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Planning and Decision Making

Policy Paper
Improving the National Energy System in Israel

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Title

The current Energy System in Israel (the Israeli Energy grid) lacks efficiency, is not environmentally effective and is not resilient enough to catastrophic events, both natural or man made.

Preface

The state of Israel needs to improve the efficiency and reliability of its Energy grid (production, transportation and distribution), make it less polluting and more resilient to external threats. The current situation is not only causing the national energy grid to fall behind in terms of cost of production, efficiency, and reliability but is also allowing the state system to lag in the development of the new technologies, mostly related to the so-called green economy. Improving the Energy system in Israel will provide:

- better public health by reducing pollution and its related illnesses;
- an increased number of jobs, all related to new technologies;
- a strengthened national security, with a more resilient energy grid;
- a stronger state economy, reducing the overall cost for energy.

Main characteristics of the problem

Many nations around the globe, like for example the US Government and the European Union, have developed policies to improve their national energy systems, mostly by promoting the implementation of Renewable Energies including micro-generation and smart grid initiatives. While the momentum is still building, Israel needs to develop a policy to improve the efficiency of its energy production and distribution system. Such a policy will guarantee longterm profits for the private sector, a more efficient, more secure, cost-effective, reliable, national energy grid, and finally, a cleaner environment. A timely and rightful intervention will stimulate the strong Israeli private sector to achieve a steady momentum of growth in technical skills and manufacturing infrastructures.

Planned steps

This paper will define the problem, explaining how government's and market's failures have brought to lack of success at improving the energy grid, then will identify and analyze the alternatives and recommendations that will be proposed as solutions.

Goals to achieve

A bill that will allow the Israeli Energy Grid to become more efficient should be set. The bill would include provisions for grid modernization, smart grid demonstration and implementation, including the latest relevant solutions, both private and commercial, and integration with the developing evolution of electric vehicles. The driving principle is to achieve a sustainable energy future based on policy advocacy activities and the development of a more efficient energy marketplace in order to guarantee a sustainable energy future and offer vast business opportunities, while at the same time increasing national security. A variety of socio-economic benefits are expected, including business and employment creation, a more secure energy supply, technology exports, decentralization of energy distribution, and efficient use of natural resources.

The new energy system should be: Resilient, Cost Efficient, Environmental Sustainable, Stimulating for the Economy, and Socially Acceptable.

Market's failures

The energy grid failed to develop and became inefficient due to failures in the Israeli energy market. Market failures can be defined as deviations from perfect markets due to some element of the functioning of the market structure. A key result for analysis of energy systems is that the decisions of a perfect, decentralized market would lead to an economically efficient use of both non-renewable and renewable resources at any given time.

The most important market failure is that the energy market in Israel is a natural monopoly and this in turn has led to the government failure of a highly centralized energy system, strengthening the failure of public bureaucracy.

Other kind of typical market failures characteristics can be identified, as for example, information failures. Information market failures relate most directly to the adoption of distributed generation renewable energy by households, such as rooftop solar photovoltaic systems or micro-generation wind turbines. If households have limited information about the effectiveness and benefits of distributed generation renewable energy, an information market failure occurs. In a perfect market, firms would undertake marketing campaigns to inform potential customers in order to maximize profits. However, for new technologies that are just beginning to diffuse into the market, information plays a decisive role. Imperfect forecasts by either firms or consumers lead to an inability to predict future conditions accurately, which may then lead to underestimate or overestimate how energy prices may rise in the future and therefore bring consumers and firms to make wrong decisions on commitments and investments.

Even with perfect information though, the individual choices would still be driven by the single's advantages at the expenses of the totality of the individuals seen as a community (Tragedy of the Commons). Let's take for example the choice of a family to install on the roof of their house a system for production of electricity through photovoltaic (PV) panels. If we assume that the national grid would be ready to manage, meaning to be smart-grid ready, the individual solar rooftop systems, still the individual families will have to endure the costs of procurement and installation (contribution/collaboration to public good). On the other hand the individuals might still gain the community benefits (cleaner air, more secure grid, etc…) without contributing, and actually might maximize their benefits acting in this selfish way (free-riding).

