The Potential of Natural Gas
In the Israeli Economy

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* Picture modified from original Tamar platform photo by Albatross Aerial Photography

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Preface

The goal of this research report is to provide a long term outlook for investments related to downstream applications of natural gas in the Israeli economy. The forecasts included in this report extend until 2040, and provide a macroeconomic framework based on the current and expected state of Israel's energy industry. The findings from this report can allow institutions (government, banks and private enterprises) to assess and adjust their activities related to the energy industry.

It is essential to first provide an overview of the upstream industry in order to understand the supply base of Israel's natural gas reserves and the industry's plans for future development. This report analyzes parameters related to the Tamar field's production capacity and development options being proposed for Leviathan. Based on our expectations for the development of Israel's upstream industry we provide our independent forecast for natural gas supply capacity to the Israeli market.

After analyzing the supply side of Israel's natural gas industry, we shift our focus to the demand side and begin by analyzing the power sector. By providing an accurate measure of the current demand for natural gas, and its contribution to Israel's energy mix, we calculate our expectations for required investments in new electricity generating capacity. The goal of these calculations is to provide an estimate for potential new investments, primarily from independent power producers, in electricity production from natural gas in the medium-long term. The report also forecasts trends in the adoption of natural gas as a transportation fuel, as well as the integration of natural gas in domestic industries. It is evident from the findings in this report that natural gas will play a key role in the development of Israel's economy in the coming decades.

Part 1: Overview of the Upstream Industry

Introduction to Natural Gas in Israel

Noble Energy began operating in the Eastern Mediterranean in 1998 and started supplying natural gas to the Israeli market in 2004 from the Yam Tethys/Mari-B field, located 25 km off the coast of Israel. In 2009, the largest natural gas discovery of that year in the world was made with the Tamar discovery, holding an estimated resource of approximately 10 TCF of natural gas, and by April 2013 Tamar began supplying natural gas to the Israeli market. Since the start of production at Tamar, the field has been supplying Israel with an average of approximately 750 MMCF/d, with a current system capacity of 1 BCF/d. (Noble 2013) Subsequent to the Tamar discovery, Israel made an even larger discovery in 2010 with the Leviathan gas field, holding an estimated 19 TCF of natural gas. The partners in the Leviathan field are currently finalizing an agreement to divest a percentage ownership in Leviathan to a strategic partner, Woodside Petroleum, an Australian energy company with expertise in liquefied natural gas (LNG). Noble Energy and their license partners have made several other smaller gas discoveries in offshore Israel, as well as a significant discovery in offshore Cyprus, containing an estimated resource of 5 TCF of natural gas.

Tamar Design

The Tamar platform was designed with a capacity to process 1.6 BCF of gas per day, well above its current processing rate of just under 1 BCF. (Noble 2013) This excess capacity will allow the platform to meet the requirements of Noble Energy's future plans to increase processing capacity at the onshore gas terminal, as well as increase production from the subsea system. The US$220m investment for compression at the Ashdod onshore gas terminal is expected to increase overall system capacity by 22%, for an additional 200 MMCF of gas per day. (Noble 2013)

In order to increase production capacity at Tamar, license partners will be investing in system optimizations and are currently evaluating the following expansion design concepts. Firstly, the location of the Tamar platform is in close proximity to the Mari-B platform, which was modified to be able to receive gas from Tamar and inject it into the Mari-B reservoir. This configuration will allow Mari-B to be utilized as a strategic operational reserve to receive Tamar gas during off-peak hours and supply

the Israeli market with additional gas, depending on demand. (Noble 2013) However, the viability of such a concept is coming under scrutiny by claims that using the depleted reservoir as a reserve may not be possible due to leakages and technical issues with the wells. Another option is to increase production by connecting the recent Tamar Southwest discovery to the Tamar subsea system through an 8 mile tieback. (Noble 2013)

