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Eastern Mediterranean Deepwater Gas to Europe: Not Too Little, But Perhaps Too Late

By **Dr. Shangyou Nie** and **Robin Mills**
March 2023

REPORT

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Table of Contents

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He is the author of two books, The Myth of the Oil Crisis, which evaluates global long-term oil supply, and Capturing Carbon, the first comprehensive overview of carbon capture and storage for the non-specialist, and co-editor of Low-Carbon Energy in the Middle East and North Africa. He is the columnist on energy and environmental issues at The National newspaper (Abu Dhabi) and comments widely on energy issues in the media, including Foreign Policy, the Financial Times, The Atlantic, CNN, CNBC Arabiya, BBC, Al Jazeera, Bloomberg, Sky News and others.

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Executive Summary

The Russian invasion of Ukraine in February 2022 precipitated a global energy crisis with Europe as its epicenter. The war compelled Europe to endeavor to end its long-standing dependence on Russian natural gas, a goal that required diversification of supply. This process has proven challenging, however. Compared with oil, which is relatively fungible, gas is difficult to redirect due to high capital costs and long lead times for pipelines and liquefaction plants.

Amid this crisis, one region that has emerged as a promising new gas source for Europe is the Eastern Mediterranean, particularly Israel, Egypt, and Cyprus. Since 1999, exploration in deepwater basins in these three countries has resulted in the discovery of approximately 2,400 billion cubic meters (Bcm), or 80 trillion cubic feet (Tcf), of gas resources. Moreover, exploration is ongoing and new discoveries are possible, meaning that even greater volumes of gas could be available in the future.

This report, part of the work by the Center on Global Energy Policy, Columbia University SIPA, on oil and gas and the energy transition, focuses on the aforementioned three countries' prospects of supplying gas to Europe from a technical, geopolitical, and economic perspective. Drawing on company, government, and press sources, the report finds that such gas can meaningfully contribute to European energy security, though mainly in the medium term and only given the involvement of external players—likely the US and/or the EU—and with buy-in from Eastern Mediterranean countries, which will need to see an upside in terms of their own energy security and energy transition.

Additional takeaways of the report are as follows:

- In the short term, existing Egyptian liquefied natural gas (LNG) export plants could make the greatest contribution, which can be maximized by measures to boost Egypt's energy efficiency and renewable capacity.
- In the medium term, and on an aggressive timeline for field development, the Eastern Mediterranean could have a surplus of approximately 50 Bcm/y of gas production by the early 2030s. Even more could be available if significantly more gas is discovered in Cyprus, Israel, Egypt, or elsewhere in the region and if demand growth in Egypt can be contained.
- How much of this surplus could be available to Europe remains to be determined. Eastern Mediterranean countries, especially Egypt, have strong domestic demand that governments in the region will prioritize. By contrast, the companies that own or operate the gas fields will be eager to take advantage of profitable export options, especially though not exclusively

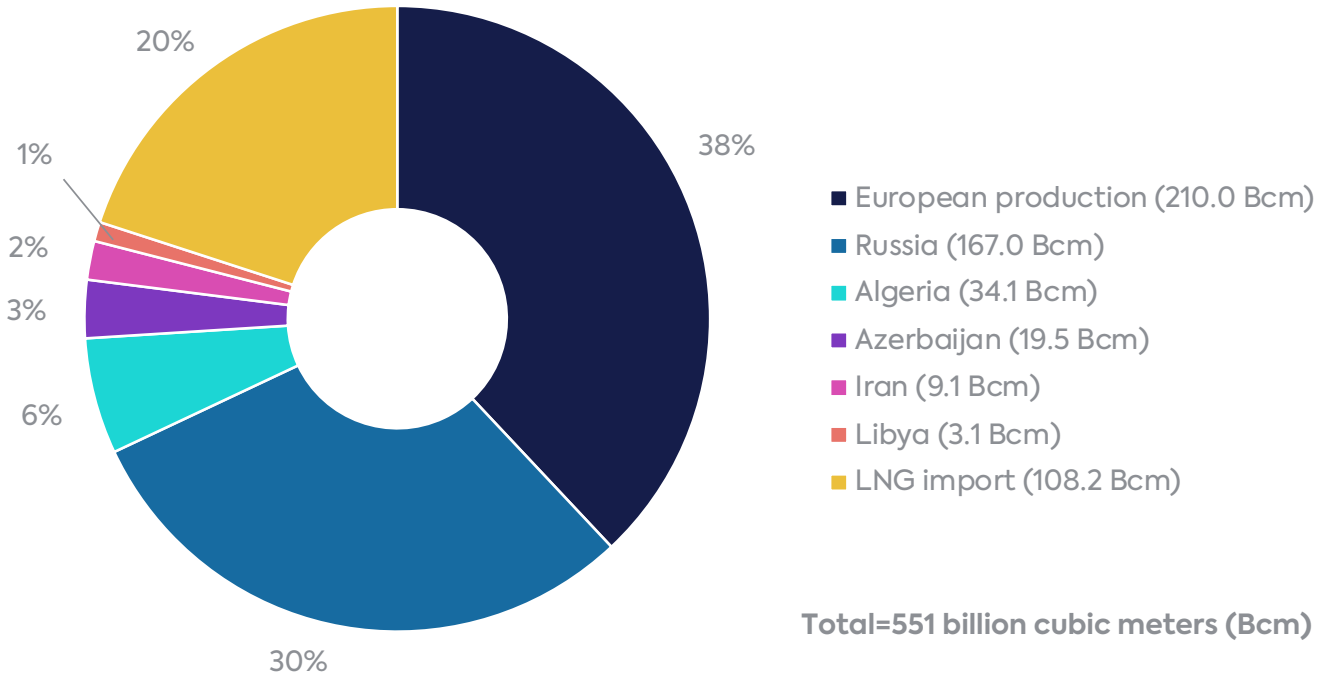
in Europe. Doing so will depend on their ability to establish appropriate arrangements with regional governments as well as Egypt's ability to raise domestic prices and thereby attract pipeline imports.

- Any plan to supply Europe with this gas will need to contend with the Eastern Mediterranean's complex politics. Regional rivalries and conflicts make constructing new pipeline connections with Europe challenging, especially in combination with Europe's reluctance to commit to any new long-term fossil fuel infrastructure. In meeting European demand, companies with Eastern Mediterranean gas resources are therefore likely to prioritize LNG options, including using existing LNG terminals in Egypt and constructing new (floating) LNG plants in Israel and/or Cyprus.

1. Introduction

Europe is in an energy crisis as it tries to break free of its dependence on Russian gas imports. This crisis is focused on natural gas. In 2021, Europe[1] produced only 210 billion cubic meters (Bcm), or 38 percent of its natural gas consumption, whereas Russian pipeline gas exports to Europe amounted to 167 Bcm, or 30 percent of Europe's total gas supply of 551 Bcm (Figure 1).

Figure 1: European total gas supply by source, 2021



Source: BP Statistical Review of World Energy 2022, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf.

On March 8, 2022, soon after Russia's invasion of Ukraine, the European Commission announced its REPowerEU plan "to make Europe independent from Russian fossil fuels well before 2030, starting with gas." In addition to boosting energy savings, stocking up EU member states' gas storage, and increasing renewables, the new policy prioritized the need to "diversify gas supplies, via higher liquefied natural gas (LNG) and pipeline imports from non-Russian suppliers."[2]

In this regard, like several other gas-producing regions adjacent to Europe,[3] the Eastern Mediterranean[4] has emerged as a potentially key new supply region, thanks to 2,400 Bcm, equivalent to more than 80 trillion cubic feet (Tcf),[5] of offshore gas discoveries made over the past two decades in Israel, Cyprus, and Egypt.

This analysis addresses this potential from a technical, economic, and political perspective. It concludes that Eastern Mediterranean gas can play a secondary role in diversifying European supply, though only in the medium term (the latter part of the next decade) and therefore not in time to help fulfill Europe's more urgent gas needs. Moreover, the fragmented national and corporate ownership of these gas resources, as well as related geopolitical challenges, means that their successful development will require support from the EU, the US, and other partners. In attempting to solve the European energy crisis and guarantee European energy security, these partners could benefit from a holistic approach to Eastern Mediterranean resources.

2. Natural Gas Resource Base and Exploration Potential in the Eastern Mediterranean

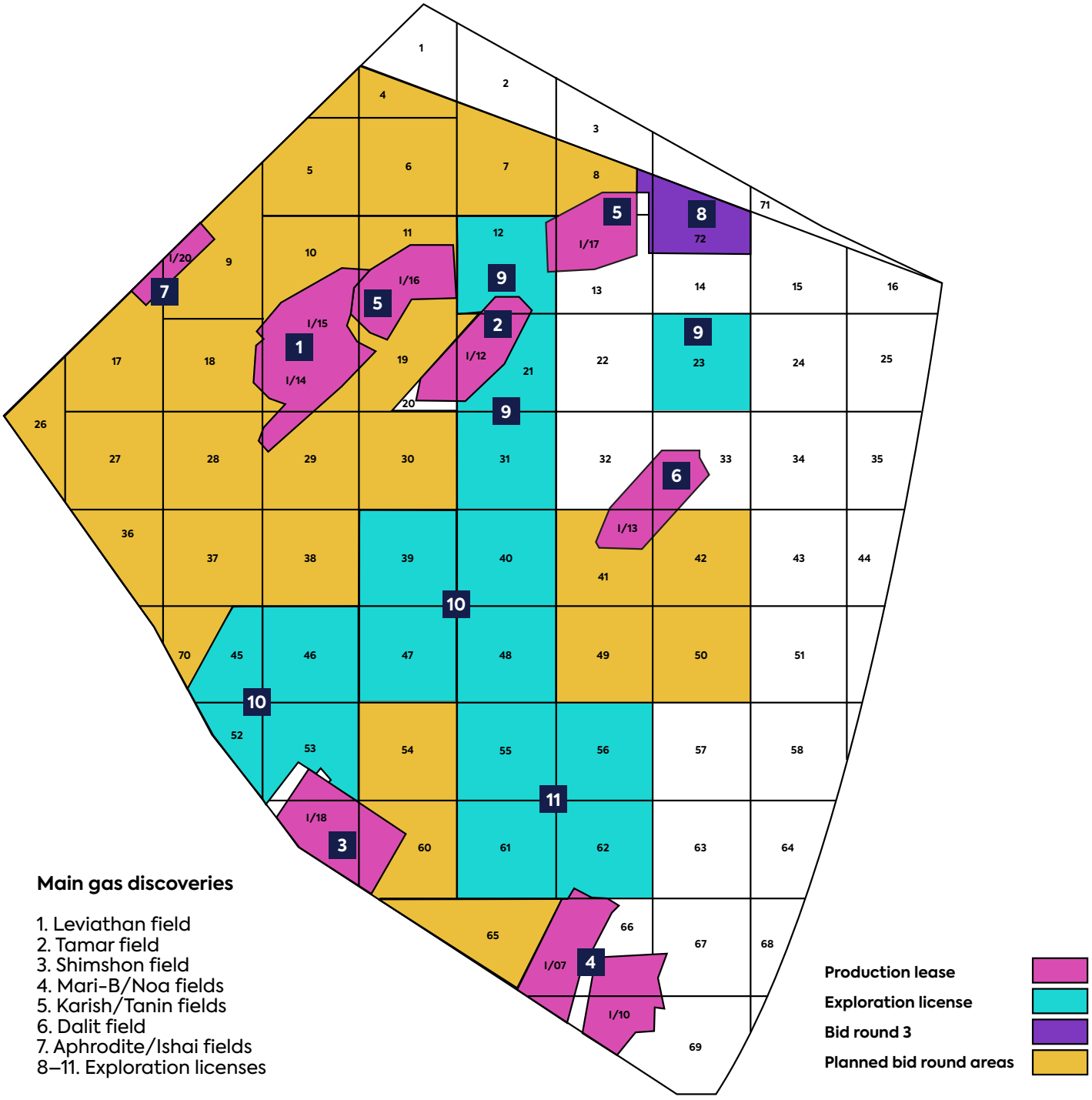
Since 1999, a total of 2,435 Bcm (86 Tcf) of recoverable gas has been discovered in offshore basins of the Eastern Mediterranean in Israel, Egypt, and Cyprus (Table 1). The history of offshore gas exploration and development in this region can be divided into four periods.

2.1 Initial Success (1999–2008)

For many decades, Israel was labeled an "energy desert" within the oil- and gas-rich Middle East. Although exploration in the country started as early as the 1950s,[6] only a few small oil and gas fields were discovered before 1999.

In the late 1990s, Delek Drilling CEO Isaac Tshuva invited American independent oil and gas company Noble Energy to join Delek's offshore exploration efforts.[7] (Delek Drilling was renamed NewMed Energy in February 2022; Noble Energy was acquired by US major Chevron in October 2020.) The partnership signed numerous offshore blocks in the Levant Basin in 1998 and made the first two gas discoveries, Noa and Mari-B, in 1999 and 2000, respectively (Figure 2), containing a total of 34 Bcm (1.2 Tcf) of gas reserves. Mari-B was located at a water depth of 235 meters (m) about 40 kilometers west of the coastal city of Ashkelon, while Noa was located at a depth of 790 m in the deeper part of the basin.[8]

Figure 2: Discovered gas fields and exploration licenses in offshore Israel



Source: Israeli Ministry of Energy, https://www.energy-sea.gov.il/English-Site/Pages/Offshore%20Bid%20Rounds/Tender_Block_Delineation.aspx.

In 2000, BG (acquired by Shell in 2016) found the Gaza Marine field,[9] located at a depth of 603 m near Mari-B, with about 28 Bcm (1 Tcf) of gas contingent resources. The field lies in the marine area adjoining the Gaza Strip, between Israeli waters to the northeast and Egyptian waters to the southwest.

These two commercial discoveries, though relatively small, turned out to be critically important for three reasons: (1) they proved that offshore Israel had a working hydrocarbon system and the potential for more significant commercial gas in the future; (2) the shallow water location of Mari-B allowed for a production platform (and additional shallow water platforms) to be constructed, through which Noa and subsequently more substantial deepwater gas fields were connected via subsea gas pipelines to enable economic development;[10] and (3) they initiated the development of an Israeli gas market and policy, though for political reasons the Gaza Marine gas field was much more difficult to develop.

Unlike oil, which can be readily transported by oil tankers and commercialized relatively quickly as an international commodity, natural gas discoveries, particularly those in deepwater settings, tend to take a long time to develop. Gas needs to have a ready local or regional market with commercially viable gas prices—unless the resource base is large enough to be monetized via either a long-distance international pipeline or an LNG plant, both of which require significantly more capital investment, often reaching to several billion dollars.

Noble Energy and its partners were able to bring both the Mari-B and the Noa fields into production in 2003 to feed local Israeli energy needs. For almost a decade, however, no other offshore gas discoveries were made in Israel (Table 1), not because the exploration programs were unsuccessful but because few exploration wells were drilled in this period. This relative lack of drilling was attributable to two factors: (1) Noble Energy was an independent, oil-focused company; and (2) Noble Energy and its partners, as well as the Israeli Ministry of Energy, were trying to formalize the market and regulatory situation.

