April 2026

Financial Innovations Lab Report

Financial Instruments for Israel's Energy Transition

Electricity and Environmental Derivatives for the Israeli Economy

Ministry of Energy and Infrastructure
www.energy.gov.il

Milken Innovation Center - Israel

מכון ון ליר בירושלים
THE VAN LEER JERUSALEM INSTITUTE
معهد فان لير في القدس

Executive Summary[1]

Israel's electricity sector has undergone significant infrastructure and transactional reforms in recent years, moving rapidly toward an open and integrated market. This study proposes the use of financial instruments to assist electricity producers in managing risks, to facilitate new infrastructure investments, and thereby to contribute to accelerating the development of Israel's electricity sector.

International experience demonstrates that open, liquid, and competitive wholesale energy markets are essential factors for the transition to alternative energy sources and the reduction of carbon use. The high volatility of demand and prices in the energy market complicates long-term planning and increases business risks.

Based on the government's 2020 plan of NIS 22 billion over 10 years, Israel requires approximately NIS 2.2 billion per year to advance its energy transition to 2030. Areas of investment include solar projects, upgrading the electricity grid infrastructure, electricity storage, distributed energy resources (generation, storage and flexible demand system, combined heat and power, and systems and aggregation including virtual power plants), carbon utilization, capture and storage.

Natural gas infrastructure investment is needed to support the transition to renewable energy. Electricity and environmental derivatives are essential for the energy transition, providing capital market integration, risk management through price discovery, regulatory easing of capital flows through the creation of standardized instruments, providing tradable products, reducing entry barriers for investors, and creating market mechanisms that encourage carbon reduction.

Advantages

1. **Energy Security:** Enables hedging against price volatility and supply shocks
2. **Capital Mobilization:** Creates investable, standardized instruments for institutional capital
3. **Renewables Integration:** Supports financing of solar and storage through predictable revenue streams
4. **Market Efficiency:** Improves price discovery and reduces transaction costs
5. **Regional Leadership:** Positions Israel as a **financial and energy innovation hub**

Trading in electricity and environmental derivatives in the Israeli economy would enable the transfer of a larger share of financial risks to the capital market, and acquire instruments and greater certainty for market participants. The use of financial derivatives would help reduce volatility and lack of certainty and contribute to leveraging existing companies and new initiatives for new opportunities.

This research was supported in part by a research grant from the Chief Scientist at the Ministry of Energy and Infrastructure of Israel. The findings and conclusions presented here are those of the researchers and of the Milken Innovation Center-Van Leer Jerusalem Institute only, and do not represent the official position, opinion, or endorsement of the Israel Ministry of Energy and Infrastructure

[1]The Milken Innovation Center hosted a Financial Innovation Lab on January 29, 2024 and a follow-up working session on September 4, 2025. This process accompanied applied research on issues raised at the Lab and a Fellowship appointment supported by the Ministry of Energy. The principal authors of the applied research that is the basis of this Financial Innovation Lab are Prof. Yigal Newman of Finance and Marketing at the Hebrew University School of Business Administration, ynewman@huji.ac.il, and Ron Shmueli, a Milken Fellow (20224-25) and teaching fellow at the Hebrew University School of Business, rshmueli@mail.huji.ac.il.. Their full report can be found in Hebrew at https://milkeninnovationcenter.org/he/publication-type/research-he/.

Table of Contents

Contents

1. Introduction: Why Financial Derivatives Are Needed in the Israeli Electricity Market

Israel's electricity sector faces a specific set of challenges that financial derivatives are designed to address. Producers investing billions in solar farms, storage facilities, and gas infrastructure need certainty about future revenue streams before committing capital. Without the ability to lock in prices of equipment, supplies, transport, storage and/or tariff prices, a solar developer cannot confidently project returns over a 20-year asset life. Similarly, suppliers and large industrial consumers face unpredictable costs that complicate budgeting and long-term planning.

The current system, where most transactions occur at spot prices set by the system operator, leaves all parties exposed to volatility driven by weather, fuel costs, demand fluctuations, and the growing "duck curve" effect as renewables penetration increases. This volatility is not merely an inconvenience—it fundamentally impedes the capital investment required for Israel's energy transition.

Derivatives solve this by allowing participants to separate the physical delivery of electricity from the financial management of price risk. A producer can sell futures contracts to guarantee revenue, a supplier can buy them to stabilize costs, and financial intermediaries can provide liquidity—all without anyone needing to physically generate or consume a single additional kilowatt. In essence, derivatives create the financial architecture that enables the physical transformation of the energy sector.

Real-World Applications: How Derivatives Enable the Renewable Energy Transition

The following examples from major energy markets illustrate how financial derivatives function as essential infrastructure for renewable energy investment, grid stability, and market resilience.

Example 1: Solar and Wind Project Finance — The Role of Synthetic PPAs

A large-scale solar farm requires hundreds of millions of dollars in upfront capital, with returns spread over 20 or more years. Lenders and investors will not commit that capital unless future revenues are reasonably predictable. This is why Power Purchase Agreements (PPAs) and synthetic PPAs—which are essentially long-term derivative contracts—have become the backbone of renewable energy project finance worldwide.

A synthetic PPA functions like a fixed-for-floating swap: the developer receives a guaranteed fixed price per MWh while the physical electricity is sold at spot market prices, and the parties settle the difference financially each quarter. This structure separates the physical delivery of electricity from the financial management of price risk. Without it, the developer bears the full volatility of spot markets over the entire asset life—a risk profile that most financiers will not underwrite.

The practical impact is decisive: the vast majority of utility-scale solar and wind capacity built globally in the past decade was financed with some form of derivative-based revenue guarantee. In markets that offer standardized hedging instruments—including the European Union, the Israel's current market, which lacks standardized financial hedging instruments, forces developers to absorb price risk that their counterparts elsewhere can transfer to willing counterparties. This gap directly constrains the pace of renewable deployment needed to meet the 2030 target of United

Kingdom, and North America—renewable energy investment has accelerated rapidly. 30% renewable generation.

Example 2: Texas (ERCOT) — The Cost of Inadequate Hedging

Texas operates an energy-only wholesale market through ERCOT (the Electric Reliability Council of Texas) with no capacity mechanism, a regulatory measure in electricity wholesale markets that pays power generators, storage providers, or demand-response firms to ensure adequate capacity is available to meet demand. This structure, unlike energy-only markets that pay only for energy produced, provides payments for being available during shortages, and ensuring grid reliability. With this mechanism, this structure has successfully attracted massive renewable investment—wind and solar now supply over 40% of ERCOT's generation. However, the February 2021 winter storm (Winter Storm Uri) exposed in dramatic fashion what happens when market participants are inadequately hedged.

During the crisis, wholesale prices spiked to the $9,000/MWh regulatory cap—roughly 300 times normal levels—and remained there for days. Retailers and suppliers who had not purchased futures contracts or other hedging instruments faced billions of dollars in losses virtually overnight. Several major retailers went bankrupt, and the financial fallout cascaded through the entire Texas energy ecosystem. By contrast, the retailers and suppliers who had hedged their exposure through futures contracts and other derivatives survived the crisis intact, their losses capped by the instruments they had purchased in advance.

This episode demonstrated conclusively that derivatives are not speculative luxuries—they are essential risk management infrastructure. Israel, with its own exposure to demand spikes during summer heat waves, the growing intermittency of solar generation, and geopolitical disruptions, faces analogous risks. The absence of a liquid derivatives market means that Israeli market participants currently have no standardized tools to protect themselves against extreme price events.

Ørsted and the Nordic Model — Derivatives as the Foundation of Offshore Wind Investment

Ørsted, the world's largest offshore wind developer, provides a compelling illustration of how a mature derivatives market enables large-scale renewable investment. The Danish company explicitly relies on electricity derivatives markets to manage the revenue risk of its global wind portfolio, hedging against price fluctuations by participating in power forward and futures markets across the Nord Pool and the European Energy Exchange (EEX).

Ørsted's approach integrates physical assets with financial markets: the company uses a combination of tools for virtual flexibility, such as day-ahead, intraday, and forward instruments alongside battery storage for physical flexibility. This integrated strategy—physical assets managed through financial markets—is what allows Ørsted to commit billions of euros to new offshore wind projects with the confidence that revenue streams will be sufficiently predictable to satisfy investors and lenders.

