNPC to deliver piped gas through the "Far Eastern Route". The Power of Siberia 2 Project's commissioning is uncertain. By 2026, Russian gas production is estimated to be 677 BCM / year^{li}.

The European Union's decision to phase out Russian gas imports entirely by 2027 has predominantly impacted Russia's upstream developments in the Nadym-Pur-Taz gas heartland of Western Siberia, and the Yamal Peninsula, which is mirrored in Gazprom's revised 2024 – 2033 10-year strategy, which no longer identifies Europe as a strategic market^{lii}.

The start-up of the 32 BCM / year Kharasavey field on the Yamal Peninsula has been postponed from 2023 to 2024, and the future production rates are still unclear^{liii}. The proposed expansion of the Bovanenkovo field's capacity from 115 BCM / year to 140 BCM / year is uncertain due to the lack of export offtake and is anticipated to be delayed beyond its projected timeline^{liv}.

Similarly, the supergiant Tambey field, initially scheduled to commence operations in 2026, is likely to face delays^{lv}. This field was intended to supply the proposed 18 BCM / year Baltic LNG Project; however, the project has hit a roadblock due to the withdrawal of Western engineering and construction service providers^{lvi}. It is sited mainly to supply Europe, and therefore has lost its rationale in the current political situation.

The 8.9 BCM / year Arctic LNG Train 1 has commenced operations this year, despite its ramp-up schedule and initial utilisation rates still being uncertain. The launch of Arctic LNG Train 2 is likely to be postponed to 2025, with production expected to increase between 2025 – 2026^{lvii}. The commission of Train 3 is also anticipated to be delayed beyond 2026.

In Eastern Siberia, the Chayandinskoye field is on track to achieve its 25 BCM / year capacity by 2024, facilitating an increase in piped gas supplies through the Power of Siberia Pipeline to China^{lviii}. The Kovyktinskoye field, officially commissioned and connected to the Power of Siberia pipeline system at the end of 2022, will also complement the efforts at the Chayandinskoye field^{lix}. The consistent growth of these two fields will enable Russia to expand its piped gas exports to China to 38 BCM / year by 2025 via the Power of Siberia Pipeline^{lx}.

Gazprom has entered into a 25-year contract with China's CNPC to deliver 10 BCM / year of piped gas through the "Far Eastern Route"^{lxi}. The source of supplies is the 21 BCM / year Yuzhno-Kirinskoye field offshore Sakhalin Island, which is scheduled to be commissioned by 2025 and is expected to initially produce 5 BCM / year^{lxii}. However, this seems to be something of a "consolation prize" from China, given the indefinite delays to the more strategic Power of Siberia 2 pipeline.

The 50 BCM / year Power of Siberia 2 pipeline would run from Yamal across Mongolia to north-eastern China. It is unlikely to be commissioned within its planned timeline of 2030^{lxiii}, due to the lack of a long-term offtake agreement with Chinese buyers^{lxiv}.



China has historically not wanted to compete with European buyers of Russian gas, and has therefore focussed on non-connected Russian pipelines. That motivation may now not be relevant, but Beijing knows it is in a strong bargaining position. Although it wants to boost its overland gas import capacity to avoid too much reliance on seaborne LNG, it also does not want to be too dependent on Russia, which has shown itself to be an unreliable supplier.

In 2023, Russia's gas production is expected to drop by 50 BCM / year, or 8% y-o-y, marking its lowest output since 2009^{lxv}. This will naturally necessitate downward adjustments in Russia's upstream activities, particularly across ageing fields of the Nadym-Pur-Taz region, which are more susceptible to production shutdowns. Consequently, by 2026, Russian gas production is estimated to remain at 677 BCM / year, and less than 2021 production levels of 721 BCM, which was an all-time high^{lxvi}.

Turkmenistan's gas production has evolved with the operational Galkynysh field and increased output from CNPC's Bagtyarlyk and Petronas's Caspian projects. Galkynysh, in its third development phase, is one of the world's biggest fields and could yield 200 BCM / year if fully developed^{lxvii}. China is now the main destination for Turkmen gas exports, currently at 35 BCM / year^{lxviii}. Gazprom and Turkmengaz resumed exports in 2019 under a five-year contract after a 2015 halt due to pricing issues.

Turkmenistan's gas production profile has undergone three major changes in recent years. First, the supergiant Galkynysh field has become operational, boasting a production and processing capacity of 30 BCM / year. Second, two fields managed by foreign companies, CNPC's onshore Bagtyarlyk field, which exports to China, and Petronas's Caspian offshore project in Block No. 1, which sells to Turkmengaz for onshore processing have seen a rapid increase in production.