The situation is a clear public goods problem can be analyzed through a typical Prisoners' Dilemma chart.

Let's assume that we have the single player (individual or family) versus all the rest (collection of other individuals or families) and a decision if collaborating (buying and installing the PV system) or not must be made.

If we assume:

b = benefit gained by others collaborating

ε = benefit from individual collaboration (normally very small compared to C)

C = cost of collaboration

It can be seen that:

- the Nash Equilibrium sits where neither the individual nor all the others collaborate (0 >-C and b >b-C);

		ALL OTHERS	
		COOP	NON-COOP
INDIVIDUAL	COOP	$b + \varepsilon - C$	$\varepsilon - C$
	NON-COOP	b	0

- the Pareto's Optimum sits where both the individual and the whole community collaborate if b >C;
- the Pareto's Optimum sits where neither the individual nor the whole community collaborate if b < C.

In order to move the Nash Equilibrium either incentives for individuals installing the system or disincentives for individuals not installing will have to be introduced, or a combination of both.

<u>Government's failures</u>

The majority of the failures that has led to a scarce modernization of the national energy system in Israel stems from Government's failures, mostly in the field of regulatory failures. Then, as already mentioned in the market's failures paragraph, the fact that energy in Israel is a natural monopoly has also led to the government failure of a highly centralized energy system, strengthening the failure of public bureaucracy.

The following figure (Figure 1) shows an example of the interactions between Interest Groups, Bureaucrats, and Politicians and the related failures:

- lack of Direct Regulation and government sponsored R&D in the sector of new types of Energy, where representative democracy failed to implement actions that would improve social welfare (politicians-interest groups);
- lack of tax incentives and/or subsidies, where public bureaucracy worked to maintain its privilege position dictated by the management of tax derived public funds/budget (bureaucrats-politicians);
- lack of information programs and definition of product standards, where converging interests by both the elected officials and bureaucrats led to mis/non-information to the public on new alternatives advantages/benefits (bureaucrats-politicians and interest groups);
- Interest Groups focused in maintaining the status quo and pushing politicians in not changing the regulatory framework (politicians-interest groups).