Leviathan Development

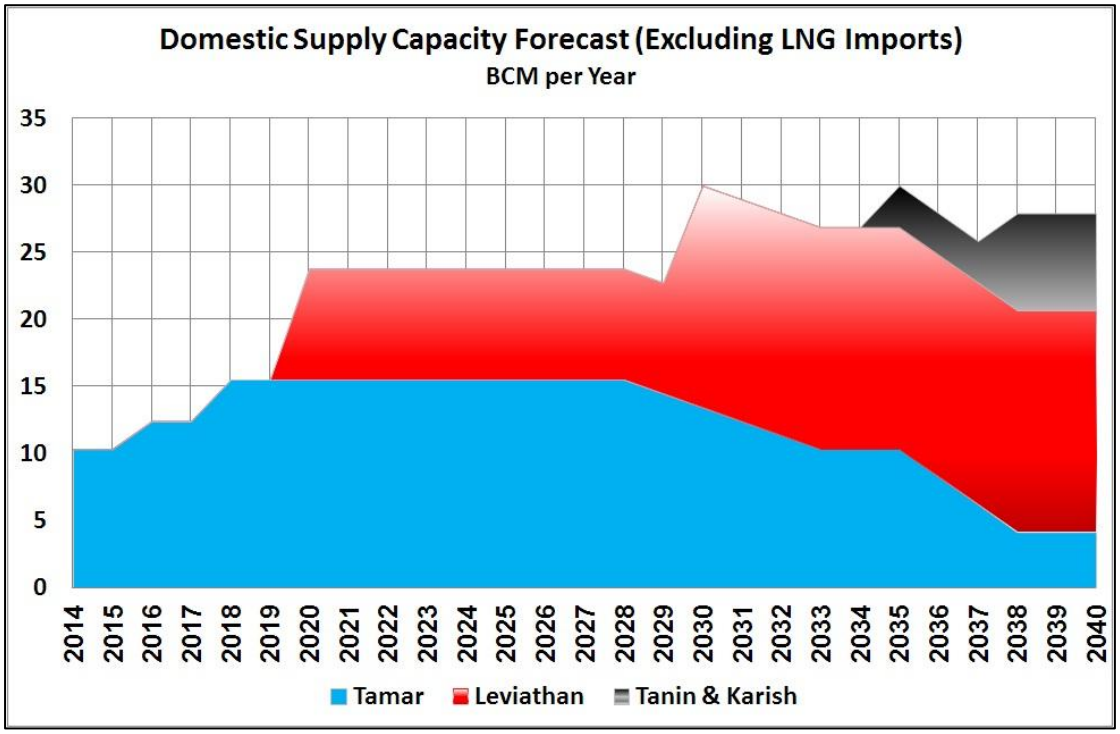
The choice of Woodside as a strategic partner reflects the plans of the Leviathan license partners to incorporate LNG in future operations. Originally, Noble Energy wanted to build an onshore LNG plant in Israel to receive, liquefy and export gas from Leviathan. However, due partly to the logistical requirements that the plant be located close to the shore, a suitable location in Israel has yet to be established. Therefore, Noble is interested in the possibility of utilizing a relatively new technology, a floating liquefied natural gas (FLNG) system. It should be noted that despite industry enthusiasm about the future of FLNG, there is not a single FLNG project in operation, which adds some uncertainty to this development concept.

In addition to FLNG, Noble is examining the possibility of utilizing compressed natural gas (CNG) as well as building pipelines to sell gas to regional markets. Noble is also planning on building an onshore LNG facility in Cyprus, which will be supplied primarily with gas from its Cyprus-A field, and therefore a pipeline from Leviathan could also supply a portion of gas to the Cyprus LNG facility, as well as to the domestic Cyprus market. Another option is to build a pipeline to supply gas to existing LNG facilities in Egypt, as well as pipelines to Turkey and Jordan.

While the Tamar field was developed within budget and in just 2.5 years from project sanction to first gas, the Leviathan project could prove to be more challenging. Noble's most updated timeline for the completion of the first stage of Leviathan's development, to supply the Israeli market, has already been pushed back a year to 2017. This was due mostly to delays in the approval of exports, and related taxation issues, by the Israeli government, which in turn has postponed finalizing the deal between the Leviathan partners and Woodside. Regulation is therefore the main barrier for the timely development of Leviathan, which could also be manifested in the permitting process for additional gas terminals and other infrastructure. ***It is reasonable to believe that the earliest Leviathan will be able to produce first gas for the domestic market will be in 2019.***

Potential Supply Capacity to the Domestic Market

The following graph illustrates our forecasts for natural gas production capacity based on discovered resources and our expected timeline for the completion of infrastructure projects. It is expected that current and future technological advancements in enhanced petroleum recovery will be used in Tamar as the field approaches terminal decline. Another assumption is that domestic supplies from Leviathan will increase by 2030 as a result of investment in additional production capacity, in order to provide adequate supplies of gas to meet forecasted domestic demand. It is also important to note that the available capacity does not equate with the actual quantities of gas that are estimated to be supplied to the Israeli market. Rather it is the expected maximum amount of annual production that can be supplied to the Israeli market.



