IDC HERZLIYA

Aaron Institute for Economic Policy
In the name of Aaron Dovrat z"l

Optimal Planning Strategy for the Israeli Energy Sector

Hila Axelrad, Zvi Eckstein, and Sergei Sumkin*

Policy Paper 2021.03 / May 2021

This is a short summary, for the full paper (in Hebrew) see https://www.idc.ac.il/he/research/aiep/pages/policy-papers.aspx.

* Prof. Zvi Eckstein is Head of the Aaron Institute for Economic Policy and Dean of the Tiomkin School of Economics at the IDC Herzliya, zeckstein@idc.ac.il. Dr. Hila Axelrad and Dr. Sergei Sumkin are senior researchers at the Aaron Institute for Economic Policy.

Aaron Institute for Economic Policy

In the name of Aaron Dovrat z"l

The vision of the Aaron Institute for Economic Policy is to sustain economic growth and social strength in Israel, by researching, modelling and developing modern, innovative and up to date strategies and policy tools for the Israeli economy, based on up-to-date global knowledge.

All modern economies aim for economic growth, achieved through employment increase and a rise in workers' productivity. The Aaron Institute conducts economic research that yields proposals for innovative policy tools and reforms for promoting growth, employment and productivity. The goal of policy research is to influence monetary and fiscal policy, as well as to formulate long-term plans for economic and social issues and contribute to the narrowing of social gaps. The institute aims to affect professional discourse, spur discussion based on credible information and socio-economic research, which will ultimately provide tools that will support a growth path and create social resilience in Israel.

The main aim of the Aaron Institute for Economic Policy at the Tiomkin School of Economics is to develop policy strategies that eliminate weaknesses and empower the strengths of the Israeli economy. We propose broad reforms as well as policy changes to particular industry sectors. In this framework Israel's relative advantages in technologic innovation and advances in the public and services sectors can be maximized. At the Aaron Institute, we crucially define quantitative goals while involving some of the countries' best economists in research and policy paper discussion meetings.

Board Members:

Mr. Shlomo Dovrat (Chairman), Ms. Yael Andorn, Ms. Judith Bronizki, Mr. Yoel Carasso, Prof. Zvi Eckstein, Prof. Martin Eichenbaum, Ms. Anat Levin, Mr. Zvi Limon, Prof. Rafi Melnick, Mr. Roni Naftali, Mr. Ronen Nir, Dr. Tali Regev, Mr. Haim Shani, Ms. Ofra Strauss, Mr. Erez Vigodman.

Head:

Prof. Zvi Eckstein.

Scientific Committee:

Prof. Zvi Eckstein (Chairman), Prof. Martin Eichenbaum, Prof. Zvi Hercowitz, Prof. Rafi Melnick, Prof. Omer Moav, Dr. Tali Regev, Dr. Yaniv Yedid-Levi.

Contact details:

The Interdisciplinary Center Herzliya - IDC, P.O. Box 167, Herzliya, ISRAEL 4610101

Phone: 972-9-9602431

Email: aaron.economics@idc.ac.il

Website: https://www.idc.ac.il/en/research/aiep/pages/main.aspx

Optimal Planning Strategy for the Israeli Energy Sector

Energy security is a primary policy objective for the energy sector in every developed country. In order to achieve energy security, the design of the energy sector focuses on the attainment of three goals: power supply reliability, a clean and diverse fuel mix, and competitive pricing of electric power. The risks of power supply shortage are incorporated into all of these goals,[1] hence failure of the physical electricity supply is a primary component in the assessment of energy security.

Increasing the share of variable renewable energy sources (solar and wind power) creates additional complexity in the development and management of the power grid, since these energy sources cannot provide continuous supply, nor can they be fully controlled by the system manager. Therefore, designing the energy sector to ensure energy security becomes more complicated, due to the need both to attain the goal of reliable power supply and to increase the share of renewable energy produced from variable (intermittent) sources. In developed countries, the planning of the energy sector draws on a model which makes it possible to attend simultaneously to the three goals of the energy sector: the reliability of power supply, the share of electric power produced from renewable sources, and competitive pricing. Through this model, it is possible to calculate the economic price of electricity – a price which takes into account the trade-off between the rate of renewable energy on the one hand, and infrastructure quality and grid reliability on the other. The outcome of this model-based planning of the energy sector in developed countries is an electricity system characterized by high reliability – which keeps improving – along with an increasing share of renewable energy sources.

