Natural Gas and Israel's Energy Future

Planning Amid Deep Uncertainty

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Abstract

An analysis of whether Israel can shift toward natural gas to meet future electricity demand showed that controlling demand is critical. There are then strategies for Israel to build an energy infrastructure in which natural gas provides up to 40 percent of base-load electric-power generating capacity without jeopardizing its security. Israel should shift from a planning process not well suited to avoiding surprise to one that would allow planners to exploit more and better information adaptively; increase foreign natural-gas purchases but only up to the limits of existing pipeline capacity; draw on domestic natural-gas sources before investing in infrastructure for more imported gas; and plan for, but delay, constructing a liquefied-natural-gas terminal until future demand and costs become clearer.

Israel is very much an "island" in terms of electricity supply. For political reasons, its grid is not connected with those of its neighbors. Until recently, it had little in the way of domestic deposits of fossil fuels to generate electricity. Thus, Israel relies on imported coal as the primary fuel for base-load electric-power generation: In 2007, coal was used to generate about 70 percent of Israel's electricity. Most of the rest of its base-load generation (20 percent) now comes from natural gas, increasingly from imports through a natural-gas pipeline from Egypt. Recently, Israel discovered large, domestic offshore natural-gas deposits.

Should Israel shift away from imported coal and toward natural gas (both imported and domestic) as a way to meet future demand for electricity from its growing economy? Because of long lead times in constructing base-load capacity, Israel must make expensive, momentous investment decisions in the near future while considering likely future levels of demand, the costs and availability of sources of fuel supply, security of fuel supply, future development of alternative technologies, reliability, environmental effects, and land use. All these factors are fraught with deep uncertainty.

This study assessed the opportunities and risks Israel faces in shifting to a greater reliance on domestic and imported natural gas by applying an innovative, quantitative robust decision-making (RDM) approach to the central question of how large a role natural gas should play in Israel's energy balance. Rather than relying on the typical method of optimizing plans around a "most likely" or small number of scenarios, RDM helps planners discover robust strategies—strategies likely to achieve satisfactory levels of success across a large range of plausible futures. When the future cannot be forecasted with confidence, RDM helps planners examine the available alternatives and ask which would be best to choose.

Working with a future time frame of 2030, the study considered strategies for natural-gas use that would lead to different levels and patterns of consumption of natural gas and then considered strategies for ensuring that there will be enough natural gas to satisfy future levels of demand.

How Large a Role Should Natural Gas Play in Israel's Energy Mix?

Using RDM, the researchers assessed alternative strategies based on how well they perform against criteria—in this case, acceptable threshold levels for total system costs out to the year 2030, greenhouse gas (GHG) emission levels in 2030, and the land area required for the additional electric-power generating capacity called for by different

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strategies—across 1,400 future states of the world created by varying assumptions about future demand, prices, technologies, policies, and external developments.

The analysis started with a simple set of modeling strategies and then made them more complicated based on the simulation results. After repeated trials, the analysis led to four strategies. One was a Baseline strategy, designed using traditional planning techniques, that determines an optimal set of investments in electric-power capacity based on forecasts of future demand and other variables. The other three strategies were adaptive, each allowing planners to construct renewable, non–fossil fuel generating capacity and employ policies to enhance energy conservation. One of these strategies always seeks the least-cost solution for supplying Israel's energy (Least Cost + Conservation, or LCC). Another seeks a cautious balance between fuel types, including renewable fuels, such as solar, to minimize the effects of possible cutoffs in natural-gas supplies (Less NG + Renewables + Conservation, or LessNGRC), while the third seeks to maximize the use of natural gas as well as using renewable fuels (More Natural Gas + Renewables + Conservation, or MoreNGRC).

The analysis demonstrates that adaptive plans reduce the risks to Israel and, thus, increase the likelihood that Israel will achieve its goals. A combination of demand management and using several energy sources, particularly non–fossil fuel ones, reduces risk. When demand is left unchecked and follows a high-growth path, it is hard to choose any strategy that will meet Israel's goals.

Figure 1 shows that a strategy that greatly enhances the use of natural gas in Israel—MoreNGRC—may be both consistent with Israel's interests and relatively robust across many plausible futures. It succeeds in meeting the cost threshold almost as well as the LCC strategy while at least matching the other strategies in GHG emissions and land use.

Which Strategy Best Ensures Supply of Natural Gas?