(Leumi's forecast)

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Part 2: Downstream Potential of Natural Gas

Introduction to the Power Sector in Israel

In 2011, Israel was generating approximately 43% of its electricity from coal and 37% from natural gas, with renewables contributing negligibly to electricity production. (Ernst & Young 2011) According to the June 2013 official budget proposal by the Ministry of Energy and Water Resources, the proportion of electricity produced from natural gas has increased to approximately 60%. The use of natural gas for electricity production only started in 2004, and by 2010 Israel was consuming approximately 5.3 BCM per year of natural gas, with electricity production accounting for 90% of consumption. Domestic demand for natural gas during 2013 is expected to have amounted to 7.8 BCM, with annual demand expected to grow to 8.6 BCM in 2014. (Ministry of Energy 2013) From 2008-2012, around 60% of Israel's natural gas was domestically produced by Noble Energy with the remaining 40% imported via pipeline from Egypt. However, in April 2012, the gas supply agreement that was in place since 2008 between Egypt and Israel was cancelled due to repeated pipeline bombings and other economic reasons. As a result, Israel quickly built the necessary infrastructure to receive LNG imports, including the deployment of a floating storage and regasification unit (FSRU).

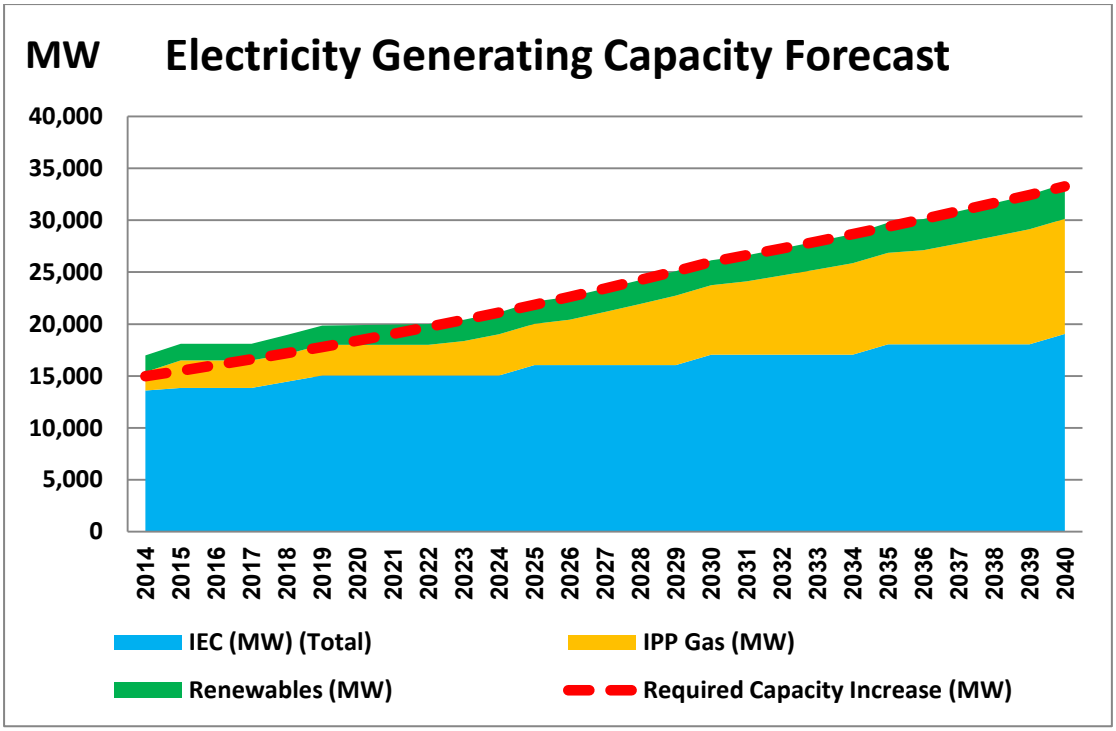
Natural gas is expected to play a significant role in Israel's future energy mix. In addition to organic growth in electricity consumption, natural gas demand will be boosted by a preference for natural gas fueled power stations as well as increased industrial usage and possible applications as a transportation fuel. Major government institutions like the Ministry of Finance and the Public Utilities Authority have also voiced their preference for generating electricity using the least expensive energy source, being natural gas. However, natural gas faces some competition in the electricity market from the Israeli government's renewable energy policies, such as their policy targets for renewables as a proportion of electricity generation of 10% by 2020. Furthermore, Israel instituted, "a new quota law in 2011, setting requirements for the addition of 110 MW of on-site generation from decentralized renewable systems, as well as up to 800 MW of centralized wind turbines, 460 MW of large solar systems, and 210 MW of biogas and waste generation plants, all to be grid-connected by 2014." (REN21 2012)