In Israel, as of 2019, the share of solar and wind energy was around 7%, and the stated reserve ratio was around 33%. This reserve ratio reflects low reliability of the power grid, being lower by some 35 percentage points than the reserve ratio required for such a rate of renewable energy sources, according to the European Union.

The plan presented by the Israeli Ministry of Energy aims to increase the percentage of electricity produced from renewable sources to 30% by 2030, meaning an increase of 23 percentage points in renewable energy production rate. According to the outcomes of the model presented by the Electricity Authority, the excess cost for electricity consumers caused by increasing the target percentage of renewable energy sources to 30% (taking into account

[1] Lack of installed generation capacity, unstable transmission and distribution infrastructure, and fluctuation of fuel prices are all threats to energy security.

the additional benefits of reduced air pollution) would be between an excess cost of around NIS 2 billion and a saving of around NIS 4 billion.

This model, however, fails to consider the trade-off between goals: the reduced emission of pollutants caused by increasing the percentage of renewable energy sources should be weighed against the cost of lacking power supply due to grid reliability and investment in infrastructure. The cost of supply shortage caused by lack of installed generation capacity and/or grid failures is significant, and over the last two years it has amounted to at least half a billion NIS per year, with an upward trend. Since the electricity price as derived from the Electricity Authority model does not incorporate the cost of power supply shortage, its assessment of the benefit of increasing renewable energy production rate to 30% is overestimated. A policy of increasing renewable energy production rate, divorced from improving grid reliability, might increase the costs of supply shortage and add a hefty cost to the savings generated by reducing air pollution.

Israel's unique features – a country which is an "energy island"[2] with substantial security threats, low grid quality (old, overhead), and reliance on just one variable renewable energy source, all metrics which indicate low reliability levels – add up to exacerbate the challenges involved in managing the Israeli energy sector, and augment the need for high reliability level of the power supply, for a stable and sufficient reserve, and for proven solutions for energy storage.

Therefore, we recommend improving policy measures as follows:

1. Formulate a "Beyond 2030 Plan" based on a quantitative model of the energy sector, which would make it possible to examine various scenarios of grid reliability levels and renewable energy production rates, as well as costs of grid development, construction, operation and improvement. We recommend utilizing one single model for the Israeli energy sector, to be used by all pertinent stakeholders: The Ministry of Energy, Electricity Authority, system administrator, The Israel Electric Corporation, manufacturers, and private entrepreneurs.
2. Assess the overall economic implications of setting a 30% goal for renewable energy production rate, in regards to energy security, and calculate the price of electricity while considering the trade-off between the energy sector goals: reduced pollutant emission due to increased share of renewable energy sources in the fuel mix on the

[2] Connecting Israel to neighboring countries (e.g., subsea cable connection with Cyprus and Greece) would enhance energy security.

one hand; the cost of supply shortage caused by lack of grid reliability and insufficient investment in infrastructure and production plants on the other.

3. Set agreed goals for 2030 in terms of grid reliability and share of renewable energy sources, by choosing an optimal investment alternative for attainment of the three goals for the energy sector.
4. Determine agreed, transparent metrics which would inform a continuous policy aiming to achieve goals and to monitor the operation of the energy sector.
5. Enact regulation which supports attainment of measurable goals and ensures governance, transparency and effective operation of the electricity sector.
6. Appoint an objective oversight apparatus which comprises periodical, transparent publication of metrics.
7. Establish incentive mechanisms which would encourage electricity producers to meet their ascribed goals.