Table 1: Gas fields in Eastern Mediterranean offshore basins

Country	Field	Operator (working interest)	Partners (working interest)	Recoverable reserves (trillion cubic feet)	Recoverable reserves (billion cubic meters)	Year of discovery	Water depth (m)	Status	Year of first production	Notes
Israel	Noa	Noble Energy (47%)	NewMed Energy (53%)	0.2	6	1999	790	Depleted	2012	First commercial offshore gas field of Israel, discovered by the Tethys Sea Partnership of Samedan (a previous name for Noble Energy) and Delek. The field was in production from 2012–2014 and is now depleted.
	Mari-B	Noble Energy (47%)	NewMed Energy (53%)	1	28	2000	235	Depleted	2003	
Palestinian Authority	Gaza Marine	Palestine Investment Fund (100%)	n/a	1	28	2000	603	In develop-ment	n/a	Egypt's EGAS reportedly will lead development of the gas field. BG was the original operator and 90% owner of the field discovered in offshore Israel/Palestine.
Israel	Tamar	Chevron (25%)	Isramco (28.75%), Mubadala (22%), Tamar Petroleum (16.75%), Dor (4%), Everest (3.5%)	11.2	317	2009	1,680	In product-ion	2013	Original discovery was made by Noble Energy. Mubadala acquired its equity from Delek in December 2021 with subsidiary Tamar Investment 1 RSC Ltd and Tamar Investment 2 RSC Ltd. Original discovery was made by Noble Energy, acquired by Chevron in 2020.
	Dalit	Chevron (25%)	Isramco (28.75%), Mubadala (22%), Tamar Petroleum (16.75%), Dor (4%), Everest (3.5%)	0.5	14	2009	1,380	In appraisal	n/a	Original discovery was made by Noble Energy, acquired by Chevron in 2020.
	Levia-than	Chevron (40%)	NewMed Energy (45%), Ratio (15%)	22.0	623	2010	1,650	In product-ion	2019	Current company names are used. NewMed was previously called Delek Drilling.

Continued on next page

Country	Field	Operator (working interest)	Partners (working interest)	Recoverable reserves (trillion cubic feet)	Recoverable reserves (billion cubic meters)	Year of discovery	Water depth (m)	Status	Year of first production	Notes
Israel (cont'd)	Tanin	Energean (100%)	n/a	0.9	25	2012	1,750	In appraisal	n/a	Energean acquired from Delek in 2016. Original discovery was made by Noble Energy.
	Shim-shon	ATP (40%)	Isramco (39%), other minority owners (21%)	0.2	6	2012	1,100	In appraisal	n/a	ATP bought into the license in June 2011.
	Karish	Energean (100%)	n/a	1.1	31	2013	1,750	In product-ion	2022	Energean acquired from Delek in 2016. Production started on October 26, 2022.
	Karish North	Energean (100%)	n/a	1.4	40	2019	1,731	In develop-ment	2H 2023 (estimated)	First new deepwater gas field found in Israel in past five years. Will be developed through a subsea tieback to Energean FPSO.
	Athena	Energean (100%)	n/a	0.4	12	2022	n/a	In appraisal	n/a	Energean announced on May 9, 2022, that Athena well is a commercial gas discovery in Block 12, and provided a volume update in a November 7, 2022, press release.
	Hermes	Energean (100%)	n/a	0.4	11	2022	n/a	In appraisal	n/a	Energean announced on October 6, 2022, that Hermes well has made a commercial discovery of 7–15 bcm in Block 31.
	Zeus	Energean (100%)	n/a	0.4	13	2022	n/a	In appraisal	n/a	Energean announced on November 7, 2022, that it has made a commercial discovery of 13.3 bcm at Zeus in Block 12.
Israel and Palestinian Authority subtotal				**40.7**	**1,153**					

Continued on next page

Country	Field	Operator (working interest)	Partners (working interest)	Recoverable reserves (trillion cubic feet)	Recoverable reserves (billion cubic meters)	Year of discovery	Water depth (m)	Status	Year of first production	Notes
Cyprus	Aphro-dite	Chevron (35%)	Shell (35%), NewMed Energy (30%)	4.5	127	2011	1,689	In appraisal	n/a	Main field is located in Cyprus economic zone, with some (estimated to be less than 10%) in Israeli waters. Field was originally discovered by Noble Energy. Chevron and Shell equity were obtained through acquisitions of Noble Energy and BG, respectively.
	Calyp-so	Eni (50%)	TotalEnergies (50%)	3	85	2018	2,074	In appraisal	n/a	Confirmed extension of Zohr-like play from Egyptian side to Cyprus. There is no official reserve announcement. The field is estimated to be as large as 8 Tcf.
	Glau-cus	ExxonMobil (60%)	QatarEnergy (40%)	6.5	184	2019	2,063	In appraisal	n/a	First well in the block, Delphyne-1, was dry. First appraisal well Glaucus 2 was drilled in 2022, said to have confirmed high-quality reservoir. Estimated to contain 5–8 Tcf.
	Cronos	Eni (50%)	TotalEnergies (50%)	1.75	50	2022	2,287	In explora-tion	n/a	Eni stated that preliminary estimates are the gas field contains 2.5 Tcf of gas in place. 70% recovery factor used to estimate recoverable reserves.
			Cyprus subtotal	**15.8**	**446**					
Egypt	Zohr	Eni (50%)	Rosneft (30%), BP (10%), Mubadala (10%)	**30**	**849**	2015	1,450	In prouction	2017	Largest ever hydrocarbon discovery in Egypt and East Mediterranean region. This field doubles the gas reserve of the entire country of Egypt.
			Total	**86**	**2,448**					

Note: "Reserves" refers to recoverable reserves as originally reported by the companies; current reserve number might be smaller after fields have been in production. For Egypt, shallow water gas fields are not included.

Source: Annual reports and company statements of Eni, Chevron, NewMed Energy, Rosneft, Mubadala, Energean, ExxonMobil, Isramco, Ratio, BP, QatarEnergies, Tamar Petroleum, Shell, Alon, Everest, ATP; energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestinian Authority, and Lebanon; the Middle East Economic Survey (various editions). Water depth information from Israeli Ministry of Energy, "Gas Opportunities in Israel" (2015), and Energean corporate website for Karish North.

2.2 Major Gas Discoveries in Israel and Cyprus (2009–2014)

Noble Energy and its partners opened a new chapter of offshore exploration in Israel by making two large gas discoveries at Tamar (317 Bcm [11 Tcf] in 1,700 m of water) in 2009 and Leviathan (623 Bcm [22 Tcf] in 1,540–1,800 m of water) in 2010. They also discovered a smaller field near Leviathan called Dolphin in 2011[11]—though its reserves were downgraded the following year to just 2.3 Bcm[12] and the field was relinquished to the Israeli government in 2016—in addition to fields at Tanin and Karish in 2012 and 2013, respectively. These were all in unusually deep water for standalone gas developments at the time (until 2009, most global deepwater development concentrated on oil), and therefore posed technical and commercial challenges, especially for midsize companies such as Noble and Delek.

Nevertheless, Noble Energy and its partners brought the Tamar gas field onstream in 2013. In addition, Noble Energy tried to identify potential markets for its larger Leviathan field. Israel not only became self-sufficient, with the ability to begin phasing out coal power and expand gas-based industry, but also soon became a natural gas exporter to its neighbors Jordan[13] and Egypt.[14] This was a significant advance, as Israel had often sought to build economic relations with Arab states with which it had signed peace treaties but made little progress. Israel had previously bought gas from Egypt but stopped in 2012 following a shortage of gas in Egypt and repeated sabotage to the pipeline link through Sinai (which also inhibited Egyptian gas sales to Jordan).[15]

In analyzing seismic and geologic data, Noble Energy also realized that the hydrocarbon accumulations it had found might extend beyond the Israeli border into offshore Cyprus. Therefore, the technically able and commercially savvy company, together with partners BG[16] and Delek, signed the first-ever deepwater block (Block 12) with the government of the Republic of Cyprus in 2008, before even drilling the exploratory wells that led to the discoveries of Tamar and Leviathan (Table 2).

In 2011, Noble Energy and its partners made a third major gas discovery, Aphrodite (127 Bcm [4.5 Tcf]), this time in Cypriot waters, at 1,700 m water depth (Table 1; Figure 2). The Aphrodite field is thought to extend into Israeli waters, to what is called the Ishai (or Yishai) field, with 7–10 Bcm of reserves. As of October 2022, Israel and Cyprus appeared to be close to an agreement on the field's exploitation and revenue-sharing.

2.3 Breaking New Ground in Deep Offshore Egypt and Cyprus (2015–2019)

The main reservoir rocks in Noble Energy and its partners' three consecutive finds in Israel and Cyprus are Oligocene-Miocene deepwater slope and fan sandstones buried underneath Miocene salt

layers, with excellent reservoir quality and thus good well flow rates.[17] The gas is primarily biogenic[18] and 95–99 percent methane, with very low condensate yields (condensate-gas ratio[19] [CGR] of 2 barrels per thousand cubic feet [bbl/mcf] in Aphrodite, 1.7 bbl/mcf in Leviathan, and 1.3 bbl/mcf in Tamar), making it straightforward to develop from a technical perspective, though less valuable than a "wetter" gas due to lack of liquids. However, the Karish fields have a higher condensate yield: the shallower sands in Karish have a CGR of 4 bbl/mcf, but the deeper sands have 25 bbl/mcf and Karish North has 35–80 bbl/mcf, implying an element of thermogenic charge. Due to deeper burial and compression following biogenic gas charge, the fields tend not to be full to the spill point.[20]

Table 2: Summary of exploration and exploitation licenses issued by Cyprus

Block	Award year	Operator (Working interest)	Partners (Working interest)
2	2013	Eni (60%)	Kogas (20%)
			Total (20%)
3	2013	Eni (50%)	Kogas (20%)
			Total (30%)
6	2017	Eni (50%)	Total (50%)
7	2019	Total (50%)	Eni (50%)
8	2017	Total (50%)	Eni (50%)
9	2013	Eni (60%)	Kogas (20%)
			Total (20%)
10	2017	ExxonMobil (60%)	Qatar Petroleum (40%)
11	2013	Total (50%)	Eni (50%)
12 (Aphrodite)	2008 (2019)	Chevron (35%)	Shell (35%)
			Delek (30%)

Source: Cyprus Ministry of Energy, Commerce, and Industry, http://www.meci.gov.cy/meci/hydrocarbon.nsf/page16_en/page16_en?OpenDocument.

Note: The current Block 12 (Aphrodite), awarded in 2019, is an exploitation license, carved out from the previous exploration Block 12 signed in 2008 by Noble Energy and its partners.

In 2015, Italian company Eni announced[21] it had found the major gas field Zohr, which is estimated to contain more than 849 Bcm (30 Tcf) of recoverable gas, the largest-ever discovery in Egypt, at a water depth of 1,450 m. Zohr (meaning "noon" in Arabic) represented a new type of play in the region: rather than the sandstones found in earlier Israeli and Cypriot gas fields, this was a high-quality Miocene platform carbonate reservoir,[22] opening a completely new exploration frontier in the Eastern Mediterranean region. The seal, which again is comprised of Miocene salt deposited during the Messinian evaporation of the Mediterranean Basin, can trap gas columns of more than 600 m.[23] Similar carbonate reservoirs may be found at other locations around the Eratosthenes High, a submerged bank rising 2,000 m above the seafloor between Cyprus and Egypt.

Significant oil has not yet been found in the Israeli or Cypriot parts of the basin. However, as noted, indications exist of an older thermogenic source rock, and deeper drilling could explore the Lower Cretaceous sandstones and Upper Jurassic carbonates for reservoirs sourced by the Upper Jurassic. Oil shows have been noted at these levels in wells near the Israeli (Yam-2, Yam Yafo-1) and Sinai (Mango-1) coastlines.

Deepwater exploration for oil and gas is a high-risk endeavor. In Egypt, Eni reportedly tried but was unable to find partners to share the exploration risk in the Shorouk Block before drilling the Zohr prospect, which was assessed at a less than 20 percent chance of success.[24] The 100-square-kilometer (km^2) block was part of a much larger (45,000 km^2) North East Mediterranean Deepwater block called NEMED, and located south of the Egypt-Cyprus border. The NEMED acreage was previously operated by Shell with partners ExxonMobil and Malaysia's Petronas. The Shell consortium eventually relinquished it in 2011, however, after a 10-year effort that resulted in two subcommercial gas discoveries.[25]

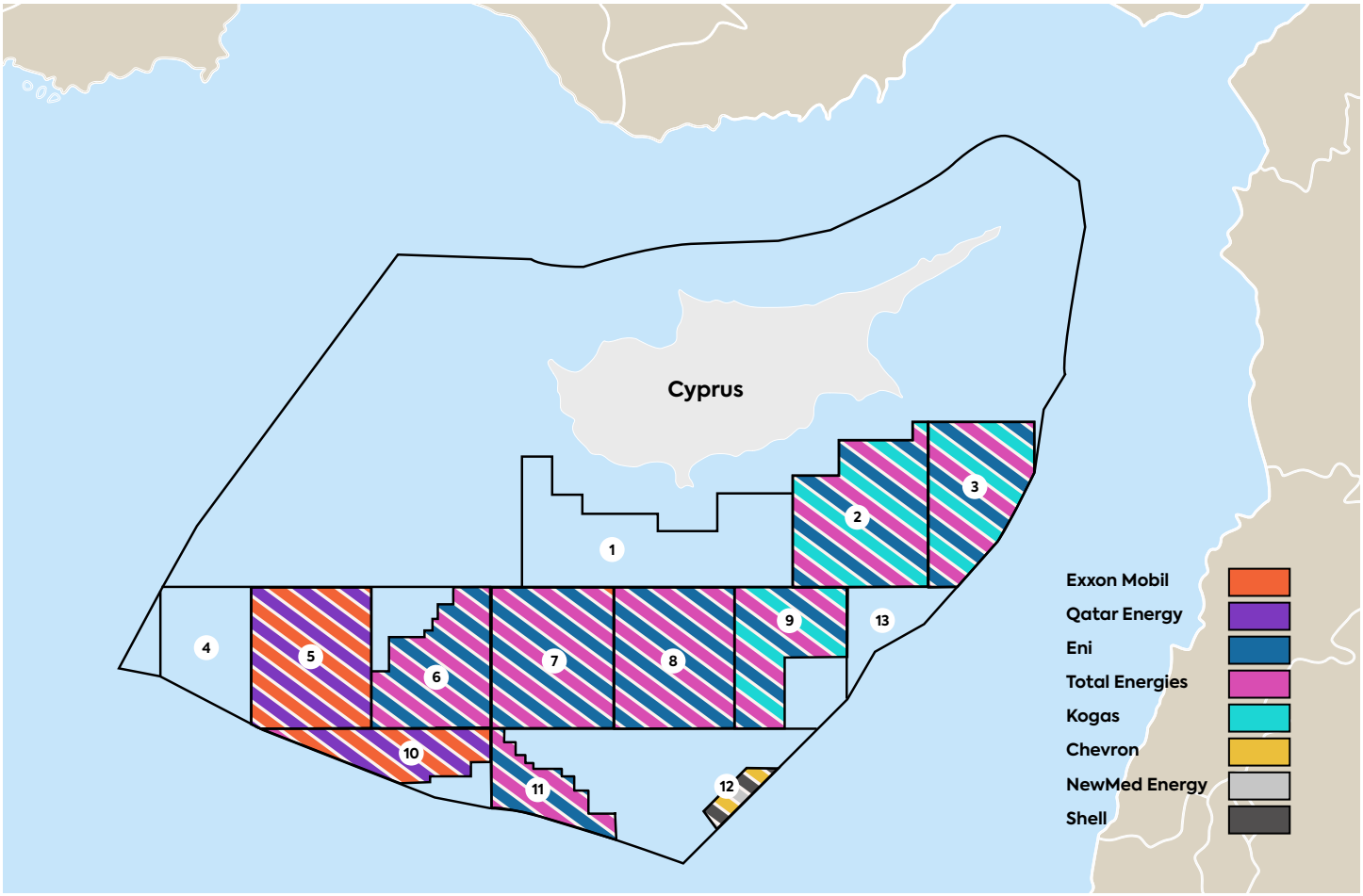
Eni's Zohr discovery was extremely timely for Egypt, as the country was fighting a significant domestic gas production decline largely due to lack of upstream investment over the previous decade, a sharp rise in demand because of subsidized domestic prices, and—to a lesser extent—political turbulence following the 2011 Egyptian Revolution. The Petroleum Ministry had to ask LNG operators BG and Union Fenosa to mothball Egypt's two existing LNG plants, at Idku and Damietta, between 2011 and 2017[26] so that any gas production could be used to meet domestic needs first and foremost. Egypt actually had to import LNG to fill the gap[27] temporarily.