The Galkynysh gas field has the potential to produce a consistent 200 BCM / year if developed across seven phases^{lxi}. That would be larger than Qatar's North Field, the world's currently biggest producing field (excluding US shales which are continuous accumulations rather than discrete fields). At present, the field is in its third phase of development, set to boost gas production to 95 BCM / year^{lxx}. The reserves of Galkynysh, inclusive of the Yashlar and Garakel fields, are estimated at 27 TCM^{lxxi}.

The first phase already produces 30 BCM / year, a portion of which is supplied domestically and to China via three strings of the Turkmenistan-Uzbekistan-Kazakhstan-China gas pipeline^{lxxii}. Negotiations for the second phase are in progress, with the produced gas intended to supply an additional 25 BCM / year to China through the fourth string (Line D) of the pipeline, extending from Turkmenistan to China via Uzbekistan, Tajikistan, and Kyrgyzstan^{lxxiii}. Negotiations over Line D have been lengthy and it has to cross difficult mountainous terrain. The third phase aims to supply an extra 33 BCM / year through the Turkmenistan-Afghanistan-Pakistan-India (TAPI) Pipeline, which is currently in early construction but whose prospects of completion look very doubtful because of the difficult political and economic situations in Afghanistan and Pakistan^{lxxiv}.

Apart from Galkynysh, the Bagtyarlyk field, near Turkmenistan's border with Uzbekistan, by CNPC started production in 2009 and has now reached a stable output of 13 BCM / year, all of which is exported to China.

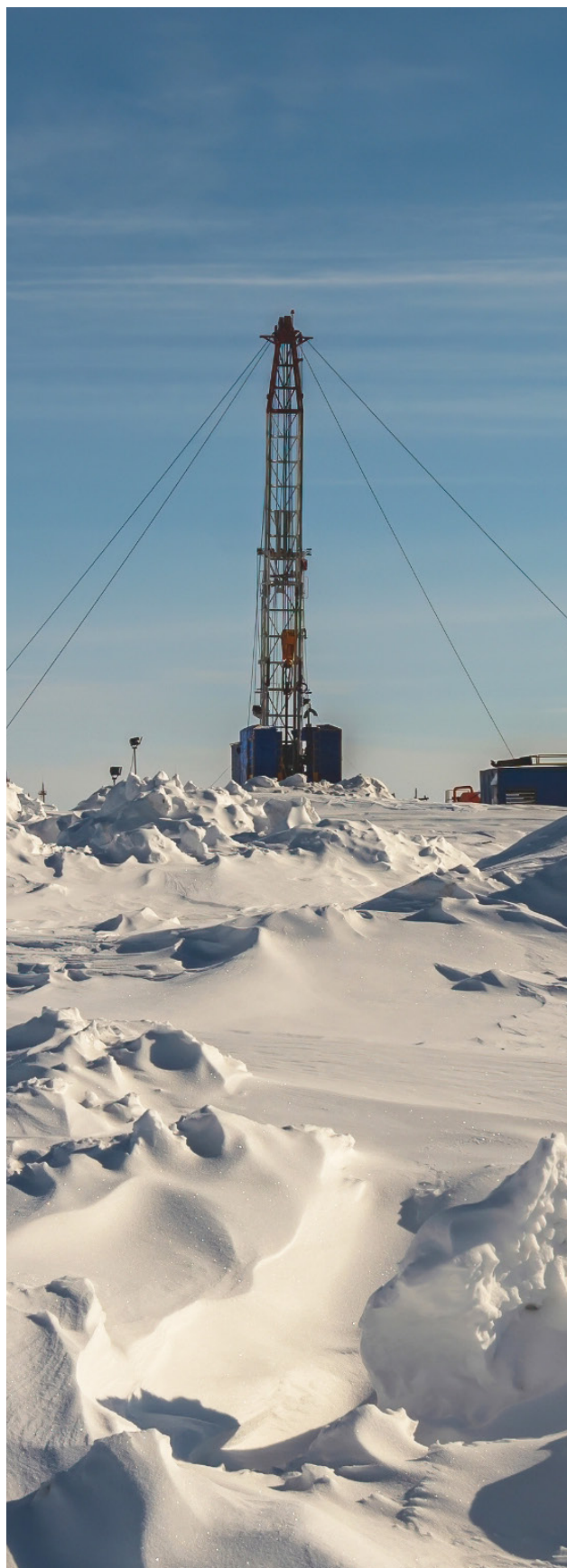
China has emerged as the primary export destination for Turkmen gas exports, which currently amount to 35 BCM / year^{lxxv}. The China-Turkmenistan gas pipeline, with a current capacity of 55 BCM / year, is expected to reach a flow capacity of 85 BCM / year upon completion^{lxxvi}. The pipeline's first three lines were commissioned in 2009, 2010, and 2014, respectively. While there is no confirmed completion date for the fourth line, China is expediting its construction to source gas from Turkmenistan, even as Russia advances its new Siberian connection. This move reflects China's efforts to balance its energy security needs with diplomatic priorities^{lxxvii}.

