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NATURAL GAS EXPORT OPTIONS FOR ISRAEL AND CYPRUS

Simon Henderson

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Cover photo: Gas tanker loading in port, Japan. © Oldmaster

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EXECUTIVE SUMMARY

Recent discoveries of natural gas offshore Israel and Cyprus give both the countries the potential to become energy exporters. But the fields, deep below the seabed in waters 2,000 meters deep and more than 100 kilometers from the coast of either country, present technical and diplomatic challenges for which there are no obvious simple solutions. The prospect of finding additional significant gas fields, and even exploitable oil deposits, compounds decision-making challenges. The way forward appears to be the development of a range of export options, both by pipeline and liquefied natural gas (LNG), and perhaps as electricity. Cooperation between Israel and Cyprus is likely an important element in each country's successful exploitation of the new-found riches.

1 INTRODUCTION

Israel and Cyprus have found significant amounts of natural gas in their offshore Exclusive Economic Zones (EEZ) in the Eastern Mediterranean Sea and are predicted to discover more.¹ The two main Israeli fields — Tamar, 10 trillion cubic feet (tcf), discovered in 2009, and Leviathan, 19 tcf, discovered in 2010 — were the biggest deepwater natural gas finds for those years. The fields so far discovered are in up to 2,000 meters of water, with the actual hydrocarbons several thousand meters more under the sea bed. The single Cypriot find so far, the Aphrodite field, discovered in 2011, has an estimated 5.2 tcf. In global terms, these reserves are comparatively small. Iran has proved reserves of 1,187 tcf and Qatar has 885 tcf. Even in the Eastern Mediterranean area, Egypt has proved reserves of 72 tcf.² However the discoveries are large enough to have a considerable impact on the economic development and energy security of the two countries.

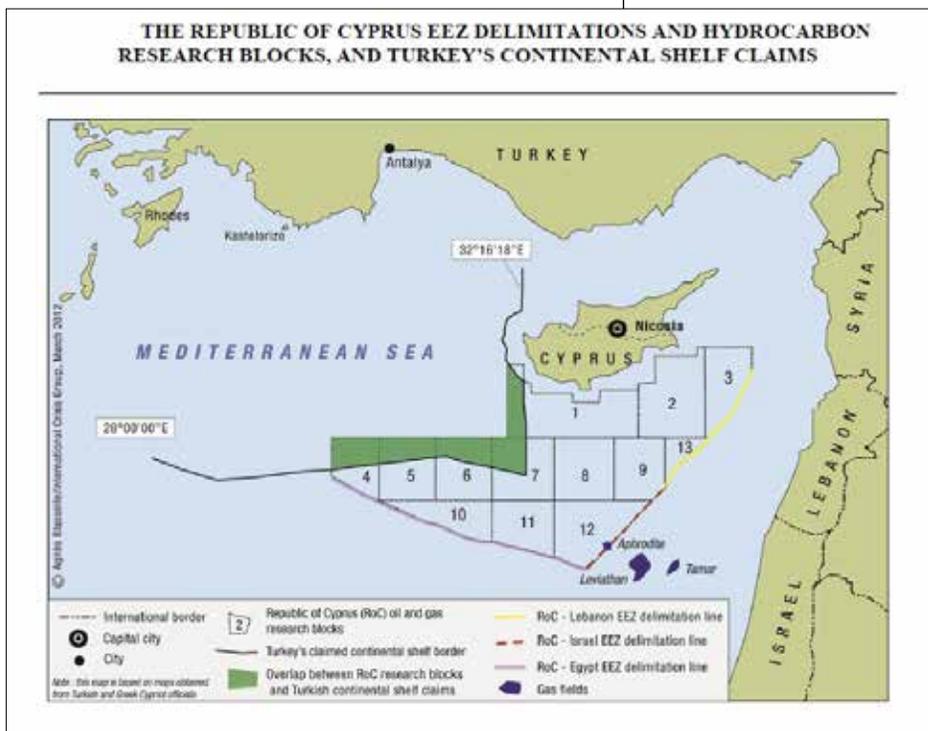
Leviathan and Aphrodite, as well as other new fields, have yet to be fully explored. But it is already clear that both countries will have a surplus available for export. In the case of Israel, the government has decided that 40 percent of its gas reserves, as estimated in 2013, can be exported. Cyprus, with its smaller population, will require less than 10 percent of its reserves for domestic consumption, so the bulk of its gas looks likely to be designated for export.

No oil has been discovered yet but future exploration is likely to find some reserves.³ Given

¹ <http://pubs.usgs.gov/fs/2010/3014/pdf/FS10-3014.pdf> The U.S. Geological Survey estimated in March 2010 that there was 122 trillion cubic feet (3,416 billion cubic meters) of natural gas in the Levant Basin, an area bounded by the Jordan Valley in the east and stretching towards Cyprus, including the coast of the Gaza Strip, Israel, Lebanon, and Syria.

² BP Statistical Review of World Energy, June 2013.