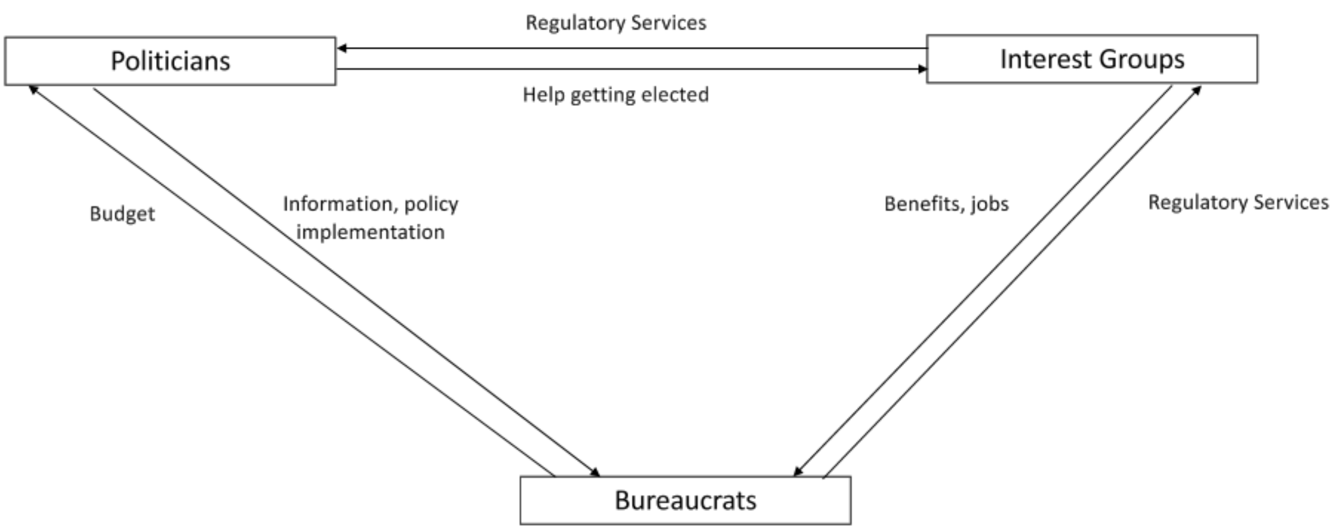
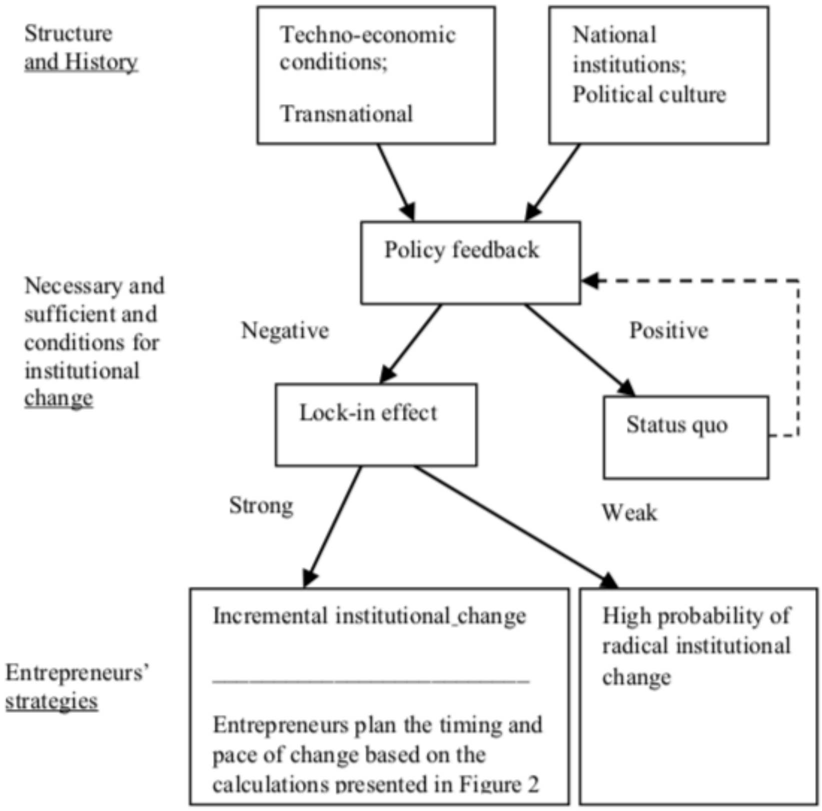


Figure 1

Barriers

The public is relatively passive meaning that Policy feedbacks are positive (Figure 2), or at the very least not completely negative, and this has led to a very rigid system in which change has become extremely difficult because politicians have little incentives to alter the *status quo*.

Figure 2



Given what has been presented so far, the main barriers to implementing a Policy/Bill with the aim to significantly increase the Energy system efficiency in Israel today appear to be:

- no political party is willing to accept the price of reduced public support by implementing legislation that would increase public spending (at least during the development and transition phases) in the short term;
- political parties will not accept to lose support by private companies currently employing fossil fuels to provide energy to Israel;
- bureaucrats in public offices will resist the proposal of tax reductions/subsidies, which will decrease their power to influence the political actors, to support new investments in new Energy technologies;

- political parties and public officials both resist the diffusion of proper information, mainly about longterm cost/environmental benefits, about new energy technology implementation in order to maintain the *status quo*;
- the public is relatively passive making policy feedback positive;
- mostly due to positive policy feedback, politicians have no incentive to change the *status quo*.

Policy Strategy/Instruments

What has been illustrated in the previous paragraphs has shown how the policy of energy in Israel has failed to recognize changes in technology, possible threats, and environmental sensitiveness, resulting in a vulnerable and inefficient system.
The causes of this effect are multiple and, again as shown above, mostly due to barriers deriving from conflicts between the commercial/influence dividends of the Interest Groups, the electoral interests of the Politicians, the structure of the bureaucratic system and the social culture of the Citizens/Public. Given the complexity of these barriers, the specificity and technicality of a nationwide energy system, and its importance for basic security needs, it is possible to assume that a strong intervention on the Public might be the one presenting the best chances for a new policy to be put into practice. In fact, Israel is probably the country in the world were the public opinion is most sensible to national security and protection from external threats. Finally, it should be noted that today there are not a great number of possible solutions to be implemented in a national energy system due to the current limitations in technology, natural resources, and to the peculiar geography of the country.