Figure 6: Galkynysh Gas Field and Pipelines



In 2009, Turkmenistan was forced significantly to reduce its gas exports to Russia, which was its primary export market. As demand in Europe and Russia declined, Gazprom reduced its purchases to 10 – 11 BCM / year and sought a revision of the oil-linked price formula agreed upon with Turkmengaz in 2008^{lxxv.ii}. When no agreement was reached, Gazprom ceased all purchases in 2015 and initiated arbitration proceedings for a price revision^{lxxix}. In 2018, following improvements in Russia-Turkmenistan relations and progress in the previously stalled Caspian Sea delimitation talks, the arbitration claim was dismissed^{lxxx}. By April 2019, Gazprom and Turkmengaz had agreed to resume exports under a five-year supply contract, delivering 5.5 BCM / year from 2019 – 2024^{lxxxi}.

Iran was the second largest importer of Turkmen gas after Russia over the last two decades. In 2017, Turkmenistan halted deliveries to Iran, claiming US\$ 4.5 billion was outstanding for gas supplied in previous years^{lxxxii}. The National Iranian Gas Company said that most of this money had been paid, but the dispute went to arbitration in 2018^{lxxxiii}. In 2017, the Damgan-Neka Pipeline was completed to bring gas from southern Iran to the northern areas previously supplied by Turkmenistan^{lxxxiv}. In 2021, Iran, Turkmenistan, and Azerbaijan signed a gas swap deal for ~2 BCM / year, through which Iran will receive gas from Turkmenistan and deliver an equivalent amount to Azerbaijan^{lxxxv}.



Africa is projected to more than double its gas production by 2050, with Nigeria and Mozambique driving the growth. Russia and Central Asia rank as the second largest gas-producing region globally (after North America), with Russia accounting for over half of the region's increase in production by 2050. The Middle East is the third-largest gas-producing region, with Iran, Qatar, and Saudi Arabia being key players. Qatar is expected to lead the charge in gas production growth with the highest annual rate.

Africa is poised to make significant contributions to the global gas supply, thanks to its abundant onshore and offshore reserves across the continental shelf and deepwater regions. However, the untapped potential of these resources remains largely unexplored due to various challenges. These include inadequate investments, lack of transportation and export infrastructure, technological limitations in deepwater exploration, and an insufficient pipeline network.

Despite these obstacles, Africa's future in the gas sector holds great promise. It is the only region projected to witness more than a doubling of gas production growth, surging from 249 BCM / year in 2022 to 585 BCM / year in 2050, corresponding to an annual growth rate of 3% / year^{lxxxvi}. This growth will largely be driven by Nigeria and Mozambique, which are expected to account for 63% of Africa's output expansion by 2050^{lxxxvii}.

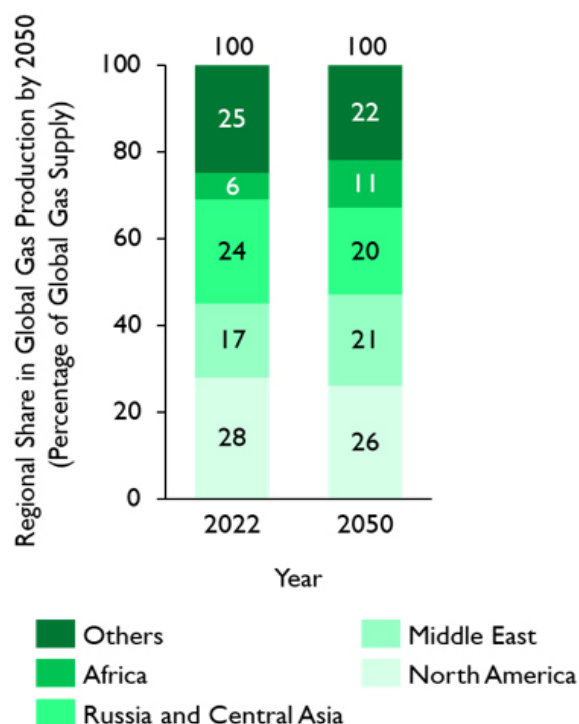
Russia and Central Asia rank as the second largest gas-producing region globally, trailing only North America. In 2022, the region's gas production reached 805 BCM / year, representing a notable 20% of the global output^{lxxxviii}. By 2050, the region will witness a significant expansion, adding over 155 BCM / year to its