³ The U.S. Geological Survey study of the Levant Basin also forecast a mean of 1.7 billion barrels of recoverable oil.



the current price differential between oil and gas — about 4:1 in terms of energy content, lower production costs and easier marketing — there will be considerable incentive to extract any oil found, provided the quantities found make this commercially attractive. The principal explorer and operator in the Israeli and Cypriot EEZs, Noble Energy of the United States, is planning to drill a “deep oil test” in 2014 and has noted that there are “multiple similar prospects” in its acreage.⁴ Already the Tamar and Leviathan fields have yielded significant amounts of natural gas condensate, a valuable associated product that can be used for petrochemicals.⁵ Gas condensates are liquid hydrocarbons that are separated from gas at low temperatures.

⁴ <http://www.nobleenergyinc.com/Operations/International/Eastern-Mediterranean-128.html>

⁵ Delek Group, June 2013.

2 PIPELINES OR LNG OR ELECTRICITY

Natural gas can be exported via pipeline or, after conversion into liquefied natural gas, in a specially built tanker. Pipelines are cheaper for shorter distances between the exporter and the customer. Conversion to LNG involves an expensive, large-scale industrial plant but has the advantage of freeing the exporter from relying on one route and one customer at the end of a pipeline. A third option is to use the natural gas to generate electricity and then export electric power. International trade in electricity is well-established between neighbors: for example, France exports power generated by nuclear power plants to Britain, using cables laid on the sea bed of the English Channel. There is also an interconnector link between the Netherlands and Britain.

Deciding between pipeline and LNG, or a combination of both, requires knowledge of the total amount of natural gas available, the cost of recovery, and the price for which the gas is

sold. All these factors, in the cases of Israel and Cyprus, are largely unknown. So far, the discovered volumes of natural gas, by themselves, barely justify the construction of LNG plants. Only if considerable additional volumes are discovered or if the production of both Israel and Cyprus is supplied to a joint LNG plant does the venture become commercially viable. There is considerable interest in the LNG option, especially in Cyprus, given hopes for further discoveries and political constraints on pipeline options.

The usual rule-of-thumb for choosing between a pipeline and LNG option is that LNG tankers become commercially viable for distances greater than 3,000 miles (4,800 kilometers). In the context of the Eastern Mediterranean discoveries, this suggests that future European customers would be best supplied by pipeline while LNG tankers would provide for Asian customers.

3 NATURAL GAS PRICE VARIATIONS

Currently, this divide between European and Asian markets also mirrors a price differential for natural gas. Prices in Europe (which themselves are higher than those in the United States) are dwarfed by the prices in Asia. This makes profits for East Mediterranean natural gas marginal in European markets but potentially more viable in Asian markets. In a presentation to analysts in December 2012, Noble Energy included a chart showing the cost of supply for LNG being shipped to the Far East. The chart suggested a cost of between \$7 and \$8 per million Btu (British thermal unit) for Israel gas, with gas from Cyprus being close to \$7 per million Btu. In both cases, more than a quarter consisted of shipping cost, the remainder being upstream and liquefaction costs. This suggests that LNG exports from the Eastern Mediterranean would be profitable in Far Eastern markets but not in Europe.⁶

Investors in natural gas tend to look at 20-year time horizons because of the expense of building pipelines and LNG facilities. Until recently, natural gas prices were systematically linked to oil prices and tied to long-term contracts. Many gas contracts are still linked to oil, or to a band of oil-related prices. However natural gas prices are becoming more independent, albeit with wide regional variations. The advent of shale gas in the United States has considerably increased the supply of natural gas and lowered prices.

⁶ Noble Energy Analyst Conference, December 6, 2012.

Natural gas, like oil and coal, is a fossil fuel. But it has a lower carbon footprint and so is relatively attractive. Even so, oil and coal are expected to dominate world energy supply for the foreseeable future.⁷ Price differentials between different gas markets will probably narrow as LNG increases its market share over internationally piped gas; this will gradually make the gas market resemble the oil market for which there is a global price with some regional variations. In 2012, international trade of natural gas by pipeline was 705 billion cubic meters (bcm) and, for LNG, nearly 330 bcm.⁸ In December 2012, Noble Energy forecast 2022 demand for LNG at around 530 bcm.⁹ Experts differ, however, on the likely future evolution of markets for LNG and pipeline gas.

⁷ <http://www.eia.gov/forecasts/ieo/?src=home-b1> The U.S. Energy Information Agency, in its International Energy Outlook 2013, predicts that fossil fuels will continue to supply almost 80 percent of world energy needs through 2040.

⁸ BP Statistical Review of World Energy June 2013, page 29.

⁹ Noble Energy Analyst Conference, December 6, 2012.

4 LAW OF THE SEA ISSUES

Natural gas export options are also affected by disputes over the control of offshore resources, which need to be resolved via negotiation within the framework of the United Nations Convention on the Law of the Sea (UNCLOS). The route of any oil or gas pipeline that passes through the EEZ of a country needs the approval of the coastal state.¹⁰ This effectively gives it a veto over such projects.

The Eastern Mediterranean region presents a number of problems in terms of diplomatic recognition, adherence to UNCLOS, and agreed maritime boundaries.¹¹ Turkey does not recognize the Republic of Cyprus, the 2007 maritime boundary agreed between Cyprus and Lebanon, or the 2010 maritime boundary between Cyprus

¹⁰ United Nations Convention on the Law of the Sea, Article 79, paragraph 3. “The delineation of the course for the laying of such pipelines on the continental shelf is subject to the consent of the coastal State.”