Electricity Generating Capacity

The Israeli electricity market is expected to have significant excess generating capacity until 2020. At year end 2012, Israel's total electricity generating capacity, inclusive of IPPs and renewable energy, stood at just under 14,000 MW. (Ministry of Energy 2013) This capacity is expected to significantly increase in the coming years with the addition of over 2,000 MW of natural gas powered IPPs from 2013-2016, as well as numerous renewable energy projects (including decentralized systems) and investments by the IEC, which should result in excess generating capacity. This excess capacity is not necessarily the quantity of electricity reserves relative to peak demand, but rather the excess supply over the expected requirements for generating capacity. Expected requirements are calculated to include a suitable quantity of reserve generating capacity for the Israeli economy, and assume that there is a requirement for a marginal reserve buffer over expected peak demand.

$$Required\ Capacity = Peak\ Demand + Reserve\ Capacity$$

We forecast that by 2020, total capacity will reach approximately 19,900 MW, compared to our expectations for capacity requirements of approximately 18,400 MW. The following graph displays our forecasts for installed electricity capacity, with IPPs investing in new production capacity to meet the requirements of the Israeli economy. It should be noted that the short term forecast for renewable energy is based on an aggregate analysis of the following parameters: Israel's quota requirements, policy targets, installed capacity (including measurable decentralized systems) and a portion of the roughly 1,700 MW of existing conditional licenses for electricity production from renewable sources (issued as of 2012). (Ministry of Energy 2013)



(Leumi's forecast)

We assume that the Israeli economy will require an annual increase of 3.5% in electricity generating capacity from 2014-2030, which will decrease to 2.5% from 2030-2040. From 2020-2040 it is assumed that investments by the IEC in net additional capacity will be equivalent to 1000 MW every 5 years, while projects in renewable energy will add on average 50 MW of capacity annually from 2020-2030, increasing to 100 MW annually from 2030-2040. Under these assumptions, only in 2023 will the Israeli electricity market require additional production capacity from IPPs.

We forecast that the total estimated capacity available for IPPs from 2020-2030 is approximately 3,740 MW. This amount is in addition to renewable energy investments and therefore there is the potential for this quantity to be solely powered by natural gas power stations. Using a capital cost per MW of US$1.5m, inclusive of all associated costs, these investments are estimated to be approximately US$5.6bn[1]. From 2030-2040, the total estimated capacity available for IPPs is approximately 4,390 MW, which translates into investments of US$6.6bn. It should be noted that the lead time from project planning & financing to construction and commissioning could be significant and therefore financing arrangements for some of these projects will generally start many years before construction commences.

[1] All forward looking US$ figures are in 2014 prices.

It is important to note that the projected investments focus entirely on new production capacity and do not include changes in ownership via, for example, sales of existing output units from the IEC to private producers. Other noteworthy points include the fact that our investment projections for the IEC do not include the investments associated with dismantling old, decommissioned, production units, or upgrading existing units through a conversion to natural gas usage. Other investments not included in the figures that we present are those pertaining to the expansion and upgrading of the electrical transmission and distribution operations, as well as proposals for the construction of a nuclear power plant, known as project E. Therefore, the figures shown for investment in electricity generating capacity are biased downwards.

A portion of the investments made by IPPs in additional capacity could include onsite power generation by large institutions, rural communities and industrial companies installing private cogeneration or dual cycle systems and connecting to the national gas grid. According to Madei-Taas, the market for onsite power generation is expected to amount to 300-350 MW in the next 10 years, which would translate into investments of approximately US$500m.