The Nordic electricity derivatives market, one of the most mature in the world, provides the liquidity and contract variety that makes this possible. Producers can hedge years of future output, consumers can lock in costs, and financial intermediaries ensure that the market functions efficiently. Israel's ambition to reach 28% renewable generation by 2030, supported by a 13-fold expansion in storage capacity, will require a similar financial ecosystem to attract the necessary capital and manage the inherent risks of an increasingly renewable-dependent grid.

These three examples illustrate the argument from complementary perspectives: the first demonstrates why derivatives are structurally necessary for renewable energy project finance; the second shows what can go wrong in their absence; and the third shows what success looks like when a mature derivatives market supports large-scale clean energy investment. Together, they make a compelling case that this is not a theoretical proposition—financial derivatives are how the global energy transition is being funded, managed, and sustained.

2. What Makes for a Good Electricity Derivative?

A well-designed derivative contract requires several essential characteristics to be effective:

1. Standardization. Contract terms—size, duration, and settlement method—must be uniform so that any buyer can trade with any seller without negotiating bespoke terms each time. This study proposes contracts sized at 1 MWh multiplied by the hours in the period, with quarterly, monthly, and annual durations as a starting point.
2. A Reliable Underlying Reference Price. The contract must settle against a transparent, widely accepted benchmark. In Israel's case, this would be the System Marginal Price (SMP) in the day-ahead market, which is already published and understood by market participants.
3. Central Clearing. This is critical because it removes counterparty credit risk—participants do not need to evaluate whether the party on the other side of their trade can pay. The clearinghouse guarantees performance through margin requirements and daily mark-to-market settlement, dramatically reducing systemic risk.
4. Sufficient Liquidity. A derivative is only useful if participants can enter and exit positions without moving the market dramatically. This requires enough participants with diverse needs—producers hedging revenue, suppliers hedging costs, and financial players providing depth. This is precisely why this report recommends gradually opening the market beyond just physical producers and suppliers.
5. Regulatory Transparency and Consistency. Mandatory reporting of all transactions to a central database, clear position limits to prevent manipulation, and oversight from a credible authority are essential to maintaining market integrity and public confidence.

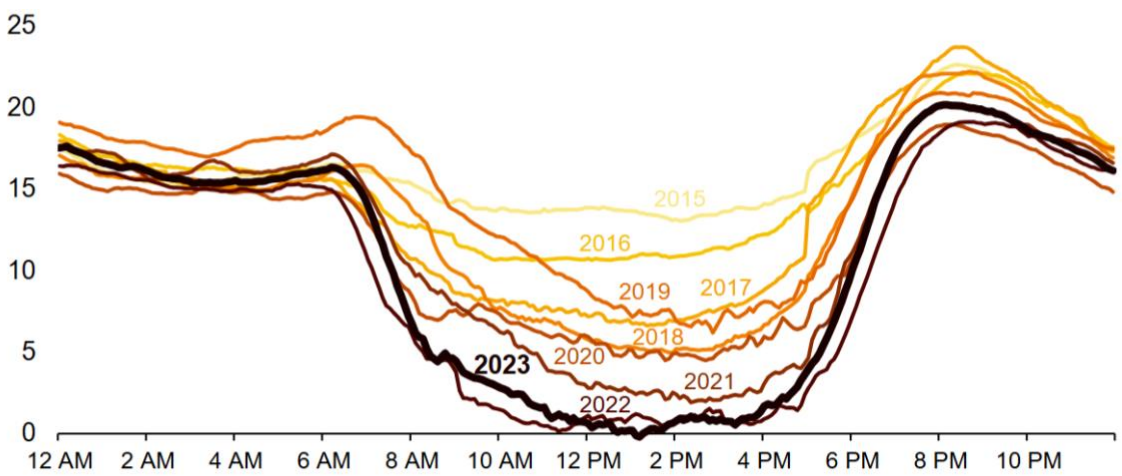
3. Electricity as a Commodity

Electrical energy has an economic value that can be measured (in watt-hour units), stored and transported, and can be exchanged. Unlike other commodities, often the cost of storage is not available for exchange, and most electricity produced must be consumed immediately. This relative lack of storage infrastructure is a distinguishing characteristic.

Electricity prices in modern energy markets are characterized by volatility. On the supply side, volatility is influenced by fossil fuel costs affecting production costs. Even the transition to renewable energy does not resolve this issue fundamentally: renewable energy sources are affected by weather conditions and therefore their supply is not continuous.

The interplay between demand and supply creates the "duck curve" — changes in the net energy demand throughout the day. Figure 1 shows the duck curve in California, illustrating the challenge of adapting to evolving energy sources. It is central in electricity markets because it captures the timing mismatch between when solar produces the most and when consumers need the most power, creating operational, pricing, and investment challenges.

Figure 1: The Duck Curve — Net demand (in gigawatts) on a peak load day in CAISO (California Independent System Operator)



Source: California Energy Commission, 2024

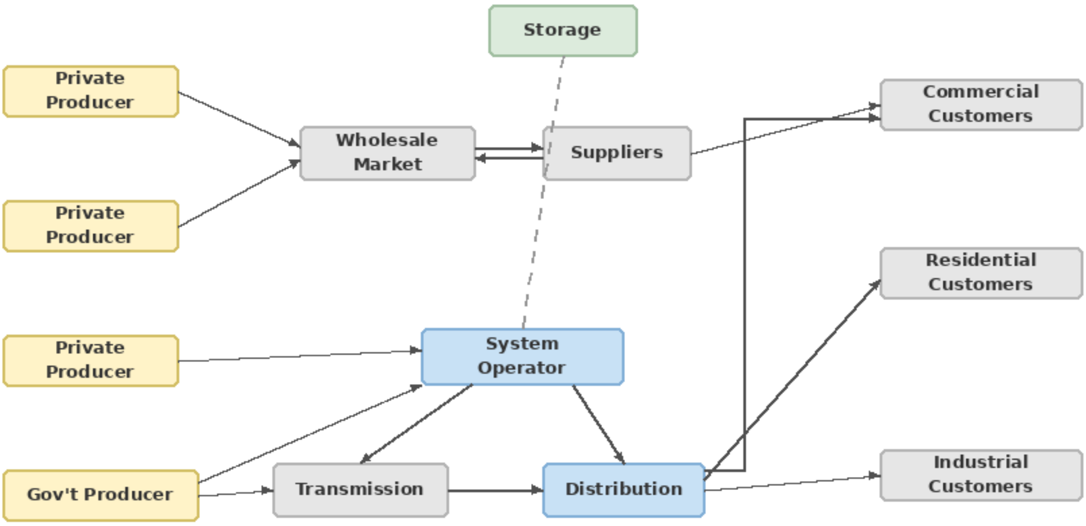
[Chart shows electricity consumption curves throughout the day for the years 2015–2023, with the typical duck-curve shape: high consumption in the morning, a dip in the afternoon due to solar production, and a sharp rise in the evening.]

In an optimal decarbonization pathway, the duck curve should gradually **flatten and shift**, so that net load over the day looks more like a smooth, modestly varying profile instead of a deep midday “belly” with a steep evening “neck.” The goal is not to eliminate solar-driven dips, but to use storage, demand flexibility, and diversified low-carbon supply so that these dips and ramps are small enough to be managed largely with clean resources

3.1 Electricity Trading Worldwide

This Lab distinguishes between regions that have not undergone liberalization (traditional electricity markets) and those that have undergone liberalization (competititve modern electricity markets). In non-liberalized areas, the entire value chain is managed by a single entity. In liberalized areas, there is competition in generation and organized market mechanisms.

Figure 3: Schematic of System Operator Activity in a Fully Liberalized Market



In nearly all regions that have undergone a process of reshaping electricity supply by unbundling the electricity sector as displayed above. The purpose is to replace administered prices and single-buyer arrangements with market based pricing and multiple competing suppliers. Futures contracts and electricity derivatives are used as tools for risk management. For example, in North America, the European Union, Australia, and Britain, both spot electricity trading and long-term futures contracts are conducted.

Electricity market liberalization is the process of transitioning from a government-controlled, monopoly-based electricity system to one with competition and market-driven pricing. In a traditional (non-liberalized) market, a single state-owned utility controls the entire chain — generation, transmission, distribution, and retail — and the government sets prices. Consumers have no choice of provider.