¹¹ Tulio Scovazzi, “Maritime Boundaries in the Eastern Mediterranean Sea,” German Marshall Fund of the United States, Washington DC, 2012, <http://www.gmfus.org/archives/maritime-boundaries-in-the-eastern-mediterranean-sea/>

and Israel. Turkey argues that Cyprus should be considered as an island with no rights to an EEZ beyond its 12 nautical mile territorial limit. No country other than Turkey recognizes the “Turkish Republic of Northern Cyprus” (“TRNC”). For its part, the “TRNC” administration has assigned areas to the north, east, and south of the island to Turkey’s state-owned Turkish National Oil Company for offshore exploration. Two of these offshore blocks are areas that the Republic of Cyprus regards as within its EEZ.

The area to the west of Cyprus is also problematic. Cyprus and Egypt signed a maritime boundary agreement in 2003. Turkey asserts a right to an EEZ border with Egypt, which would conflict with this. Additionally, Turkey does not recognize the right of Cyprus to have an EEZ beyond 12 nautical miles to the west of the island. Turkey’s sensitivity to the rights of islands stems from Greek claims in the Aegean Sea, where most of the islands are part of Greece. Such differences may affect possible routes for undersea pipelines or power cables between Cyprus and Greece.

5 CURRENT DOMESTIC MARKETS

Israel

Israel has been producing gas from the now-depleted Mari-B well in the Yam Tethys field off the coastal city of Ashdod since 2004. The gas has been sold to the state-owned Israel Electric Corporation (IEC), which also received gas from Egypt between 2008 and 2012. This gas, along with production that started coming ashore from the Tamar field in March 2013, is sent to power stations, the biggest of which belong to the IEC, and directly supply the national electricity grid. Other smaller power stations, also gas-fired but financed by private companies, are providing electricity to industrial plants. Israel has around 12,000 megawatts (MW) of installed capacity for electricity.

By 2015, 50 percent of Israel's electricity will be generated from natural gas.¹² Previously, coal was used to generate the majority of Israel's power, with oil as a back-up fuel. Of Israel's five largest power stations, three already use natural gas: Reading (north Tel Aviv), Eshkol (near Ashdod), and Haifa (in the industrial zone of the northern coastal city). There are plans to convert the Orot Rabin power station, near Hadera, from coal to natural gas. This leaves only one large power station, Rotenberg, near Ashkelon, using coal, in order to diversify security of supply. IEC has signed a 15-year take-or-pay contract to buy 78 bcm of gas from the Tamar field, with an option to increase this to 99 bcm. Other contracts signed bring the contracted supply volume to 145 bcm, with options of an additional 23 bcm. This leaves a further 114 bcm of the field available to be sold.¹³

Israel also proposes to use some natural gas and gas condensates as a feedstock in its petrochemical plant at Haifa. Desalination, a process very sensitive

to fuel costs, is also an attractive use as Israel has plans to considerably increase its production of desalinated water. The use of methanol and compressed natural gas (CNG) for transport, particularly for truck and bus fleets, is projected to increase. But there is also concern that Israel's economy will become too reliant on natural gas. This is principally a security concern: the natural gas infrastructure is vulnerable, and damage to it would have a disruptive effect on the economy. In any event, the success of a general transition to natural gas in Israel depends on the discovery of considerable additional exploitable deposits of natural gas.

Israel announced its gas export policy in June 2013. A group made up of Prime Minister Binyamin Netanyahu, Finance Minister Yair Lapid, Energy and Water Minister Silvan Shalom, and Bank of Israel Governor Stanley Fischer proposed that 40 percent of production should be available for export. The group made a provision that sales to Jordan and the Palestinian Authority, which governs the West Bank, should come out of the 60 percent reserved for domestic use. But that clause was rejected by the full Cabinet. The government decision on the 40 percent export figure faces legal challenge by political and environmental groups, which argue the decision should be made by the full Knesset (the Israel parliament). A decision is pending. It appears likely that exports will eventually be authorized, in light of the gains to the balance of payments and the need to provide incentives to investors.

Cyprus

The Electric Authority of Cyprus has a total generating capacity of 1,410MW, of which 830MW is provided by the newly completed power station at the Vassilikos energy center on its southern coast, where three 130MW steam turbine units burn heavy fuel oil and two 220MW units currently run on diesel but will be able to use natural gas,

¹² <http://energy.gov.il/English/Subjects/Natural%20Gas/Pages/GxmsMniNGEconomy.aspx>

¹³ Delek Energy, June 2013.

either imported or piped from the Aphrodite field. Vassilikos is also the site of a projected LNG plant, provided authorization is given and the necessary investments are forthcoming. The decision on the LNG project, made by the Ministerial Council in 2012, was reconfirmed by newly elected President Nicos Anastasiades in April 2013. Natural gas could also be useful for desalination, as water shortages are a persistent problem.

The availability of domestic supplies of natural gas is expected to improve the country's balance of

payments and to lower electricity prices, currently among the highest in Europe. Construction of the necessary infrastructure will generate employment and lower electricity prices will give a competitive boost to the economy. This should reinforce efforts to restructure the economy away from dependence on banking and financial services, in the wake of the economic and financial crisis.