We forecast that renewable energy will consistently account for 10% of the country's installed generating capacity from 2020-2040. IPPs utilizing natural gas based power stations are expected to account for approximately 15% of total capacity in 2020, rising to 25% and 33% in 2030 and 2040, respectively.

Summary of Potential New Investments (unplanned) in Electricity Production from Natural Gas:

Period	*IPP*	*IEC*
2020-2030	***US$5.6bn***	***US$1.5bn***
2030-2040	***US$6.6bn***	***US$3.0bn***

Natural Gas as a Transportation Fuel

CNG as a transportation fuel is currently used on a very small scale in Israel, while globally natural gas vehicles have been adopted on a wider scale. According to NGV Global, in the past 10 years, the total number of natural gas vehicles worldwide has grown at a compound annual growth rate of 21.6%, and in 2012 there were just under 20m natural gas fuelled vehicles in the world. The segments for natural gas vehicles can be divided into four categories: bus, truck and taxi fleets, as well as private vehicles. The following chart displays the total number of vehicles in Israel from each segment, as well as their respective annual growth rates.

	Number of Vehicles 2012	*Average Annual Growth Rate 1990-2012*
Private Vehicles	***2,246,053***	***5%***
Trucks	***341,859***	***4%***
Buses	***15,625***	***3%***
Taxis	***19,222***	***4%***

(Central Bureau of Statistics)

We believe that meaningful adoption of CNG as a transportation fuel in Israel will only take place after 2025. From 2025-2040, we expect the biggest investments in the upgrade and purchases of CNG fuelled vehicles to take place in truck fleets. There is the potential for 50% of trucks to be fueled by natural gas, which would translate into investments in the conversion of existing truck fleets and purchases of new CNG vehicles (calculated as the differential in price for a CNG truck versus a diesel truck) of approximately US$3.0bn.

Compared to truck fleets, we expect the value of investments in CNG bus and taxi fleets to be relatively marginal. This is despite our belief that buses could lead the industry in the adoption of CNG, as well as our belief that a high proportion of bus and taxi fleets will be fueled by CNG by 2040. We estimate that private vehicles using CNG will represent 10% of all private vehicles by 2040. Investments in purchases of non-truck CNG vehicles are expected to amount to about US$1.5bn until 2040. Note that the above mentioned investment figures pertain only to investments in the vehicles and do not include the required investments in filling stations and the accompanying infrastructure. Therefore, the total investment figure of US$4.5bn is biased downwards.

In Israel, transportation accounts for 41% of consumption of primary energy (Ministry of Energy 2013), with buses representing a significant portion of this consumption, and therefore there is interest in the possibility of switching to CNG fueled buses. While CNG for buses is a proven cost effective technology, the main risk associated with this technology is fires. Australia is an example of a country that adopted the use of natural gas in city bus fleets. However, buses have slowly been reverting back to diesel as a result of a high rate of fire incidences and a subsequent increase in fire related insurance claims. (Gas Tech Conference 2014) This safety issue, coupled with limitations on natural gas vehicles being in closed areas, like underground parking lots and bus depots, will limit the growth potential of this technology. Prudent government policy to support a transition in Israeli bus fleets to natural gas would provide incentive for gas infrastructure to be built to initially serve the public transit segment. Once widespread infrastructure is built, taxi and truck fleets could then economically and logistically be transitioned to CNG, followed by possible significant adoption by private vehicle owners.

Industrial Applications

Alongside the supply of natural gas from Tamar, several large industrial companies have been investing in the integration of natural gas in their operations (in addition to onsite electricity production), by connecting to Israel's natural gas pipeline system. Some examples of these investments include the use of natural gas as an input chemical in the refining process at Israel Oil Refineries (Bazan), as well as the use of natural gas in the heating process at Hadera Paper. While we believe that a portion of the available investments for the integration of natural gas in the industrial sector (excluding electricity production) have already been made, there is still room for significant investments in the next 5 years. However, we believe that the forecasts from the Tzemach Committee, that industrial demand will increase from 1.5 BCM in 2013 to 3.8 BCM by 2020, might be too aggressive. We believe that total investments in industrial applications from 2014-2020 will be around US$500m.

