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Executive Summary

Expanding Solar Energy Production on Residential Buildings

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The Program awards annual fellowships to outstanding Israeli graduate students. We train and deploy some of Israel's best and brightest young professionals to create pragmatic financing and economic policy solutions.. Our applied research and Financial Innovations Labs® are a launching pad for transformative change, using innovative financing mechanisms, programs and policies to bridge social, regional, economic and productivity gaps within Israel and between Israel and the world.
In addition, Fellows craft their own projects during their internship aimed at barriers to job creation and capital formation in Israel. The Fellows' research, carried out under the guidance of an experienced academic and professional staff, support business and policy makers to shape economic reality in Israel. The program offers the ultimate training opportunity, combining real-life work experience with applied research.

Throughout the year, Fellows receive intensive training in economic and financial analysis, public policy and research methods. They acquire tools for communication and presentation, policy analysis, leadership and project management. The fellows participate in a weekly research training workshop where they work with senior economic and government professionals, business leaders, and top academic and financial practitioners from Israel and abroad. They also participate in an accredited MBA course, taught at the Hebrew University School of Business Administration by Prof. Glenn Yago.

Fellows Program alumni can be found in senior positions in the public and private sectors. Some serve in key positions in government ministries while others work at private-sector companies or go on to advanced graduates studies at leading universities in Israel, the United States and Great Britain.

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In the context of the global efforts to combat climate change, expanding electricity generation from renewables is no longer a privilege, but rather a necessity. This subject has been reinforced by the historic agreement that was signed at the 2015 United Nations Climate Change Conference (COP 21) in Paris, as well as by Israel's national strategy to reduce greenhouse gas emissions to 81 million tCO2e in 2030, a 25% per capita reduction from the 2005 GHG emissions level of 10.2 tCO2e per capita.

An integral part of Israel's greenhouse reduction goals is photovoltaic (PV) technology, as it constitutes the most popular alternative electricity production technology in Israel today, and may continue to be the leading technology in the transition to renewable energy production in the coming decades. This would follow the shift in the U. S. and Europe to increase the majority of new electrical production capacity through renewable energy.

Despite its popularity, however, the volume of production of photovoltaic energy in Israel today is not only quite low relative to other developed countries, but is also mostly limited to ground-based facilities. In light of that gap, this research focuses on photovoltaic facilities installed on rooftops. Photovoltaic on rooftops have a number of advantages to ground-based facilities, including: preventing encroachment onto nature reserves, reducing transmission costs, and create a more redundant network.[1] Moreover, most buildings in Israel are residential buildings, with huge roof space potential for installation of the systems. Finally, expanding (or shifting) the installation market to residential rooftops will decentralize the benefits across a large number of individuals, and thus will create a more equitable market.

There are also a number of barriers to the expansion of installations of photovoltaic systems on residential buildings roofs, including: limited roof space necessary also for other uses, conservative planning and building design that discourages the use of the roof for the purposes of energy production, changes in electricity prices that affect the level of profitability of the project, tenants' concerns, and lack of cheap storage solutions. Yet while these barriers are difficult to address, there are two more significant challenges in which policy intervention can have an important impact: (a) regulation and (b) multiple owners of the roof.

(a) **Regulation Barriers** - current regulation allows for the establishment of photovoltaic facilities for personal use only. In other words, one cannot benefit from a solar system that is not connected to his own electricity meter. This restriction prevents the possibility of

[1] A redundant network allows for electricity to be produced in many small-scale facilities, rather than through a large, concentrated power generation facility, which allows for risk diversification and creates a network which is more robust to malfunctions and unexpected incidents.

dividing the benefits among the tenants, and in practice means that solar energy can only be used for the common energy needs of the building.

(b) **Multiple owners** – in multi-family houses, the roof is jointly owned by all tenants. Therefore, in order to promote the establishment of a joint photovoltaic system on the roof, agreement and cooperation are required from all residents of the building. This may lead to a "blackmailer tenant" problem and to difficulties of coordination and organization of all tenants towards this common goal.

In light of these barriers, this research compared five different models for constructing a photovoltaic facility on residential roofs. Each model is categorized by the entity that initiates the installation of the system, the extent to which the model matches the current regulation in Israel, as well as their advantages and disadvantages relative to other models.