Three basic policy options will be analyzed:

- Maintaining the *status quo*, keeping the energy system basically as it is;
- The use of nuclear power to generate electricity;
- The use of Renewables Energy coupled with ample modern storage systems, such as batteries.

Practical analysis of the alternatives

The three main alternatives are analyzed (Table 1) by assigning to them values based on their capability to achieve five Public Goals: System Resilience, Cost, Environment, Economy Boost, and Public Acceptance. These five goals are further subdivided into 10 Criteria to better specify them and evaluate their potential. Values ranging from 10 to 50 points are assigned to each criteria, with 10 representing the score for "least capable" and 50 the score for "most capable" to achieve the goal.
To each goal, and consequently to each criteria, a specific individual weight (altogether adding up to a total of 1.0) is assigned with reference to its relevance toward the previously identified barriers, in order to establish how likely the criteria will affect them and with the final aim of choosing the most beneficial and effectively adoptable policy. Finally, a sum of the weighted scores is produced for each alternative with the highest indicating the most adhering to the identified goals.
Taking into consideration the already mentioned peculiarities of the Israeli society, with its strong sensitivity toward national security, the highest weight (0.3) is assigned to both the goals of System Resilience and Public Acceptance, while the lower weights are assigned to the goals of Cost (0.2), Environment (0.1) and Economy Boost (0.1).

Goal 1 - System Resilience (total weight of 0.3).

Criterion 1 (weight 0.2): ability for the energy system to sustain and recover from catastrophic events, both man-made (terror attacks, war, etc.) or natural (flooding, tsunami, earthquakes, etc.). A score of 20 is assigned to the *status quo* alternative because of a relative minimal capacity to sustain attacks, given the structure of the energy grid, the number of energy power plants, and the diversification of fuel sources. The minimum score of 10 is assigned to the nuclear option because nuclear power plants are extremely vulnerable to attacks/catastrophes with heavy secondary effects, such as radiation related ones, to be added to the unavailability of energy production. The maximum score of 50 is assigned to Renewables energy because of the great number of small, decentralized energy production centers that characterize this kind of energy grids, making them particularly resistant to disruptive events.

Criterion 2 (weight 0.05): independence from global fuel supply. The maximum score of 50 is assigned to the Renewables option because of the virtually complete independence from external energy sources, an intermediate score of 30 is given to the nuclear alternative for the long duration of the nuclear fuel once acquired, and a medium-low score of 20 is allocated to the *status quo* option for its partial dependance from non-national sources.

Criterion 3 (weight 0.05): capability to employ the system for military purposes. The Renewable Energy option's intrinsic modularity makes it ideal for secondary military uses, and therefore is assigned a score of 50. The minimum score of 10 is given to the Nuclear option and 25 to maintaining the *status quo*.

Goal 2 - Cost (total weight of 0.2).

Criterion 1 (weight 0.1): non-recurring costs to implement the alternative. It is self evident that no “initial” cost is needed to maintain the *status quo* (score of 50) while a certain amount of investment would be required to implement renewables (score of 20) and a very significant one would be necessary for eventually building nuclear power plants and the relative infrastructure (score of 10).

Criterion 2 (weight 0.1): recurring costs to run the alternative. If the costs to manage the energy production with the three different alternatives are compared it can be observed that the renewables option is the cheapest one, basically not requiring any specific energy source other than sun and wind and needing only recurrent maintenance (score of 50). The nuclear option running costs (score of 35) are expected to be higher than the renewables but lower that the *status quo* (score of 25) which mostly makes use of fossil fuels, because once the energy source material is acquired than it can last for a very long period of time.

Goal 3 - Environment (total weight of 0.1).