Eni quickly developed Zohr, bringing the deepwater gas field onstream in less than three years, in December 2018. Along the way, Eni sold 50 percent of its working interest in the field, to BP (10 percent in 2017), Russian NOC Rosneft (30 percent in 2018), and UAE's Mubadala, a strategic investor owned by the Abu Dhabi government (10 percent in 2019). The company capitalized on its

successful exploration strategy, as the new partners had to pay for both past exploration costs as well as the value of a clearly commercial project.

Eni's breakthrough discovery of Zohr partially triggered major international oil companies (IOCs) ExxonMobil, Total (now TotalEnergies), and Eni itself to sign three deepwater exploration blocks (6, 8, and 10) in 2017, to the north in the southern part of offshore Cyprus (Table 2; Figure 3), under the expectation that the Miocene carbonate play extended northward into Cyprus.

Figure 3: Exploration and exploitation licenses in Cyprus



Source: Cyprus Ministry of Energy, Commerce, and Industry, http://www.meci.gov.cy/meci/hydrocarbon.nsf/page16_en/page16_en?OpenDocument.

This turned out to be the case. In 2018, Eni and its equal partner Total made the Calypso discovery[28] in Block 6. One year later, ExxonMobil and its partner Qatar Petroleum (now QatarEnergy) made the Glaucus gas discovery in Block 10[29] in the same carbonate play (Table 1).

Turkey quickly objected to drilling in the waters claimed by Cyprus, however, contending that parts fell either within its own territorial waters or within those of the Ankara-backed Turkish Republic of Northern Cyprus (TRNC). In February 2018, Turkish military ships prevented an Eni-hired drill ship from commencing activities in Block 7.[30] Turkey also acquired seismic data and drilled wells of its own in the area, though apparently did not make any discoveries. In November 2019, Turkey signed a maritime delineation agreement with the Tripoli-based, Turkish-backed government in Libya, which did not make reference to overlapping Cypriot and Greek claims,[31] and in October 2022 the two governments signed a memorandum of understanding on hydrocarbon exploration by Turkish-Libyan companies in both offshore and onshore areas of Libya.[32]

Political complexities also held back development of the fields in Israel. In 2014, the Israeli Antitrust Authority determined that the Noble Energy–Delek partnership held too much of the discovered gas resources and could potentially constitute a monopoly to the detriment of Israeli energy consumers. The Israeli government forced the two companies to divest from or dilute some of their gas discoveries. Supermajor oil companies had limited interest in Israel due to perceptions that operating there could cause them political problems in some Arab and other Muslim countries, an issue that has since largely receded.[33] In 2014, Australian LNG specialist Woodside negotiated to buy a stake in Leviathan but pulled out when it could not agree to tax terms with the Israeli government.[34]

London-listed Energean was therefore able to buy 100 percent of the Tanin and Karish gas fields from Noble Energy and Delek in 2016. Delek consequently spun off part of its interest in Tamar in 2017 to a then newly listed special-purpose company, Tamar Petroleum,[35] which subsequently acquired part of Noble's interest in Tamar as well.

2.4 Expanding the Eastern Mediterranean Gas Success Story (2019–present)

One of the most significant developments of this latest period is the emergence of small Eastern Mediterranean–focused independent operators such as Greece's Energean, which, as previously described, built up its position through the Noble Energy–Delek consortium's forced divestment of Karish-Tanin. In September 2021, following the normalization of Israel-UAE relations, Mubadala bought Delek's remaining 22 percent stake in Tamar and Dalit for $1 billion.[36] In December 2022, however, Israeli businessman Aaron Frenkel exercised his option to buy half of Mubadala's stake in Tamar (11 percent of the overall field) for $520 million.[37]

Israel halted its licensing process in 2012 before relaunching it in 2016. An Indian consortium led by the Oil and Natural Gas Corporation (ONGC) was awarded Block 32 in late 2017, but relinquished it in 2021 after judging it had low prospects for success.[38] Energean won five exploration blocks—12, 21, 22, 23, and 31—situated around the Tamar, Karish, and Tanin fields.

Energean now holds nine exploration and exploitation blocks at 100 percent[39] and has announced four relatively small but commercially viable gas discoveries (Karish North in 2019; Athena, Hermes, and Zeus[40] in 2022; see Table 1), making it the most active explorer in offshore Israel. Energean holds 100 percent of 127 Bcm (4.5 Tcf) of reserves and discovered resources in Israel. Furthermore, the company announced that it successfully brought the Karish gas field onstream on October 26, 2022,[41] with a plan to commence output from Karish North in the second half of 2023 via a subsea tie back to the Karish main field. The Karish cluster has a production capacity of 8 billion cubic meters per year (Bcm/y) and will be a key contributor in meeting Israeli domestic gas needs. The anti-monopoly policy delayed development, but it has been significant in bringing down prices in Israel, as Energean substantially undercut the sale prices of Tamar and Leviathan.[42]

In the meantime, IOC license owners in Cyprus have intensified their appraisal and exploration activity over the past two years. In August 2022, Eni-TotalEnergies made another discovery in carbonate reservoirs at Cronos[43] in Block 6, reportedly with 71 Bcm in place. They began drilling the Zeus-1 exploration well just south of Cronos in August 2022, which was announced in December 2022 as a discovery of 57–85 Bcm,[44] and plan to follow up with an additional well on the same block, likely an appraisal of Calypso.

The Aphrodite partners will drill an appraisal well in the first half of 2023, and have allocated money for an initial engineering study.[45] According to the Cypriot government,[46] ExxonMobil and partner QatarEnergy had a successful campaign in Block 10 with their Glaucus 2 appraisal well, confirming reservoir quality, and are assessing the prospect of developing the field.

Cyprus is now therefore one of the most widely watched gas exploration theaters in the world, with five major IOCs (ExxonMobil, Chevron, Shell, Total, and Eni) as well as important Middle Eastern (QatarEnergy, Delek Group) and Asian (Kogas) partners actively conducting exploration and appraisal programs. However, neither ExxonMobil nor Eni has yet to confirm the commercial viability of their discoveries in Cyprus.

2.5 Exploration Potential of Eastern Mediterranean Deepwater Basins

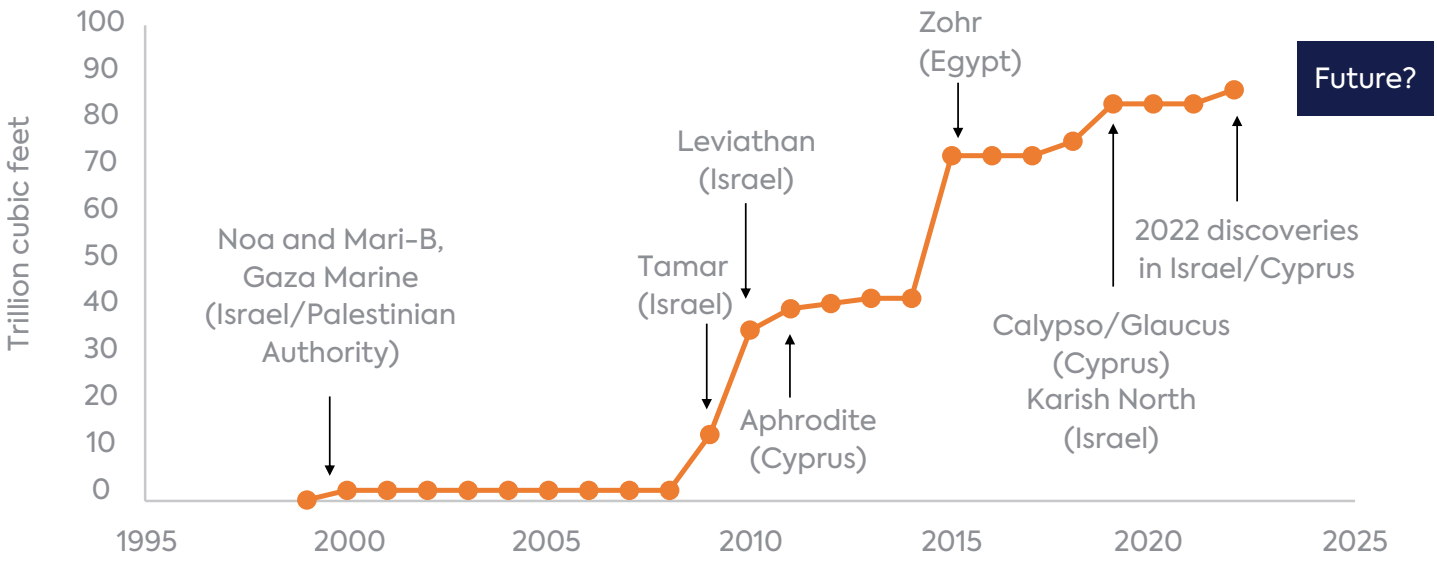
The Eastern Mediterranean deepwater basins have significant exploration potential for more gas discoveries. This exploration potential can be evaluated in two ways.

The first is to use basic geological information to assess the hydrocarbon generation and accumulation potential for a basin, as in a 2020 US Geological Survey assessment[47] that estimated the presence of 8,000 Bcm (282 Tcf) of technically recoverable gas resources yet to be discovered in offshore basins of the Eastern Mediterranean. These are located not only in Israel, Egypt, and Cyprus but also in Lebanon, Syria, Greece, Turkey, and Libya, in addition to some of the 2,435 Bcm (86 Tcf) of gas reserves, or commercially recoverable gas, already discovered in Israel, Egypt, and Cyprus (Table 1).

The Israeli Ministry of Energy assesses that Israel's discovered reservoirs hold 921 Bcm (32.5 Tcf) of technically recoverable resources, while another 500 Bcm (17.7 Tcf) could be discovered through the current licenses.[48] The ministry also assesses that the Israeli part of the Levant Basin could hold 2,135 Bcm (75 Tcf) of recoverable gas and 6.6 billion barrels of oil[49] in addition to the discoveries made to date.

The second way of evaluating the exploration potential of the Eastern Mediterranean's deepwater basins is to examine the cumulatively discovered volumes of wells drilled over time through what is called "a creaming curve." Steep creaming curves or steep segments of a creaming curve indicate the presence of significantly more gas to be discovered, whereas a sustained flatness over many years could suggest that a basin or region has reached a certain limit of exploration maturity (Figure 4). In other words, when the creaming curve is flat, few new hydrocarbons are expected to be found, unless new geological play concepts are discovered (e.g., the carbonate platform play of Zohr in Egypt, which was followed by subsequent discoveries in Cyprus) and/or a new technological breakthrough occurs that could lead to the discovery of new types of fields (e.g., the multiple waves of deepwater oil exploration successes in the US Gulf of Mexico).

Figure 4: Cumulative gas discoveries in Eastern Mediterranean basins



Note: For details of the fields, see Table 1.

Source: Annual reports and company statements of Eni, Chevron, NewMed Energy, Rosneft, Mubadala, Energean, ExxonMobil, Isramco, Ratio, BP, QatarEnergies, Tamar Petroleum, Shell, Alon, Everest, ATP.

Ongoing exploration efforts in Cyprus have produced mixed results. Although there have been several discoveries, all of them have been medium-size deepwater fields that are hard to commercialize on their own. Both ExxonMobil's Glaucus gas discovery (142–198 Bcm) and Eni's Cronos discovery (142–227 Bcm) could be at the lower end of the reported recoverable resource ranges.[50] Calypso, initially reported to contain 170–227 Bcm of gas, could contain as little as 28–42 Bcm, in which case it would be hardly commercially viable.

It is important to note that, for the Eastern Mediterranean basins, the flat parts of the curve (e.g., from 2001–2008 and 2011–2015) were mainly due to exploration inactivity while the operator (i.e., Noble Energy) and the Israeli Ministry of Energy evaluated the market and regulatory situation, rather than a result of many unsuccessful exploration wells being drilled during these periods.

As explorers (e.g., Energean) pick up the pace of their campaigns, more discoveries might emerge. Energean and Eni have recently made additional, albeit not very large, finds. Geologist Yossi Langotsky, who was involved in the early discoveries in Israel, does not believe that more large discoveries similar to Tamar and Leviathan will be made in Israel, though he does see potential for oil in deeper reservoirs.[51] In December 2022, Israel launched its fourth offshore bid round,[52] which will

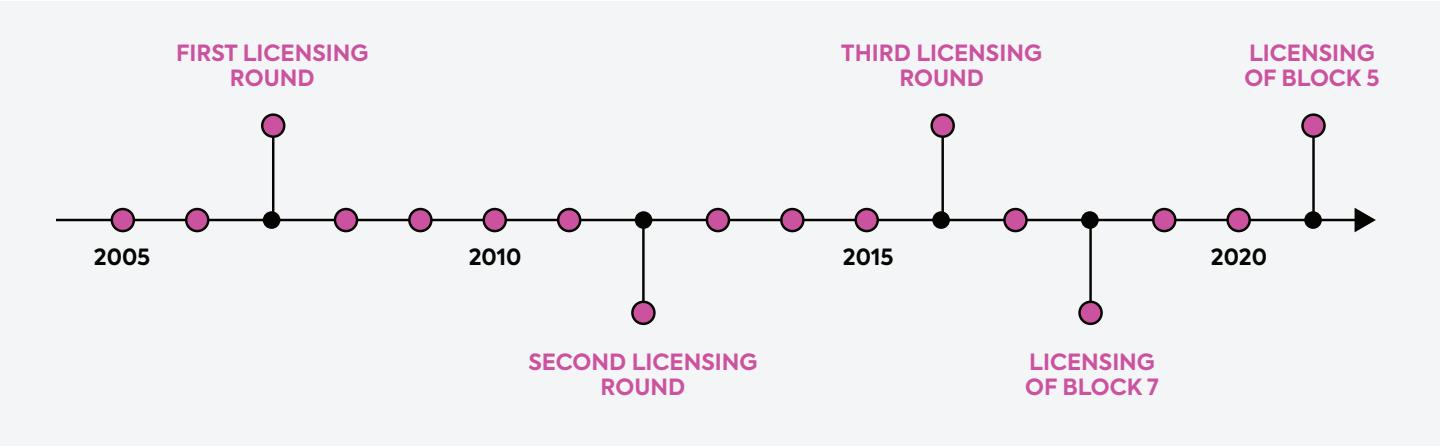
include about 20 blocks mostly in the further offshore areas, each with a maximum area of 400 km^2.

This is not to say that exploration disappointments—such as the noncommercial exploration well that TotalEnergies and its partners Eni and Novatek drilled in 2020 in Block 4 in Lebanon (Byblos)[53] or the two earlier unsuccessful wells Eni and its partner Kogas drilled in Block 9 of Cyprus—will not recur.[54] Byblos targeted the Tamar sandstone (Lower Miocene), the main reservoir for the Israeli fields, with sediment sourced from the proto–Nile Delta, but the reservoir was absent, probably due to the northerly location. Gas shows were observed in the Oligo-Miocene section, suggesting that a source rock is present, but requiring suitable reservoir rocks to be located for a commercial discovery. A second well on the more southerly Block 9 has not yet been drilled because of problems related to the COVID-19 pandemic as well as the political and economic crisis in Lebanon and its border dispute with Israel. The Qana (Sidon) prospect crosses into an area that was disputed between Israel and Lebanon until October 2022; Israeli discussions suggest it might hold in the range of 750 Bcf (21 Bcm).

On October 27, 2022,[55] a US-mediated resolution of the border dispute between Israel and Lebanon was reached, opening the way for TotalEnergies (35 percent stake), Eni (35 percent), and QatarEnergy (30 percent) to explore Qana. Lebanon will hold a further bid round with a closing date of June 30, 2023[56] that includes all eight unlicensed blocks across the entirety of the country's offshore area. The bidding process has been repeatedly delayed by the country's ongoing political and economic crisis, and may be postponed again.