6 EXPORT OPTIONS

This section reviews the export options under consideration by Israel and Cyprus and briefly analyses the advantages and disadvantages of each.

Israel

Israel's potential as a gas exporter, although important nationally, is small in world terms. Its current reserves, estimated at 680 bcm (24.3 tcf) by the official Zemach committee in 2012,¹⁴ are very small — less than 0.4 percent of the world's proven reserves of natural gas. This compares with the proven reserves of Iran (18 percent), Russia (17.6 percent), and Qatar (13.4 percent).¹⁵ Even Egypt has substantially more proven reserves (2 percent of the world total). In terms of annual production, the figures for 2013 were Iran 160 bcm, Russia 592 bcm, and Qatar 157 bcm. By comparison, Israel will be producing around 7 bcm by the end of 2013 from its main operating Tamar field.

The 2013 Israel cabinet decision to authorize exports of 40 percent of reserves is being challenged in the courts. The principal argument is that such a decision should be taken by a vote in the Knesset (parliament). Secondary arguments are concerned with the environment, the division of revenues between current spending and a fund for future generations, and profits made by private investors.

Pipelines

- **To Jordan:** The Hashemite kingdom's gas imports from Egypt have been disrupted since the overthrow of the Hosni Mubarak regime in early 2011. In early 2013, the volumes were averaging a fraction of the contractual commitment of around 3 bcm annually, forcing Jordan to buy expensive fuel oil to replace natural gas in generating electricity. Israel's

national gas pipeline infrastructure extends or will extend both to Sedom, at the southern end of the Dead Sea, and to the end of Jezreel Valley in the north, just south of the Sea of Galilee. From both these places, it is only a few miles to the border with Jordan.

One proposal under discussion is that Israel should supply gas to Jordan's Arab Potash Company by extending the gas line that currently carries gas to the Dead Sea Works, operated by Israel Chemicals.¹⁶ A major, though minority, investor in the Arab Potash Company is Canadian, so any deal could be represented as a U.S. company (ie Noble Energy) supplying a Canadian company, in order to minimize domestic Jordanian political opposition. But other shareholders, apart from the Jordanian government, are Saudi, Kuwaiti, and UAE investors, as well as the Islamic Development Bank, whose acceptance of the deal would also be required.

- **To the Palestinian Administration in the West Bank:** there is a proposal for a power station to be built near the city of Jenin in the northern part of the West Bank using natural gas supplies from Israel or from Gaza Marine, the unexploited field with around 1 tcf (28 bcm) reserves lying offshore the Gaza Strip. Currently, there are no power stations in the West Bank; Israel supplies 95 percent of the demand for electricity, and Jordan the remaining 5 percent. The Gaza Marine field is owned by the Palestine Investment Fund, which is controlled by the Ramallah-based Palestinian Authority rather than the Hamas administration in the Gaza Strip. Technically, the simplest option could be to connect the field to Israel's offshore gas network; the field is very close to the now-depleted Mari-B and the new production

¹⁴ The Recommendations of the Interministerial Committee to examine the Government's policy regarding natural gas in Israel (aka The Zemach Report), September 2012.

¹⁵ BP Statistical Review of World Energy 2013

¹⁶ <http://www.haaretz.com/business/jordan-in-secret-talks-to-import-natural-gas-from-israel-s-tamar-field.premium-1.503672>

platform, which processes gas from the Tamar field. Alternatively, such a power station could buy gas directly from Israel.

- **To the Gaza Strip:** currently controlled by Hamas rather than the Palestinian Authority, the one power station uses fuel oil imported from Israel. Extra electric supplies come from Israel and, partly, from Egypt. It is proposed to convert the Gaza power station to natural gas and supply it either from Israel or from the so-far unexploited Gaza Marine gas field off the coast.

The above options relating to Palestine require some resolution of political problems. Neither Israel nor the Palestinian Administration wishes Hamas to benefit politically or financially from such projects. There is a potential win-win-win solution: Israel would no longer be exporting electricity or fuel oil, for which it is not properly paid, to Gaza; the Palestinian Administration could earn royalties from the Gaza Marine gas; and the Hamas Administration would assure better supplies to the citizens of the Gaza Strip. But this option would require the approval of all three parties.

- **To Turkey:** gas from the giant Leviathan field would be sent north through a pipeline lying on the seabed of the Cyprus EEZ, though not coming ashore on the island of Cyprus. This would give Israel access to the large Turkish domestic market, currently consuming 40 bcm annually, as well as the transit routes across Turkey into Europe. Cyprus could effectively veto this route under its rights as a signatory of UNCLOS to approve the pipeline's route through its EEZ. But its dire financial circumstances since the 2013 financial and economic crisis might inspire greater flexibility. Similarly, Turkish antipathy towards Cyprus

could be moderated by its need to diversify gas imports, currently dominated by Russia, and gain lucrative pipeline projects for Turkish construction companies.