Criterion 1 (weight 0.1): capability to minimize CO2 emissions. Renewables have a clear advantage, but today it is still not fully clear how the production and disposal of the batteries used for energy storage, affect the CO2 cycle, therefore a score of 40 is assigned. The Nuclear option is as well a favorable one from the CO2 emissions point of view, if the problem of disposal of nuclear waste is disregarded, and also a score of 40 is given. The legacy systems employed in the *status quo* make extensive use of fossil fuels and hence the score of 25 is assigned to the criterion for this alternative.

Goal 4 - Economy Boost (total weight of 0.1).

Criterion 1 (weight of 0.05): capacity to stimulate new jobs. The nature of Israel as the "Startup Nation" is that of being extremely flexible and responsive to adapt to new jobs requests and a score of 40 is given to the option of Renewable Energy because its connected technologies are in a very active state of development and this will most likely bring new jobs. Lower scores of 30 and 25 are assigned to Nuclear and maintaining the *status quo* respectively.

Criterion 2 (weight of 0.05): potential to develop new technologies. The same considerations illustrated above for the previous criterion apply for this one and the same relative scores of 40, 30, and 25 are hence assigned.

Goal 5 - Public Acceptance (total weight of 0.3).

Criterion 1 (weight of 0.2): Public understanding of increased national Security. This criterion is one of the most important ones because it measures the capability for the policy to inspire an actual change and break the positive feedback. Israel has a great understanding of National Security coming from a long history of having to confront many regional threats. While it would be difficult for the Public to fully understand the economic and environmental advantages, it is safe to assume that a more secure energy system would be immediately perceived as vitally important, *de facto* overriding any other consideration. The maximum score of 50 is assigned to the option of Renewable Energy because of the already explained characteristics related to resilience and improved national security, the minimum score of 10 to the Nuclear alternative for its high vulnerability and the intermediate score of 25 to the *status quo*.

Criterion 2 (weight of 0.1): Public understanding of advantages other than National Security, such as environmental and economic ones. The public is less capable to understand why a *status quo* should be changed for only economical/environmental reasons, as previously discussed in the Market's Failures paragraph. The maximum relative score of 40 is hence assigned to the *status quo*, the minimum relative score of 15 to the Nuclear option and the intermediate score of 30 to Renewables.

GOALS (Weight)	**CRITERIA** (Weight)	**POLICY ALTERNATIVES** Value - (Weighted Value)		
		STATUS QUO	**NUCLEAR**	**RE+STORAGE**
System resilience (0.3)	Resistance to catastrophic events (0.2)	**20 - (4.0)**	**10 - (2.0)**	**50 - (10.0)**
	Independence from global fuel supply (0.05)	**20 - (1.0)**	**30 - (1.5)**	**50 - (2.5)**
	Deployability/ Military Use (0.05)	**25 - (1.25)**	**10 - (0.5)**	**50 - (2.5)**
Cost (0.2)	To implement (0.1)	**50 - (5.0)**	**10 - (1.0)**	**20 - (2.0)**
	To run (0.1)	**25 - (2.5)**	**35 - (3.5)**	**50 - (5.0)**
Environment (0.1)	CO2 Impact (0.1)	**25 - (2.5)**	**40 - (4.0)**	**40 - (4.0)**
Economy Boost (0.1)	New Jobs (0.05)	**25 - (1.25)**	**30 - (1.5)**	**40 - (2.0)**
	New Tech Development (0.05)	**25 - (1.25)**	**30 - (1.5)**	**40 - (2.0)**
Public Acceptability (0.3)	Public Understanding of Increased Security (0.2)	**25 - (5.0)**	**10 - (2.0)**	**50 - (10.0)**
	Public Understanding of other advantages (0.1)	**40 - (4.0)**	**15 - (1.5)**	**30 - (3.0)**
WEIGHTED SUM (1.0)	**(1.0)**	**(27.75)**	**(19.0)**	**(43.0)**

Table 1 - Analysis of the Alternatives

Table 1 shows the full count of the scores and the final weighted sum revealing how the Renewable Energy alternative appears to be, by far, the most adherent to the identified goals with a weighted score of 43.0 as compared to 27.75 for maintaining the *status quo* and 19.0 for the nuclear one. The advantages of the third option are effectively overwhelming and it is also safe to assume that, again because of the peculiar situation of Israel, all deciding actors, like Politicians, Interest Groups and Bureaucrats, will likely be willing to set aside some of their personal or category advantages for the good of the nation.