The promising exploration potential of the Eastern Mediterranean region explains why major IOCs including Eni, Chevron, ExxonMobil, Shell, Total, and BP have signed exploration blocks in Cyprus (Figures 3, 5), Israel (Figure 6), Egypt, Lebanon (Figure 7), and Greece.

Figure 5: Exploration licensing by Cyprus



FIRST LICENSING ROUND
May 4–August 16, 2007
Blocks on offer: 1,2,4-12
Result: **Noble Energy** won Block 12*

SECOND LICENSING ROUND
February 11–May 11, 2012
Blocks on offer: 1-11, 13
Result: **Eni/Kogas/Total** won Blocks 2,3, and 9; **Total/Eni** won Block 11

THIRD LICENSING ROUND
March 24–July 22, 2016
Blocks on offer: 6,8,10
Result: **Eni/Total** won Block 6, 8; **ExxonMobil/Qatar Petroleum** won Block 10

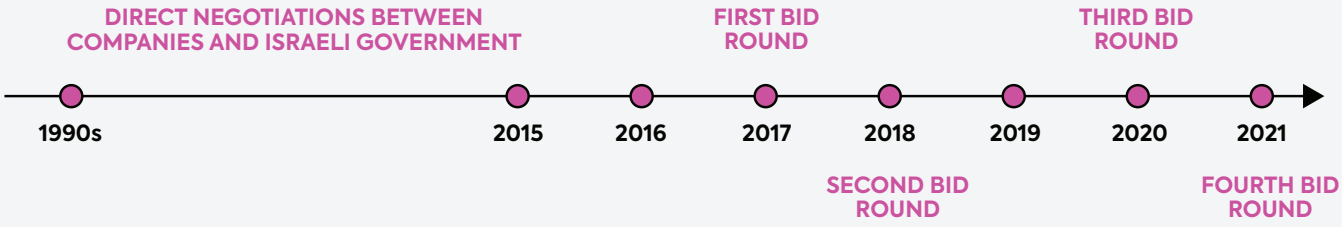
LICENSING OF BLOCK 7
October 2018
Result: **Total/Eni** won Block 7

LICENSING OF BLOCK 5
June 2021
Result: **ExxonMobil/Qatar Petroleum** won Block 5

*Note: *Part of Block 12 around the Aphrodite area was awarded as an exploitation license to Noble, BG, and Delek Drilling. Chevron is the current operator with partners Shell and Delek Drilling after Chevron and Shell acquired Noble Energy and BG, respectively.*

Source: Cyprus Ministry of Energy, Commerce, and Industry.

Figure 6: Offshore exploration licensing in Israel



DIRECT NEGOTIATIONS BETWEEN COMPANIES AND ISRAELI GOVERNMENT
Late 1990s–2015
Led by **Noble Energy, Delek Group,** and **BG**
Result: Signing of blocks that yield major gas discoveries (Tamar, Leviathan)

FIRST BID ROUND
September 1, 2016–November 15, 2017
Acreage on offer: 20 out of 69 blocks
Result: **Energean** won four blocks (12,21,23,31) and area near Tanin/Karish fields; **ONGC** and partners won Block 32*

SECOND BID ROUND
November 26, 2017–July 15, 2018
Acreage on offer: 5 zones A–E in southern EEZ (each zone includes up to 4 blocks)
Result: **Cairn/Pharos/Ratio** won Zones A & C; **Energean/Israel Opportunity** won Zone D

THIRD BID ROUND
June 23–September 23, 2020
Acreage on offer: 72 (former Alon D license area)
Result: No winner announced yet (per news release of January 3, 2021)

FOURTH BID ROUND
Launched in December 2022
Four zones on offer
Bids are due in July 2023

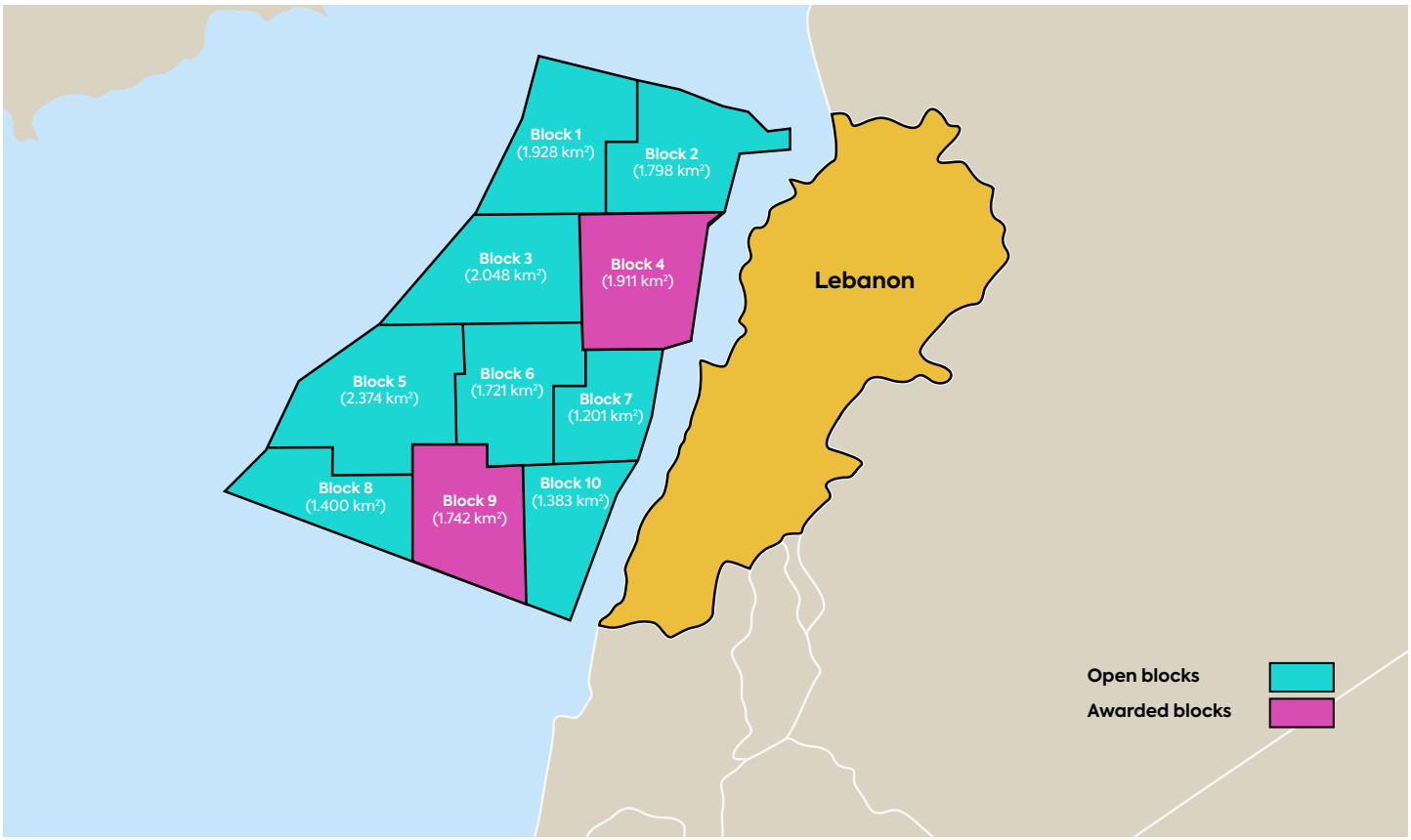
*Note: *ONGC and partners relinquished Block 32 in September 2021.*

Source: Israel Ministry of Energy, https://www.gov.il/en/departments/news/press_131222.

In Egypt, both ExxonMobil and Shell have returned to the offshore Nile Delta and the offshore Mediterranean, and in 2016 BP paid $375 million plus reimbursement of past costs to obtain a 30 percent working interest in Eni's Shorouk Block. Recent deepwater exploration has not enjoyed similar success to Zohr; in 2019, Eni found a relatively disappointing 57 Bcm (2 Tcf) at the Nour-1 well. A 99 Bcm (3.5 Tcf) discovery by Chevron at Narges off the Sinai Peninsula was reported in December 2022,[57] while Dana Gas's Merak-1 (2019) and Edison's Ameeq-1X (2020) were dry. Dana Gas failed to find a farm-in partner for its North El Arish block, which adjoins the offshore Gaza Strip containing the Gaza Marine field,[58] but it was re-awarded to Eni, which began drilling the 311 Bcm (11 Tcf) Thuraya prospect in November 2022,[59] with rumors of a gas find but no results reported as of the time of writing. The Palestine Investment Fund holds the license for the Gaza Marine field, hoping to supply Palestine and possibly Egypt; as of October 2022 it appeared that

Egypt and Israel had reached an agreement to permit the field's development after a long delay due to Israel's insistence that gas revenues not reach the Hamas administration of the Gaza Strip.[60] Egypt's involvement may help to overcome Israel's objections, though Israel also has an interest in maintaining its near-monopoly of electricity and gas sales to Palestine.

Figure 7: Second offshore bid round blocks of Lebanon



Source: Lebanese Petroleum Administration, https://www.lpa.gov.lb/english/licensing-rounds/second-licencing-round/open-blocks1.

Russian companies have also entered the Eastern Mediterranean basins. Rosneft, for instance, paid $1 billion for 30 percent of the Zohr field.[61] Similarly, TotalEnergies' main LNG partner in Russia, Novatek, joined TotalEnergies (40 percent) and Eni (40 percent) with a 20 percent stake in two offshore blocks in Lebanon (Blocks 4 and 9; see Figure 7), though it subsequently withdrew from both after the failed drilling campaign in Block 4. The company's 20 percent equity in both blocks was taken over by the Lebanese government.[62] As of January 2023, QatarEnergy joined TotalEnergy

and Eni for 30 percent stake, with the two European partners holding 35 percent each in both Blocks 4 and 9.[63] So far, the fallout of Russia's invasion of Ukraine, including sanctions, does not seem to have directly affected Rosneft's position in Zohr.

In Greece, operator ExxonMobil (40 percent) and partners Total (40 percent) and Hellenic Petroleum (20 percent), a local company, signed two offshore blocks, West Crete and Southwest Crete, in June 2019 to evaluate their exploration potential as part of their overall Eastern Mediterranean efforts. In June 2020, as oil prices declined sharply, TotalEnergies withdrew from the two blocks near Crete[64] and transferred ownership of Block 2 in the Ionian Sea to Greek company Energean.[65] It is not clear what led TotalEnergies to leave; most likely it was financial pressure from low oil prices at the time, high exploration risk, and/or environment and climate concerns. ExxonMobil (70 percent) and remaining partner Hellenic Petroleum (30 percent) have taken over TotalEnergies' equity in the two blocks near Crete.[66]

The potential of deepwater Libya has not been the focus of any IOC in recent years, as the country tries to recover from political turmoil. In October 2022, however, the head of Libya's National Oil Corporation referred vaguely to a Mediterranean field (or prospect) believed to be larger than Zohr.[67]

As noted, Turkish state oil company TPAO has also acquired seismic data and drilled wells around Cyprus, both in areas claimed by the Republic of Cyprus and areas claimed by the TRNC, which is recognized only by Turkey. However, there are no signs it has made a commercial discovery in these areas or in the Eastern Mediterranean waters of Turkey itself. TPAO has succeeded in making several large reported discoveries in Turkey's Black Sea waters,[68] which may have diverted the company's attention from the Eastern Mediterranean for now.

In summary, about 2,400 Bcm (86 Tcf) of gas has been found in Israel, Egypt, and Cyprus over the past two decades. Though impressive, this volume is only 30 percent of the potential of the Eastern Mediterranean basins estimated by the USGS.[69] Industry and decision makers will be keen to find out how much more gas can be found in the region through accelerated exploration drilling in the next five years.

3. Gas Supply and Demand in the Eastern Mediterranean

The Eastern Mediterranean region is becoming a gas exporting area, as a significant amount of gas has been discovered in the deepwater basins in Israel, Cyprus, and Egypt. However, strong regional gas demand, especially in Egypt, will limit the amount of gas available for export, unless much more gas can be discovered there.

3.1 Gas Supply

Regional gas supply in Eastern Mediterranean countries has been provided by production from Egypt and Israel, in addition to some LNG imports (Figure 8).

Gas production in the Eastern Mediterranean is still dominated by **Egypt** (67.8 Bcm in 2021), mostly in its offshore Nile Delta and deepwater areas, but also with substantial output in the onshore Delta and Western Desert and lesser quantities from the Gulf of Suez. However, gas production decline rates are rapid. The period between 2009 and 2016, which included the 2011 Egyptian Revolution, witnessed few new production startups, and output fell at an average annual rate of 5.6 percent. Absent major new finds comparable to Zohr or major unconventional gas output onshore, Egyptian production is forecast here to decline to 42 Bcm by 2035 (accounting for the development of several recent discoveries such as Nour and Nargis, but excluding substantial further exploration success and any continued impact on production from recent problems of water influx seen at Zohr field[70]).

Israel will make an increasingly significant contribution, with 20 Bcm in 2021 forecasted here to rise to 42.6 Bcm by 2027 and then stay on a rough plateau. This accounts for expansions of the Leviathan field in 2022, 2027, and 2029; of the Tamar field in 2025 and 2026 (drilling will begin this year on the Tamar Southwest satellite field[71]); and the startup of the Energean fields, including Karish and satellites Tanin, Athena, Hermes, and others. Further exploration success by Energean could contribute additional volumes; if 2022 discoveries by Energean are representative (Table 1), however, these will likely be relatively small (Athena was only 8 Bcm, but it was said to have de-risked 50 Bcm in other prospects).

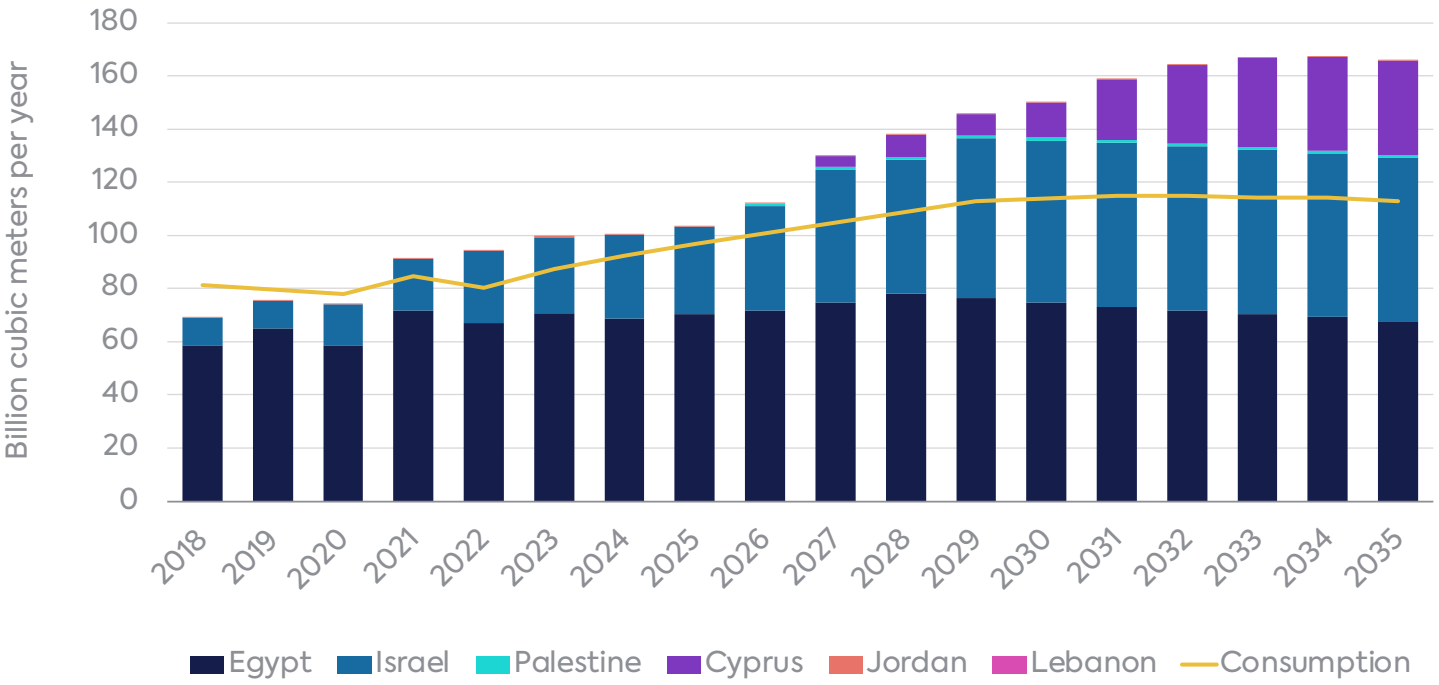
Major production growth will also occur in **Cyprus**, where the successive development of Aphrodite (assumed to start in 2027), Glaucus (2030), Calypso (2031), Cronos (2032), and Zeus (2033) is projected here to contribute to an overall national plateau of about 32 Bcm/y. This does not take

into account any potential future exploration success, which is uncertain and difficult to predict with confidence, and is optimistic on the pace of development given the lengthy delays to date as well as political and commercial barriers.