- **To Turkey, via Cyprus:** gas from the Israeli Leviathan field, combined with gas from the Aphrodite field belonging to Cyprus, would be piped north to the island, coming ashore at the Vassilikos energy center, so-called because the area includes the island's main power station, as well as the projected LNG plant. (The route is made complicated by a deep underwater trench that lies between the Aphrodite field and the Cypriot coast, but this can be avoided, according to experts.) Following processing to remove water vapor and other impurities, the gas could be piped north across the island into the territory currently controlled by the "Turkish Republic of Northern Cyprus." From there, an undersea pipeline would take it to the Turkish mainland, where it could link in with the domestic pipeline system or the transit routes running across the country to Europe.¹⁷
- **To Greece, via Cyprus:** an option has been discussed for a long undersea pipeline to carry both Israel and Cypriot gas to Greece where it could connect to European gas grids. The distances are challenging, though, and

¹⁷ Options involving both Cyprus and Turkey depend on progress towards overcoming the division of the island. New talks are foreseen in 2013 under United Nations auspices to seek a comprehensive settlement. Their outcome, however, remains uncertain. While the Republic of Cyprus is recognized internationally as having sovereignty over the whole island, about one-third of the island is controlled by the "Turkish Republic of Northern Cyprus," an authority that is recognized only by Turkey. Ankara insists that both communities on the island should benefit from exploitation of natural gas and that this should not take place until the issue is resolved. The Republic of Cyprus accepts this latter point in principle but is unwilling to authorize the export of gas northwards while Turkish military forces occupy part of the island.

the seabed is said to be not conducive to a pipeline.¹⁸

- **To Egypt, reversing the El Arish to Ashkelon pipeline:** since the overthrow of the Mubarak regime, Egypt's domestic demand for natural gas has risen dramatically. Egypt has contractual commitments for export volumes that are difficult to meet. In August 2013, Qatar made LNG cargoes available to be delivered to Egypt's export customers. A demand for imported gas remains, though Egypt has no regasification vessel available at present. Israel therefore remains a potential supplier of gas, although such a scheme would face likely Egyptian domestic political objections. This problem might be overcome if Israel establishes itself as a gas supplier to Jordan, the Palestinian Authority in the West Bank, and to the Gaza Strip.

LNG

- **LNG plant on Mediterranean coast:** this would receive gas from the Tamar and Leviathan fields and convert it into liquefied natural gas for export. The LNG could be sold either in Europe or be shipped via the Suez Canal to Asian customers or to other markets. Until the overthrow of the Mohamed Morsi government in Egypt in summer 2013, it seemed unlikely that a Muslim Brotherhood-dominated government in Cairo would countenance Israeli LNG cargoes transiting the Suez Canal. (Although treaty obligations guarantee free passage, politically motivated inspections of Israeli cargoes on spurious safety grounds could render the route unviable.) The military-supported regime that replaced the Morsi administration may be more open to Israeli LNG traffic through the waterway. Besides

possible external political difficulties, this option faces environmental objections in Israel and a shortage of available sites.

- **LNG plant on the Red Sea coast near Eilat:** an area of land outside Eilat port has been considered for an LNG plant. The attraction of an LNG plant on the Red Sea coast is that it could supply the Asian market directly with Israeli gas without having to transit the Suez Canal. Apart from restrictions on its size because of the small land area available, which may make it commercially unviable, any LNG facility in Eilat would be vulnerable to hostile rocket and mortar fire from Egyptian and Jordanian territory.¹⁹
- **LNG plant fed by Israeli gas in the industrial zone of the Jordanian Red Sea port of Aqaba:** The facility could be in the industrial zone of Aqaba, the Jordanian port city that is adjacent to Eilat. Noble Energy has evaluated this site, along with sites in Israel and Cyprus, and was planning to complete the "Pre-FEED" (Preliminary Front End Engineering Design) in 2013.²⁰ The U.S. government supports the development of Aqaba as an energy hub, also encouraging a pipeline from Iraq to an export terminal at Aqaba, to bypass the strategically vulnerable Strait of Hormuz. However, Israel is unlikely to countenance the location of a strategic asset in Jordan. Arab countries, including Kuwait and Qatar, appear to be trying to block this option by offering finance to Jordan for an LNG regasification facility, so

¹⁸ The website of Delek Energy, the main Israeli partner of Noble Energy, shows a direct pipeline to Greece, as one potential export option. www.delek-energy.com. PowerPoint presentation dated June 2013.

¹⁹ In August 2013, the Israeli authorities closed Eilat airport for several hours because of fears of a rocket attack by terrorists in the Egyptian territory of Sinai, which has become increasingly lawless since the collapse of the Mubarak regime. The city limits extend to the Egyptian border.

²⁰ Presentation for Noble Energy 2011 Analyst Conference, <http://www.nobleenergyinc.com>.

Jordan could import LNG and not need to buy Israeli gas or allow its export.²¹

- **A Floating LNG (FLNG) plant in the Mediterranean offshore Israel:** an FLNG plant could be positioned directly over the producing field. Tankers being loaded would be positioned alongside it. An additional advantage of an FLNG vessel is that it reduces the need for complex and expensive undersea pipelines. An FLNG vessel can be moved from one part of a field to another, or to a new field. Noble Energy is evaluating FLNG for the Tamar field, envisioning a capacity of 3.4 million tons per annum (mtpa) and a target start-up in 2018.²² The Noble-led consortium has an agreement with Daewoo Shipbuilding and Marine Engineering (DSME) of South Korea to examine the FLNG option. There is a non-binding letter of intent between DSME and Gazprom of Russia for the latter to receive LNG from the proposed FLNG plant.