In the longer term, the natural gas discoveries in Israel have the potential to develop new industries. In particular, we believe that investment in a methanol plant will occur in 2020-2030, with methanol production commencing closer to 2030. It is anticipated that there will be one major producer with a medium sized plant, with capital costs of approximately US$500m. However, a smaller plant in the area of US$200m could initially be constructed with the potential for increased capacity in the future. The existence of a methanol plant could also result in secondary industries that use methanol to create other chemical and plastic products.

There is also the possibility of constructing a gas-to-liquids facility to produce liquid fuels from natural gas. There are several commercial GTL plants in operation with the largest being Shell's 140,000 bbl/d Pearl GTL plant in Qatar. Based on comparable projects, the capital costs for a GTL plant are generally US$1bn/10,000bbl/d of capacity. Given the chemical makeup of Israel's natural gas, we currently believe that there is an extremely low probability that a GTL plant will be built in Israel. However, the following factors could contribute to the construction of a plant: technological developments resulting in improved efficiency and economic viability, a dramatic increase in the spread between natural gas and crude oil prices and the availability of high ethane gas in Israel. If a GTL plant will be constructed it will probably have an output capacity of 10,000-15,000 bbl/d, and begin production during 2030-2040, at a capital cost of US$1-1.5bn.

Impact on Israel's Macro Economy

Israel's natural gas discoveries have paved the way for the country's energy independence and for significant cost cutting and productivity gains. Aside from the impact on economic activity and the country's degree of competiveness, the revenues that the state of Israel will receive from natural gas taxation and royalties, are expected to be significant (as illustrated in the following chart).

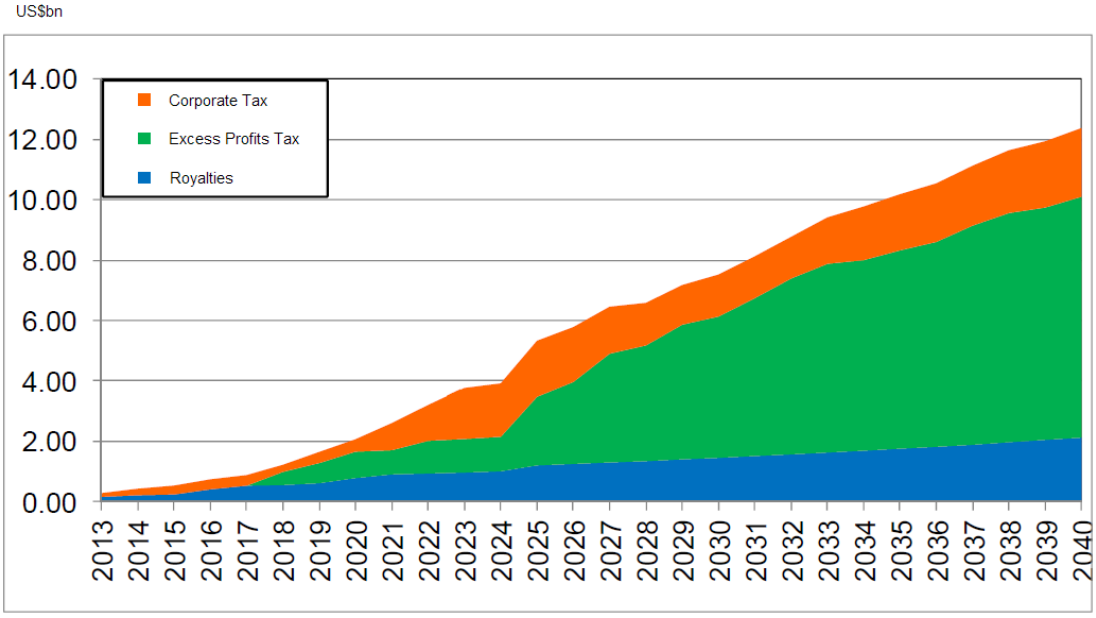
According to the protocol from the government's projections, royalties will reach US$30bn, with corporate tax reaching a similar level, during the period of operation of the reservoirs (in current prices). Taxes on surplus profits are supposed to reach US$70-80bn, although it is estimated these revenues will begin only in 2018 from “Tamar” and in 2025 from “Leviathan”, since prior to these periods, the profits are expected only to cover the initial investments in the reservoirs.