current production levels^{lxxxix}. This growth will primarily be driven by Russia, accounting for more than 59% of the overall increase^{xc}. Turkmenistan, Kazakhstan, and Azerbaijan are also expected to contribute a larger share to the region's output in the long term. But Russia's expansion depends critically on the future of relations with Europe, and whether it is able to reorient exports to China and the global LNG market. Despite this growth, the region will lose market share to the Middle East and Africa.

The Middle East is the world's third-largest gas-producing region, accounting for 18% of global output^{lxc}. Over the years, production in the region has experienced rapid growth, with an impressive annual increase of 3% / year from 545 BCM / year in 2012 to 721 BCM / year in 2022^{xcii}. Notably, Iran, Qatar, and Saudi Arabia serve as key players, accounting for 78% of the Middle East's total gas output^{xciii}. These three nations will continue to be gas production hotspots until 2050, with Qatar expected to lead the charge with an annual growth rate of 3% / year, the highest among the three countries^{xciv}.

Global gas trade will continue to increase by 2050, with LNG trade surpassing long-distance pipeline trade by 2026^{xcv}. The spot market for LNG is experiencing high demand and prices, leading to more long-term supply contracts. European gas imports are projected to decrease by 80 BCM / year by 2050, with a focus on reducing reliance on Russia^{xcvi}. Global liquefaction capacity is set to surpass 1 billion tonnes / year by 2050, with the Asia-Pacific region witnessing the largest additions to regasification capacity^{xcvii}. Russia plans to expand its LNG export capacity, while Africa has the potential to become a more significant LNG exporter.

Figure 7: Regional Share in Global Gas Production by 2050



Global gas trade is projected to increase between 2022 – 2050, reaching an annual volume of 1,700 BCM / year, accounting for almost one-third of the world's gas demand^{xcviii}. Furthermore, LNG trade is anticipated to surpass long-distance pipeline trade by 2026 and is expected to more than double by 2050, reaching an annual volume of 850 MT / year^{xcix}.

The current spot market for LNG is experiencing high levels of demand and prices, leading to a rise in long-term supply contracts. In 2022 alone, 65 MT (88 BCM) / year of LNG supply contracts were established^c. The Asia-Pacific region dominated the end-user contracts, accounting for two-thirds of the total, with China alone responsible for approximately half of the newly concluded volumes^{ci}.

By 2050, European gas imports are projected to decrease by 80 BCM / year^{cii}. This decline

will primarily occur before 2030, as countries strive to decrease their reliance on gas and reduce imports from Russia. In order to meet their short and medium-term LNG import needs, the European bloc is actively expanding and augmenting its regasification capacity, particularly in Germany.

Global liquefaction capacity is set to surpass 1 billion tonnes / year by 2050, with an estimated utilisation rate of 80%^{ciii}. Looking ahead, regasification capacity could potentially reach a substantial 1.8 billion tonnes / year by 2050, with utilisation just under 50% based on current demand projections^{civ}. Notably, the Asia-Pacific region is expected to witness the largest additions to regasification capacity by 2050^{cv}.

Russia's 2035 energy strategy outlines the ambitious plan to expand the country's LNG export capacity from the current 30 MT / year to a range of 80 – 140 MT / year by 2035^{cvi}. This strategy emphasises the exploration of new markets for LNG, particularly in developing Asian economies. Additionally, it addresses the pressing need for technological advancements in the face of restrictive sanctions that limit the import of LNG industry equipment and technology. Novatek, a leading player in the Russian LNG sector, aims to inaugurate the first train of its Arctic LNG 2 venture by the end of 2023. Notably, Arctic LNG 2 will mark Novatek's second LNG project in the polar region, building upon the success of Yamal LNG, which commenced operations in 2017.

Africa has the potential to become a more significant LNG player, with its liquefaction capacity projected to increase three-fold, from the current 71 MT / year to an impressive 200 MT / year by 2050^{cvi}.