Liberalization typically unfolds in stages. First, the generation segment is opened to private producers, breaking up the monopoly on power production. Then a wholesale market is created where generators compete to sell electricity. Eventually, retail competition may follow, allowing consumers to choose their supplier. Throughout this process, transmission and distribution usually remain regulated, since building duplicate grid infrastructure wouldn't make economic sense. However, that regulation can also integrate minigrids to reduce transmission needs in weakly served areas by making access to electricity cheaper and faster. Financing grid-connected minigrids can supply local demand during peak periods and provide ancillary services such as voltage support and frequency regulation, reducing congestion and upgrade needs on central transmission and distribution networks.

The key changes include separating ("unbundling") the different functions that were previously handled by one entity, establishing an independent system operator to manage the grid impartially, and creating market mechanisms for price discovery through spot and futures trading.

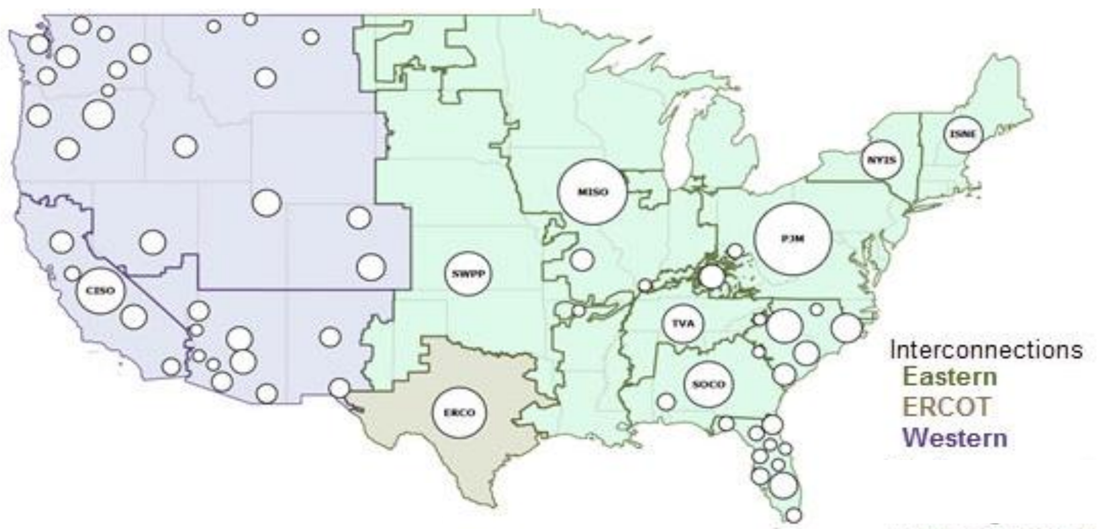
The overwhelming rationale is that competition drives down costs, encourages innovation, attracts private investment, and gives consumers more choices. It also facilitates the integration of renewable energy by allowing new entrants — like solar and wind producers — to sell power on the open market rather than being shut out by an incumbent monopoly.

That said, liberalization comes with challenges too: price volatility increases, market manipulation becomes a risk, and there's a need for sophisticated financial instruments so that producers and consumers can manage uncertainty. Israel's electricity sector is partway through this liberalization journey and needs these financial tools to complete the transition effectively.

3.2. International Experience:

In the northeastern United States, Midwest, Texas and California regions, competitive wholesale markets operate where producers sell the electricity they generate to suppliers – utility companies – who will sell it to consumers in the retail market.[2] Traders also operate in the wholesale market, purchasing "future" electricity from producers to sell it later to suppliers. Additionally, at CME, the Chicago Mercantile Exchange, standard futures contracts are listed for trading for base and peak loads in each region's electricity grid.

Map 1: Scheme of Activity Areas of the Electricity Market in the United States



[2] More detailed explication of the various electricity market shaping strategies can be reviewed in the full report (Newman and Shmueli, 2025).

Source: U. S. Energy Administration, 2024

The European Union electricity market liberalization process began in the 1990s, with the goal that market competition would lead to better service and lower prices for consumers. In 1996 the Union ordered member countries to separate electricity generation, transmission and distribution. An additional directive in 2003 required functional separation between transmission and distribution companies and service providers, and in 2009 independent regulatory bodies were established at the national and European levels. In 2019 the European policy on clean energy was approved. In summary, the wide variety of trading options shaping global electricity markets characterizes the different development of the electricity market in each region or country. *The common denominator for all markets surveyed is that the more developed the market and the more advanced stage of liberalization and integration with neighboring markets - the more trading mechanisms are integrated into it, both in electricity itself and in various financial derivatives.*

3.3 Carbon as a Commodity

Carbon emissions are a modern commodity because of government regulation. Regulation ranges on a scale between imposing a tax on emissions and voluntary trading in credits.

Like electricity, carbon emissions (a byproduct of fossil fuel combustion) are also a modern commodity: they are identical in nature in all markets and therefore can be traded easily, they have economic value (negative) because of state regulation on carbon emissions (which itself derives from global agreements regarding reducing the climate footprint). The following table shows the availability of carbon-related trading instruments across selected countries:

Table 1: Details on Electricity Trading in Global Principal Electricity Markets

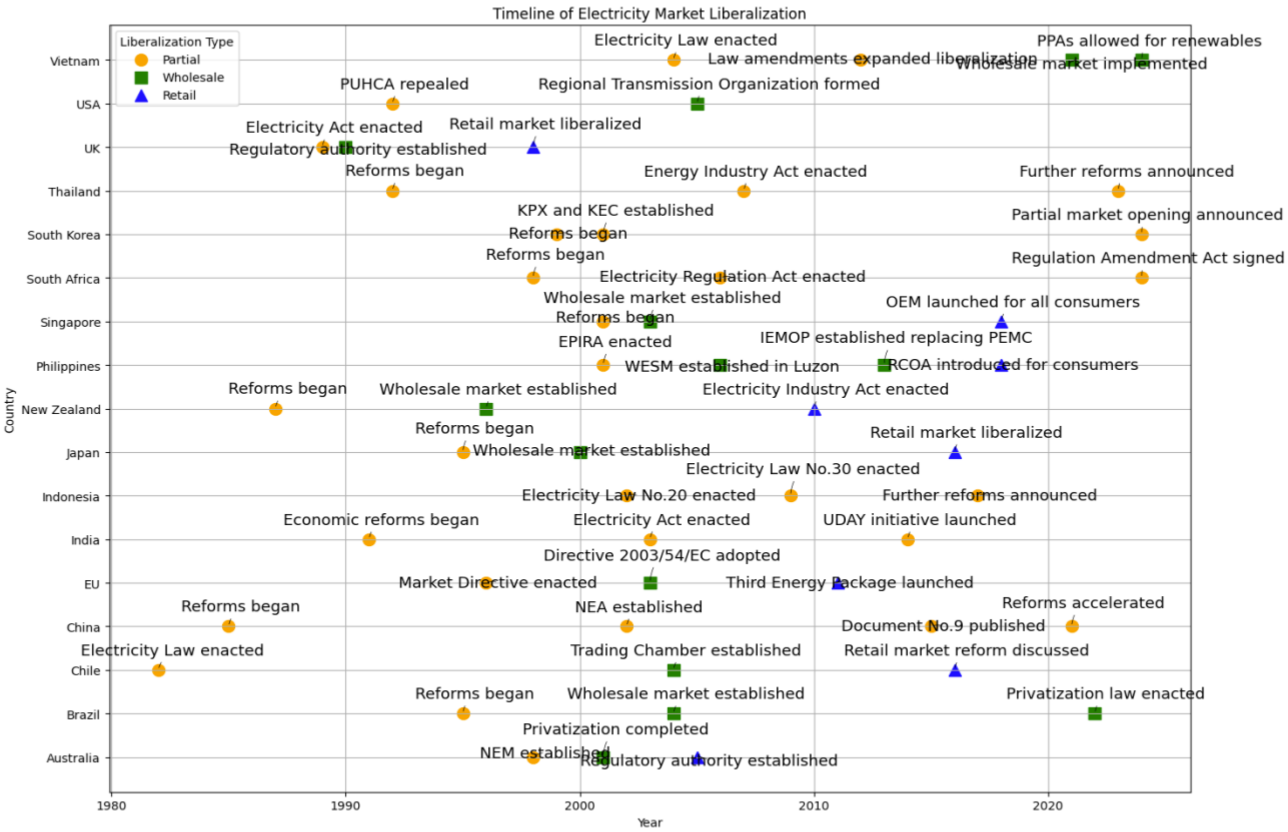
Country	Spot	Day-Ahead	Futures	Long-term Contracts	Base Load	Peak Load	Offsets
Australia	✓	✓	✓	✓	✗	✓	✓
Brazil	✓	✓	✗	✓	✓	✗	✓
Canada	✓	✓	~	✓	✓	✗	✓
Chile	✓	✓	✗	✓	✓	✗	✗
China	✓	✓	~	✓	✓	✗	~
EU	✓	✓	✓	✓	✓	✓	✓
France	✓	✓	✓	✓	✓	✗	✓
Germany	✓	✓	✓	✓	✓	✗	✓
India	✓	✓	✗	✓	✓	✗	~
Indonesia	✓	✗	✗	✗	✗	✗	✗
Italy	✓	✓	✓	✗	✓	✓	✓
Japan	✓	✓	~	✗	✓	✓	~
Mexico	✓	✗	✗	✗	✗	✗	✗
Netherlands	✓	✓	✓	✗	✓	✓	✗
New Zealand	✓	✓	✓	✗	✓	✓	✓

