

# Carbon-free Electricity Supply in a Cournot Wholesale Market: Israel

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In the Rome Summit held in October 2021, the G20 countries reaffirmed their commitments of deep decarbonization. Achieving such commitments requires large-scale development of renewable resources like solar and wind that are carbon-free. An electric grid may accommodate high penetration of intermittent solar and wind generation via investments in flexible capacity and transmission. An important component of flexible capacity is energy storage, best exemplified by battery systems that can be readily deployed.

Responding to the overarching policy goal of deep decarbonization, numerous studies assess the optimal combination of intermittent renewable generation and energy storage. As most of these studies focus on the operational aspects of storage, we develop a two-stage model of a Cournot wholesale electricity market to answer a substantive research question: how may photovoltaic *cum* battery (PVB) become carbon-free electricity supply in Israel, a country endowed with abundant solar resource potential? This question's real-world and policy relevance is the pursuit of deep decarbonization and solar resource abundance in countries that are heavily dependent on fossil fuels (e.g., China, India, Australia, and those in Africa and Middle East). Hence, its answer informs how carbon-free electricity supply under wholesale market competition may emerge in a country's clean and sustainable energy future.

This paper presents the analytics of a Cournot wholesale electricity market's mix of PVB and combined cycle gas turbine (CCGT) capacities, generation levels, and price levels. Our case study of Israel shows that declining battery costs enable PVB firms to displace CCGT firms, resulting in carbon-free electricity supply as a market-based outcome. The battery cost threshold for this outcome is estimated to be ~24% of a CCGT's capacity cost, implying that albeit its carbon content, natural gas is a transitional fuel in Israel's pathway to deep decarbonization, which can be accelerated by Israel's implementation of policies that promote large-scale renewable energy development.

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