FLNG would be pushing at technological boundaries as the first such vessel has yet to be completed and become operational offshore Australia. The Australian company involved in that project, Woodside Petroleum, is in negotiation with Noble Energy and its Israeli partners to take a strategic investment in the Leviathan field.²³

Such a huge installation, comparable in size to four aircraft carriers, would be vulnerable to attack by anti-ship missiles or even rocket-propelled grenades. Industry experts

²¹ http://www.menafn.com/qn_news_story_s.aspx?storyid=1093471234

²² Noble Energy Analyst conference, December 6, 2012.

²³ The original deal, announced in 2012, was premised on Israel allowing a greater proportion of gas exports than subsequently decided by the government. The 40 percent limit on exports has led to further negotiations between Woodside, Noble Energy and its Israeli partners.

play down the security risk and predict that the attractiveness of FLNG, not only in the Eastern Mediterranean but also other parts of the world, will lead to breakthroughs in technology, cost constraints and commercial viability.

- **Israel could send natural gas from its Leviathan field by undersea pipeline to the planned LNG plant at Vassilikos on the southern coast of Cyprus:** This would enhance the plant's commercial viability. Plans for building up an LNG capacity will remain tentative until the Aphrodite field is more fully explored. Its current size, estimated at 5.2 tcf (145.6 bcm), could notionally provide enough feedstock for a one-train LNG plant. If Aphrodite is found to be bigger, or additional fields are found, or Israel or Lebanon are prepared to pipe gas from their EEZs to Cyprus, then the economics of an expanded LNG installation improve considerably.

Since a pipeline to the Cyprus mainland is already planned from the Cypriot Aphrodite field, an Israeli line could join with this. The distance — more than 180 km — is considerable and would probably need to be longer to circumvent geological challenges on the seabed, but the combined volumes from the Aphrodite and Leviathan fields would improve the commercial logic of a Vassilikos LNG plant, enabling it to be expanded from one 5 mtpa train to three trains or even more, on the most optimistic projections. The costs of incremental LNG trains decline, permitting economies of scale.²⁴ The commercial viability of an LNG facility at Vassilikos is discussed in more detail in the section on Cyprus below.

²⁴ "Eastern Mediterranean New Offshore Resources: What's in it for Europe." Presentation by Dr. Charles Ellinas, CEO, Cyprus National Hydrocarbons Company, Brussels, June 4, 2013.

A decision for Israel to route its natural gas exports via Cyprus could be at odds with one of the main recommendations of the 2012 Zemach Committee — that all gas fields on Israel’s territory and/or EEZ be connected to the national gas transmission network. A second recommendation — that there is an absolute preference to export natural gas from facilities (onshore or offshore) located within Israeli territory (including its EEZ) — might allow for the possibility of exports via Cyprus.

- **Using spare Egyptian LNG capacity:** Israel could make use of the under-utilized capacity of the Egypt LNG and Segas LNG plants on Egypt’s Mediterranean Coast. When initially mooted, the opposition of the Muslim Brotherhood-led government appeared to be a total block on such a project. Since the mid-2013 replacement of this regime by the Egyptian military, this option may be given further consideration. In August 2013, the leading Israeli gas company, Delek, informed the Tel Aviv Stock Exchange that it was in talks to pipe gas to Egypt and had proposed reversing the Ashkelon-el-Arish line, which, until 2012, brought Egyptian gas to Israel, in order to reach the LNG facilities.²⁵

CNG

There have been reports that Israel might supply compressed natural gas (CNG) to fuel the new 440 MW combined cycle units at the Vassilikos energy center on Cyprus, which became operational in 2013.²⁶ The amount of gas the center needs is between 0.5 and 0.7 bcm. The CNG method is proposed in the absence of a pipeline from Israel or an LNG plant. The idea is to use a specially constructed ship, which would be cheaper and

²⁵ <http://www.globes.co.il/serveen/globes/docview.asp?did=1000874990&fid=1725>

²⁶ <http://www.globes.co.il/serveen/globes/docview.asp?did=1000782346&fid=1725> and Middle East Economic Survey (MEES), August 30, 2013.

suit the temporary nature of the need in advance of supplies from the Aphrodite field being piped to Cyprus. The downside is that such technology is not established and suitable ships are not immediately available. It does not, therefore, appear to be a viable option.

Cyprus²⁷

Pipelines

- **To Greece: with or without Israeli gas:** Cyprus is considering a scheme for a pipeline on the seabed to Greece, joining up with the European gas networks. But the water is very deep — 6,000 feet — which limits the diameter of the subsea pipelines that can be installed. Five or six pipelines might be needed to export a credible amount of gas, making the scheme uneconomic.
- **To Turkey:** this faces severe political constraints but has an apparent commercial logic. Turkey itself has a large and growing demand for gas, around 40 bcm annually. The country also provides access to Europe, where the annual demand is 400 bcm, much presently provided by one supplier: Russia. Logistically, such a route needs a comparatively small length of undersea pipeline (about 100 km). Distances on land in Cyprus from the southern to northern coasts are short. In Turkey, new pipelines would need to be constructed to link to the national gas network and transit routes to Europe.

