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The Path Toward Low Carbon Energy Systems in Israel: Regional Cooperation for Mitigation of and Adaption to the Effects of Climate Change

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Abstract

Israel is already experiencing debilitating climate change impacts with frequent extreme weather events. However, its climate change mitigation and adaptation plans are lagging, followed by unambitious emission reduction targets and the lack of sufficient supporting policies. The projected increase in electricity demand due to massive electrification of the transportation and industrial sectors, and for seawater desalination capacity, requires Israel to rethink its fuel mix, which currently relies mainly on fossil fuels. Since the electricity sector is the country's main emitter of greenhouse gases, a transition to low-carbon energy systems is necessary. In this paper, we review the current state of the electricity grid in Israel and the barriers it faces to integrate electricity from renewables production. Considering that Israel is an energy island, one of the densest populated countries in the world and has limited access to land resources, we see a necessity to engage in regional cooperation on energy and water security challenges in the face of the climate crisis. Being aware of the political challenges in Israel and its neighbor countries, unofficial diplomatic channels (Track II) can provide a platform for developing practical cross-border strategies to facilitate formal and informal agreements addressing water- and energy security in light of climate change between Israel, Palestine, and Jordan.

Introduction

Although some might argue that due to its size and types of industries, Israel's share of total carbon emissions is negligible, Israel is already experiencing debilitating climate change impacts: rising minimum and maximum temperatures, decreases in precipitation, sea-level rise, and more frequent extreme weather events, including prolonged droughts and floods *(The State Comptroller and Ombudsman of Israel, 2021)*. Therefore, Israel must formulate practical climate adaptation tools and policies while contributing to the world's mitigation efforts to transition to a low-carbon society.

During COP26 in Glasgow, former Prime Minister Naftali Bennet declared Israel would offset its emissions by 2050. The Glasgow agreements determined that all countries, including Israel, are required to review and update their targets for reducing greenhouse gas emissions for 2030 within a year to be consistent with the global need for a 45-50% reduction in greenhouse gas emissions (GHG). Approximately 55% of Israel's GHG emissions are associated with electricity production, more than transportation, industry, and agriculture combined *(Israel, 2020*). The massive entry of electric vehicles, the electrification of public transportation systems (Israel Railways, light rail, metro, and buses), various industrial sectors, potable water generation through seawater desalination, and others, will increase the demand for electricity at a rate of about 3.5% per year. The practical meaning is that Israel must end its dependence on fossil fuels and set operative actions to promote an electricity market based on renewable energy and storage.

To meet the declarations made in Glasgow and accordingly to update the emission reduction targets, Israel needs to increase its renewable production capacity to 40% by 2030 (and not 30% as planned) of which more than 80% are to be derived from solar energy by 2050. Transitioning to a decarbonized energy system involves implementation challenges related to land availability, power grid capacity, and power grid stability. These challenges can be overcome through decentralization and regional cooperation. Cross-border energy trade can expand the use of renewable energy and provide environmental, political, and economic benefits while increasing mutual energy security and mitigating climate change.

Challenges of Developing the Renewable Energy Sector in Israel

In ratifying the Paris agreement, the Israeli government set national targets for reducing emissions by 2030. This may be achieved through the setting of specific sectoral goals: a 17% reduction in electricity consumption, an increase in electricity generated from renewable sources to 30% (with a 10% milestone by 2020) *(Ministry of Energy, 2018)*, and a 20% reduction in the use of private vehicle transport. In addition, coal-based generation will be phased out by 2030, and the transport sector will shift to electricity and natural gas (*Proaktor et al., 2016)*.

Nonetheless, no decline in electricity consumption or private transportation has been recorded in recent years. The Israeli electricity fuel mix today includes 69% natural gas, 23% coal, and only 8% renewables *(The Electricity Authority, 2021*), while Israel is increasing its dependency on natural gas. The pledge to reduce emissions amounts to 10.4 to 7.7 million tons of CO2e per capita by 2030. However, due to Israel's high birth rate, the envisioned per capita reductions will likely be compensated by population growth. Thus, Israel is not expected to reduce its overall emissions in the near future.

