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Producing Energy at Sea in a Net-Zero Economy

Orin Shefler

This article places a spotlight on future needs and methods for producing energy at sea for Israel and provides a brief overview of some new technologies and processes that will unlock this potential. The premise is that the State of Israel is now a producer and exporter of natural gas and has sufficient natural gas reserves to sustain itself and its neighbors for years to come. It is presumed that future developments of offshore natural gas fields will give rise to new opportunities in a "net-zero" economy. To the extent that Israel is able to diversify its energy portfolio, the potential for producing cleaner energy from the sea will rise.

New Supply and Demand Value Chains

To understand where Israel is headed with respect to producing energy from the sea, one must first envisage future energy supply and demand scenarios. Also, it is imperative to set goals for rolling out new technologies in order to achieve Israel's net-zero targets. Any game-changing plan to decarbonize the Israeli economy must first account for lowering the existing carbon footprint, some of which is attributed to traditional methods of producing energy at sea (such as during the production of natural gas, oil, condensate or LNG [liquefied natural gas]), and going forward, finding ways to eliminate, mitigate, or capture the carbon emissions attributed to traditional energy production. Current assumptions foresee that a full transition to a net-zero economy (i.e., the amount of time that it will take to transition from modern-day reliance on traditional energy sources until achieving Israel's net-zero goals) may last between ten to thirty-five years from the present day,[1] although there are those who would prefer to see this interim period shortened significantly.

During the interim period, it will be the responsibility of the Government of Israel to ensure a steady, uninterrupted supply of energy for Israel that is capable of catering to local and regional energy needs, but also ensuring (a) reasonable energy prices, (b) abundance, reliability, and maintainability of energy for the nation, and (c) keeping to a minimum unavoidable environmental impact. That being said, the length of the interim period will also depend on the pace that scalable and commercial "net-zero" energy

1 See Elai Rettig, "Solar Hopes and Grounded Reality: Should and Could Israel Meet Its 2030 Renewable Energy Transition Target", in *Maritime Strategic Evaluation for Israel 2021/22*, ed. Shaul Chorev and Ziv Rubinovitz (Haifa: Maritime Policy and Strategy Research Center, 2022), 244–250.

production technologies (including storage and transmission infrastructure) can mature in Israel and be successfully deployed.

Also, the main factors to shortening the interim period will be the ability to raise capital for this purpose (a price tag that could be astronomical) and to obtain the necessary Government approvals for new energy projects (including the time needed to plan, fund, and build new infrastructure).[2] At the international level, experts now believe that "annual investments in energy supply and production are expected to double by 2035 to reach $1.5 trillion to $1.6 trillion". Furthermore, the majority of energy production growth is expected to come from "decarbonization technologies and power which will exceed [present day] total energy investments by the year 2050".[3]

Diversifying the Israeli Energy Portfolio

To get the ball rolling toward "net-zero", the Government will need to redefine how Israel produces and consumes energy. Just to be clear—when the term "energy" is used in this article in the context of the sea, it has a two-prong definition that includes (a) production, storage, transmission, or consumption of natural resources used for energy production (such as oil, gas, and their derivatives), and (b) generating electricity from the sea by harnessing nature's elements through technological means such as solar, offshore wind, tidal and wave turbines, and transmitting it directly to consumers.

At present, Israel is still very much dependent on traditional hydrocarbon energy production, which is either produced via concessionaires at sea or otherwise imported from sellers through established sea routes and international supply chains. Unfortunately, traditional hydrocarbon energy production has a massive carbon footprint that will not be sustainable for Israel in the long run, unless the carbon footprint can be mitigated.

So, what does this strategic transformation to "net-zero" mean for Israel in the short term and in the long term when it comes to producing energy from the sea? In the short term, it means that Israel will need to diversify its energy portfolio by blending traditional and renewable energy sources. During the interim period, the name of the game will no longer be to just produce oil and gas from the sea, but rather to begin to produce and consume new forms of energy from the sea that may include traditional hydrocarbon products as

2 McKinsey & Co., Global Energy Perspective 2022: Executive Summary, April 2022.

3 Ibid.

well as other forms of energy such as hydrogen (H_2, Blue[4] or Green[5]), liquefied natural gas (LNG), compressed natural gas (CNG), ammonia, methanol, and more. And also noting that the sea holds vast potential for producing additional means of energy such as solar power, wind power, tidal energy, wave energy, geothermal energy, and other viable sources (collectively, Alternative Sources).