The principal objection to Israel using more natural gas is the possibility that supplies could be disrupted and be less reliable than they would be using coal or petroleum. The authors used the RDM approach again to assess alternative strategies for obtaining additional supplies of natural gas through 2030. They examined in depth four strategies involving newly discovered domestic deepwater (DDW) reserves and imports of liquefied natural gas (LNG). In the first strategy, Israel draws all additional future supply from DDW reserves (DDW Only). In the second, Israel first relies on DDW reserves and adds LNG later when needed (DDW Then LNG). In the third and fourth, Israel constructs an LNG terminal and develops its domestic reserves simultaneously. However, in the third strategy, Israel relies on DDW reserves as the main supply with LNG as a supplement (Joint DDW/LNG–DDW Priority), while, in the fourth, it does the reverse to prevent too-early depletion of the domestic supply (Joint DDW/LNG–LNG Priority).

Figure 1
The MoreNGRC Strategy Outperforms the Other Strategies

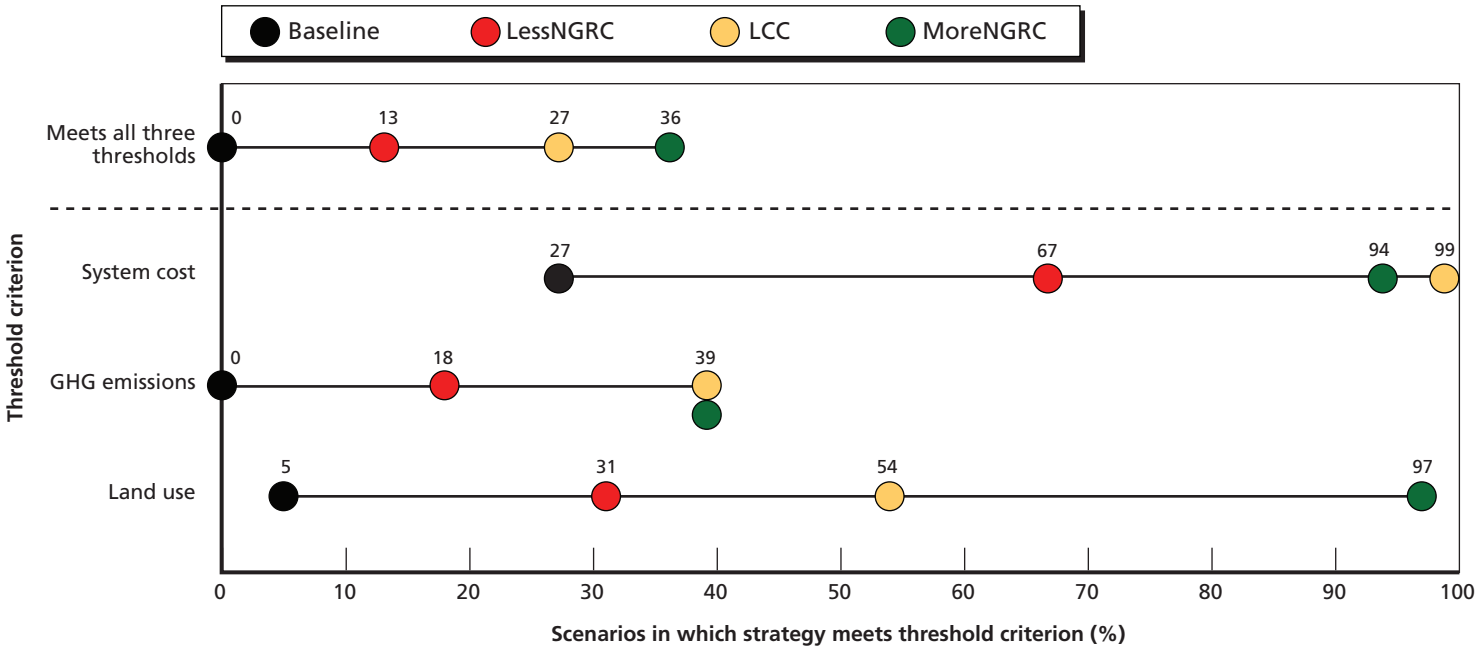
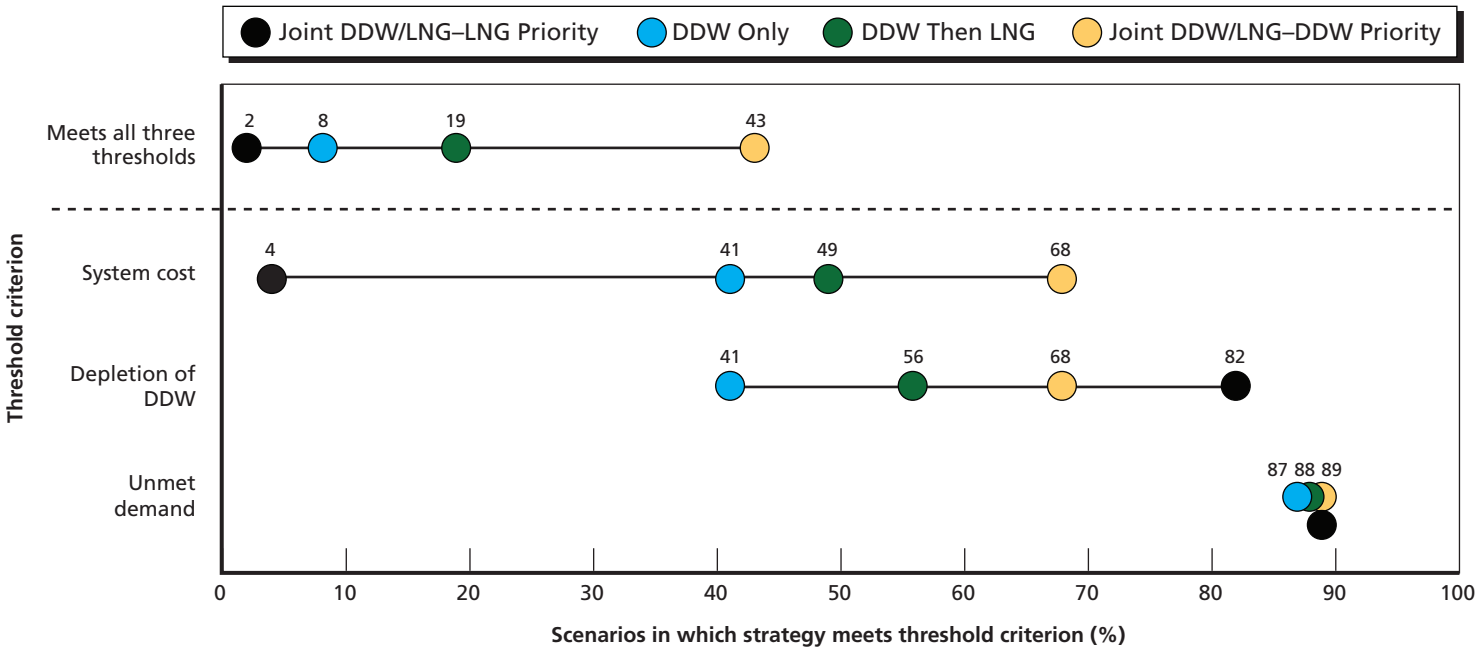