Several factors may explain Israel's unambitious emission reduction targets and the lack of sufficient supporting policies. The revenues from the discovered natural gas deposits and the taxes on transport fuel are significant contributors to the national budget—a contribution that renewable energy cannot easily replace. Israel's shortage of land makes land-intensive renewable technologies less favored by planners and some environmental NGOs; complex and lengthy planning procedures slow the construction process of any new energy infrastructure, including photovoltaic solar facilities and wind turbines. Finally, years of low investments in upgrading the transmission lines have led to insufficient transmission capacity. This makes it hard if not even impossible in some cases, to connect renewable electricity generation sites with the main consumers. The former are likely to be located mainly in Israel's southern peripheral regions, while the areas of high population density and high demand are located primarily in the center of the country *(Zohar et al., 2021).*

Israel needs to add 23 gigawatts (GW) of new capacity to be installed in less than a decade (currently, only 3.2 gigawatts are installed) and, by 2050, to establish a total of 109 GW, most of it in photovoltaic systems. However, this will require about 900,000 dunams (900 km²) of available land, which Israel does not have *(Bank of Israel, 2022).* A second scenario where the share of renewables is lower (around 50%) involves carbon capture and storage. However, as these technologies are not fully developed, their efficacy is currently in doubt (International Energy Agency *(IEA), 2021*).

A high share (over 30%) of renewable energy in the fuel mix implies complex planning issues and environmental implications. Israel is one of the densest populated countries in the world and has the highest population growth rate among the OECD countries, accompanied by an intensive and extensive development. The degradation of the natural, forested, and agricultural areas in Israel, particularly the fragmentation of the open land, is among the highest in the world. The accelerated pace of industrial, commercial and residential infrastructure development directly destroyed habitats and damaged the ecological systems *(Ben-Moshe and Renan, 2022).* The changes in land use combined with climate change increase the frequency of fires and the extent of the burnt area. The rise in sea temperature is significantly higher than the world average, and the loss of forests and vegetated areas leads to decreased precipitation *(Ben-Moshe and Renan, 2022).* Thus, Israel needs to determine how to utilize optimally its resources in order to provide holistic solutions to its energy and water challenges.

Moving Towards a De-Centralized Low Carbon System

The larger the share of renewables in the energy mix, the greater the challenge to balance production and consumption while maintaining power grid stability. Although these are technological challenges shared by other countries seeking to increase electricity production from renewable energy, in Israel, the energy transmission challenge is the most urgent. The reluctance of the Israeli government to sponsor new technologies inhibits the advancement of proven innovative technologies, which require considerable financial support in the early deployment phases. The Government's share of investment in R&D is the lowest among OECD countries and was only 9% in 2019, with the share of climate and energy technologies in this support being very limited (*Israel Innovation Authority – Economics and Research Division, 2022*). This results in a bias against smaller renewable energy facilities in urban areas, such as rooftop solar installations on commercial and public buildings, in favor of large projects over open lands. Already today, about a third of the entrepreneurs who won tenders for the establishment of renewable energy facilities received a negative response to grid connection requests since additional electricity flow from new production sites in most regions of the country is currently impossible due to network congestion *(Gershon and Naama, 2022).*

Improving the transmission infrastructure to accommodate distributed renewable energy generation could take 5-15 years. This is likely to slow and even stop the pace of new installations and make Israel's goal of 30% renewable production by 2030 difficult to achieve. It will require innovative and creative thinking oriented towards dual land use, emphasizing the integration of renewable energy into the built environment. Previous work by the Ministry of Environmental Protection *(Ministry of Environmental Protection, 2022)* estimates the potential for installing solar systems on facades and roofs of buildings and over interchanges, parking lots, water reservoirs, agricultural land, greenhouses, and fishponds at 24 GW, providing 43% of Israel's electricity consumption by 2030.

Especially in an arid climate, the dual use of agricultural land is most promising. The synergistic effects of Agrivoltaics systems were found as a holistic solution for the Water-Energy-Food Nexus. Increased yield production is projected due to the reduction of the harmful effects of radiation, thus promoting food security. Slow evaporation under the shade may reduce water consumption and minimize financial losses due to otherwise increased irrigation during droughts. Dual use maintains a sequence of open land, thus benefiting the ecosystem, reducing dependency on fossil fuels and the need to install gas infrastructure, saving on transmission losses, and leveraging the economy by creating new jobs.

The transition to decentralized low-carbon systems deepens Israel's commitment to mitigating climate change and enables a more sustainable and resilient electricity market. In addition, it reduces risks such as security and cyber threats and natural disasters damaging the electricity system, thereby contributing to the reliability of the electricity supply.