In the long term, and once Israel's energy portfolio has been diversified to include Alternative Sources, Israel will be able to phase out its reliance on traditional hydrocarbon energy sources and divert surplus quantities to other regions that are behind on their energy transition or still reliant on traditional energy sources.

Each of the Alternative Sources have unique characteristics and may be suitable for different segments of Israel's new "net-zero" economy. The common denominator between all the Alternative Sources is that they must each be made safely available as commodities or consumables to the general public at a reasonable price with minimal environmental impact.

Expected Increase in the Demand for Hydrogen and LNG in a Net-Zero Economy

In practice, there must be a very clear understanding of what future energy demand scenarios will look like for Israel, and once that understanding is crafted, the Government will be better positioned to initiate new offshore projects, and provide potential investors with the comfort that they need to take final investment decisions (FIDs) and invest the billions of dollars necessary for new offshore projects at sea.

For example, focusing on the vehicle and transportation segment of the new Israeli "net-zero" economy: Will cars of the future be purely electric? Or maybe they will run on hydrogen fuel cells (fuel cell electric vehicles; FCEVs)? Or perhaps car manufacturers will offer a mix between various forms of energy? Clearly, the preferred fuel choice for the

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4 "Blue hydrogen is when natural gas is split into hydrogen and CO_2 either by Steam Methane Reforming (SMR) or Auto Thermal Reforming (ATR), but the CO_2 is captured and then stored. As the greenhouse gasses are captured, this mitigates the environmental impacts on the planet. The 'capturing' is done through a process called Carbon Capture Usage and Storage (CCUS)". Alex Haynes, "The Difference between Green Hydrogen and Blue Hydrogen", *Petrofac,* Retrieved December 2022.

5 "Green hydrogen is hydrogen produced by splitting water by electrolysis. This produces only hydrogen and oxygen … to achieve the electrolysis electricity (power) is needed. The process for making green hydrogen is powered by renewable energy sources, such as wind or solar. That makes green hydrogen a clean energy source – hydrogen from renewable energy sources without CO_2 as a by-product". Haynes, "The Difference between Green Hydrogen and Blue Hydrogen".

vehicle and transportation segment in Israel will very much affect the supply and demand scenarios for Alternative Sources in Israel, especially with regard to hydrogen, LNG, methanol, or CNG. It is a generally accepted principal that hydrogen, for example, will be one of the preferred fuels of choice for the future vehicle and transportation segment because it can be produced with a low carbon footprint from natural gas or water and has similar range and energy values in comparison to modern-day petrol when used in cars.

As such, experts foresee an immediate need to initiate a "timely deployment of infrastructure across the whole supply chain … to meet hydrogen demand".[6] The up-side for using hydrogen as a preferred fuel for vehicles of the future is that it emits minimal by-products when used such as water (H_2O) and heat—which are both nontoxic to the environment. The downside is that hydrogen can only be delivered either in liquid form below 252.87°C—which (a) requires cooling apparatus, (b) extensive safety measures, and (c) carries high energy costs—or it can be delivered in compressed form if stored between 350 Bar and 700 Bar. This means that any new hydrogen infrastructure must also be cost efficient and matured to the highest safety standards prior to being deployed to the general population. These types of challenges will surely affect the cost-benefit analysis for scaling up hydrogen infrastructure for the vehicle and transportation segment and adopting it into the mainstream of the new Israeli economy.

And another example: How will commercial shipping consume energy in the future? Will ships sail using LNG, hydrogen, methanol, ammonia, or perhaps even CNG as their fuel of choice? What type of refueling depots would need to be made available in Israel's ports in order to serve the demand of international commercial shipping fleets? And where would these Alternative Sources be sourced?

Since there is no clear international standard to follow, at present it is difficult to predict where the market trend will go on this matter at this point in time. Nonetheless, a good market indicator can be better understood by studying the forecast of commercial shipping companies, such as ZIM, an Israeli company that ships containers. ZIM announced in August 2022 that it has entered into a long-term LNG bunkering agreement with Shell that will secure LNG supply for ZIM's recently ordered LNG-fueled vessels that are expected to enter service in 2023.[7]

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6 McKinsey & Co., *Global Energy Perspective 2022*.

7 *ZIM*, "ZIM Announces Large-Scale Long-Term LNG Bunkering Agreement with Shell", August 31, 2022.