Palestine's Gaza Marine field is assumed here to start production in 2026 with a plateau of about 1 Bcm/y, reflecting the limitations of domestic demand. **Jordan's** minor onshore tight gas production is forecasted to decline over time. No discoveries are assumed in **Lebanon**, though the Qana prospect could contribute modestly to the regional gas supply, or in **Syria**.

Overall, while conservative on future exploration success, this forecast is quite aggressive on commercialization and development timelines.

Figure 8: Gas production modeling for the Eastern Mediterranean



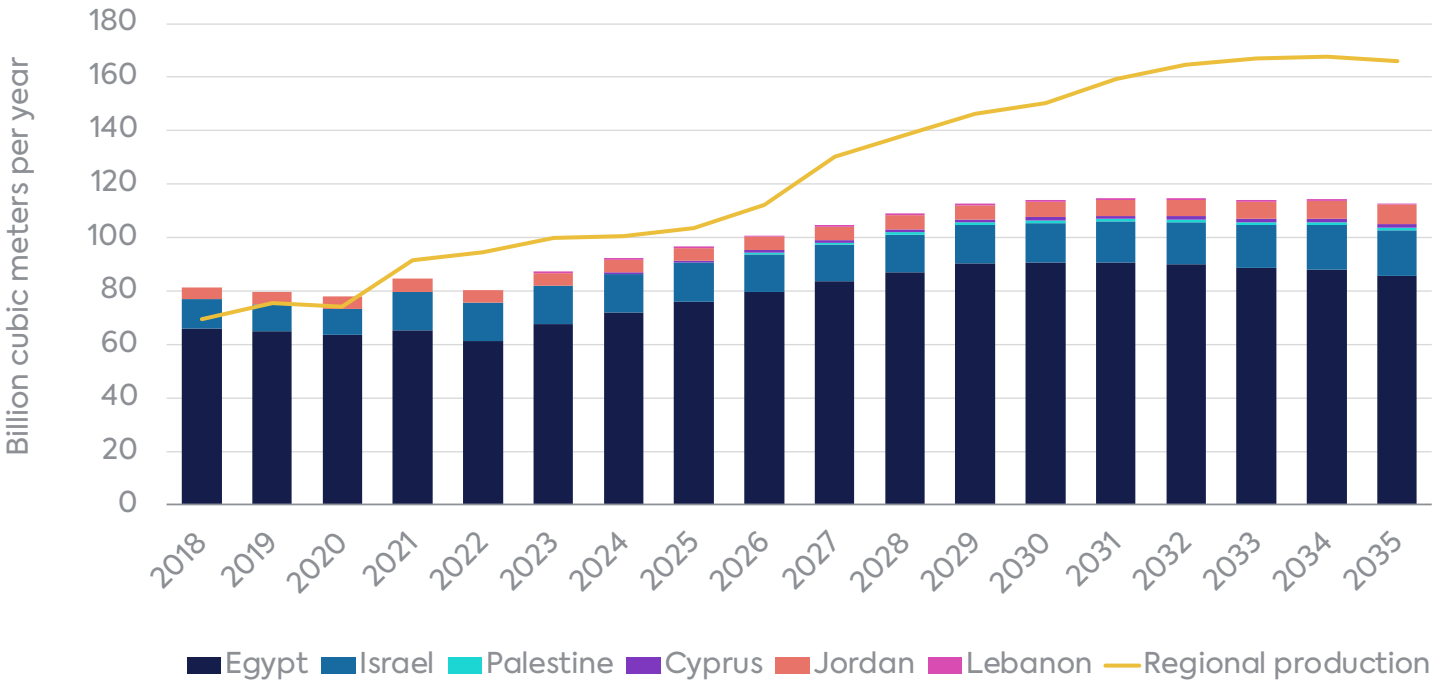
Source: Annual reports and company statements of Energean, Noble, NewMed, Eni, TotalEnergies, Chevron; press reports based on those (all cited elsewhere in this paper); data from the energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestine, and Lebanon; and the Middle East Economic Survey.

3.2 Gas Demand

Gas demand forecasts in this study are based on previous work,[72] updated for recent developments (Figure 9). Consumption in the Eastern Mediterranean is dominated by Egypt (67.8 Bcm in 2021), and secondarily by Israel (12.3 Bcm). Jordan consumes a small amount (3.2 Bcm), nearly all imported. Cyprus, Lebanon, and Palestine do not currently consume gas, but could do so in the future via either their own production or imports. They would all be small markets (in the order of 1 Bcm/y). This analysis excludes Syria, though in a postwar scenario it could be involved as a producer and consumer. Discussions have taken place regarding the transit of Egyptian (in practice, relabeled Israeli) gas to Lebanon via Syria, though as of December 2022 these appeared to have stalled over sanctions concerns.

For the purposes of this analysis, Turkey, a large gas consumer and importer (57.3 Bcm of consumption in 2021, nearly all imported), is grouped with Europe as a potential "extra-regional" market for Eastern Mediterranean gas, given its pipeline connectivity to European neighbors.

Figure 9: Gas consumption modeling for the Eastern Mediterranean



Source: Annual reports and company statements of Energean, Noble, NewMed, Eni, TotalEnergies, Chevron; press reports based on those (all cited elsewhere in this paper); data from the energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestine, and Lebanon; and the Middle East Economic Survey.

Between 1999 and 2012, Egyptian gas consumption rose rapidly due to low subsidized prices and a policy of gas-based industrialization and power generation. The low prices also restrained new exploration and development, leading to a severe shortage during 2012–2015. This followed but was mostly independent of the 2011 Egyptian Revolution. In turn, the shortage, along with repeated sabotage of the pipelines through Sinai, caused Egypt's gas exports to Israel and Jordan to cease, encouraging Israel to move ahead with developing its own gas and Jordan to commence LNG imports and gas purchases from Israel. Egypt set up two LNG import terminals, reformed gas pricing to both producers and users, and by 2016 was mostly able to overcome the shortfall. It now maintains one LNG import terminal for security of supply. In 2018, Egypt was able to restart the Idku LNG export plant near Alexandria, and in February 2021 it also re-commenced operations from the Damietta plant.

Gas consumption in Egypt has remained relatively flat in recent years (2018–2022). Five main factors are responsible:

- The COVID-19 pandemic starting in 2020
- The installation of a large quantity of more efficient combined-cycle power generation facilities to replace older gas and steam turbines, along with more preferential dispatch of the high-efficiency units
- Subsidy reform and price rises for electricity, gas, and water
- The addition of more solar and wind generation
- Efficiency measures in 2020 including turning off lights in public buildings, redirecting gas to the most efficient plants, and running power plants on mazut (heavy fuel oil) instead of gas, in order to save gas and export more of it at high world LNG prices

However, strong rises in gas demand are expected to resume as the effects of the pandemic ease and the one-off gains from combined-cycle deployment are exhausted. Rapid population growth and economic expansion will support demand. Oil-based power plants will be switched back to gas when LNG prices fall back below energy-equivalent oil prices. Previously planned coal power plants are assumed here to be not built for climate reasons. Greater use of renewables will eventually lead to a flattening of gas demand in the early 2030s. The Integrated Sustainable Energy Strategy plans for 32 gigawatts (GW) of solar photovoltaic (PV), 12 GW of concentrated solar power (CSP), and 18 GW of wind by 2035 for electricity generation, not including renewable capacity devoted to "green" hydrogen production. Three major wind power deals were recently signed totaling 21.1 GW, indicating that the wind target could be exceeded. "Green" hydrogen production could help substitute natural gas in ammonia and methanol production and oil refining, though most will be exported.

Egypt's first nuclear reactor, at El Dabaa on the northwest coast, has begun construction after long delays and is expected to reach full capacity (4,800 megawatts [MW]) by 2030.[73] Given the involvement of Russian companies, however, the project could be delayed by issues related to sanctions, financing, or technology access, and no more reactors appear likely to enter service within the forecast period.

Even allowing for these factors, Egyptian gas demand is forecasted here to rise at a compound annual growth rate of 5 percent between 2022 and 2030 to reach 90.7 Bcm in 2030, before gradually falling through 2035 as nuclear and renewables ramp up. It should be recognized, however, that the renewable targets are aggressive; if they are missed, or if much of the new renewable capacity is dedicated to "green" hydrogen production for export, Egypt's gas demand could well be higher.

All Israeli and Cypriot gas production not required for domestic use or export to Jordan is, in the base case, assumed to be exported to Egypt, with any remaining deficit covered by LNG imports.

As shown in Figure 9, Israeli domestic demand is also anticipated to rise through 2025 before flattening out. This shift is driven by the phase-out of coal power generation by 2025 as well as additional demand from industry and (possibly) transport. After 2025, demand will stagnate because of the country's strong targets for renewables, which will cut power-sector gas use. The Electricity Authority and Energy Ministry plan for 30 percent of electricity from renewables by 2030, the target adopted in this study, while the Environment Ministry has proposed a plan for 40 percent.

If the Palestinian Authority proceeds with its plans to develop gas power plants at Gaza, Jenin, and Hebron, its electricity imports from Israel would no longer be needed, slightly reducing Israeli gas demand (though about 1 Bcm of gas demand would be created within Palestine itself). The Gaza and Jenin plants are reasonably well advanced in planning and have significant support from the international community.

Jordan uses small amounts of gas for industry, which will drive demand growth of about 2 percent per year. Similar to the cases of Egypt and Israel, continuing successful renewables deployment will limit gas use in power generation.

Cyprus does not currently use gas, as it has not historically been available. LNG imports have been proposed since at least 2009, but have been repeatedly delayed by indecision on precise plans; the small size of the local market; controversies over tenders; an accidental explosion at the planned import location in the port of Vassilikos, on the southern coast between Limassol and Larnaka, in 2011; and the discovery of illegally dumped chemicals at the site.[74] The theoretical domestic market is too small on its own to support the development of offshore resources, but Nicosia now finally

plans to start up an 0.6 million metric tons per annum (Mtpa) LNG import terminal at Vassilikos by October 2023.[75] In addition, the latter site has an 878 MW oil-fired power plant that could be converted to gas, as well as a cement plant. There are also oil-fired power plants near Larnaka (460 MW) and Limassol (150 MW).[76] A new 160 MW combined-cycle gas turbine power plant at Vassilikos has been proposed. Finally, the internationally unrecognized TRNC operates 273 MW of oil-fired power generation. Gas would reduce air pollution and carbon dioxide emissions from these facilities and would usually be expected to be cheaper than oil. Cyprus could later use gas from its own offshore fields, assumed here to start in 2027. If that gas is used to displace oil in the power sector, in addition to industrial use for cement and other activities, the country could consume about 1 Bcm/y by 2030, with growth flattening out after this due to increased use of renewables.

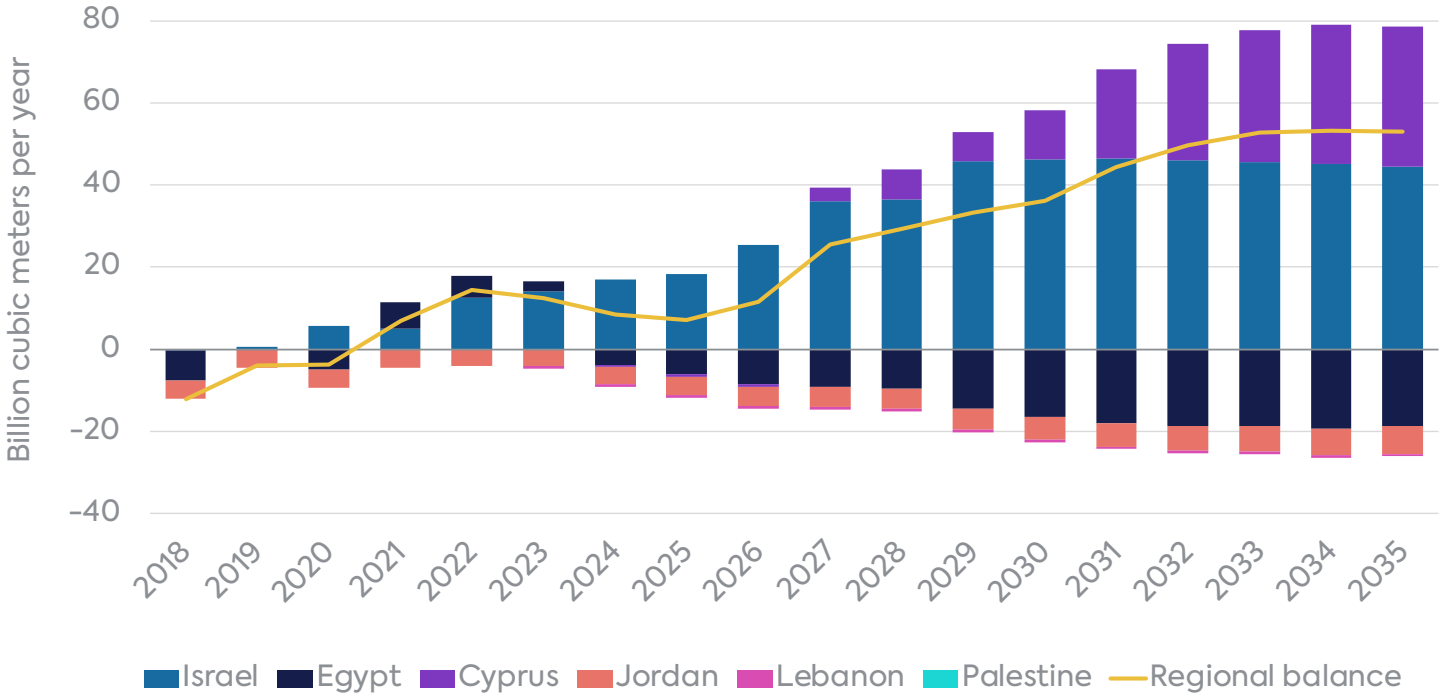
Lebanon is suffering a political and economic crisis that has resulted in severe shortages of fuel and electricity. US-backed plans to supply Egyptian (in reality, Israeli) gas via Jordan and Syria to the Deir Ammar power plant in northern Lebanon have advanced, but have not yet been implemented due to sanctions problems related to the Assad regime and the need to rehabilitate war-damaged infrastructure in Syria. This supply could amount to about 0.6 Bcm/y, here assumed to remain constant from 2023 onward. Lebanon has had plans in the past to install three LNG import terminals, though these appear unlikely to progress for now given political wrangling and the current focus on the Qana prospect. Total demand, including replacement of all oil-fired power and small industrial uses, could reach about 2 Bcm by 2035, but this is not included in this study. A discovery at Qana could supply the domestic market, but development will likely be substantially delayed by domestic Lebanese political issues.