Norway	✓	✗	✓	✗	✓	✓	✓
Philippines	✓	✗	✗	✗	✗	✓	✗
Singapore	✓	✗	✓	✓	✓	✓	✓
S. Africa	✓	✗	✗	✓	✗	✗	✗
S. Korea	✓	✗	~	✓	✗	✓	~
Spain	✓	✓	✓	✗	✓	✓	✓
Thailand	✓	✗	✗	✓	✗	✗	✗
UK	✓	✓	✓	✓	✓	✓	✓
USA	✓	✓	✓	✓	✗	✓	✓
Vietnam	✓	✗	✗	✗	✗	✗	✗

Source: **Carbon Pricing Dashboard, World Bank, 2024**

The following table illustrates the changes in national policies over time, demonstrating the trends towards liberalization and integration of new capital market instruments.

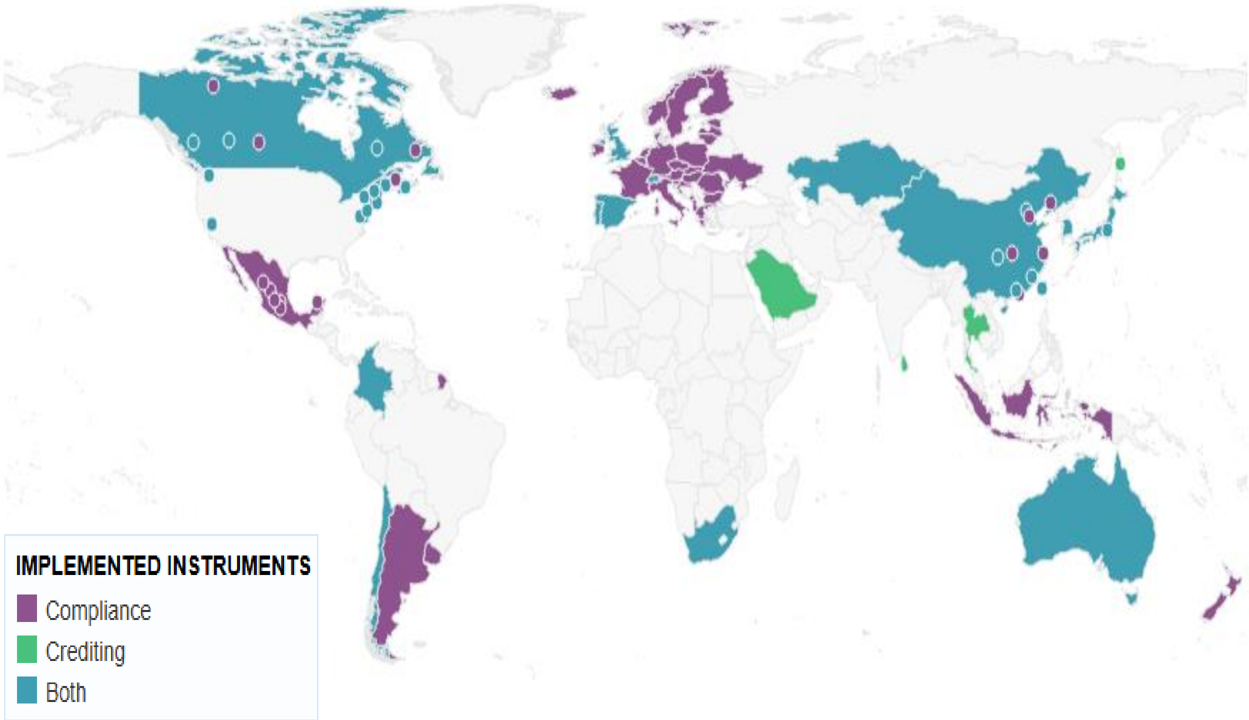
Figure 4: Timeline of Electricity Market Liberalization



3.4 Carbon Trading

State regulation varies from country to country and ranges on the scale between imposing a tax on emissions to voluntary trading in credits, but common to all countries is the desire to create an economic mechanism that incentivizes polluters to limit and/or reduce the amount of carbon they emit, with the goal of reducing carbon emissions and as part of a broad array of global policy measures aimed at dealing with climate change. Obviously, the market structure and type of state incentives have a decisive impact on the success chances of emission reduction efforts. Map 2 shows the different regulatory mechanisms designed to help reduce carbon emissions in each country.

Map 2: Implementation of Financial Policy Mechanisms for Carbon Trading



Source: World Bank, 2025

The following table shows the regulator and the carbon trading system among selected counties.

Table 7: Carbon Trading Systems and Responsible Regulators by Country

Country	Responsible Regulator	Carbon Trading System
United States	Environmental Protection Agency (EPA) and State Regulators	State initiatives such as RGGI in 11 northeastern states and Cap-and-Trade in California
European Union	European Commission	EU Emissions Trading System (EU ETS)
Norway	Ministry of Climate	Participates in the EU ETS
United Kingdom	Department for Business, Energy and Industrial Strategy	UK ETS linked to EU ETS
Canada	Federal Authority and All Provinces	Output-based federal system, also at provincial level
Mexico	Ministry of Environment	Voluntary carbon trading; mandatory programs under review
Australia	Clean Energy Regulator	Emissions Reduction Fund, Safeguard Mechanism, secondary markets
New Zealand	Ministry of Environment	NZ Emissions Trading Scheme (NZ-ETS)
Brazil	Ministry of Environment	Sao Paulo Climate Exchange, international markets
Chile	Ministry of Energy	PRE program for emission reduction and additional initiatives
Japan	METI	Cap-and-Trade under Tokyo Protocol
China	Ministry of Ecology and Environment	Regional pilot programs, national roadmap
India	Ministry of Environment	State programs and voluntary initiatives

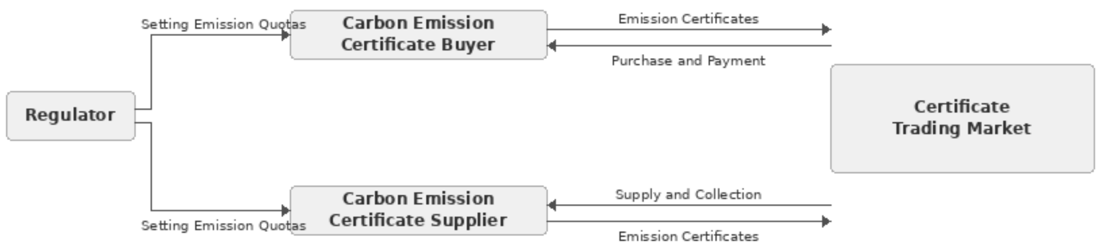
The most authoritative and up-to-date source for global environmental and carbon commodity data is the **World Bank's State and Trends of Carbon Pricing 2025** report and its interactive Carbon Pricing Dashboard. Here are the key highlights:

- **Scale of carbon markets:** About 28% of global greenhouse gas emissions are now covered by a direct carbon price, and carbon pricing instruments mobilized over $100 billion in public revenue in 2024.
- **Market size:** The global carbon credit market was estimated at roughly $114 billion in 2025, projected to grow to around $482 billion by 2035.
- **Instruments in use:** The dashboard tracks two main categories worldwide — compliance instruments (emissions trading systems and carbon taxes) and carbon crediting mechanisms (voluntary and regulated). Over 70 carbon pricing instruments are now in operation or scheduled for implementation across the globe.
- **Recent expansion:** New systems are launching rapidly — Brazil plans a national carbon registry in 2026, and multiple Southeast Asian and Latin American countries are establishing or expanding their programs. The operationalization of Article 6.4 of the Paris Agreement is opening a new era of cross-border carbon trading. See Appendix Figure

Global carbon trading is based on cap and trade systems, where governments set a limit on the total amount of greenhouse gas emissions allowed in their jurisdiction and allocate to companies permits (Credits) that allow them to emit a certain amount of greenhouse gases. If a company emits fewer greenhouse gases than the permits it holds, it can sell its unused permits to other companies that exceed their limits; similarly, when a company emits more greenhouse gases than the permits it holds, it purchases unused permits from other companies. (See Appendix C, Figure 14).