As can be seen, the rise of LNG as a preferred Alternative Source will significantly impact the international shipping industry;[8] this is yet another reason to assume that future demand for LNG will continue to rise (an assumption attributed to both local consumption and export factors). Therefore, LNG will most certainly be a very valuable commodity for Israel to produce at sea in the near future and should be made a strategic matter by the Government.

At this early stage of the transition to "net-zero", one thing is certain: it is very plausible that certain segments of the Israeli economy (such as power generation, industrial, residential, commercial, shipping, transportation, railways, etc.) will each have independent energy value chains that will have its needs met by different means.

The term "energy value chain" refers to the set of unique steps that should be taken by the Government with regards to developing each segment of the Israeli net-zero economy to encourage a swift and efficient transition to Alternative Sources. For example, if the vehicle and transportation industry is truly heading toward adopting hydrogen as a key component for powering cars, then the Government must take all the steps necessary to make hydrogen available to the general public starting from developing the supply side (i.e., causing local production at the source), creating transmission, delivery and storage capabilities, and also developing the demand side, i.e., making hydrogen readily available to the public without interruption, at a reasonable price, at the highest safety standards and on a day-to-day basis. If the Government wishes to promote the adoption of hydrogen-powered cars, then hydrogen must be made available to the public at convenient locations such as gas stations for use with FCEVs. Thus, an entire value chain must be designed and created from scratch to achieve this goal.

As such, the Government will undoubtably need to carry out a very detailed modeling of supply and demand scenarios for all Alternative Sources in order to prepare the market to respond accordingly.

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8 "The OECD predicts that the transition to LNG as a maritime fuel will lead to the reduction of maritime pollution and an increase in maritime safety. Such transition will lower the carbon footprint of ships entering ports in heavily populated cities. LNG is largely considered a superior marine fuel with the best option for improving air quality. It is also easily scalable and has been named as the leading choice that could assist in meeting decarbonization goals". Orin Shefler, "A Strategic Perspective for Israel on Contending with Innocent and Transit Passage through Maritime Chokepoints In Wake Of Heightened Energy Collaboration In The Middle East", in Benny Spanier, Orin Shefler and Elai Rettig (eds.), *UNCLOS and the Protection of Innocent and Transit Passage in Maritime Chokepoints* (Haifa: Maritime Policy and Strategy Research Center, University of Haifa and Konrad Adenauer Foundation, 2021), p. 53.

Interestingly, there are currently around "40 countries that [already] … have dedicated hydrogen strategies in place".[9] In the Netherlands, for example, the government (in partnership with Shell) has already initiated and deployed hydrogen fueling stations alongside major highways as a pilot for adopting hydrogen as a preferred fuel choice for trucks and cars.[10]

Figure 1. A hydrogen refueling station in the Netherlands by Shell[11]

And yet a third example still attributed to the public transportation segment: some market indicators have shown that the public transportation segment may lean toward adopting CNG as one of its Alternative Sources of choice, at least during the interim period. To that extent, in Israel, for example, a local natural gas distributor called SuperGas announced in October 2022 that it has entered into agreements to supply CNG for the Metropolin bus fleet (Metropolin is an Israeli bus and transportation company). SuperGas predicts that will be able supply up to 600 buses with CNG by 2024.[12]

It is safe to assume that CNG will be an Alternative Source of energy in the new Israeli economy, at least during the interim period. CNG can either be produced directly at sea

9 McKinsey & Co., *Global Energy Perspective 2022*.

10 WaterstofNet, "Shell Opens First Hydrogen Refueling Station of H2Benelux in Amsterdam", *WaterstofNet*, October 13, 2022.

11 Ibid.

12 *ICE*, "SuperGas in a Large Deal: These Buses Will Run on Gas" [In Hebrew], October 2, 2022.

by gas producers at the source and then distributed in pressurized tanks to consumers anywhere in the world, or it can otherwise be produced using dedicated onshore compressors located at exit points at or near the site of consumption or via the national transmission system (NTS) for gas.

CNG could be an especially viable solution for public transportation since Israel has very large quantities of natural gas readily available for immediate consumption that can be easily transmitted from offshore to onshore to the end user at any time.

The problem with CNG is that it must be pressurized at least between 200 to 250 Bar for use in vehicles. Compressing natural gas in large quantities requires a lot of power generation which in itself has a high carbon footprint and a high electricity cost. As such, the CNG market still needs to mature and be proven to have effective safety measures in place in a cost-effective manner. To that extent, carbon mitigation or capturing measures should be carefully evaluated when designing compressing solutions for the production of CNG.