Model name	**Explanation**	**Matches the current regulatory environment?**	**Advantages of the model**	**Disadvantages of the model**
The public housing model	Establishes facilities on the public housing assets that will be managed by the government housing companies. The benefits will be used for the maintenance of the buildings.	Yes	Experience of public housing companies with asset management All the benefits are channeled to public goals.	Scalability problem due to companies' electricity consumption capacity.
The municipal model	Establishes facilities on multi-family houses in the city, managed by the local authority. Benefits will be used	Yes	Management by a publicly-oriented organization. All the	May enhance inequality by improving assets of strong populations. Municipalities

	for the maintenance of the buildings.		benefits are channeled to public goals.	do not have experience with asset management.
The tenants' association ("Va'ad HaBait") model	The solar facility will be erected by the tenants via the Vaad Bait. Benefits will be used as a fund for common needs (lightning, cleaning, gardening etc.)	Likely matches	Simplicity – no interaction with other stakeholders	No precedent in the current regulation. Electricity tariff structure lowers accrual of benefits for Va'ad Bait.
The cooperative / Partnership model	The tenants will be bundled as partners in a corporation for electricity production. The corporation will charge the tenants a fee and will pay for their private electricity bills.	Likely matches	Strong incentive for the tenants – lowering private electricity bills through corporation's savings.	Convoluted bureaucracy. Requires active management by the tenants.
Shared economy model	Creates a market for the benefits of the solar facilities, where tenants with no access to the roof will be able to buy solar rights directly from other tenants that have a solar facility on their roof.	No	Creates a market for roof area, and optimizes the resource allocation process.	Requires changes in current regulation. Requires supporting technology development.

Taking into account the external benefits through distributed local power generation, governments have a significant interest in promoting installation of photovoltaic systems in residential buildings. Governments also have the necessary tools to do so – both by creating economic incentives and appropriate regulation, and also by initiating projects and increasing demand as a key player in the economy. This research recommends effective interventions of this sort to promote this issue by the government in the short term and in the medium-long term, including:

- **Short-term**
    - Regulatory adjustments - changing "net-metering" regulation to allow for the balancing of electricity production not only with the consumer that owns the photovoltaic system, but also with another legal entity – other tenants, the tenants' association (Va'ad Bayit), etc. This will enable easier distribution of benefits for the residents in multi-family houses, and will create a market for virtual net-metering, both of which will allow for increased access for consumers to produce electricity and to trade revenues from the photovoltaic systems.
    - Promoting projects on public buildings initiated by the government – many real estate assets owned by and/or managed by the state can be used to promote pioneer projects of photovoltaic systems installation. Projects on the roofs of public housing properties, student dormitories, nursing homes and more. These projects can be used as proof-of-concept in order to develop the market and illustrate feasibility, which will remove concerns and uncertainty prevailing among consumers and others thinking about implementing PV technologies.
- **Medium/Long-term**
    - Tax benefits – External benefits that stem from the rooftop solar systems, such as reduction transmission costs and redundancy, are not being taken into account today in the production costs of PV implementation and operation. Therefore, it is justified to subsidize facilities being built on the roofs by giving tax benefits that will internalize these benefits. Providing a tax benefit will increase the profitability of these projects and will increase the number of multi-family houses that establish common photovoltaic systems.
    - Revolving fund – an effective and simple tool for which the government would only incur a one-time expenditure in order to establish a revolving *budget* fund or a revolving *loan* fund. Using the primary budget, the government can create a photovoltaic facility that will grow annually by either directing the benefits of the

system towards the installation of additional financing facilities held by the government, or by using the benefits as loans to private investors to install more rooftop facilities. In the case of revolving budget fund, the primary facility and the facilities to be added can be built on properties of a large public entity such as a local authority, public housing companies or government agency that possess many physical properties. In the case of revolving loan fund, the use of a limited guarantee could leverage other private and philanthropic funds and expand the capacity of the revolving loan fund.

- Informational - In view of the need for the tenants' agreement, removing concerns and increasing demand "bottom-up" requires advocacy activities that will give the public information about the benefits of installing photovoltaic facilities in multi-family houses and on how to perform such a project.

The research estimates that implementing the full range of policy measures described would reduce Israel's CO2 emissions by about 1 million tons annually or about 4% of the country's CO2 emissions reduction. Moreover, the impact on the profitability of the residential PV installation market will likely translate into the expansion of the PV market in Israel as a whole.

As can be seen in mature green building markets, buildings that not only consume energy but also generate energy will become the new standard of the building sector in the near future. Making this conceptual change in the near-term will allow Israel to both achieve its strategic environmental goals and ensure the country's sustainable growth of this sector.

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