This growth will be driven by planned projects, which, if realised, will pave the way for sub-Saharan African countries like Mozambique, Tanzania, Mauritania, and Senegal to emerge as key exporters of LNG from the continent.

To achieve Africa's long-term gas supply goal by 2050, a total investment of US\$ 1.7 trillion is needed, with a focus on countries like Algeria, Egypt, Southern and Eastern Africa, and Nigeria^{cxviii}. Deepwater developments will receive the majority of investments in sub-Saharan Africa. Midstream investment will be driven by projects in Mozambique, Tanzania, Mauritania, Nigeria, Egypt, and Senegal. In the Russian and Central Asia region, a significant investment of US\$ 2.5 trillion is required to enhance gas production, particularly in challenging basins^{cix}.

In 2022, African upstream gas investments showed a strong increase, reaching US\$ 34 billion, surpassing the previous year's investment of US\$ 25 billion driven by greenfield investments in sub-Saharan Africa and brownfield developments in North and West Africa^{cx}.

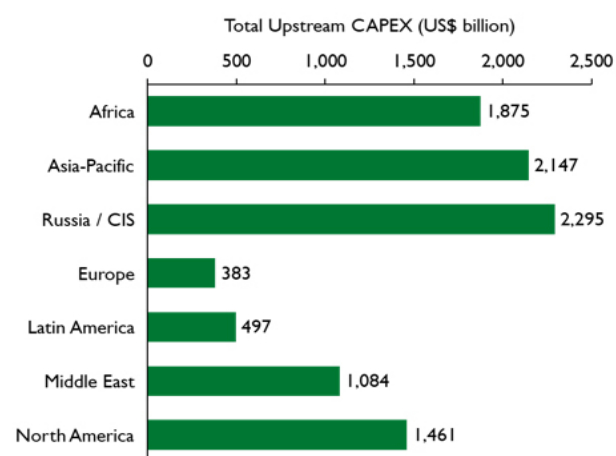
In order to meet Africa's long-term goal of supplying 585 BCM / year by 2050, a total upstream investment of US\$ 1.7 trillion will be required^{cx}. The majority of this investment, accounting for 84%, will be focused on countries such as Algeria, Egypt, Southern Africa, and Nigeria.

In Sub-Saharan Africa, the primary focus of upstream gas investment will be on deepwater developments. By 2050, deepwater investments will make up 70% of the total upstream investment in the region. Mauritania and Senegal have successfully attracted investment for the deepwater Greater Tortue Ahmeyim project, thanks to the appeal of their agreements with international oil companies, led by BP.

African midstream investment will be driven by new projects in Mozambique, Tanzania, and Mauritania, as well as to a lesser extent in Nigeria, Egypt, and Senegal. These countries will collectively contribute to total spending surpassing US\$ 115 billion, with 61% of the investment anticipated to occur in the 2030s^{cxii}. New entrants, notably Namibia, could also take a prominent role.

To enhance gas production in the Russian and Central Asia region by 2050, a substantial upstream investment of around US\$ 2.5 trillion will be required^{cxiii}. This substantial investment is primarily driven by the significant funding necessary for challenging basins such as the offshore Kara Sea and the Yenisey-Khatanga Basin in the Arctic.

Figure 8: Total Upstream CAPEX by 2050





The production and distribution of challenging gas resources in regions such as the Eastern Mediterranean, Africa, Russia, and Central Asia have historically been difficult. However, with the help of commercial and technical advancements over the past two decades, the process has become more manageable.

Despite this progress, those who possess substantial gas resources must now also consider additional factors to ensure the long-term viability of their gas supply. These factors include market dynamics, geopolitical issues, environmental concerns, and changing energy policies. By addressing these considerations, gas producers are navigating the evolving landscape and securing a sustainable future for their gas supply in the medium-term with long-term implications.

The Eastern Mediterranean region, including Israel, Cyprus, and Egypt, has seen a boost in gas exports due to significant discoveries in deepwater basins. However, the high demand for gas, particularly in Egypt, limits the available gas for export. To meet this demand, further exploration efforts are necessary to increase gas reserves.

There are two main options for commercialising the gas discoveries in the region: long-distance gas pipelines or seaborne LNG deliveries. Pipelines have the potential to accommodate hydrogen transportation, while LNG options involve leveraging existing projects in Egypt, establishing a new project in Cyprus, or constructing a floating LNG facility in Israel. Another option is a subsea electricity line connecting Greece, Cyprus, and Egypt, which offers flexibility and potential for regional integration and decarbonisation.