Land Scarcity and Positioning New Infrastructure at Sea

Another important factor to take into account when advocating the production of energy at sea (especially applicable to the State of Israel) is the issue of land scarcity. The dense and ever-growing population of Israel has driven massive urban construction,[13] has raised public awareness to environmental concerns,[14] and has triggered objections to positioning energy-centric infrastructure near cities or towns (the NIMBY phenomenon – Not In My Back Yard).[15] In the future, there will be less and less available land in Israel to build the variety of new energy infrastructure needed to cater the ever-growing energy portfolio.

Israel has for years deliberated on the potential of establishing artificial islands for a variety of purposes. Such discussions and plans have often included initiatives to construct artificial islands for new airports, energy hubs, platforms, sea ports and more. For such a small country like Israel, it makes perfect sense to seek new ways to use the vast and unpopulated Mediterranean Sea as a preferred location for Israel's new energy facilities. Even more so since the majority of Israel's energy supply and natural resources are already sourced at sea from its oil and gas reservoirs.

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13 Arik Mirovsky "Building Starts in Israel Hit 26 Year High", *Globes*, March 20, 2022.

14 Tamar Pileggi, "Hundreds Protest in Tel Aviv against Natural Gas Deal", *Times of Israel*, July 4, 2015.

15 Hagay Hacohen "Thousands in Tel Aviv protest location of planned Israeli gas platform", *Jerusalem Post*, September 2, 2018.

There are currently many international precedents to rely on when promoting the construction of artificial islands (in any form) for energy-centric infrastructure and hubs. One such recent example can be identified in Belgium. Belgium has already announced plans to construct an artificial energy island almost 45 km off the Belgian coast. This energy island is intended to serve as a link between offshore wind farms and an onshore high-voltage grid.[16] It will house critical energy-producing infrastructure. This new type of artificial island modeling can be adjusted and re-developed specifically for Israel's needs in one form or another.

Aspects of the United Nations Convention on the Law of the Sea (UNCLOS)

But before "deep diving" into the practical aspects of initiating new energy projects at sea, Israel must establish its fundamental right to do so. Israel is a coastal state according to international law and is entitled to an exclusive economic zone (EEZ). This right stems from Article 56 of the United Nations Convention of the Law of the Sea (UNCLOS) that states as follows:

> In the exclusive economic zone, the coastal State has:
> - Sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds;
> - jurisdiction as provided for in the relevant provisions of this Convention with regard to: (i) the establishment and use of artificial islands, installations and structures; (ii) marine scientific research; (iii) the protection and preservation of the marine environment.[17]

Israel has a right, among other things, to establish and use artificial islands, installations, and structures in its EEZ to explore, exploit, conserve, and manage the natural resources thereto, and also to conduct economic exploitation activities such as the production of energy from the water, currents, and winds.

Based on these principles, Israel recently commissioned its first deep water Floating Production and Storage Offloading (FPSO) located in its EEZ citing the recent start-up of the Energean "Power" FPSO for the Karish gas field, which began producing natural gas and derivatives for Israel late in 2022.

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16 Offshore Magazine, "Elia Planning 'World's First' Artificial Energy Island", October 3, 2022.

17 United Nations Convention of the Law of the Sea ("UNCLOS"), Article 56.

Figure 2: The Energean "Power" FPSO crossing the Suez Canal[18]

This ground-breaking project has already set the stage for all future offshore developments in the eastern Mediterranean and has become the case study for which Israel's jurisdiction in its EEZ has been crafted. It is very likely that in the near future, additional floating energy infrastructure or other forms of artificial islands will be announced based on the current experience accumulated through the commissioning the Energean FPSO.

Aspects of Israeli Law, Regulation, and New Government Initiatives

Israel's own interpretation of its rights and responsibilities in its EEZ were originally defined in a legal opinion issued by the Government in January 2013 (Legal Opinion).[19] Also, Israel officially declared the maritime boundaries of its EEZ through several formal

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18 Image used in article by Nermina Kulovic, "Crossing of Energean Power FPSO Marks 'First-of-Its-Kind' in History of Suez Canal", *Offshore Energy*, June 3, 2022.