The conclusions of this report are therefore based largely on the outlook for Egyptian and, to a lesser extent, Israeli demand. The study's projections include neither intra- or extra-regional electricity trade nor any gas used to produce "blue" hydrogen for export.

Overall, the region has a moderate gas surplus of 6–13 Bcm/y through 2026, which then increases from 2027 to 53 Bcm by 2032 (Figure 10). This rise is driven by a large surplus in Israel and Cyprus, partly counterbalanced by a large emerging deficit in Egypt.

Egypt can continue exporting LNG internationally and pipeline gas to Lebanon for a time, by importing Israeli and, from 2026, Cypriot gas. The Egyptian LNG terminals have a maximum export capacity of about 16.5 Bcm/y, which exceeds the likely amount available by re-exporting Israeli and Cypriot gas after meeting Egypt's own demand. The Egyptian supply-demand gap becomes increasingly wide from 2030 onward (Figure 10), reducing the net amounts available to export from the Eastern Mediterranean region.

Figure 10: Regional gas balance in the Eastern Mediterranean



Source: Annual reports and company statements of Energean, Noble, NewMed, Eni, TotalEnergies, Chevron; press reports based on those (all cited elsewhere in this paper); data from the energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestine, and Lebanon; and the Middle East Economic Survey.

This analysis of the gas demand and supply balance suggests that:

- Egyptian LNG exports will be significantly constrained during 2023–2026, even with re-exports of Israeli gas. Egypt may restrain domestic demand through conservation and more use of oil in power, but it will still be limited in its ability to help Europe during the most critical period of the shift away from Russian gas.
- New Eastern Mediterranean gas exploration that could enter production around 2030 would find a ready market in Egypt.
  - Depending on the evolution of international LNG prices, Egypt may need to raise domestic prices to continue attracting imports.
  - However, gas producers in Israel and Cyprus would likely not want to be completely dependent on the Egyptian market given that Egypt would have large commercial

leverage and (as in the post-2011 period) may not pay promptly, may divert gas from LNG re-exports to the domestic market, and/or may seek to pay well below LNG parity.[77]

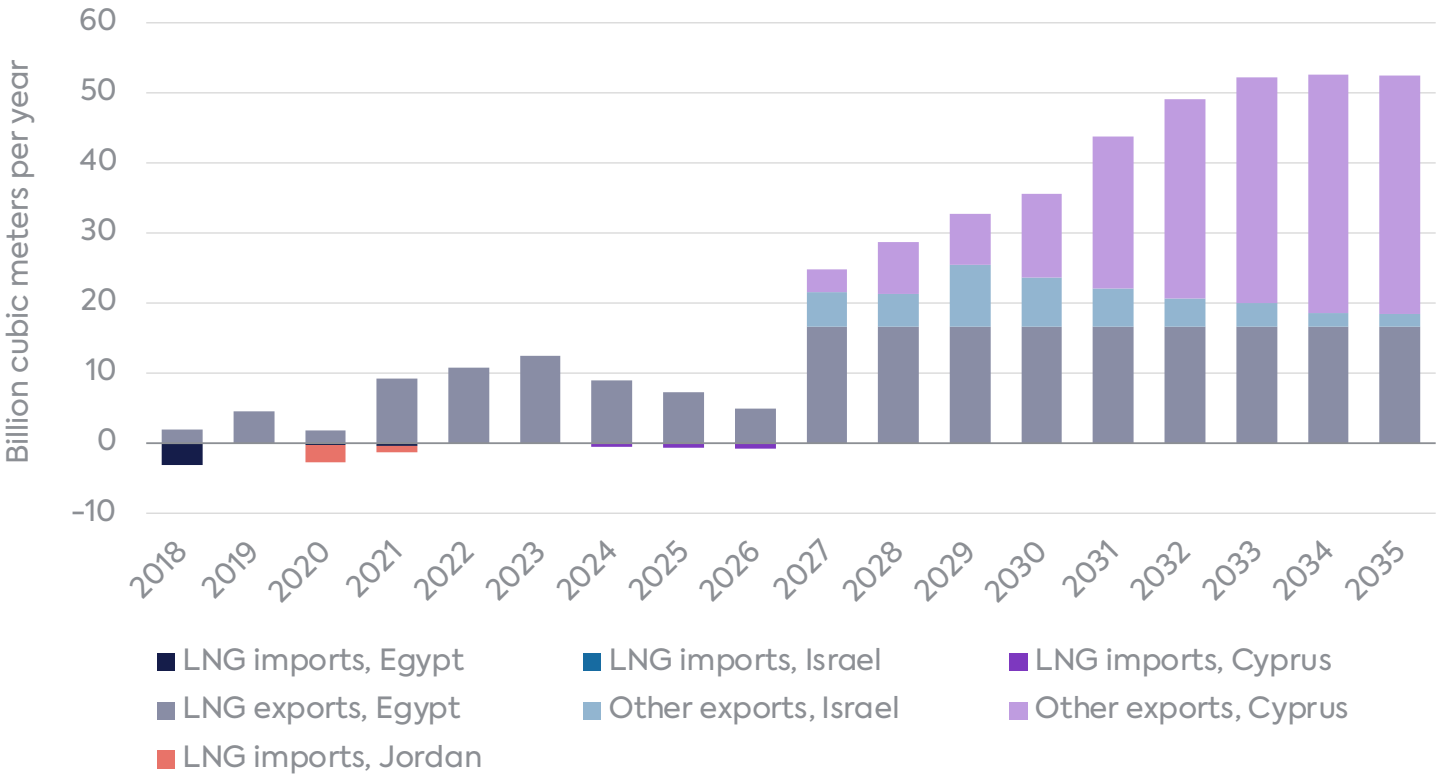
- Development of substantial extra-regional exports will occur only in 2027 at the earliest (and more likely later) and would require:
  - Aggressive development and expansion of the main discoveries and producing fields in Israel and Cyprus (the long delays in developing Aphrodite and Cyprus's LNG import terminal are not encouraging in this regard)
  - Focusing Israeli and Cypriot surplus gas on export (standalone LNG in their home countries or pipeline to Turkey or Europe) rather than on supplying Egypt
  - Substantial exploration success somewhere in the basin, combined with demand restraint in Egypt (by some combination of slower economic growth, subsidy reform and energy efficiency gains, and alternative power generation)

If these conditions can be met, there can be sufficient surplus gas to support a combination of Eastern Mediterranean pipeline and/or LNG exports, totaling 40–50 Bcm/y.

3.3 Two Scenarios for Gas Supply and Trade

Two illustrative scenarios are shown here. In the first (Figure 11), surplus Israeli or Cypriot gas is sent to Egypt to supply its domestic market, and any spare gas is then liquefied for export from Egypt's existing LNG plants up to their full capacity. If Egypt is still in deficit, it would then import LNG. In this case, it can be seen that Egypt has little spare gas in the near term, and its continuing LNG exports depend on managing domestic consumption and sustaining domestic output. The decision to prioritize LNG exports over domestic consumption in 2023–2026 requires LNG netbacks to remain above oil parity pricing, to favor the use of fuel oil in Egyptian power plants. Even securing sufficient gas for re-export from 2023 onward would require debottlenecking or expanding the existing 7–10 Bcm/y of Israel-Egypt pipeline capacity. Then the arrival of extra Cypriot and Israeli gas from 2027 onward would allow Egypt to reach near-full capacity.

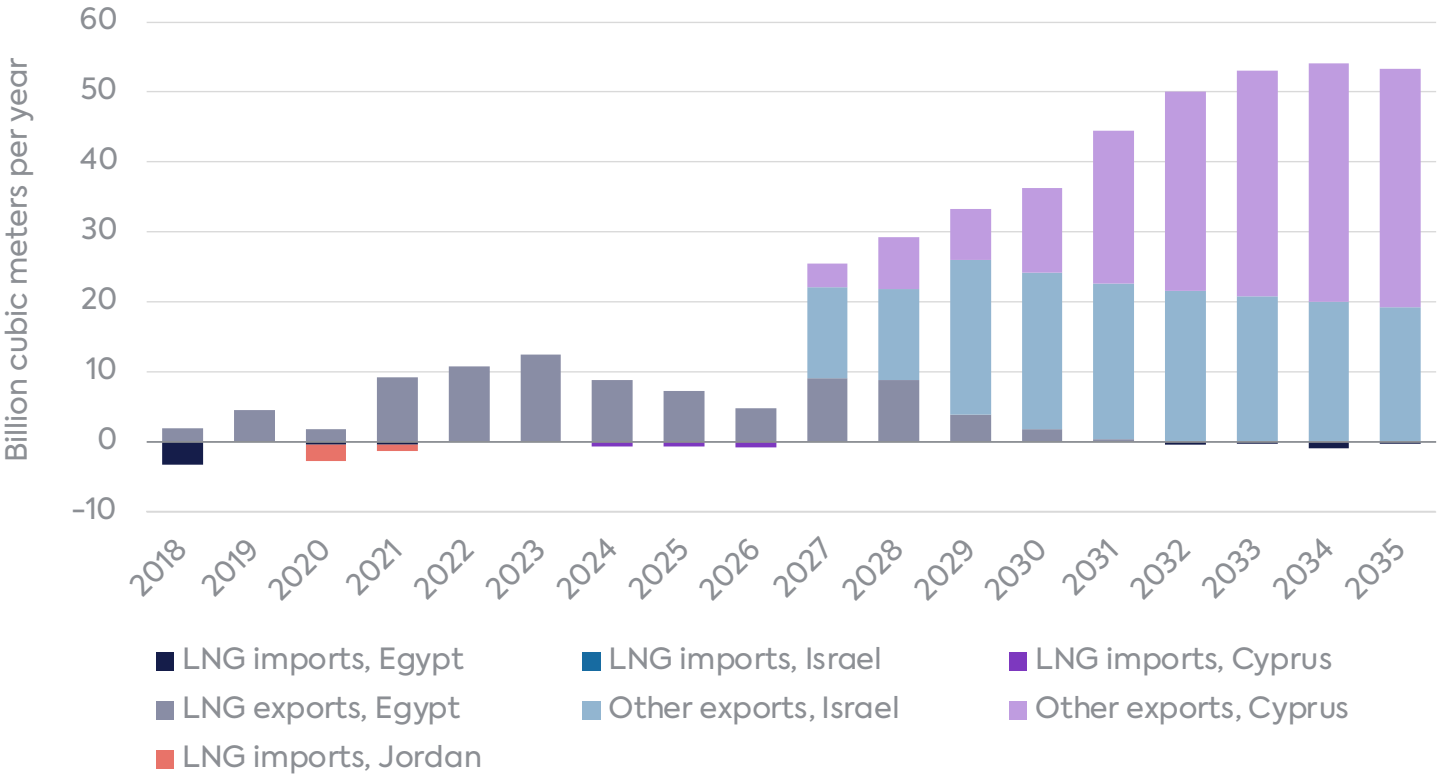
Figure 11: Regional Eastern Mediterranean gas imports and exports, with Egypt as priority (scenario 1)



Source: Annual reports and company statements of Energean, Noble, NewMed, Eni, TotalEnergies, Chevron; press reports based on those (all cited elsewhere in this paper); data from the energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestine, and Lebanon; and the Middle East Economic Survey.

In the second scenario (Figure 12), Israel exports to Egypt up to the capacity of the existing pipeline plus a proposed 5 Bcm/y expansion, but not more. For the surplus, Israel and Cyprus develop (individually or jointly) extra-regional exports by pipeline and/or dedicated LNG. In this case, from 2027 onward the region develops just over 50 Bcm/y of potential exports, about 23 Bcm of which come from Israel and 32 Bcm from Cyprus, but Egypt requires small quantities of LNG imports. Note that these scenarios assume Israel would, if required, lift its restriction on gas exports, which currently dedicate 60 percent of reserves to the domestic market.

Figure 12: Regional Eastern Mediterranean gas imports and exports, with Egypt as priority (scenario 2)



Source: Annual reports and company statements of Energean, Noble, NewMed, Eni, TotalEnergies, Chevron; press reports based on those (all cited elsewhere in this paper); data from the energy/hydrocarbon ministries and regulators of Israel, Cyprus, Egypt, Jordan, Palestine, and Lebanon; and the Middle East Economic Survey.

4. Political and Energy Policy Setting—Potential Enablers and Blockers for Gas Monetization

Hydrocarbon resources in the Eastern Mediterranean are moderate in global terms, if significant on a regional scale. The politics surrounding these resources, though, are exceptionally complex (Table 3), encompassing three long-running conflicts: the Israeli-Palestinian conflict; the conflict over the divided island of Cyprus between the Republic of Cyprus (a member of the EU since 2004) and the TRNC; and, since 2011, the Syrian Civil War, which concerns Lebanon, Israel, and Turkey and has brought Russia back into the regional calculus. Apart from these, Lebanon is suffering economic and energy breakdown and political paralysis, while the armed Iranian-backed group Hezbollah maintains a leading role in its politics and in pursuing confrontation with Israel. Domestic politics in Israel is fractious and encompasses a wide range of views on the role of gas and on policy toward the Palestinian Territories and Israel's neighbors, with the right-wing government formed in December 2022 under Benjamin Netanyahu promising a hardline approach. External players, notably the US, Russia, Italy, France, the UAE, and Qatar, have also been drawn into gas-related disputes, trying either to mediate or to support their favored parties.

A runoff[78] in the Republic of Cyprus's presidential election on February 12, 2023, resulted in victory for Nikos Christodoulides, a former foreign minister.[79] Christodoulides said in April 2022 that the Eastern Mediterranean could provide Europe with about 25 Bcm/y of gas, which amounts to 15–16 percent of its annual imports from Russia.[80] His campaign platform urged continuing efforts to resolve the division of the island, accelerate the green transition, and utilize Cyprus's offshore energy resources.[81]

The role of politics in frustrating Eastern Mediterranean gas development has sometimes been overstated; much progress has occurred despite political turmoil, and many of the delays that have occurred relate to commercial disagreements, domestic political indecision, and the difficult economics of some proposals. Israel has succeeded in developing exports to Jordan and Egypt, and (indirectly) even made progress supplying Lebanon via Syria, despite often negative public opinion in all four countries as well as volatile or nonexistent political relations with Jordan, Lebanon, and Syria.

Nevertheless, politics do remain an obstacle to some schemes, particularly those involving subsea pipelines through waters disputed among the Republic of Cyprus, the TRNC, Turkey, and Greece. If

Turkey were to make a commercial gas discovery in the maritime area of the Republic of Cyprus, after shooting seismic data and drilling several wells (so far apparently unsuccessful), that would also lead to controversy.