Figure 2
A Joint Investment Strategy That First Draws Natural Gas from DDW Sources Outperforms the Other Strategies



The authors examined many variants of these four basic strategies by assuming different amounts and types of storage of natural gas and backup fuels, levels of storage, the amount of natural gas imported through the existing foreign supply pipeline, and levels of "insurance" in which Israel should invest in the form of extra supplies and additional supply infrastructure to make up for possible supply disruptions. The strategies were again assessed against three criteria—whether they met acceptable cost thresholds, the rate of depletion of domestic reserves, and potential unmet demand—across a test set of 5,000 futures.

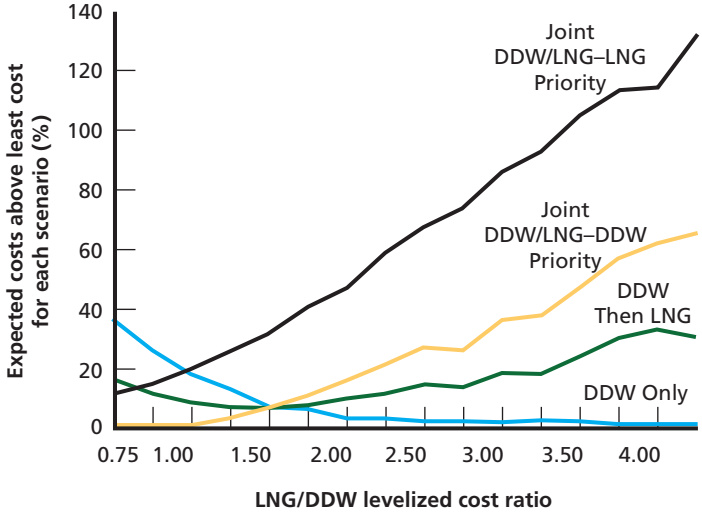
In Figure 2, the analysis shows that all the strategies do quite well in terms of ensuring that Israel will be able to meet projected demand. The joint investment strategy that draws first on LNG does better than the other strategies in terms of conserving Israel's domestic reserves. However, this strategy does poorly in meeting cost criteria, while the joint strategy that instead draws on the DDW sources first does much better than the others in terms of costs.