19 A legal opinion issued on January 13, 2013, by Adv. Avi Licht (the deputy attorney general at that time) determining, among other things, that Israeli regulation on oil and gas, environmental protection, and fiscal laws of the State of Israel apply to marine areas. This legal opinion also determined that these laws applied to the surface and the subsurface of the sea and the legal basis for applying these laws to the marine areas was, first and foremost, the Underwater Areas Law—1953.

actions including: (a) entering a delimitation agreement signed with Cyprus in 2010 (Agreement with Cyprus), (b) issuing a government decision about its northern maritime border with Lebanon in 2011 (Government Decision), and (c) entering a new delimitation agreement with Lebanon announced in October 2022 regarding the settlement of the northern maritime boundary line dispute (Agreement with Lebanon). Additionally, there is a new draft law in its final stages prior to enactment titled the Marine Areas Law–2017 (Draft Marine Areas Law) that clearly establishes the scope of Israeli jurisdiction in the EEZ (to the extent necessary) in order to exercise Israel's sovereign rights according to international law.[20]

The Legal Opinion, the Agreement with Cyprus, the Government Decision, the Agreement with Lebanon, and the Draft Marine Areas Law have all cherry-picked key principles from UNCLOS and international law, among others, and applied them to Israeli law in order to establish the necessary legal framework for exploiting Israel's natural resources in its EEZ. By defining the scope of its EEZ, Israel has marked the territory in which it has rights to establish dedicated offshore infrastructure in accordance with the law of the sea. This is an especially tricky task since Israel is not an actual signatory to UNCLOS but has traditionally accepted UNCLOS as customary international law and mostly abides with the majority of the provisions set forth thereto.[21]

In parallel, the Government ministries (such as the Ministry of Energy, the Ministry of Environmental Protection, and more) are all currently deeply involved in analyzing the strategic importance of expanding the applicable uses of the Israeli EEZ. One significant initiative is a recent request for information and tender issued by the Ministry of Energy titled "Strategic Environmental Assessment for examining the production of renewable energy and developing climate technologies for the marine areas of Israel" (SEA Report).[22]

In the upcoming SEA Report, for which a tender has been (or is expected to be) issued by the end of 2022 or the beginning of 2023, the Government will examine and collect critical maritime data necessary in its EEZ in order to (a) establish a database for policies and decisions about potential exploitation of Israel's natural resources in the EEZ, (b) make recommendations about the best ways to exploit the natural resources in the EEZ, and (c) establish the preferred locations in the EEZ for construction of new infrastructure to allow

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20 The Proposed Marine Areas Law—2017.

21 See also Benny Spanier, "The State of Israel and the Convention on the Law of the Sea: The Current State", in *Maritime Strategic Evaluation for Israel 2021/22*, ed. Shaul Chorev and Ziv Rubinovitz (Haifa: Maritime Policy and Strategy Research Center, University of Haifa, 2022), 301–310.

22 Issued under the guidance of Directive 2001/42/EC on the assessment of the effects of certain plans and programs on the environment (SEA Directive).

such exploitation. According to the Ministry of Energy, a SEA Report is the recognized method for all OECD states to build tools necessary to initiate new infrastructure.[23] These actions corelate to actions taken by many other governments in the regions in parallel.

To be clear, if, as a result of the SEA Report, certain areas in the Israeli EEZ are found to have an appropriate wind factor suitable for offshore wind electricity production, then a consequence could be that the Government would issue offshore licenses to construct offshore wind farms in that area of the EEZ. Or, if, as a result of the SEA Report, certain areas are found to have strong tidal currents or wave strength suitable for offshore electricity production, then a consequence could be that the Government would issue licenses to construct tidal or wave farms in that area in the EEZ.

As such, based on the results of the SEA Report, the potential of producing Alternative Sources at sea will eventually be evaluated and better understood by the Government. The SEA Report process will then encourage private entrepreneurs to initiate and carry out studies or research with respect to energy production at sea through Government-backed fast-track approval processes and allocation of dedicated areas in the EEZ for this purpose.

Applicable Offshore Technologies

Oil, Natural Gas, and Derivatives

At present, Israel has already established four offshore energy projects within its territorial waters and its EEZ (Existing Offshore Infrastructure).[24] The Existing Offshore Infrastructure were built over the span of at least twenty years with a primary purpose of producing natural gas and derivatives for the local and regional markets. The construction of the Existing Offshore Infrastructure has contributed significantly to securing Israel's energy security, and have elevated Israel's geopolitical position to that of an "energy producer" and "regional gas exporter".

The Existing Offshore Infrastructure are expected to continue to produce energy for Israel and the surrounding region during the interim period and possibly long after that—and there are also immediate plans to increase their production capabilities significantly for additional export scenarios.