Options that go beyond fossil fuel dependence will find more acceptance in Europe and from international financiers. Still, any project has to navigate the region's complex politics and maritime boundaries.

In North Africa, Egypt and Algeria are the leading gas-producing nations. They are collaborating with international energy companies to pursue gas and hydrogen projects. Sub-Saharan African, such as Nigeria, Mauritania, Senegal, Ghana, and Mozambique, are also increasing their gas production and export capabilities. Tanzania and possibly Ethiopia are exploring their gas reserves to become significant players.

In order to secure financing for gas projects in Africa, favourable fiscal policies implemented by African governments can play a crucial role. However, independent and local players face funding challenges due to limited options and stricter lending criteria.

European buyers are eager to see African LNG supply double in the next decade. However, commercialising African gas resources faces obstacles, including material risks that impede exports, delay project start-ups, and hinder financing and investment decisions.

The European Union's decision to eliminate its reliance on Russian gas imports has impacted Russia's upstream gas plans. Projects such as the Chayandinskoye and Kovyktinskoye fields, which are crucial for China's gas imports, are expected to experience delays.

Turkmenistan's gas production has seen advancements with the successful operation of the Galkynysh field and increased output from CNPC's Bagtyarlyk and Petronas's Caspian projects. China is the primary market for Turkmen gas exports.

By 2050, Africa is projected to experience a significant increase in gas production, mainly driven by Nigeria and Mozambique. Russia and Central Asia hold the second spot in global gas production today, but they will be narrowly overtaken by Africa by 2050. Russia alone is projected to account for over half of the growth in the region by 2050.

The global gas trade is expected to continue expanding, with LNG trade surpassing long-distance pipeline trade by 2026. European gas imports are projected to decline by 2050, driven by the need to manage the gas created by the Russian supply.

To achieve Africa's long-term gas supply goal by 2050, countries like Algeria, Egypt, Southern Africa, and Nigeria require a total investment of US\$ 1.7 trillion, with a focus on deepwater developments. Mozambique, Tanzania, Mauritania, Nigeria, Egypt, and Senegal will drive midstream gas investments across Africa. In the Russian and Central Asia region, a significant investment of US\$ 2.5 trillion is needed to enhance gas production, especially in challenging basins.

Successful projects will align the key success factors of technology, infrastructure, politics, commercial, market, environment, and financing. The three broad regions described in this study face different combinations of these challenges and are dealing with them in different ways.

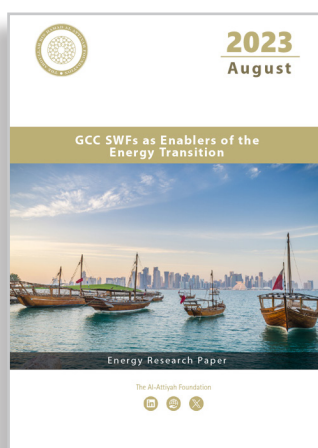
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GCC SWFs as Enablers of the Energy Transition

The last decade has seen a sharp rise in GCC SWFs' investments in developed countries, as a result of which their accumulated assets have dramatically increased. Although investments in large, advanced economies and prominent emerging markets are likely to continue in the next few years, GCC SWFs are now increasingly recycling part of their petrodollar inflows into developing economies in the Middle East.



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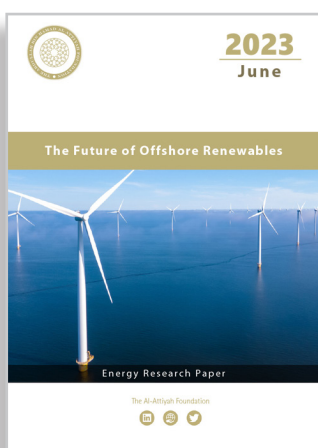
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Future of Unconventionals in a Low-Carbon World

Over the past 20 years, unconventional resources have become a significant part of the global energy mix, accounting for one-third of the world's total oil & gas supplies. However, to achieve net-zero goals by 2050-2070 and the Paris Agreement's target of keeping global temperature increases below 1.5°C, a significant transition is required in the next 30 years.



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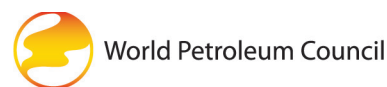
The Future of Offshore Renewables

Offshore renewable resources can be captured through various technologies such as offshore fixed or floating wind turbines, floating solar photovoltaic panels, wave and tidal conversion systems, and other ocean energy technologies such as ocean thermal energy conversion and salinity gradient.



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