Table 3: Regional political challenges to gas development and export

Country	Dispute	Main effects on gas
Israel	Internal political debates on the proper role of gas	Delays due to the advancement of new legislation and taxation provisions; anti-monopoly provisions forcing company divestments; limitations on quantities of gas exports
Lebanon	Internal political contestation	Delays in exploration; no progress on approving three LNG import terminals; fuel and power crisis
Israel-Lebanon/ Hezbollah	Maritime border dispute*	Threats to the Karish field; US mediation over border demarcation; deterrence of exploration in disputed blocks
Israel-Palestinian Territories	Territory, sovereignty, governance	Delay in developing Gaza Marine field; Palestine trying to reduce dependence on Israeli electricity imports; popular opposition in Jordan to gas purchases from Israel**
Syria	Civil war and US sanctions	No offshore exploration in Syria; difficulty in transiting gas/ electricity from Egypt via Jordan to Lebanon; end of Arab Gas Pipeline plans to Turkey
Turkey-Republic of Cyprus (RoC)	Territorial/ sovereignty over northern Cyprus and maritime areas	Turkey's refusal to recognize RoC and Greek claims over adjoining maritime areas; Turkish-conducted seismic surveys and drilling in RoC waters that Turkey claims or assigns to the TRNC; conclusion of Turkey-Libya maritime border without reference to Greece or Cyprus; difficulties of pipeline and electricity cable routing; no consideration of gas pipeline from the Eastern Mediterranean directly to Turkey; Cyprus-Greece-Egypt-Israel entente, encouraged by Cyprus dispute and Turkey's intervention

**The Israel/Lebanon resolution could help to resolve the dispute, but this depends on the attitude of the newly elected Israeli government, which opposed the resolution during the electoral campaign.*

*** This dispute has no major effect on gas trade between Israel and Egypt.*

Following the Israeli government's decision on a framework for increasing the amount of natural gas produced from the Tamar field, as well as the quick development of the Leviathan, Karish, Tanin, and other natural gas fields, NewMed Energy and Avner (which jointly held 53 percent of the reservoirs in equal shares between them) along with Chevron Energy Mediterranean (which held 47 percent of the reservoirs) were required, inter alia, to sell their holdings in the Karish and Tanin reservoirs within 14 months of the signing date of the exemption resolutions related to the Gas Framework (December 17, 2015). This measure allowed them to comply with the conditions that would entitle them to an exemption from several provisions of the Restrictive Trade Practices Law, 5748-1988.

By law, around 540 Bcm (60 percent of reserves) are reserved for the domestic Israeli market. Yet this study forecasts that demand during 2018–2040 would amount to about 350 Bcm, and after that would likely decline as the country's 2050 net-zero target approaches. (The Adiri-2 report for Israel's Ministry of Energy assessed total domestic demand over the next 25 years at no more than 481 Bcm.[82]) These restrictions therefore make it less attractive to explore for large new fields, which could not be developed before the 2040s, as opposed to Energean's incremental exploration for smaller resources.

The commercial arrangements for any cooperative development are also complicated. As noted, reserves are split among all six supermajors (Eni, Chevron, ExxonMobil, BP, Shell, and TotalEnergies; see Figure 13) as well as Energean, NewMed, Mubadala, Rosneft, QatarEnergy, and various other local and international players. Several of these are present in more than one regional country, while Eni and Shell have separate interests in the Egyptian LNG plants. This commercial fragmentation will make any agreement on a single cooperative cross-border solution harder, and will make options such as individual floating LNG (FLNG) plants more feasible.

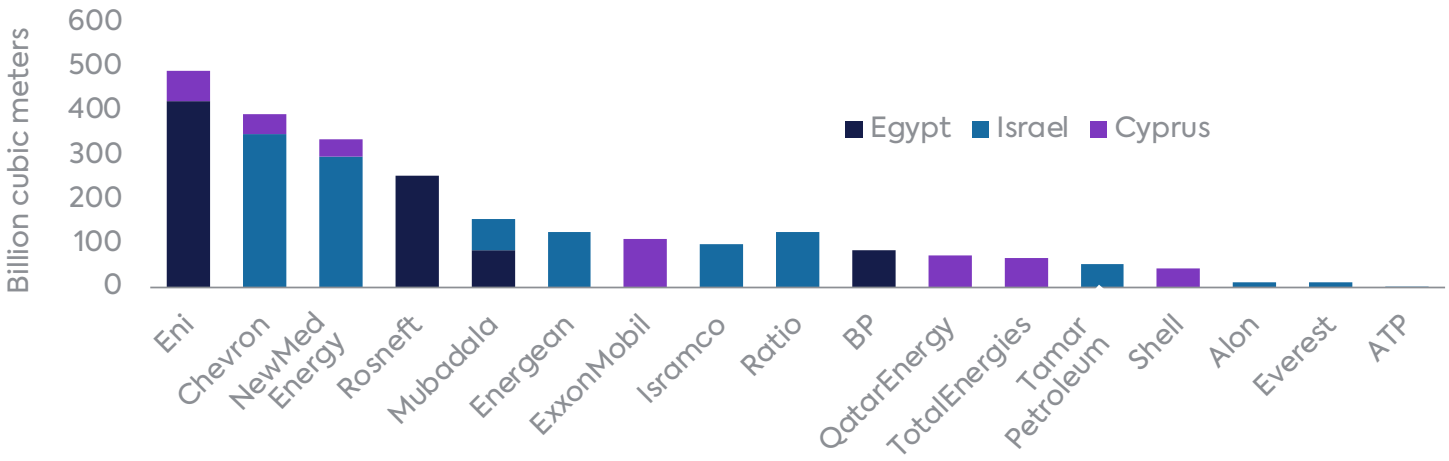
5. Current Gas Resource Owners and Their Commercial Plans

One major obstacle to the speedy commercialization of deepwater gas discoveries in the Eastern Mediterranean region is the fact that they have been made by different companies in different countries.

5.1 Key Companies Holding Discovered Gas Resources

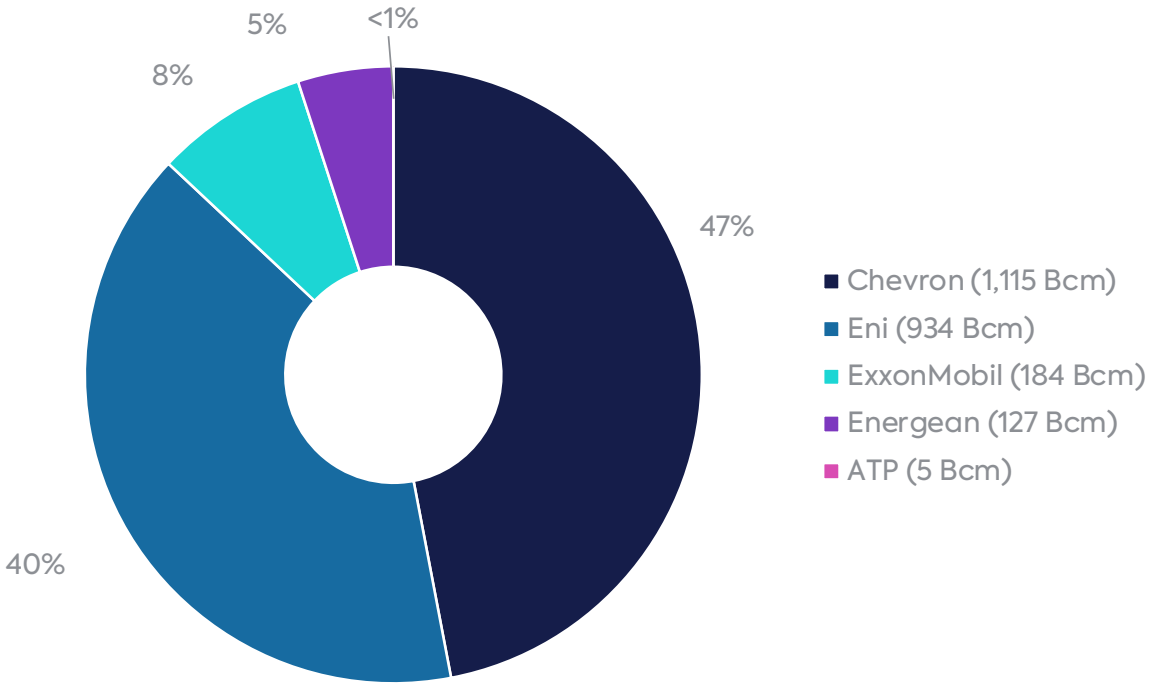
As of now, Eni and Chevron are by far the biggest holders of discovered gas resources in the three Eastern Mediterranean countries of Egypt, Israel, and Cyprus (Figure 13). Both companies have more than 368 Bcm (13 Tcf) of gas volume from their working interests in these fields. In terms of gas volume under their control, their positions are even more dominant (Figure 14), with Chevron at 1,116 Bcm (39 Tcf) and Eni at 934 Bcm (33 Tcf); ExxonMobil is in a distant third place at 184 Bcm (6.5 Tcf). Energean operates smaller fields with 127 Bcm (4.5 Tcf) of gas in Israel that are mainly targeted to supply the domestic market. Energean could also become an important gas exporter if its ongoing exploration program discovers significantly more gas in the near future.

Figure 13: Discovered gas resources in Eastern Mediterranean countries by net working interest, as of November 2022



Source: Annual reports and company statements of Eni, Chevron, NewMed Energy, Rosneft, Mubadala, Energean, ExxonMobil, Isramco, Ratio, BP, QatarEnergies, Tamar Petroleum, Shell, Alon, Everest, ATP.

Figure 14: Operated gas fields by volume



Note: Gross ownership refers to total field volume, including that of the operator, plus other volume owned by the non-operating partners.

Source: Annual reports and company statements of Chevron, Eni, ExxonMobil, Energean, ATP.

Among the more than 20 owners of discovered gas volumes in the Eastern Mediterranean, two groups of companies are worth noting from a geopolitical point of view.

- Mubadala and QatarEnergy are from the UAE and Qatar, respectively. Mubadala holds 156 Bcm (5.5 Tcf) in Egypt (Zohr) and Israel (Tamar and Dalit). QatarEnergy holds 40 percent, or 74 Bcm (2.6 Tcf), in ExxonMobil's Glaucus discovery in Cyprus, and has just joined TotalEnergies-Eni's exploration efforts in Lebanon.[83] Improved relationships between Israel and the Gulf countries, evidenced by the signing of the Abraham Accords on August 13, 2020, as well as the normalization of relations between Israel on the one hand and the UAE and Bahrain on the other[84] is a key factor in the energy geopolitics of the region. The UAE has had poor relations with Turkey, but recently these appear to have warmed significantly. Qatar, a longstanding Turkish ally, has not officially normalized relations with Israel, and its interactions with the country are complex and somewhat ambiguous, but it maintains lower-level contacts and is a

key mediator between Israel and the Hamas-led administration of Gaza.[85] As a leading global gas player and frequent regional rival to Saudi Arabia and the UAE, Doha may have strategic reasons for its interest in Eastern Mediterranean gas, though such interest is also consistent with QatarEnergy's strategy of exploration-led international growth in partnership with supermajor IOCs. Finally, the inauguration of the new right-wing Israeli government may put these relationships (and the deal with Lebanon) under strain.

- Russia's Rosneft is the fourth-largest volume holder in the Eastern Mediterranean gas play, with a 30 percent working interest in Zohr. Given the joint venture structure and the position of the Egyptian government, it would not appear that Rosneft would be able to use this position directly to obstruct gas sales from Zohr to Europe were it to wish to do so at the behest of the Russian government. Novatek, the other major Russian gas player, held 20 percent in exploration blocks 4 and 9 in Lebanon with operator TotalEnergies (40 percent) and Eni (40 percent), though no discovery has been made there. In August 2022, it was announced that Novatek would withdraw, with QatarEnergy becoming the new third partner. Under the terms of the Lebanon-Israel border demarcation, no Israeli or Lebanese company is allowed to hold a stake in the previously disputed Block 9. As noted, QatarEnergy picked up a 30 percent stake in January 2023,[86] while TotalEnergies and Eni each became a 35 percent equity owner.

Israeli companies NewMed Energy[87] (formerly Delek Group), Isramco, and Ratio all hold more than 56 Bcm (2 Tcf) of gas, with NewMed Energy involved in both Israeli and Cypriot projects. It is possible that once the monetization routes for these Eastern Mediterranean fields are more certain, they could become takeover targets, as has been the case for many small to medium-sized companies that could not realize the full value of gas discoveries by themselves (e.g., BG by Shell in 2016,[88] Anadarko by Occidental,[89] and Noble by Chevron in 2020[90]). In September, NewMed announced plans to merge with Capricorn Energy, a UK-listed oil company with assets in Egypt, among other players[91] capable of supporting its plans to supply Egypt, though it is not certain this deal will be concluded.

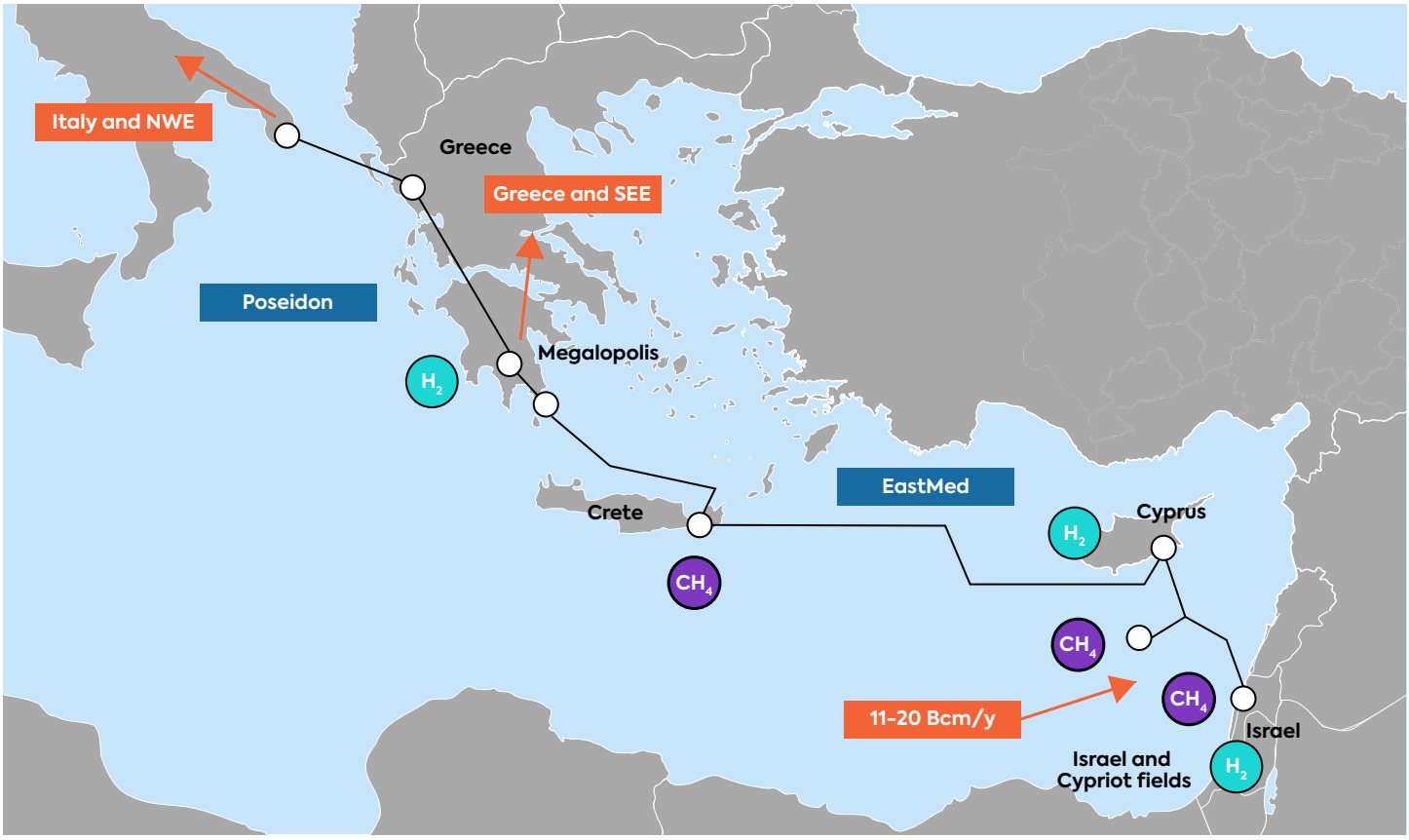
5.2 Monetization Options for Gas Discoveries in the Eastern Mediterranean

There are two main schools of thought in terms of commercializing recent gas discoveries in the Eastern Mediterranean region to Europe and the world: (1) by long-distance gas pipeline and (2) by LNG tankers.