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23 See presentation delivered by the Israeli Ministry of Energy regarding the foundations of the Sea Report. Ministry of Energy, "Webinar on Renewable Energy at Sea–13.7.2022" [In Hebrew], *YouTube*, uploaded July 17, 2022.

24 The four offshore projects are: The "Mari-B" platform (Operator: Chevron), the "Tamar" platform (Operator: Chevron), the "Leviathan" platform (Operator: Chevron), and the Karish FPSO (Operator: Energean).

Figure 3: The Leviathan Platform located within Israel's territorial waters[25]

At a global level "gas demand is projected … to increase by at least 16% before it reaches a peak in 2040".[26] Moreover, in the years to come, "additional demand for imported [or exported] gas supplied by LNG, … is projected to lead to a growth of 20–70% by 2050 compared to 2019".[27] Such projected demand scenarios for natural gas and LNG are especially accurate with respect to European countries who all have shortages of natural gas supply and have each developed dependency on Russian natural gas and are suffering from the backlash of the war between Russia and Ukraine.

As such, the European energy markets are presumed to be constantly seeking ways to increase their natural gas and LNG supply through import. The global energy demand scenarios, in turn, will trigger the continuous expansion of Existing Offshore Infrastructure production capabilities for export purposes and the initiation of new projects in the Israeli EEZ. As the Existing Offshore Infrastructure are expanded in Israel to meet the natural gas and LNG demand scenarios and as new offshore projects are conceived, it will be equally important for the Government to take further action to manage the increased carbon footprint attributed to the increase in the production capabilities.

Natural Gas and Alternative Sources (Such as LNG, CNG, Hydrogen, Ammonia, and Methanol)

Given the above, the potential growth of the natural gas and derivatives sectors in Israel and the region will most probably trigger the construction of regional LNG facilities for

25 Image from NewMed Energy, "Leviathan, with 22.9 TCF of Recoverable Gas, Is the Largest Natural Gas Reservoir in the Mediterranean, and One of the Largest Producing Assets in the Region".

26 McKinsey & Co., *Global Energy Perspective 2022*.

27 Ibid.

export. There are already several plans of action in place with respect to constructing floating liquefied natural gas (FLNG) facilities in the Israeli EEZ. This would be an ideal scenario from the concessionaire's perspective and would also align with European interest at this time. The question still remains whether or not the Government will support and approve such plans in the near future.

Figure 4: Future prospects for an FLNG facility in Israel's EEZ[28]

Fast-tracking FLNG projects will be essential if Israel and its concessionaires intend to capitalize on the growing natural gas and LNG potential in the near future. The same logic will apply to the initiation of new offshore hydrogen projects in Israel's EEZ. According to Exxon, the "global hydrogen demand is forecasted to more than double by 2030, with substantial increases from the power, industrial, and transportation sectors".[29]

Furthermore, Exxon estimates that the "size of the hydrogen market globally could be more than $1.5 trillion by 2050".[30] On hydrogen issues, Chevron has also recently started working with "Toyota, Caterpillar, Cummins and other companies to explore hydrogen's potential and create demand",[31] and also has begun "to promote hydrogen as a decarbonizing solution for transportation and industry".[32]

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28 Image from the article by Josh Lewis, "Shell's Prelude FLNG to Remain Offline for Most of Q1", *Upstream: Energy Explored*, February 4, 2022.

29 ExxonMobil, "Things You Didn't Know about Hydrogen", *EnergyFactor by ExxonMobil*, August 24, 2022.

30 Ibid.

31 Chevron, "Inside Our Alliances to Boost Hydrogen", *Chevron*, October 7, 2022.

32 Ibid.

These industrial efforts by major stakeholders will have tremendous influence on the way forward with respect to producing energy at sea in Israel since Exxon and Chevron are both key players in the global natural gas markets, and Chevron in particular operates the majority of Israel's Existing Offshore Infrastructure.[33] To that extent, "natural gas [will definitely] play a new role in blue hydrogen and ammonia production [as well]".[34] This will be a central role.

Another option to consider is repurposing Existing Offshore Infrastructure for production of low-carbon fuels such as hydrogen.[35] The possibility of repurposing Existing Offshore Infrastructure is highly applicable in Israel, especially with respect to establishing a hydrogen hub. For example, the Mari-B platform, operated by Chevron and partners, is currently standing idle following the depletion of all its subsea wells. Mari-B is a good candidate for repurposing activities initiated by Chevron with respect to producing energy from the sea. Experts predict that "regions with cost-optimal production resources, such as natural gas or renewable energy, could become major hydrogen export hubs and be at the forefront of a new global hydrogen trade".[36] This will very likely be the case for the State of Israel.