Setting aside political constraints, the commercial viability of this option can itself be questioned. It depends on the assumption of continued growth of gas demand in Turkey in line with past economic growth rates. Gas from Cyprus could well face increasing competition in Turkey with gas from other suppliers such as Iraq, Iran, and Azerbaijan.

²⁷ For an economic analysis of Cyprus’s monetization options, see a forthcoming paper by Anastasios Giamourides, German Marshall Fund of the United States (October 2013).

New sources of unconventional gas, including shale gas, are likely to increase their market share over the next decade. In light of uncertainties about future Turkish and EU demand for gas, as well as uncertainties about costs, applicable prices, and transit fees at the time when gas from Cyprus comes on stream, the commercial logic for this option is less compelling than it may appear.²⁸

Liquefied Natural Gas (LNG)

- **LNG plant on the southern coast at Vassilikos:** this is the preferred export option for Cyprus. The new Cypriot president, Nicos Anastasiades, confirmed the original 2012 decision in favor of this option in April 2013. Such a facility could ship cargoes to both European and Asian destinations. While Israel is concerned that Egypt may limit its ability to send LNG tankers through the Suez Canal, Cyprus has no such worries. Cypriot officials (optimistically) predict that an LNG plant could be exporting 7 bcm by 2020, with exports rising to 35 bcm by 2025. If Vassilikos eventually becomes an LNG hub for the Eastern Mediterranean region, taking in gas from Israeli and Lebanese fields, this could rise to 50 bcm a year.

Cyprus calls this route for LNG exports the East Med Gas Corridor, to distinguish it from the Southern Corridor that runs across Turkey to Europe, and South Stream, which goes under the Black Sea to Europe. The East Med Gas Corridor notion has yet to be accepted by the European Union although Cyprus has raised the issue. The European Investment Bank (EIB) has indicated it would consider investing in a Cyprus LNG facility. The EIB has already provided a loan of €130 million for the reconstruction of the power station at Vassilikos, which was damaged by an explosion in July 2011.

²⁸ Giamouridis, 2013

The Cyprus National Hydrocarbons Company (CNHC) regards the LNG plant at Vassilikos as the only logical, economic solution for natural gas exports by Cyprus.²⁹ Pending significant discoveries other than Aphrodite in the Cypriot EEZ, the CNHC argues that Vassilikos is also the best destination for Israeli gas and yet-to-be-discovered Lebanese gas. The commercial argument establishing Vassilikos as a regional LNG hub is that one train would cost \$6 billion plus \$3 billion to be spent on infrastructure, but expanding it to a two-train facility would only involve a further \$3 billion expenditure (ie a total of \$12 billion), and a three-train facility could be built for \$15 billion. Such plans, however, depend on more fields being discovered and a change of policy by Israel on sending its gas for processing to a third country. The prospect of gas from offshore Lebanon being delivered to Vassilikos at some point in the 2020s is even more uncertain.

On balance, this is the monetization option most likely to be adopted. However its commercial viability still depends on the delivery of additional gas volumes to Vassilikos.

- **LNG plant on the southern coast of Turkey supplied with natural gas from the Aphrodite field and, also, Israeli fields:**³⁰ the commercial logic of this proposal is that the southern Turkish coast has plenty of land available for a major LNG facility and the installation could also be used to process gas for transport overland by pipeline. However neither Cyprus

²⁹ The role of CNHC is currently under review by the Cyprus government which wants to bring gas policy under greater political control, <http://cyprus-mail.com/tag/cyprus-national-hydrocarbons-company/>

³⁰ <http://fuelfix.com/blog/2013/05/31/guest-comment-aphrodites-possibility-everyone-wins-in-the-eastern-mediterranean/>

nor Israel would, under present circumstances, consider giving Turkey such a degree of control over their resources.

6 ELECTRICITY

Israel and Cyprus, together with Greece, have had discussions about exporting electric power from gas-fired plants. The proposed Israel-Cyprus-Greece electricity interconnector, also known as the EuroAsia Interconnector, involves the laying of a 540 nautical mile (1,000 km) cable on the seabed between Israel and Cyprus, then from Cyprus and Crete, and finally from Crete to the Greek mainland. It would carry 2,000 MW of power. From Crete, it would connect with the Greek and European grids. As envisaged, the proposal would allow Israel to export electricity when it had surplus capacity and import power when there was a shortage.

When an initial agreement was signed between DEH Quantum and the Israel Electric Corporation in March 2012, the cost of the project was estimated at €1.5 billion, a figure that does not include any new electricity generating capacity. The timescale for the project, if work had begun immediately, was for it to be fully operational by 2016.

In August 2013, the ministers of energy of Israel, Greece, and Cyprus signed a memorandum of understanding in the Cypriot capital, Nicosia, to encourage joint projects on security of energy supply and energy resources. They were reported to

have reiterated their commitment to the EuroAsia Interconnector project.³¹ The route could be problematic, however, lying partly in what Turkey regards as its continental shelf and therefore forming part of its EEZ.³²

Technically, the route is also challenging because of its great depth: 2,000 meters. The credibility of the project has suffered because of the economic and financial crisis in Greece and Cyprus, which is likely to make it difficult to raise investment funds. While the three countries have agreed, in principle, to this project, numerous political, financial, commercial, and technical problems would need to be solved before it could be realized.