This result shows that RDM is not intended as a way to have computers make decisions for us. Rather, it is a tool for managed change. Israel's policymakers must determine what are acceptable costs or rates of depletion and whether one is more important than the other. RDM is a means to make trade-offs between strategies explicit and to determine which factors should govern the choice among them.

To illustrate this capability, the authors asked how the strategies would compare if an abrupt supply disruption actually occurred. Across 5,000 futures, they simulated a one-year shutoff of all supplies through foreign pipelines in 2025. Perhaps surprisingly, they found that varying assumptions about the likelihood of such a shutoff does not change the preferred supply strategy.

But the choice of strategy does depend crucially on assumptions about the unique costs associated with each natural-gas supply source. In Figure 3 on the following page, the horizontal axis shows different ratios of these costs between LNG and DDW gas. Each strategy is evaluated at each ratio level for how much greater Israel's total natural-gas supply-system costs would be, on average at that level, than the strategy whose costs would be least. Since the future is unknown, what we are really asking is what we would need to believe was true to choose one strategy over the others. In this analysis, Joint DDW/LNG–LNG Priority is never preferable from the total cost perspective across the entire range. There is a clear crossover point for the three remaining strategies at around the basic cost ratio of 1.75. If policymakers believe that LNG will cost more than domestic gas from deepwater reserves, then using only domestic gas (DDW Only) is likely to be preferred; if they believe that the LNG-to-DDW cost ratio will be low, then Joint DDW/LNG–DDW Priority is the better choice. But if they are truly unsure, then DDW Then LNG may be viewed as the most robust strategy, almost always running second best throughout the range and "failing more gracefully" in terms of cost than the other candidates.

Figure 3
Strategy Choice Depends on Policymaker Assumptions



Implications

This study carefully laid out the competing objectives and constraints that Israeli policymakers face while directly confronting the problem of deep uncertainty. The goal was to develop the means and demonstrate the value of an adaptive approach to energy-infrastructure planning and identify those elements of adaptive plans for natural gas that enhance the ability to achieve successful outcomes under many different sets of future conditions.

RAND built tools designed for transfer to Israel. The analyses point to the most-fruitful avenues for Israel's planners to investigate in greater detail using the tools created for this project.

- Curbing growth in demand for electricity is Israel's first line of defense for energy security, having the most influence on scenario outcomes.
- Israel should adopt a two-stage planning process for decisions on expanding generating capacity: Use current planning techniques for decisions on capacity additions through 2015, and use a more adaptive approach for capacity additions beyond 2015.
- Israel may primarily rely on combined-cycle natural-gas power plants—drawing on the existing foreign pipeline and potential new offshore supplies—but only if it builds infrastructure and puts in place policies to limit supply disruption.
- Israel should take delivery of contracted imported natural-gas volumes and consider new contracts up to the physical maximum available through the existing foreign pipeline, if the natural gas is competitively priced.
- Because of cost and vulnerability concerns, Israel should prepare for—but not yet invest in—an LNG terminal.
- Israel should maintain a diversified mix of energy sources for generating electricity to defray risks to the supply and cost of fuel. Despite higher costs, this should include renewables such as solar-thermal electric-power plants or the use of solar thermal to preheat steam for fossil fuel–fired power plants.
- Israel should evaluate from a total system perspective the minimum guideline threshold for the amount of electricity that must be generated by coal.
- The Israeli government should regulate the wholesale and retail prices of domestically produced natural gas based on the cost of imported natural gas.
- Because of high costs of available options for storing natural gas, Israel should guard against disruptions in natural-gas supplies by storing sufficient quantities of diesel, not natural gas, to smooth future supply disruptions.
- Israel should execute existing plans to build an inland high-pressure natural-gas distribution pipeline to parallel the existing offshore pipeline. ■

This research brief describes work done for RAND Infrastructure, Safety, and Environment documented in *Natural Gas and Israel's Energy Future: Near-Term Decisions from a Strategic Perspective*, by Steven W. Popper, Claude Berrebi, James Griffin, Thomas Light, Endy Y. Min, and Keith Crane, MG-927-YSNFF, 2009, 186 pp., $38, ISBN: 978-0-8330-4886-8, (available at http://www.rand.org/pubs/monographs/MG927/). It also draws from the underlying technical report, *Natural Gas and Israel's Energy Future: A Strategic Analysis Under Conditions of Deep Uncertainty*, by Steven W. Popper, James Griffin, Claude Berrebi, Thomas Light, and Endy Y. Min, TR-747-YSNFF (available at http//www.rand.org/pubs/technical_reports/TR747/), 2009, 286 pp. This research brief was written by Paul Steinberg. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. **RAND**® is a registered trademark.

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RB-9476-1-YSNFF (2009)