Thus, the market sets a price for greenhouse gas emissions, incentivizes companies to reduce their greenhouse gas emissions, and raises awareness of climate change. The price set in the market is determined in equilibrium between supply and demand and is affected by the economic conditions prevailing in the market. See Figure 6 Schematic below and Figure 7 showing the development of carbon emission permit prices from 2014-24 in California. Similar data is also available for prices in Europe.

Figure 6: Schematic of the Carbon Emissions Trading System



Source: Carbon Pricing Dashboard, World Bank, 2024

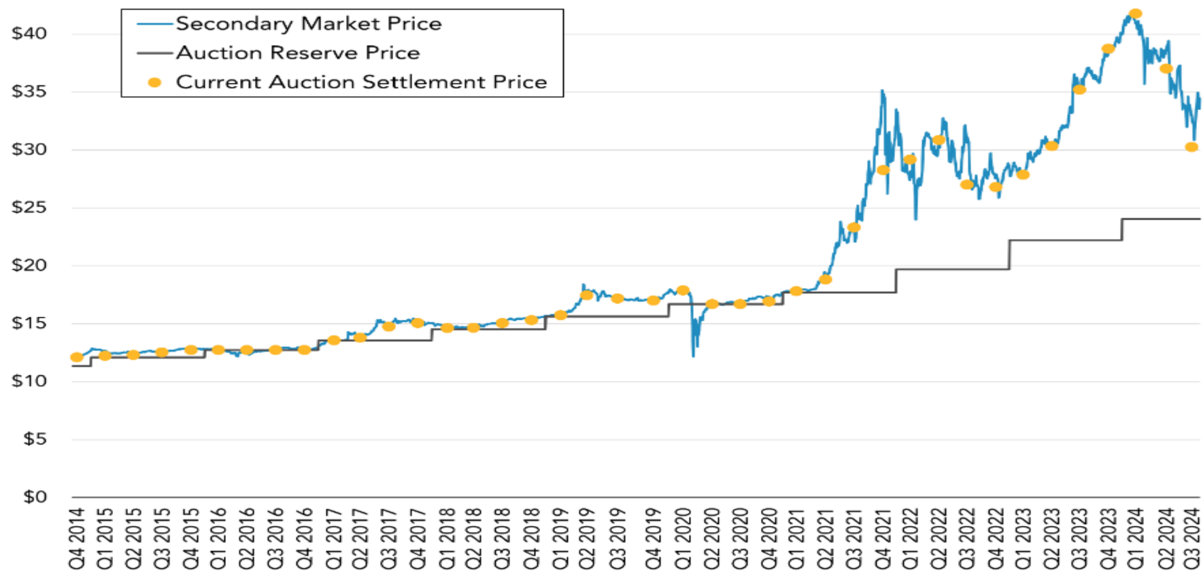


Figure 7: Carbon Emission Allowance Prices California

3.4.1 Carbon Capture, Utilization, and Storage (CCUS)

CCUS technologies aim to reduce greenhouse gas emissions by capturing carbon emissions before they are released into the atmosphere, utilizing the captured carbon in industrial processes, and storing it securely. CCUS captures CO_2 from large point sources (power plants, cement, steel, chemicals) and either stores it underground or uses it in products, reducing emissions that are otherwise very hard to abate. It also underpins “blue” hydrogen (from natural gas with capture), providing a lower-carbon bridge fuel where renewable-based (“green”) hydrogen is not yet available or cost-competitive.

In the first stage, carbon capture (CC) is performed when carbon emitted in an industrial process or during electricity production in a power plant is collected before it is released to the atmosphere. Carbon capture is performed through separation of emitted gases, carbon adsorption, and its removal. After capture, it's possible to move to the carbon utilization stage where captured carbon serves as raw material in industrial processes such as producing synthetic fuels, or into long-lived products that keep carbon out of the atmsopher and/or other industrial chemicals. At this stage, carbon emissions are utilized in a way that creates positive economic value. In the final stage, carbon that has no economic use undergoes storage (Carbon Storage), when it is stored in the depths of the earth, usually in oil or gas wells that have gone out of use. This way, carbon can be stored for long periods in a way that ensures the gas will not be released again to the atmosphere.

The combination of CCUS is seen as complementary to the use of energy from renewable sources, and as a vital strategy for supporting a sustainable transition toward a low-carbon emissions future. CCUS enables minimizing emissions while providing solutions to the inherent challenges of industries and sectors that struggle to completely avoid emissions.

While carbon storage manages emissions, it can also merge with energy storage which manages timing and energy supply and demand. Examples of dual-use products like cement-based supercapcitors and structural supercapacitor blocks are being developed precisely merge structural and energy-storage functions turning buildings and infrastructures into distribute storage assets. Current work at Israel’s National Research Institute for Energy Storage and the Guangdong Technion Israel Institute of Technology is advancing towards commercialization of advanced capacitor science and intergrating storage and infrastructure over time.

"Environmental Commodities" - Definition and Applications

The regulatory steps implemented worldwide (mainly in OECD countries) have led to the development of "environmental commodities." These are tradable financial instruments representing environmental characteristics or services aimed at incentivizing business entities and others toward desired behavior that will help promote sustainability and deal with environmental challenges.

For example, a carbon credit is a certificate issued by a government or a body authorized by it representing one ton of CO_2 that has been removed from the atmosphere or whose emission to the atmosphere has been prevented. The certificate can help its owner - the entity that removed greenhouse gases from the atmosphere or prevented emissions - meet a carbon emission target imposed on it (and then the certificate will be canceled), but the owner can also trade it in the free market and then the right is transferred onward, to the buyer. In other words, a carbon credit is an asset created when an entity performs an activity that the state wants to encourage -- carbon removal or emission prevention -- and its value is determined by trading in the free market. In this way, carbon credit plays a crucial role in incentivizing desired behaviors and reducing the impact of human activities on the environment.

Additional environmental commodities include: **renewable energy certificates (RECs), water related rights and credits, including tradable water use rights and payments for watershed services, , biodiversity and ecosystem service credits, such as biodiversity offsets, Habitat banking units and payments for ecosystem services (PES) tied to conservation outcomes, sustainable agriculture credits (Sustainable Agriculture Credits), forest carbon credits (Forest Carbon Credits), energy efficiency certificates (freight transport through optimized routing for value-chain inventory) and insetting and supply chain certificates, where emission reductings within a company's value chain are quantified and claimed via certificates (carbon insets, e.g., Nespresso agroforestry, Nestle regenerative agriculture program, fertilizer optimization programs, pooled procurement (coca, shea, vannila, etc.).**

Overall, environmental commodities and the economic incentives accompanying their trading play vital roles in promoting sustainability and environmental responsibility. Economic incentives encourage businesses and individuals to adopt environmentally friendly measures and reduce the negative environmental impact of their business activities. Additionally, environmental commodities facilitate compliance with regulatory requirements: if you cannot (or choose not to) reduce the environmental footprint of your business activity, pay someone else to do it.

The economic value that trading in environmental commodities creates can incentivize renewable energy projects, conservation initiatives, and emission reduction efforts. The free market efficiently prices the environmental impact of various entities' activities, thereby aligning financial interests with the imperative of creating a sustainable economy.

The effectiveness of carbon trading is a subject of debate. Supporters argue that this trading provides companies with efficient economic incentives to reduce emissions, while critics argue that the mechanism may lead to manipulations by various market players, especially in the field of permit allocation, and as a result lead to cost burden without emission reduction. Additionally, concerns arise regarding the accuracy of emission reports and enforcement of regulations regarding emission reduction targets.

Some carbon trading systems worldwide are local, such as the European Union Emissions Trading System (EU ETS), which operates under national regulators; also in the US carbon trading is conducted through regional programs, while emission reduction is regulated by the EPA. Other systems are global, such as the CTX exchange, a global platform for online carbon trading where permits approved by international standards such as Verified Carbon Standard and Gold Standard can be traded.