The main challenge for developing these systems is the required long-term planning that is reliant on unknown variables. Realizing the potential of renewable energy production requires mainly solar installations on various kinds of buildings and landscapes that often require the cooperation of a variety of property owners. Each type of structure is subject to different regulations and statutes, creating additional barriers. Energy storage is another critical aspect of the equation. The commonly used lithium-ion batteries do not constitute a sustainable solution *(NATURE, 2021)*, while most of the other promising technologies are not yet at the stage of maturity for a utility-scale implementation. In terms of infrastructure, massive investments in software and hardware, communication, and distribution management systems are required beyond the extensive deployment and renewal of power lines at the national level *(Gershon and Naama, 2022).*

Regional Challenges and Opportunities

Another complex issue is the electrical interconnection between Israel and other countries. Interconnection between countries allows electricity to be imported in times of shortages and to export excess production. This is especially useful for Israel due to its solar production profile. Power trading via interconnection may increase the share of renewable energy in the fuel mix, by providing additional markets for surplus offtake. Thus far, Israel remains isolated from the rest of the Middle East region in terms of electricity interconnection and functions as an energy island. A minor malfunction can result in widespread electricity blackouts with severe consequences, affecting food supply, access to water and health services, and paralyzing industry and commerce. Additionally, the Palestinian territories of the West Bank and Gaza strip are also dependent on Israel's electricity supply *(Fischhendler et al., 2016)* and the stability of its operation.

Israel, Cyprus, and Greece are planning to construct a 1,500 km undersea electric cable that will interconnect the power grids of the three countries. While the Euro-Asia Interconnector will have a 2 GW capacity, the immediate opportunities for Israel are within the Middle East region through interconnecting with neighboring countries’ grids, boosting energy security in the region.

The Middle East and North African countries are at the highest risk of being affected by climate change. These regions are characterized by a semi-arid to arid climate and are recognized as regions with the lowest water availability per capita worldwide. Climatic stress creates an ever-tightening loop in which the lack of energy, water, and food sources exacerbates political instability. Climate change does not recognize political borders. Even if Israel succeeds in implementing adaptation efforts through an energy self-sufficiency strategy, advanced agriculture and farming methods, and water technologies, it is unlikely that Israel would be able to entirely insulate itself from the spillover effects of climate change-driven crises in neighboring countries.

Thus, Israel has a vital national interest in promoting regional cooperation around energy and water issues, providing environmental, political, and economic benefits through increased mutual security. However, cooperation to manage climate-related threats becomes even more complex in the absence of official diplomatic initiatives. Unofficial diplomatic channels (Track II) and partially official (Track 1.5), have proposed collaboration options for Israel, Jordan, and the Palestinian Authority as the three attempt to address the Jordan Valley region’s water and energy security challenges *(Michael et al., 2021*).

Although Israel, as a pioneer in water technologies and desalination, considers itself prepared in the face of the water crisis, climate change and population growth will force the construction of more desalination facilities to meet water demand. While desalination capacity in Israel currently stands at about 585 million m3, forecasts predict an increase of this amount to 1,750 million cubic meters in 2050 *(Natanyahu, 2017).* Since Israel currently relies mainly on fossil fuels, transitioning to a low-carbon energy economy will require large areas for solar power generation in order to meet desalination's electricity requirements.

With a continuous flow of Syrian refugees, high population growth, and the drying of the groundwater and aquifers due to climate change and over-pumping, Jordan is at the limit of its water supply capacity. Although the establishment of a joint desalination facility in the south of Israel was proposed in the past, such an initiative has not been materialized yet for political reasons and the fear of mutual dependence on the part of both countries. Today, Israel provides Jordan with 50 million cubic meters each year according to the two countries' water annex in the 1994 Jordan-Israel peace agreement. Israel also supplies Jordan with natural gas from its offshore Mediterranean gas fields, providing an immediate alleviation of Jordan's chronic energy shortage *(Michael et al., 2021*).