The pipeline concept has two versions:

- **A 1,900–2,000 km (1,400 km offshore; 600 km onshore, mostly in mainland Greece, where it would connect to Italy and southeast Europe) gas pipeline from Israel through Cyprus, to Crete, mainland Greece, and potentially southeast Europe (via the new Greece-Bulgaria interconnector) or Italy (via the Trans-Adriatic Pipeline).** This concept is being developed by IGI Poseidon, a joint venture of DEPA (Greece) and Edison (Italy) (Figure 15).[92] With a capacity of 10 Bcm/y initially, the project is projected to cost €6.2 billion ($6.8 billion). The maximum water depth it crosses would be 3,000 m, which is comparable to other ultra-deepwater pipelines installed worldwide. This pipeline could also be designed to accommodate hydrogen, with Egypt emerging as an important future producer. European Commission president Ursula von der Leyen emphasized the importance of making infrastructure hydrogen-ready during a visit to Israel and Egypt in June 2022.[93]
- **A 600 km pipeline to the neighborhood of Ceyhan, Turkey.** This subsea pipeline is estimated to cost $2.5 billion. There is an LNG terminal near Ceyhan, and pipeline connections that should then facilitate the distribution of the gas within Turkey; an equivalent volume of other Turkish imports could then be re-exported into southeast Europe.

Figure 15: Proposed gas pipeline route from the Eastern Mediterranean to Europe



Source: EastMed-Poseidon Project, https://igi-poseidon.com.

The LNG concept has three broad alternatives:

- Using the two existing underutilized LNG plants in Egypt, though connecting pipelines need to be constructed or expanded to link the Israel-Cypriot gas fields to these terminals
- Constructing a new floating or land-based LNG plant in Cyprus
- Constructing a new LNG liquefaction plant in Israel (likely floating)

Another option—related but not directly comparable to the pipeline and LNG plant options—is a subsea electricity line. Greece, Cyprus, and Egypt have signed an agreement to cooperate on this venture, and a 1 GW (expandable to 2 GW) link between Israel, Cyprus, and Greece has secured €657 million ($698 million) of EU funding. The Cyprus-Greece section is estimated to cost €1.6 billion

($1.7 billion). This electricity line would also carry renewable-generated electricity. It could be built independently of any decision on gas exports, and indeed construction began in October 2022 on the EuroAsia connector from Cyprus.[94]

5.2.1 EastMed Pipeline

The concept of constructing an offshore pipeline to transport gas discovered in offshore Israel and Cyprus was advanced soon after Noble Energy and its partners discovered major gas fields, including Tamar (2009) and Leviathan (2010) in Israel and Aphrodite in Cyprus (2011). The European Commission set up Project of Common Interest 7.3.1 in 2016 and allocated $39 million to conduct a feasibility study on the technical and economic merits of such a pipeline route, which would start in Israel and move through Cyprus into Greece to connect to the southern European gas pipeline network. Three years later, in 2019, the study concluded that "the EastMed Gas Pipeline Project is technically feasible, economically viable and commercially competitive."[95] Certification group DNV reaffirmed the pipeline's viability in June 2022.[96]

In January 2019, the Republic of Cyprus, Egypt, Greece, Israel, Italy, Jordan, and the Palestinian Authority established the East Mediterranean Gas Forum (EMGF, or EGF) to promote regional collaboration not only among Eastern Mediterranean countries but also with Europe. France subsequently applied and was accepted as a member of the EMGF in March 2021, while the US and World Bank became Permanent Observers. A UAE attempt to join the EMGF was vetoed by the Palestinian Authority following the normalization of diplomatic relations between the UAE and Israel in September 2019, sponsored by then US President Donald Trump as part of the Abraham Accords. Notably, Turkey was excluded, and indeed the forum has been seen as intended to contain Turkey given its expansive border claims and drilling in areas claimed by the Republic of Cyprus.

In March 2019, Greece, Cyprus, and Israel signed an intergovernmental agreement to construct the EastMed gas pipeline. Then US Secretary of State Mike Pompeo witnessed the signing ceremony in Athens, in a show of support for Europe's efforts to diversify its gas supply sources and reduce its dependence on Russian gas. The US government changed its mind on the EastMed gas pipeline initiative after President Joe Biden took over the White House in January 2021.[97]

In January 2022, the Biden administration formally withdrew US government support for the pipeline, citing environmental and economic reasons. This was before the Russian invasion of Ukraine on February 24, 2022. Members of the US Congress, especially Republicans, have appealed to the Biden administration to change its position in view of Europe's ongoing energy crisis. However, members of the Biden administration have repeatedly reaffirmed its objection to the pipeline concept; some observers have speculated that this is in part because Washington does

not want to see geopolitical tensions flare up between Turkey and members of the EMGF, given the importance of NATO member Turkey to the Ukraine conflict.

For now the pipeline concept, even the modified version from Israel-Cyprus northward to Turkey (rather than westward to Greece), seems to have taken a back seat.

In the latest tripartite memorandum of understanding (MOU) between the EU, Israel, and Egypt,[98] signed on June 15, 2022, the leading concept has become for Eastern Mediterranean gas to supply Europe via LNG rather than through a new pipeline, though the MOU did encourage continued investment of IOCs in gas exploration and production in Eastern Mediterranean countries, in addition to accelerated collaboration to promote renewable energy development and other priorities.

It is important to note that, so far, the initiatives on the EastMed gas pipeline to Europe have been led mostly by governments, not the relevant oil and gas companies. Although Chevron CEO Michael Wirth was quoted in March 2022 during CERAWeek remarking that the "EastMed pipeline to Europe could work,"[99] Chevron (and its acquired Noble Energy) have so far not provided public support for construction of the pipeline.

5.2.2 LNG—Currently Favored Export Concept to Monetize Eastern Mediterranean Gas

Currently there appear to be three main concepts of exporting Eastern Mediterranean gas through LNG: (1) from Israel-Cyprus to either or both of the two existing LNG facilities in Egypt; (2) from Israeli and/or Cypriot fields to a new onshore LNG plant in Cyprus; and (3) via one or more FLNG plants in Israel and/or Cyprus (these could be dedicated to a single field of sufficient size or serve more than one field, including potential cross-border flows). Exploration drilling campaigns in 2023 by key players including Chevron, ExxonMobil, and Eni in Cyprus may yield key results that could determine how Cyprus will decide to monetize its gas discoveries.

According to Nadav Perry, vice president in charge of regulations and public affairs at NewMed Energy, a partner with Chevron in the Leviathan and Aphrodite gas fields, "the partnership has been looking at various options to diversify its market access, including floating LNG in Israeli waters to focus on the development of future stages of Leviathan."[100] Chevron is now reported to be assessing contractors' bids to construct a 5 Mtpa (6.8 Bcm/y) FLNG vessel.[101]

There are two LNG export terminals in Egypt: Idku (7.2 Mtpa), near Alexandria to the west of the Nile Delta, operated by Shell[102]; and Damietta (5 Mtpa), in the east of the Delta, operated by SEGAS/Eni.[103]

Estimated costs of delivering gas (or the equivalent in electricity) to Turkey or southern Europe are shown below (authors' calculations).

Table 4: Cost estimates of different gas monetization options for Eastern Mediterranean gas

Export option	Annual capacity	Capital cost (US$ billion)	Estimated cost of delivery (US$/MMBtu)
EastMed pipeline	10 Bcm	6.2	2.2
Turkey pipeline	10 Bcm (assumed)	2.5	0.9
Existing LNG (Egypt)	12.2 Mtpa ≡ 16.6 Bcm	0.2*	2.1
Onshore LNG	7.35 Mtpa ≡ 10 Bcm	7.35	4.5
Floating LNG	1.8 Mtpa ≡ 2.5 Bcm	2.5	5.6
HVDC electricity	2 GW ≡ 2.9 Bcm	1.6	3.2

Note: Other than the existing LNG plants, the capacity of all these options could be scaled up as required if more gas is available. 1 Bcm of gas contains approximately 34.1 trillion British thermal units, or 34,100,000 MMBtu.

**This accounts for $200 million to supply an additional 5 Bcm/y to Egypt; it does not account for any capex that may be required for plant upgrades or refurbishment. See "Israel Weighing $200 Million Pipeline to Export More Gas to Egypt -Report," Times of Israel, October 21, 2021, https://www.timesofisrael.com/israel-weighing-200-million-pipeline-to-export-more-gas-to-egypt-report.*

To get the delivered cost of gas into Turkey or southern Europe, the upstream cost can be added; based on recent sales contracts this can be assumed to be $4–5/million British thermal units (MMBtu) from Israel or Cyprus[104] and up to $5.88/MMBtu from Egypt. This cost may rise given general inflation, specific inflation in upstream oil and gas projects, and generally high international gas prices.

This analysis is indicative and should be taken with caution, particularly given recent inflation. Specific projects will have costs and practicalities that vary significantly from these general options. However, directionally it suggests that on economic grounds:

- Delivered costs into Europe would be approximately $5–10/MMBtu, in the range of import prices over the past decade and obviously much cheaper than those prevailing during 2021–2022.
- Use of the existing Egyptian LNG plants is the lowest-risk and fastest option, and though not as cheap as a pipeline to Turkey (mostly because of the costs of shipping and regasification), it has been and probably will continue to be the favored option, at least over the next few years.
- The EastMed pipeline is surprisingly cost-effective if the given capital cost can be assured.

(Given the deep water and rugged seabed, as well as recent rises in steel prices, the reported capital costs certainly require further verification.)

- The pipeline to Turkey is the cheapest option for new infrastructure, but requires some kind of resolution or compromise on the Cyprus issue.
- New LNG plants are significantly more expensive but, if capital costs can be assured, still highly competitive with other global LNG developments, particularly given their geographic proximity to southern Europe.
- The HVDC cable is more expensive per unit of useful energy than the pipelines, but still reasonable in terms of the delivered equivalent cost of gas, as long as it is operated at a high utilization (90 percent assumed here).

The pipeline options have the advantage of potentially being able to be converted to carry hydrogen to assure long-term viability. They have the disadvantages of severe political/border problems and committing sellers to a single market. They also require cooperation between many companies and several countries to combine enough gas resources for a viable project. The volatile state of Israel-Turkey ties—the two countries only restored full diplomatic relations in August 2022 after a four-year break—is a further disincentive to the direct route to Turkey, despite its economic advantages.

LNG is more expensive but more flexible in destination market and avoids border issues. FLNG facilities could be built in a modular way assuming new gas resources become available. This would reduce the problem of having to aggregate resources from numerous companies and consortia to achieve a commerciality threshold. It may also be quicker to market given the issues in surveying and permitting a pipeline route. Eni in Congo was able to fast-track a FLNG project to market within two years; Karish took four years from final investment decision to first gas, and four years is assumed here for starting up a new LNG plant in the Eastern Mediterranean.

The HVDC electricity cable has the same disadvantages as the pipelines in terms of high up-front costs, border issues, and commitment to a single market. It also delivers only electricity rather than gas or eventually hydrogen, which could also be used in industry or home heating. However, it has the advantages of being bidirectional and able to carry electricity from any source (including renewables), making it compatible with Europe's decarbonization agenda.

6. Conclusions

Based on the preceding technical, geopolitical, and economic analysis of the possibility of supplying gas from the Eastern Mediterranean region to Europe, this report concludes the following:

1. Pipeline and LNG options from the Eastern Mediterranean to Europe could be cost competitive.

2. On an aggressive timeline, a net of approximately 50 Bcm/y of surplus gas could be available from the Eastern Mediterranean by the early 2030s. However, the complicated commercial arrangements and fragmentation of reserves between fields, companies, and countries have delayed development so far. A growing supply-demand gap in Egypt will require imports from its neighbors or as LNG, limiting the availability of Eastern Mediterranean gas to supply Europe.

3. Maximizing use of existing Egyptian LNG plants would be the most fruitful short-term measure, and the EU can play an important role in coordinating gas field and pipeline development from Israel and Cyprus to Egypt. Boosting Egypt's energy efficiency and renewable capacity will also help to ensure it has spare gas for export during the 2023–2026 period.

4. This baseline assessment could change if significantly more gas is discovered in the near term in the Eastern Mediterranean region through ongoing and planned exploration programs in Cyprus, Israel, Egypt, and other countries, and if longer-term demand growth in Egypt can be restrained, most likely through regulatory reforms.

5. Government priorities will be to serve domestic demand. However, the companies that own and operate the gas fields will seek the most profitable export options after fulfilling domestic needs. This will encourage the development of commercial solutions via LNG to build market diversity, so that the gas resources of these companies can benefit from higher gas prices not only in Europe but potentially in emerging markets in Asia and elsewhere. This may require Egypt in particular to raise domestic prices again to ensure it can attract imports from Israel and/or Cyprus.

6. The approach of prioritizing existing LNG plants is not only dictated by economic factors; considerable geopolitical tensions in the region mean constructing a 2,000 km offshore gas pipeline would take a very long time, if it could be completed at all. Europe is also

very reluctant to make long-term commitments to fossil fuel infrastructure. Therefore, such a pipeline is unlikely to help Europe significantly in the next five to eight years, the critical period for Europe's shift away from Russian gas.

7 Turkey's relations with its Eastern Mediterranean neighbors are problematic, but if the EU and the US can advance political resolutions, these would ease the development of gas fields around Cyprus as well as potential exports from Cyprus and Israel to Turkey and onward to Europe. The recent Israel-Lebanon deal is an encouraging example, if it holds. A direct pipeline to Turkey could be a useful political carrot for Ankara, would be quicker and cheaper to build than the route to Greece, and could therefore make a timelier contribution to replacing Russian gas.

8 The Eastern Mediterranean's resources are substantial enough to make a material contribution to European energy security, but without external coordination and bold and urgent steps, they will come too late. This would require a powerful external party (or parties), with a clear and realistic vision, to assist in coordinating the various countries and companies involved to develop cooperative solutions. Most likely, these parties would be the EU (and its most directly concerned member states—Italy, France, and Greece) and the US. To achieve regional buy-in, this vision would have to avoid instrumentalization, stress the benefits of energy security for the nations involved, and encourage their aspirations for a faster energy transition, including hydrogen and electricity interconnections. Given the large ambitions in Egypt and neighboring countries for "green" hydrogen production, it would be appropriate for any new pipeline to be capable of carrying hydrogen, but given the economic and geopolitical urgency, the countries involved would not wish this to slow work on natural gas.

Notes

1. For the purposes of this report, Europe includes the United Kingdom, Turkey, Ukraine, Norway, and other non–European Union member states.
2. "REPowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy," European Commission, March 8, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_1511.
3. Notably, the Caspian Sea and Central Asia, West Africa, Algeria, and Iraq.
4. For the purposes of this report, the Eastern Mediterranean refers primarily to three countries with recent deepwater gas discoveries—Israel, Cyprus, and Egypt—but also includes the Palestinian Territories, Jordan, Lebanon, and Syria. Turkey, Libya, and Greece are geographically in the Eastern Mediterranean and their political role is covered, but their gas resources and consumption are not considered explicitly here.
5. See Table 1.
6. "Oil and Gas Exploration in Israel," Israeli Ministry of Energy, May 27, 2018, https://www.gov.il/en/departments/general/gas_oil_history.
7. "History and Heritage," NewMed Energy, accessed December 14, 2022, https://newmedenergy.com/about-us/#history.
8. "Oil & Natural Gas E&P in Israel," Israeli Ministry of Energy, https://www.energy-sea.gov.il/English-Site/Pages/Oil%20And%20Gas%20in%20Israel/History-of-Oil--Gas-Exploration-and-Production-in-Israel.aspx.
9. Tim Boersma and Natan Sachs, "Gaza Marine: Natural Gas Extraction in Tumultuous Times," Foreign Policy at Brookings, no. 36, February 19, 2015, https://www.brookings.edu/research/gaza-marine-natural-gas-extraction-in-tumultuous-times.
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