³¹ <http://www.financialmirror.com/news-details.php?nid=30669>

³² In July 2013, a Turkish gunboat harassed an Italian-flagged research vessel, surveying a proposed route for a fiber-optic cable in waters off the Cypriot city of Paphos.

7 CONCLUSION

Natural gas is today being discovered and extracted in remote and difficult places across the world. New discoveries in the Levant Basin offshore Israel and Cyprus offer these countries an opportunity to strengthen their energy security and to boost their economies. However Eastern Mediterranean gas presents a range of special challenges — geological, political, and commercial. There is a risk that it may become “stranded gas,” unsuitable for full exploitation, unless these specific challenges are met.

While Israel can export a small part of its surplus gas by overland pipeline to Jordan and Palestine, the prevailing logic for both Israel and Cyprus is to convert gas, which is surplus to domestic requirements, into LNG for shipment to potential customers in Europe and Asia. This will require multi-billion dollar long-term investments at a time when natural gas prices are weakening and several regional players whose cooperation would be helpful, notably Egypt and Lebanon, are in domestic political flux.

In the absence of a single consensus solution, the key to future exploitation of the natural gas fields of the Eastern Mediterranean may be to develop a range of options, including pipelines and LNG. Joint ventures, such as a pipeline from Israel to Turkey, would give both countries a mutual interest in keeping it in operation. An LNG export potential in Israel would avoid undue dependence on a fixed link to Turkey. However, multiple export options presuppose that present political obstacles will be overcome and that sufficient quantities of gas will be discovered to ensure the commercial viability of both LNG and pipelines.

The strengthening of links between Israel and Cyprus should continue in parallel to any Israeli collaboration with Turkey. This may eventually enable them to agree to joint monetization of gas resources that are destined for export. For the moment, Israel is ahead in demarcating and exploiting its far bigger fields, while

Cyprus is hampered by the persistent effects of its financial crisis.

Discovering natural gas, confirming the size of the find, and bringing a new field into production are processes that take a minimum of four to five years for deepwater fields. Developing the export potential of these fields can take several more years. In other parts of the world, the timeline from discovery to full production can be as long as 20 years, because of the need to confirm commercial viability and to secure the necessary investment.

The governments of Israel and Cyprus, along with the oil gas companies working in the license areas, need the support of both the United States and the European Union. The European Union can provide a transparent and predictable regulatory environment for investors in Cyprus. Both the EU and the United States can provide support in reducing political risk. They can also share best practices in the governance of energy resources. Access to external sources of project finance and loan guarantees will be crucial in the years ahead.

The development of offshore natural gas in the Eastern Mediterranean brings together two of the world’s longest-running and vexing diplomatic disputes: the “Cyprus problem” and the Middle East conflict. In order for the peoples of the region to benefit from their newfound hydrocarbon wealth, it is important to create conditions that permit exploration and production to go ahead, in parallel with efforts to overcome these longstanding political conflicts. There may be positive feedback from the energy to the political fields in creating shared interests in stability. There may also be a risk of escalating tensions over disputes concerning ownership of resources. This paper demonstrates that export options will only be selected if they are bankable and convince investors of their commercial viability. Any progress in resolving the region’s political disputes should be viewed as a bonus.

8 TECHNICAL NOTE

The natural gas industry uses a mixture of U.S. and European units. The volume of gas fields is usually expressed in terms of trillion cubic feet (tcf). Annual production and export volumes are in billion cubic meters (bcm). To convert tcf into bcm, one multiplies by 28 and divides by 1,000. Generally speaking, fields of 1 tcf or less are not worth exploiting unless they can be linked to existing pipelines nearby that are parts of more viable fields.

The capacity of the facilities to cool natural gas into a liquid for shipping in specially constructed tankers is expressed in million tons per annum (mtpa). To convert mtpa into bcm, one multiplies by 1.4. LNG plants consist of “trains,” typically a kilometer-long series of industrial processes, which dry, clean, and then liquefy the gas by compressing it, a procedure that also reduces its temperature to minus 160 degrees centigrade and reduces its volume by 600 times. In order to be commercially viable, LNG plants are usually thought to need several trains. A typical train has a capacity of 5 mtpa. The Ras Laffan LNG plant of Persian Gulf state of Qatar, the largest exporter of LNG in the world (though it will likely soon lose this position to Australia), has 14 trains with a total capacity of 77 mtpa, more than 107 bcm. One of the trains in

Qatar’s giant complex, about 40 miles by 20 miles in size, has a capacity of 7.7 mtpa, the largest in the world. The world’s first floating LNG vessel, the Prelude, destined for the north-west Australia coast, has one train with a capacity of 3.4 mtpa.

The pricing of natural gas is usually measured in units of dollars per million British thermal units (mBtu), which allows for different calorific values for the same volume of gas. In August 2013, spot prices for natural gas in the United States were between \$3 and \$4 per mBtu.³³ In July, 2013, prices in North Asia (ie Japan and South Korea) for August delivery were \$15.46 per mBtu.³⁴

³³ <http://www.eia.gov/naturalgas/weekly/#tabs-prices-2>

³⁴ <http://www.marketwatch.com/story/platts-asia-spot-lng-prices-for-august-delivery-gain-68-on-supply-disruptions-2013-07-19>

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