On the issue of expansion or repurposing of Existing Offshore Infrastructure, various offshore technology providers or EPC (engineering, procurement, and construction) contractors have introduced designs for establishing blue and green hydrogen hubs. One of the more significant solutions that has been presented is offered by TechnipFMC.[37] TechnipFMC has introduced a concept for generating hydrogen by electrolyzing seawater using renewable power and is working with partners on demonstrating the effectiveness of large-scale offshore hydrogen production and storage using renewable energies such as wind turbines.[38] The TechnipFMC solution is scalable and can be configured for a variety of applications, albeit this technology is still at a very early stage.

It may prove to be very effective in initiating technical discussions and international forums between Investors, Operators, EPC contractors, and the Government in order to

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33 Glen Segell, "The Chevron Corporation and the State of Israel", in *Maritime Strategic Evaluation for Israel 2021/22*, ed. Shaul Chorev and Ziv Rubinovitz (Haifa: Maritime Policy and Strategy Research Center, University of Haifa, 2022), 251–259.

34 McKinsey & Co., *Global Energy Perspective 2022*.

35 Ibid.

36 Ibid.

37 TechnipFMC Website, Retrieved December 2022.

38 *TechnipFMC*, "Hydrogen", Retrieved December 2022.

review the possibilities for adopting some these solutions and establishing a hydrogen hub offshore Israel.

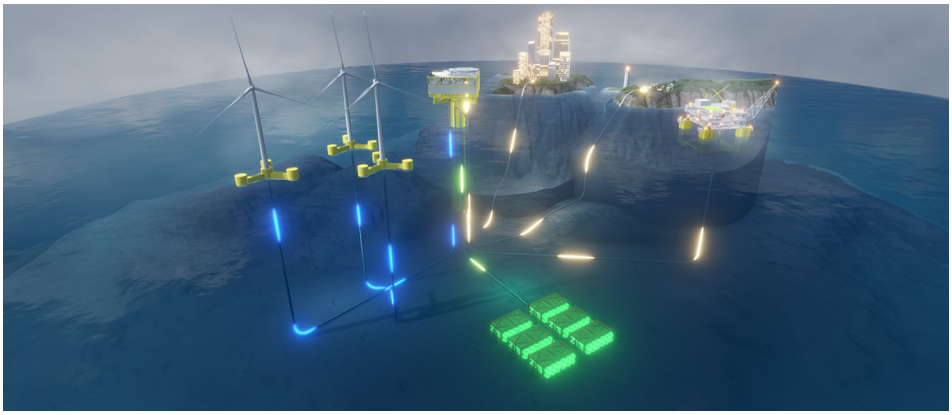

Figure 5: Future scenarios for offshore infrastructure for the production and storage of offshore electricity and/or hydrogen as envisaged by TechnipFMC[39]

At the midstream level, the Government has already taken action in preparation for the emerging hydrogen economy. The natural gas authority (NGA) recently authorized a study to be carried out by Israel Gas Lines Limited (INGL) to examine the effects of the emerging hydrogen market on the national transmission system (NTS) and the purpose of the national transmission company.[40] The purpose of the study will be to map out and to understand the capacity for using or repurposing the NTS with respect to storing, transmitting, or commingling hydrogen with natural gas in the future.

Offshore Wind Farms and Production of Offshore Electricity

The construction of offshore wind farms in Israel's EEZ may also be applicable to the extent that the SEA Report is able to identify suitable areas in the EEZ with an appropriate wind climate. Clearly, at this point in time, "solar and wind builds already come at a lower cost than existing fossil fuels in most countries and are projected to become increasingly cost competitive globally".[41] At the global level, it is becoming more and more common to see offshore wind farms catering to the needs of energy hubs at sea as a means to

39 Image from ibid.

40 "A Call to Anyone Interested in Submitting Their Proposal Or Position On Imposing A Systemic Tariff For 2023", a letter issued to the general public by the Natural Gas Authority (NGA) on October 6, 2022 (in Hebrew).

41 McKinsey & Co., *Global Energy Perspective 2022*.

provide net-zero electricity to energy-centric production and other processes at sea, for which the carbon footprint must be mitigated. This will be especially relevant when discussing the future potential for producing LNG and hydrogen offshore.