4. Financial Trading in Electricity in Israel

4.1 Recent Developments in the Israeli Electricity Sector

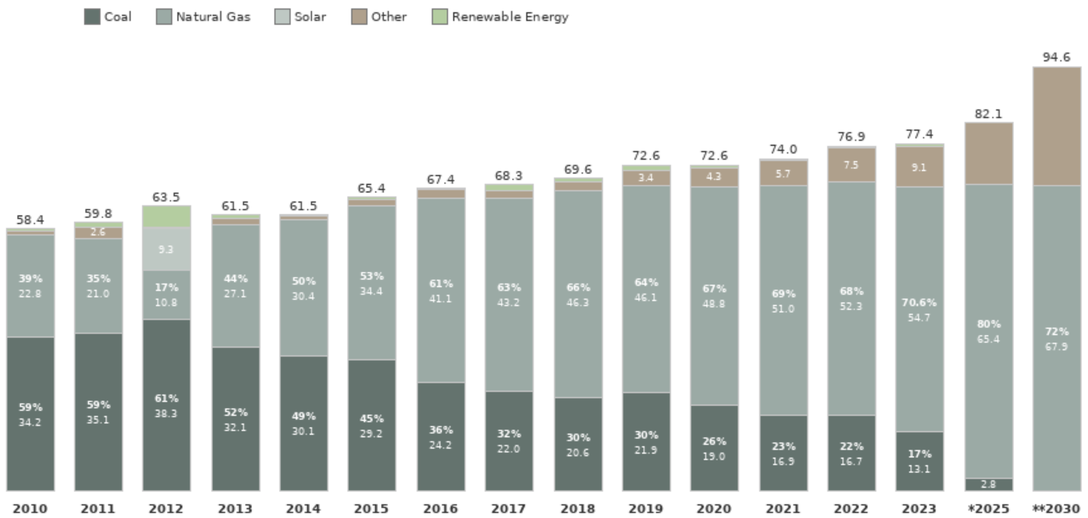
The scope of the Israeli electricity sector is estimated at approximately NIS 30 billion per year. The key changes include:

- **Renewable Energy Integration:** An increase from 2% in 2010 to 11.7% in 2023, with a target of 30% by 2030.

  Israel has achieved rapid but still limited renewable integration. Solar power now supplies roughly 14–15% of annual electricity generation, with some sunny hours in 2024 reaching over 50% instantaneous renewable supply, demonstrating that high solar penetration is technically feasible in Israel's system. Policy targets call for at least 30% renewables by 2030 (with some scenarios pushing higher), which would require more than doubling current solar capacity and adding substantial storage and grid flexibility.

  Progress is constrained less by resource potential than by system and governance limits. Israel is an "energy island" without interconnections, so balancing variable solar must rely entirely on domestic storage, flexible demand, and gas-fired generation. Land scarcity and environmental sensitivities restrict large ground-mounted projects, pushing more complex dual-use solutions (rooftops, carparks, agro-PV, floating PV). At the same time, slow, fragmented permitting and lagging grid upgrades have become binding bottlenecks, meaning the country's renewable build-out is advancing, but still not at the scale or speed needed to confidently meet its 2030 targets.

Figure 8: Generation Source Mix in the Israeli Electricity Sector



Source: Ministry of Energy and Infrastructure, Electricity Sector Status Report, September 2024

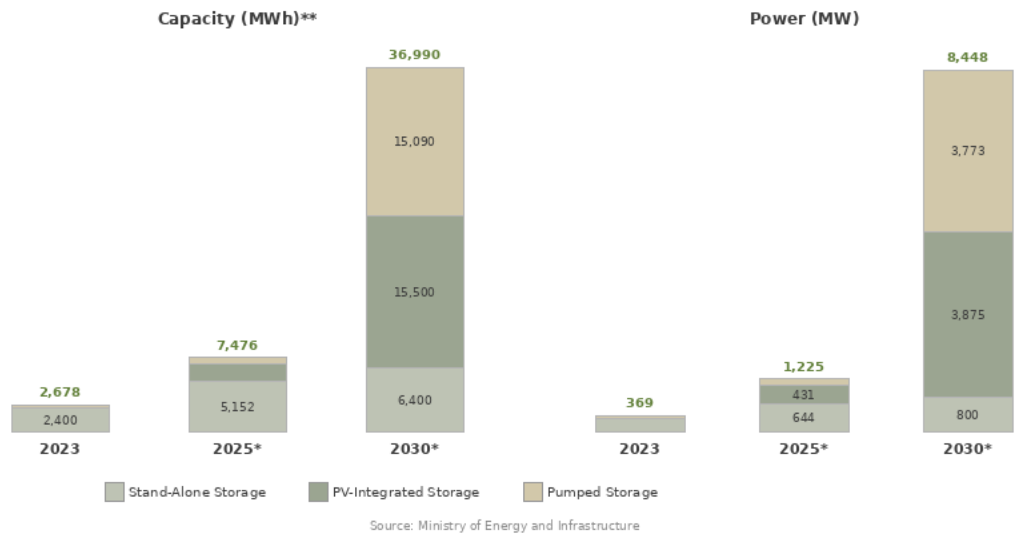
[Stacked bar chart showing the mix of coal, natural gas, solar, and other sources from 2010 to 2030. Coal decreases significantly (from ~59% to ~2.6%), natural gas increases (from ~34% to ~72%), and renewables rise substantially (from ~0.5% to ~28%).]

- **New Storage Technologies:** An expected 13-fold increase in storage capacity by 2030.

  Israel has moved in just a few years from scattered pilots to a substantial pipeline of grid-scale battery and pumped-storage projects, making storage a core pillar of its energy transition. The system now relies primarily on lithium-ion battery energy storage systems, with government-backed tenders awarding multi-GW, four-hour projects (including an 800 MW / 3,200 MWh flagship portfolio and about 1.4 GW of solar-plus-storage from earlier rounds) and new high-voltage tenders adding another 1.5 GW. At the same time, the Kokhav Hayarden pumped-storage plant has begun operation, giving Israel a major long-duration asset alongside fast-responding batteries. A national outline plan for storage, storage-friendly tariffs, and evolving competitive procedures have created a clearer regulatory and revenue framework, but the country still faces execution risks on its multi-GW pipeline, grid-connection bottlenecks, and a need to diversify beyond lithium-ion as solar penetration and resilience requirements increase.

  Israel has begun to meaningfully accelerate distributed energy resources, particularly rooftop solar and behind-the-meter storage, but progress is still early relative to its potential. A “100,000 Solar Roofs” initiative and a mandate for PV on all new medium- and large-roof buildings from late 2025 are designed to add several gigawatts of rooftop capacity and turn more households and businesses into prosumers. Regulatory changes are shifting new customers away from classic net metering toward tariffs that reward solar-plus-storage and time-shifting, which is spurring battery adoption among commercial and industrial users. At the system level, plans for DER management platforms and simplified permitting support higher DER penetration, but most new capacity still comes from larger ground-mounted projects, so Israel must scale residential and small-commercial uptake much faster to realize its distributed energy ambitions

Figure 9: Changes in Israel Electricity Storage Capacity



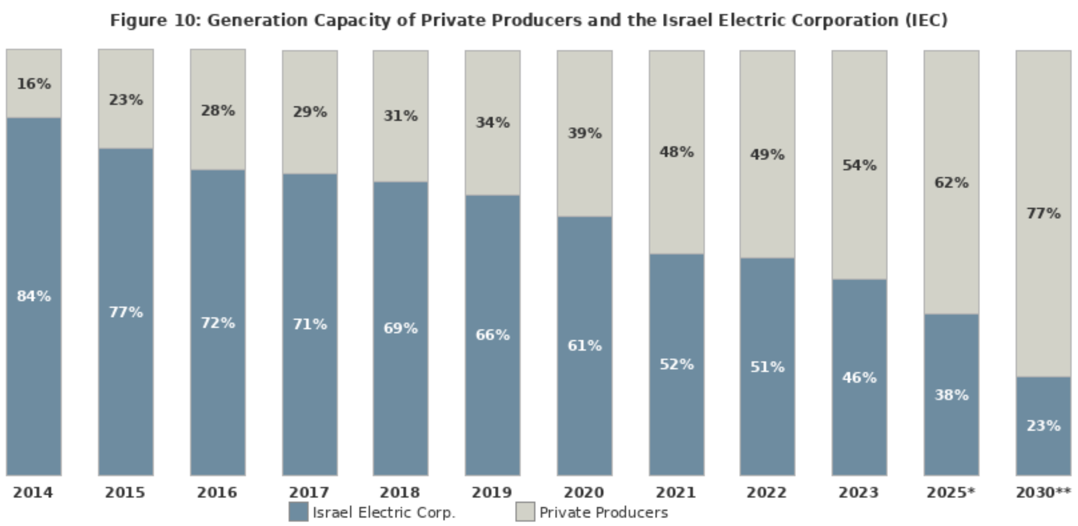
[Bar charts showing capacity (MW) and energy (MWh) growth from 2023 to 2030. Energy capacity increases from 2,678 MWh in 2023 to 36,990 MWh by 2030. Power capacity increases from 369 MW to 8,448 MW. Shows stand-alone storage, photovoltaic-integrated storage, and pumped-storage.]