Whereas the royalties and corporate taxes are intended to be regularly incorporated into the government budget, the taxes on surplus profits will be directed to a sovereign wealth fund. In terms of GDP, the government estimates its receipts will accumulate in the fund to a level equivalent to 8-9% of GDP in 2040 (equal to NIS 80-90bn in today’s terms). Over the long run, the increase in state tax revenues will enable the government to reduce its debt level and maintain a balanced budget, while increasing government spending and investment for the benefit of the economy and the population.

A concern associated with revenues from natural gas is expectations for local currency appreciation, known as the "Dutch Disease", which hurts the competitiveness of the domestic manufacturing sector. The mechanics of the Dutch

Disease and preventative measures have been discussed in greater detail in previous reports by Bank Leumi, but include the establishment of a sovereign wealth fund that invests gas proceeds in foreign assets, as well as financial assistance for domestic manufacturers[2].

Projected state tax revenues from natural gas, US$, billions



(Modified from the Bank of Israel, June 2013)

Most upstream investments will not have a significant net effect on domestic GDP because they require very little work from domestic companies, since major infrastructure projects are contracted to global service providers. However, investments in real assets related to the use of natural gas are expected to result in an average increase of 2-3% per year in the rate of growth of gross real investments, while this element alone is expected to contribute on average 0.2-0.3% to Israel's GDP real growth rate. These figures account for the fact that a sizeable part of the investment will be of imported equipment. However, there will be substantial activity related to the installation and maintenance of the systems. In addition, growth is likely to be boosted by various "spillover" developments such as demand for financial

[2] See: Bufman Gil M., Establishing a Sovereign Wealth Fund for Israel as Part of a Mechanism for Dealing with the Forces Supporting Appreciation of the Shekel, December 2013, Bank Leumi. Cohen Sagit, The Norwegian Cure for the Dutch Disease and its applicability for Israel, May 2013, Bank Leumi. Bufman Gil M., Will the Bank of Israel Succeed Once Again to Stop the Shekel from Strengthening?, June 2013, Bank Leumi.

services required as part of the investment process, demand for planning and infrastructure services and also for materials to be used in the process.

In addition, the transition to natural gas is expected to result in increased energy efficiency and a reduction of around 10% of Israel's energy costs (net of investment and maintenance costs) in the long term. This is likely to contribute to Israel's degree of global competiveness and will be particularly important for medium and low tech industries that have significant energy needs. Examples of these industries include: chemicals, food, rubber and plastics, textiles and paper. Other parts of the economy that are likely to benefit from the accessibility of natural gas include: hotels and agriculture. The use of natural gas will help Israeli exporters to increase their global market share and will help manufacturers that are focused on the domestic market to better compete against imports. In essence, the introduction of natural gas represents a technological change and has a competitive effect that is similar to a real term depreciation of the shekel.

In order to attempt to quantify the contribution of natural gas usage on the global competitiveness of Israel's business sector, we calculate the added value of energy cost savings on industry profitability, using elasticity figures from Israel's export models. Overall, we believe that the increase in competitiveness will contribute to an annual average increase of Israel's GDP growth, other things equal, of about 0.2-0.3%. Therefore, combining this contribution to growth with the expected direct contributions from investments in machinery and equipment that use natural gas, we expect to see an aggregate contribution to average multi-year GDP growth of 0.4-0.6%. It should be noted that this figure does not account for the contribution of natural gas exports to GDP growth, which are likely to commence after 2020. The value of gas exports and their contribution to GDP will be dependent on the choice and timeline of various export projects, as well as the prevailing price of natural gas in each specific contract.

Appendix

Projected investments in machinery & equipment for the use of natural gas in Israel (US$ millions, 2014 prices)				
	2015-2019	**2020-2029**	**2030-2039**	**Total**
Transportation	**26**	**649**	**3,819**	**4,494**
Electricity Production	**3,480**	**7,110**	**9,585**	**20,175**
Investments by the IEC for new output capacity (excluding distribution, transmission and decommissioning/refurbishing old units)	*2,175*	*1,500*	*3,000*	*6,675*
Investments by IPPs	*1,305*	*5,610*	*6,585*	*13,500*
Manufacturing (non-electricity)	**500**	**1,000**	**1,000**	**2,500**
Others	**100**	**250**	**500**	**850**
Total	**4,106**	**9,009**	**14,904**	**28,019**

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