The European Union has been investing for years in the establishment of offshore wind farms, and the EU prides itself as being a "first mover" on this matter. In November 2020, the EU set very ambitious goals with respect to the continuous development of offshore wind and is aiming for an installed capacity of at least 60 GW of offshore wind by 2050.[42]

In the United States, the Department of Energy (DOE) through the Office of Energy Efficiency and Renewable Energy (EERE)[43] has initiated many offshore wind projects that are now currently in operation in US waters. Among others, the EERE funds R&D and demonstration activities in US waters with the intent of making renewable energy (such as offshore wind) cost-competitive with traditional sources of energy.

Figure 6: Possible future offshore wind farms in Israel's EEZ[44]

The Biden-Harris administration, acting through the DOE and EERE, has allocated tens of millions of dollars to fund research and development projects that will lower costs for wind energy projects on land and offshore.[45] Offshore wind is still a fledgling enterprise in the United States in comparison to its potential, and as such, the EERE has defined the following issues as core for eligibility for US government funding: (a) advancing

42 "Offshore Renewable Energy", *European Commission*, Retrieved December 2022.

43 The US Department of Energy, Office of Energy Efficiency and Renewable Energy Website, Retrieved December 2022.

44 Image from National Grid, "What Is Offshore Wind Power?".

45 The US Department of Energy, "Biden-Harris Administration Announces $30 Million from Bipartisan Infrastructure Law to Speed Up Wind Energy Deployment", *Energy.gov*, October 18, 2022.

technologies needed to transmit large amounts of electricity from offshore wind over long distances, (b) improving the offshore permitting processes, (c) improving technologies to minimize impacts to local wildlife and ecosystems, and (d) developing optimal anchoring and mooring for deep water applications.[46]

An ongoing dialogue between the DOE, EERE, and the Israeli Ministry of Energy would be beneficial to prioritizing the offshore wind potential for Israel. Nonetheless, it remains to be established if Israel has commercially viable wind within its EEZ that could justify promoting offshore wind farms. If so, the potential for establishing offshore wind farms in Israel's EEZ shall increase significantly.

Conclusions

The implementation of Israel's net-zero strategy going forward is still a work in progress. Nonetheless, the die is cast (*Ālea iacta est*), and there is no turning back. As we move forward, it will be the Government's responsibility to provide clarity to the market with respect to new supply and demand value chains for energy production and consumption. Clarity will be achieved by developing reliable supply and demand models for Alternative Sources, which will prove to be critical for putting together proper business models, attracting investors and raising capital to complete an effective transition to net-zero.

Additionally, the Government will need to issue clear guidelines and policies and set realistic goals for diversifying the Israeli energy portfolio to meet the "net-zero" requirements of the future. It is already very clear that there will be an expected increase in the demand for hydrogen and LNG, which means that concrete plans should already be put in place to initiate offshore projects to cater this growing demand.

Furthermore, the Government must find solutions to address the growing land scarcity issue in Israel by taking positive measures to encourage the construction of new infrastructure at sea including defining options for construction of artificial islands or fixed or floating solutions away from the civilian populations.

Going forward, it will also be the Government's responsibility to engage in transparent dialogue with all the relevant parties (including international offshore operators, EPC contractors, technology providers, investors, etc.) to make sure that the best available technologies are matured, deployed, and made available to Israel in the near future.

Clearly, the market drivers for producing energy at sea are, and will always be, the significant oil and natural gas fields in Israel's EEZ. Therefore, all aspects of current and

46 Ibid.

future exploration, development and production of traditional hydrocarbon resources must be further encouraged, explored, and developed to secure the continuous production of a natural gas supply for local and regional needs, on the one hand, but also as the basis for sourcing new and Alternative Sources at sea (such as LNG, CNG, hydrogen, ammonia, and methanol) to cater to the needs of tomorrow, on the other hand.

Notwithstanding, as Israel continues to develop its traditional hydrocarbon industry, it will be equally important to ensure that the carbon footprint remains at minimal levels. To do this, carbon capture technologies should be explored for new offshore projects going forward, and also priority should be given to completing a transition to renewable energy at sea (such as offshore wind) to cater the power needs of offshore infrastructure. And finally, the Government should exhaust all efforts to establish viable energy hubs for natural gas, hydrogen, LNG, and electricity production in the territorial waters of Israel or its EEZ.

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