1. Summary and conclusions

Energy security is a primary policy objective for the energy sector in every developed country. Energy security is defined as stable, uninterrupted electricity supply to all consumers at a competitive price.[3] In order to achieve energy security, the design of the energy sector focuses on the attainment of three goals: reliability of power supply, a clean and diverse fuel mix, and competitive pricing of electric power. The risks of power supply shortage are incorporated into all of these goals,[4] hence **failure of the physical electricity supply is a primary assessment component of energy security.**[5]

Over the last few years, the goal of increasing the share of renewable energy sources in the fuel mix has been considered more important than it had been previously. This is due to the environmental benefits of producing energy from clean sources, as well as technological developments which enable the construction of devices utilizing such sources.[6] Increasing the share of variable renewable energy sources (solar and wind power) adds complexity to the development and management of the power grid, as these energy sources do not offer continuous supply and cannot be fully controlled by the system manager.[7] Accordingly, designing the energy sector to ensure energy security becomes more complicated, due to the need both to attain the goal of reliable power supply and to increase the share of renewable energy from variable sources.[8]

Due to the design complexity which requires simultaneous consideration of the three goals of the energy sector, developed countries employ a quantitative model as a basis for their energy sector planning. This model makes it possible to examine various scenarios of grid reliability levels and percentages of renewable energy sources, while taking into account the costs of grid development, construction, operation, and upgrading. Furthermore, such a model facilitates calculating electricity prices while considering the trade-off which exists between the energy sector goals: on one hand, reduced pollutant emission due to increased percentage of renewable energy sources in the fuel mix; on the other hand, the cost of supply shortage

[3] The International Energy Agency (IEA) defines energy security as "reliable, affordable access to all fuels and energy sources." (https://www.iea.org/topics/energy-security)

[4] Insufficient installed generation capacity, unstable transmission and distribution infrastructure, and fluctuation of fuel prices are all threats to energy security.

[5] Israeli Ministry of Energy (2020), chapter 15.1, page 150.

[6] Such as hydro, solar, wind, natural gas, and biomass energy.

[7] There is a distinction between energy sources with relatively secure availability and continuous generation capacity, which have little effect on the complexity of managing the electricity system, and renewable energy sources with intermittent, fluctuating availability, such as wind and solar power.

[8] Most developed countries have extensive experience in energy production from renewable sources, such as nuclear and hydro power.

caused by lack of grid reliability and insufficient investment in infrastructure and production plants. Using the quantitative model makes it possible to choose an optimal investment alternative for simultaneous attainment of all three goals for the energy sector, as well as to determine agreed, transparent metrics which inform a continuous policy aiming to achieve goals and to monitor the operation of the energy sector.

The outcome of such model-based planning of the energy sector in developed countries is an electricity system characterized by high (and improving) reliability, along with an increasing share of renewable energy sources.[9] In other words, increasing the share of renewable energy from variable sources is done is conjunction with improving grid reliability through an increase in the reserve ratio and a reduction of power outage minutes.[10] Thus, in Germany for example, the share of solar and wind energy had risen by around 20 percentage points from 2006 to 2018; at the same time, the reserve ratio had risen by some 100 percentage points, and power outage minutes had decreased by around 35%. In Denmark during that same period, the share of solar and wind energy had risen by around 29 percentage points, while the reserve ratio had risen by over 36 percentage points, and power outage minutes had decreased by around 30%. In the UK, the share of solar and wind energy had risen by around 20 percentage points from 2006 to 2018, while the reserve ratio had risen by some 16 percentage points, and power outage minutes had decreased by around 45%. **In average, each percentage point of increase in the share of solar and wind energy in EU countries corresponds with an increase of around 2.6 percentage points in the stated reserve ratio.**

In Israel, the share of solar and wind energy was around 7% in 2019, while the stated reserve ratio was around 33%. This reserve ratio is lower by some 35 percentage points in comparison to the required reserve ratio for that percentage of renewable energy sources, according to EU countries. Such a reserve ratio indicates low reliability of the power grid.

The current plan of the Israeli Ministry of Energy aims to raise the share of renewable energy sources to 30% by the year 2030. This policy, according to the Electricity Authority, strikes a balance between "Israel's aspirations to be at the global forefront in terms of renewable energy sources along with the need to reduce air pollution across the economy on the one hand, and the related costs, consequences and challenges on the other hand."[11]

[9] The need to maintain the element of stability while producing energy from renewable sources is what makes it necessary to increase the available reserve ratio.

[10] A frequently used macro metric for the assessment of power supply reliability is the reserve ratio. A frequently used metric for the assessment of supply reliability in the distribution segment is power outage minutes, as reflected in the System Average Interruption Duration Index (SAIDI).

[11] Electricity Authority (2020), page 8, section 27.