Jordan possesses greater availability of open land for establishing additional renewable energy installations (solar and wind) at relatively lower prices compared to Israel *(Ragione, 2021)*. In 2021, renewable energy accounted for 26% of Jordan's energy production, diversifying its energy sources and reducing the dependence on imported fossil fuels. The regional environmental peacebuilding organization EcoPeace Middle East and the Konrad-Adenauer-Stiftung put forth the proposal for a “Blue-Green Deal” in which Israel would exchange desalinated water from the Mediterranean Sea for renewable energy from Jordan desert *(Bromberg et al., 2020).*

The Water-Energy Nexus (WEN) concept presents a regional approach to mitigating the effects of climate change and its negative consequences on regional stability and resilience. Israel and the Palestinian Authority (through Gaza) have access to the Mediterranean Sea. They, therefore, enjoy an ample source of seawater for desalination, while Jordan's only access to the sea is in Aqaba, which is relatively far from population centers and other places of high-water demand. An energy-water exchange will yield mutual benefit, in which Israel, along with the Palestinian Authority once a desalination plant in Gaza is constructed, will produce desalinated water and sell it to Jordan. In return, Jordan will produce renewable energy and sell it to Israel and the Palestinians.

The possibility of purchasing solar electricity from Jordan will make it possible to divert the sources of supply from Israel, increasing the reliability of the supply to the Palestinian territories. During the COP27 in Sharm El-Sheikh, Jordan and Israel signed a United States and United Arab Emirates-mediated agreement to implement ‘Project Prosperity’. The project has two components: Prosperity Green in which Jordan will construct a 600 MW solar farm complemented with energy storage to export to Israel; and Prosperity Blue in which Israel will export to Jordan 200 million cubic meters of desalinated water per annum *(Ministry of Energy and Infrastructure, 2022).* However, in Gaza, due to the lack of external funding and political issues, desalination facilities have not yet been built, thus it is currently not included in the energy-water exchange agreement.

The Palestinian water sector is under immense pressure. Here too, Gaza and the West Bank depend on Israel for part of their water supply. The inability to agree on a more equitable allocation of natural water shared by the Palestinians and Israel adds to the existing predicament. Moreover, the severe electricity and clean water shortage in Gaza creates an ongoing humanitarian crisis, disrupting the availability of essential services such as sanitation, hygiene, medical care, and food production.

In 2016, the Arava Institute for Environmental Studies launched one of the most comprehensive regional Track II initiatives, to enable key civil society organizations and individuals who represent both state and non-state actors to discuss, negotiate, and develop practical cross-border strategies to facilitate formal and informal environmental agreements between Israel, the Palestinian Territories and Jordan. This informal forum for environmental diplomacy implements practical projects in water, energy, sustainable agriculture, and public health. As such, at the peak of the COVID19 pandemic, Israeli and Palestinian members of the forum obtained approval for the transfer of a ground-breaking water production unit from Israel to Khan Yunis hospital in Gaza, providing high-quality drinking water powered by solar energy. It was the third unit of its kind to be transferred to Gaza with the support of WaterGen Technologies (https://www.watergen.com/). Other ongoing projects include treating and reusing wastewater in the West Bank.

Independent renewable energy production in the Palestinian territories could significantly reduce Palestinian dependence on Israel. Solar panels on rooftops will improve energy security in the Palestinian Territories, especially in Gaza, by reducing reliance on fossil fuels and electricity imports, most of which are delivered through poorly maintained lines. Financial investments can be focused on roofs of buildings that provide humanitarian needs such as health services and water supply, thus ensuring these essential services have access to continuous electricity supply.

The great challenge is the cooperation between the authorities across the three areas of the West Bank developed during the Oslo Peace Process. Most of the available land for large solar installations is in Area C, over half of which is under Israeli authority, and any development requires Israeli approval. Israel needs to look forward now and integrate the dimensions of climate change into its concept of national security. Adding production capacity in Area C will support meeting its 30% renewable energy commitment by 2030.

Conclusion

Diplomacy through informal channels has the power to open doors for regional cooperation, but most likely, the change will be local and on a small scale. Formal cooperation based on interdependence is essential to achieve the water, energy, and food security needed for the region. The Middle East lacks a regional mechanism to support countries' cooperation in preparing and implementing regional adaptation and mitigation plans. The need to increase regional environmental resilience, with Jordan, Israel, and the Palestinian Authority at its core, offers an opportunity to combine resources to support regional stability in the face of the foreseeable vulnerabilities to climate change.

While national adaptation and mitigation goals are essential, they may undermine the respective countries' efforts in the absence of a regional framework for tackling climate changes and their impacts. Such a regional cooperation framework must include capacity building and information exchange, coordinated regional financing, establishing a regional cooperation council on climate change, and enhancing public-private partnerships.

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