- **Increased Competition: Entry of new producers, especially in renewable energy.**

  Israel's electricity market is now significantly more competitive than a decade ago, particularly on the retail side, but Israel Electrical Corporation (IEC) still anchors the system. A multi-year reform reduced IEC's share of generation and opened the supply segment so all consumers, including small households, can choose among multiple private suppliers, while transmission and distribution remain regulated IEC monopolies. Dozens of suppliers are licensed and around 18–20 are active, with private producers already providing more than half of total generation.

  On the demand side, several hundred thousand households have already switched away from IEC, typically receiving discounts of roughly 5–20% relative to the standard tariff, though price advantages vary by contract and supplier. However, some new retailers report losses under current wholesale and tariff rules, pointing to possible consolidation and underlining that IEC still effectively controls about two-thirds of end-user supply once purchased IPP power is included. Further reforms to the wholesale pricing framework and grid regulation are in progress to deepen competition, integrate more renewables, and address lingering market-power and infrastructure constraints

Figure 7: Generation Capacity of Private Producers and the Israel Electric Corporation (IEC



[Stacked bar/pie chart showing the shift from 84% IEC / 16% private in 2014 to an expected 23% IEC / 77% private by 2030.]

- **Direct Transactions:** Authorization of transactions between producers and private suppliers, as well as the launch of virtual suppliers.

  Direct transactions in Israel's electricity market have expanded, but remain tightly structured and mostly mediated through Noga and standardized frameworks rather than free bilateral PPAs. The reform shifted more trading activity into organized wholesale and tender mechanisms, with Noga operating an SMP/MCP-based market in which private producers compete to sell power and suppliers (rather than IEC alone) increasingly purchase, while IEC retains the grid monopoly.

For most renewable and conventional generators, sales still flow via PPAs with Noga or IEC on regulated terms, with limited scope for true bilateral long-term contracts outside those schemes. On the retail side, direct commercial relationships between suppliers and hundreds of thousands of end-users have grown as consumers switch from IEC to private suppliers, but the suppliers themselves are largely buying from Noga’s pool and discounted tenders, with a gradual move planned toward more direct producer–supplier contracts after 2029. Virtual power plants, virtual utilities along with virtual or synthesized Purchase Power Agreements enable both physical minigrids to design and finance distribute energy resources over a wider system. This limitations and barriers to expansion of these resources can be addressed through electricity derivatives.

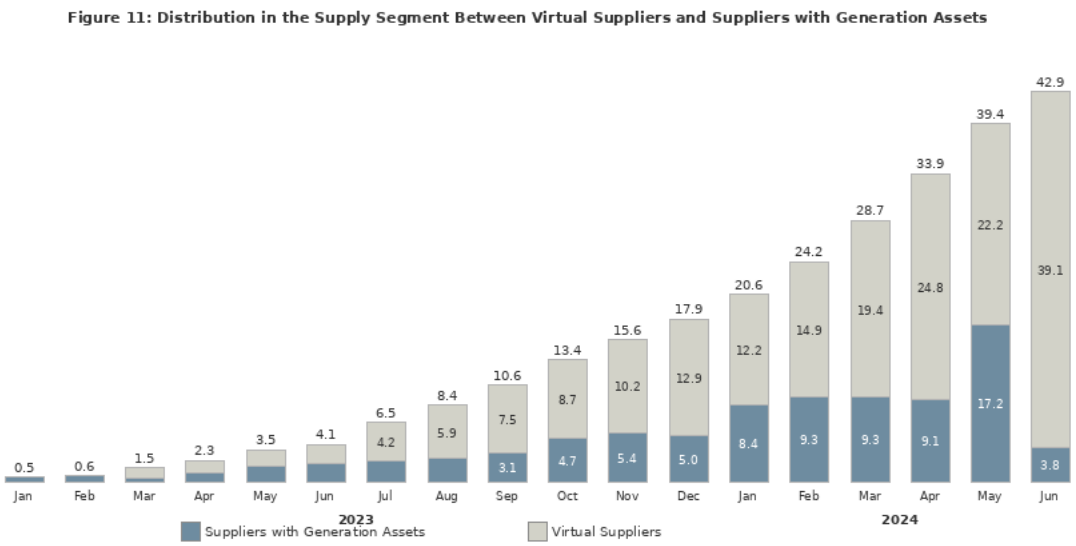


Figure 8: Distribution in the Supply Segment Between Virtual Suppliers and Suppliers with Production Facilities

[Bar chart showing the growth of supply division between household suppliers with generation assets and virtual suppliers from January 2023 to June 2024, with virtual suppliers reaching 42.9%.]

4.2 Adaptation for Electricity Derivatives Trading

- **System Marginal Price (SMP):** Updated price calculation and maximum price ceiling for producers. (for further detail, see: Newman and Shmueli, Applied Research Solutions Report _163, Milken Innovation Center, 2026).

- In Israel's liberalized power market, the wholesale electricity price is now determined as a **Market Clearing Price (MCP)**, which replaces the former System Marginal Price (SMP) terminology but retains the same core concept of a half-hourly marginal price reflecting system conditions. NOGA, the Independent System Operator, computes the MCP every 30 minutes using an optimization model that balances electricity demand with available generation and storage, subject to network and operational constraints, and publishes the resulting prices as the central reference for wholesale settlements and market signals.

4.2.1 Market Risk and Financial Instruments Trading

The advancement of the electricity sector toward liberalization exposes market participants to market risks. Market prices are most efficiently determined based on supply and demand, and price volatility creates risks. The use of futures contracts would help reduce volatility and contribute to price stabilization, as well as prevent manipulation by enabling risk mitigation

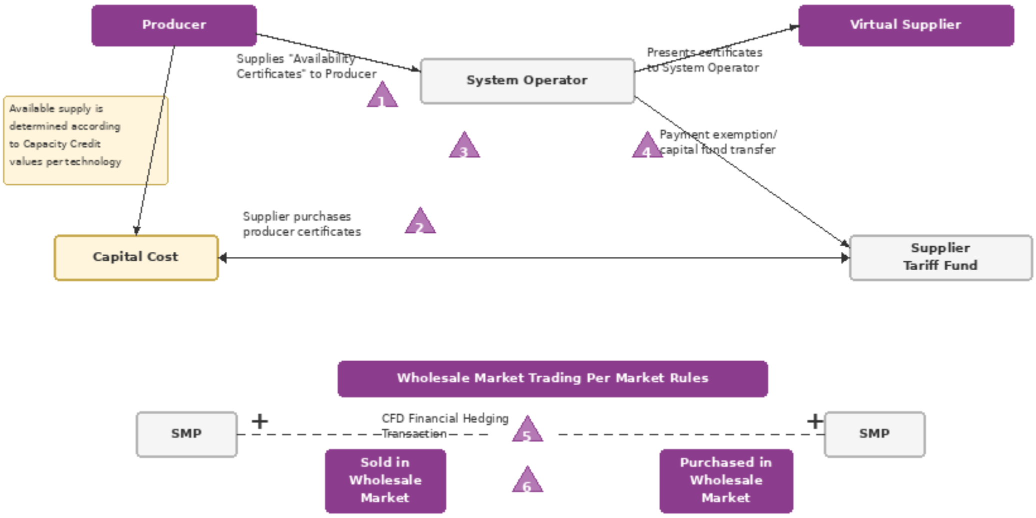
4.2.2 The Proposed Regulation — April 2024

The Electricity Authority published a "Call for Comments — Principles for Bilateral Market Regulation" proposing two types of transactions:

a. **Availability Transactions:** Obligation to sell available supply between producers connected to the transmission grid and suppliers/virtual suppliers.

b. **Financial Energy Transactions (Bilateral):** Without dependence on physical availability. The regulation defines availability certificates and CFD (Contract for Difference) transactions for market prices. In the Israeli electricity market context described in the report, it works like this: a producer and a virtual supplier agree on a fixed price for electricity. When the actual wholesale market price (SMP) turns out higher than the agreed price, the producer pays the difference to the supplier. When the SMP is lower, the supplier pays the difference to the producer. Neither party physically delivers electricity to the other — they just settle the financial gap. This is useful because it lets both sides lock in price certainty. The producer knows what revenue to expect regardless of market swings, and the supplier knows their cost. It's essentially an insurance mechanism against price volatility, which is why it's classified as a "hedging" transaction in the diagram. The actual electricity still flows through the system operator and wholesale market as usual — the CFD is purely a financial layer on top.