Lastly, it must be noted that the Nuclear option would bring along a very complex set of geopolitical consequences, regarding nuclear power and the Middle East, that are not analyzed in this paper but that today would make this alternative an extremely improbable one.

Renewable Energy as the solution to the problem

Powered by inexhaustible sources of domestic fuel, renewable energy can provide a vital contribution to a nation's security. Renewable energy generators do not rely on fuel supply chains that can be disrupted intentionally or by natural events and normally do not pose a risk of dangerous leaks or explosions that threaten human health and public safety. Renewable energy generation facilities can be constructed within a short timeframe and, by being dispersed throughout different regions, they are less vulnerable to acts of terrorism and/or war.

Finally, renewable energy generators, combined with advanced grid management technologies, increase the reliability and resilience of the entire electrical grid during high-impact events. In cases where continuity of power supply is vital for national defense operations, renewable power can be coupled with modern energy storage technologies to form highly efficient self-sustaining micro-grids.

The most pervasive forms of renewable energy generation, wind turbines and solar photovoltaic (PV) panels (especially when coupled with decentralized energy storage systems), have intrinsic characteristics that make them uniquely capable of withstanding many of the above threats, making them particularly valuable from a national security perspective:

- Independence from Global Fuel Supply. Renewable energy sources are not dependent on global marketplaces and transport systems that can be vulnerable to volatile price spikes or unexpected changes to fuel availability due to geo-political events.
- Virtually Inexhaustible Fuel**.** Renewable electricity relies on sources of fuel that are naturally occurring, free and self-replenishing such as sunlight, wind, the earth's heat or the kinetic energy of a flowing river. While some of these fuel sources can vary temporally, they are normally steady over annual periods. Advanced modeling can accurately predict their availability. Storage systems and smart grid technologies can help flatten the supply/demand curves over time.
- Smaller, Decentralized Power Generation**.** Large centralized power facilities are an important national security vulnerability. Renewable energy can be economically deployed in much smaller units. Rooftop solar, for example, can be installed on homes and commercial buildings where it is either consumed or feeds back into

the grid. Utility-scale wind and solar can be economically built in electrical capacities varying from one megawatt (MW) to over a gigawatt (GW).[1][2][3]

- Resources Available practically Everywhere. Almost every region of the nation has the potential to harvest substantial wind and solar energy.
- Rapidly Deployable. Renewable energy can be built and deployed far more quickly than traditional fossil or nuclear generation. From initial siting and analysis to electricity production, large utility-scale wind or solar farms (over 250 MW) are typically constructed and brought online within one to three years.[4] Coal and nuclear generation, on the other hand, usually take many years to construct, sometimes more than a decade. A 500 kilowatt (kW) rooftop solar project with storage can be completed in just a few months.[5]
- Affordable. Renewable energy plus storage is already cheaper than building new conventional generation plant in some part of the world.[6] The exponential improvement in technologies, and its related continuous price drops coupled with increased efficiency, will eventually make the choice of renewables the only economically viable one.[7]

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[1] https://www.utilitydive.com/news/an-offer-utilities-cant-refuse-the-low-cost-of-utility-scale-solar/529373/ dated 9 Aug 2018

[2] https://www.resourcesmag.org/common-resources/what-are-costs-and-values-wind-and-solar-power-how-are-they-changing/ dated 10 Aug 2019

[3] https://www.forbes.com/sites/jamesellsmoor/2019/06/15/renewable-energy-is-now-the-cheapest-option-even-without-subsidies/#18af33775a6b dated 15 June 2019

[4] Development Timeline for Utility-Scale Solar Power Plant, Solar Energy Industries Association. https://www.seia.org/research-resources/development-timeline-utility-scale-solar-power-plant

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