However, the model employed by the Electricity Authority to plan that increase of renewable energy sources did not consider the trade-off between different goals**: the reduction of pollutant emission caused by increasing the share of renewable energy sources should be weighed against the cost of power supply shortage due to insufficient grid reliability and investment in infrastructure.** The cost of supply shortage caused by lack of installed generation capacity and/or grid failures is significant, and over the last two years it has amounted to at least half a billion NIS per year, with an upward trend. Since the electricity price derived from the Electricity Authority model does not incorporate the cost of electricity supply shortage, its assessment of the benefit of increasing renewable energy production rate to 30% is overestimated. **A policy of increasing renewable energy production rate, divorced from improving grid reliability, might increase the cost of supply shortage and add a hefty cost to the savings generated by reducing air pollution.**

Israel's unique features – **a country which is an "energy island" with substantial security threats, low grid quality (old, overhead), and reliance on just one variable renewable energy source, all metrics which indicate low reliability levels – add up to exacerbate the challenges involved in managing the Israeli energy sector and augment the need for high reliability level of the power supply, for a sufficient stable (conventional) reserve, and for proven solutions for energy storage.**

Therefore, we recommend improving the model and enacting the following policy measures:

- Formulate a "Beyond 2030 Plan" based on a quantitative model of the energy sector, which would facilitate examination of various scenarios of grid reliability levels and renewable energy production rates, as well as costs of grid development, construction, operation and improvement. We recommend utilizing one single model for the Israeli energy sector, to be used by all parties involved: The Israel Electric Corporation, private manufacturers, system administrator, The Electricity Authority, and The Ministry of Energy.
- Assess the overall economic implications of setting a 30% goal for renewable energy production rate (grid-related risks and costs of supply shortage, land costs, regulatory

risks, technological risks, pollutant emission reduction) in regards to energy security,[12] and calculate the price of electricity while considering the trade-off between the energy sector goals: reduced pollutant emission due to increased share of renewable energy sources in the fuel mix on the one hand; the cost of supply shortage caused by lack of grid reliability, and insufficient investment in infrastructure and production plants, on the other. We would like to point out that, according to past experience in EU countries, increasing the share of electricity produced from variable renewable sources (solar and wind) by 23 percentage points, from 7% to 30%, corresponds with raising the stated reserve ratio by some 60-95 percentage points at least, matched with a similarly substantial increase in installed generation capacity.[13]

- Set agreed goals for 2030 in terms of grid reliability and share of renewable energy sources, by choosing an optimal investment alternative for attainment of the three goals for the energy sector.
- Determine agreed, transparent metrics which would inform a continuous policy aiming to achieve goals and to monitor the operation of the energy sector.
- Enact regulation which supports attainment of measurable goals and ensures governance, transparency and effective operation of the electricity sector.
- Appoint an objective oversight apparatus which comprises periodical, transparent publication of metrics.
- Establish incentive mechanisms which would encourage electricity producers to meet their ascribed goals.

[12] A similar recommendation is included in the materials published by The Planning, Development, and Technology Division of the Israel Electric Corporation, as appended to the paper "Increased Goals of Renewable Energy Production Rates for 2030" (IEC, 2020), page 4, bullet point 3: there is a need for "examination of the additional costs and the reduction in pollutant emissions due to increasing the goal of renewable energy production rate from 17% to 30% in each one of the alternatives to be assessed". In particular, since the four alternatives for expanding renewable production rate to 30% which were examined by the IEC (page 1) are as follows:
1. reference alternative – does not incorporate storage devices in the development plan;
2. a relatively high-cost scenario which incorporates battery-based storage devices;
3. battery-based storage devices incorporated according to a set of assumptions put forward by the Electricity Authority (assuming, among other things, a relatively low cost of devices);
4. Similar to the second alternative, with the addition of pumped-storage devices.
The first development alternative is the only one which has been examined in full, including dynamic balance assessment of the production and gas transmission systems.

[13] It should be noted that each country has its own unique climate. Therefore, each country has different capacity to accurately predict the exact production hours of variable renewable power plants. Accordingly, each country requires a different reserve ratio to back up the generation capacity of variable renewable power plants. Hence it is also difficult to find benchmark countries which can be used as reference points for determining the target reserve ratio.