Figure 12: Relationship Between Suppliers, Producers, and the System Operator Under the Proposed Regulation



Source: Israel Electricity Authority, 2025

Flow diagram showing: Producer ↔ System Operator ↔ Virtual Supplier, with connections including availability certificates, supply purchases, tariff fund, Contract for Difference (CFD)financial hedging transactions, and SMP pricing. The capital cost and supplier tariff fund feed into the system.

4.3 Advantages of Futures Contracts

Futures contracts can play a central role in managing Israel's energy transition by turning volatile wholesale electricity prices into more predictable cashflows. They allow generators, retailers and large consumers to lock in prices months or years ahead, reducing exposure to sharp swings driven by gas prices, weather and renewables variability. This smoothing of revenues and costs helps protect both investors and end-users from price shocks that might otherwise erode support for the transition.

For renewables and storage, a liquid futures market creates a transparent forward price curve that underpins bankable financing. Standardized power futures (base, peak, profile products) give Israeli solar, wind and storage developers clearer expectations for future revenues and a tool to hedge merchant exposure beyond PPAs, thereby lowering financing costs and supporting large-scale deal flow in the sector. At the system level, futures trading deepens market liquidity and attracts a broader set of participants, providing robust reference prices for bilateral contracts and retail tariffs, which in turn reinforces competition in Israel's liberalizing electricity market.

Israel's exchange-traded futures market is relatively new and still focused on a narrow set of index products. In early 2026, TASE expanded liquidity-support programs for the futures market as part of a broader effort to deepen the derivatives segment and attract more institutional and international participation. This is a great opportunity to explore expansion of these financial instruments for application to Israel's electricity market.

- Faster transaction rate
- Removal of entry barriers
- Efficient collateral management
- Low credit risk
- High liquidity in the secondary market
- Price transparency

Daily Mark-to-Market settlement enables real-time risk management and reduction of credit risk.

Daily mark-to-market settlement reduces risk in electricity futures by forcing profits and losses to be realized and collateralized every day, so large unpaid losses cannot silently accumulate over the life of the contract. At the close of each trading day, the exchange re-values every open electricity futures position at the official settlement price and credits gains or debits losses to each participant's margin account, triggering variation-margin calls when needed.

This mechanism sharply lowers counterparty credit risk: if prices move sharply against a buyer or seller, the losing side must post additional margin immediately or the exchange will close out the position, preventing a situation where a defaulting trader owes a huge amount at expiry that cannot be collected. In electricity markets, where price spikes can be extreme and sudden, this continuous collateralization ensures the clearinghouse and surviving participants Daily mark-to-market settlement reduces risk in electricity futures by forcing profits and losses to be realized and collateralized every day, so large unpaid losses cannot silently accumulate over the life of the contract. At the close of each trading day, the exchange re-values every open electricity futures position at the official settlement price and credits gains or debits losses to each participant's margin account, triggering variation-margin calls when needed.

This mechanism sharply lowers counterparty credit risk: if prices move sharply against a buyer or seller, the losing side must post additional margin immediately or the exchange will close out the position, preventing a situation where a defaulting trader owes a huge amount at expiry that cannot be collected. In electricity markets, where price spikes can be extreme and sudden, this continuous collateralization ensures the clearinghouse and surviving participants remain protected, stabilizing the market and supporting reliable hedging for generators, retailers, and large consumers.

Figure 13: Daily Settlement of Parties in a Futures-Based Transaction

[Timeline diagram showing: Day 0 (Start) Purchase of futures contract at $100, contract size 744 MWh Day 0 (Initial margin deposit of $11,160 = 15% of contract value) Day 1 (Price rises to $105, profit $3,720, margin balance: $14,880) Day 2 (Price drops to $90, loss $11,160, margin balance: $3,720, maintenance margin call: $6,696) Close (Position closing and final settlement)]

Table 2: Comparison of Bilateral Trading Model to Futures Trading Model

Parameter	Bilateral Trading (Forward)	Futures Trading
Transaction Rate	Slow	Fast
Entry Barriers	High	Low
Collateral Management	Individual and expensive	Central and efficient
Credit Risk	High (settlement at expiration)	Low (daily settlement)
Liquidity	Low	High
Price Transparency	Less transparent	Transparent

5. Policy Recommendations

5.1 Standardized Electricity Trading

Key Recommendation: Gradual opening/diversification of the financial energy transactions market to financial players who are not only producers or suppliers. The advantages:

- Improving responsiveness (price discovery) of market prices to information
- Reducing uncertainty
- Removing entry barriers
- Increasing liquidity and competition

6. Carbon Policy in Israel

6.1 Carbon Pricing

Israel has introduced an explicit carbon tax on fossil fuels starting in January 2025, using the existing excise system to phase in a carbon price as part of its low-carbon transition plan. The tax applies to consumption of coal, natural gas, fuel oil, LPG and petroleum coke, and is designed to rise over time, with government documents indicating an aim toward prices in the range of about 130 NIS (≈40 USD) per ton of CO_2 in the medium term.

Evaluations by international and Israeli analysts are mixed: they welcome the move as a key step that broadens explicit carbon pricing, but judge current levels and coverage as insufficient for Israel's 2030 and 2050 climate targets. OECD and other assessments emphasize that effective carbon rates remain low in several sectors (especially natural gas for power and industry), and recommend raising rates and widening coverage, while Israeli policy studies highlight both the modest macroeconomic impact of a stronger carbon tax and its regressive distributional effects if not paired with compensation for low-income households.

The carbon pricing mechanism to commence in 2025 includes:

- Pricing through a non-tax mechanism on polluting fuels
- Gradual increase until 2030
- Relief mechanism for vulnerable populations
- Non-harm to industrial competitiveness

6.2 Carbon Pricing Policy Update

Israel's carbon pricing story is relatively recent and still evolving. Here's where things stand:

The mechanism: In September 2024, the Knesset approved a carbon tax that works through amendments to existing fuel tax and purchase tax ordinances rather than a standalone emissions trading system. It's structured as a tax on polluting fuels — not a cap-and-trade system — which took effect starting January 1, 2025.

Gradual phase-in: The tax rates are increasing incrementally from 2025 through the beginning of 2030, at which point they're intended to fully internalize the external costs of fuel consumption, covering both greenhouse gas emissions and local pollutants.

EU alignment: A key motivation is the EU's Carbon Border Adjustment Mechanism (CBAM). By having a domestic carbon price on the books, Israeli exporters can demonstrate they've already paid a carbon tax at home, reducing what they'd owe at the EU border.

Support for industry: To ease the transition, the government allocated up to NIS 450 million between 2024 and 2027 for grants and efficiency programs to help fuel-consuming industries adapt. There's also an emissions capture grant program that opened for applications in late 2024.

What's missing: The current tax-based approach focuses on penalizing emissions but does not create a tradable market. This eliminates the possibility of emissions trading and the positive incentive value that comes from being able to sell credits for reducing emissions below your baseline. This report recommends complementing the tax with a carbon credit system and CCUS support to create those market-based incentives.

6.3 Implications for Emissions Trading

The current tax mechanism focuses on the negative costs of marginal emissions without providing positive incentive value for emission reduction, thereby eliminating the option for emissions trading.

6.4 Carbon Policy Recommendations

- **1. Declining subsidies:** Support for producers for a limited period with gradual reduction.
- **2. Carbon credit system:** Integrating credits for emission areas not covered by the tax.
- **3. CCUS support:** Support mechanisms for carbon capture and storage projects.

7 Implementation Roadmap

To establish a **transparent, liquid, and risk-managed derivatives-based energy trading platform** in Israel that enables producers, suppliers, large consumers, and financial institutions to hedge price risk, improve price discovery, and mobilize private capital investment into the energy transition sector.

The platform will be implemented in **phased stages**, transitioning from a hybrid bilateral market to a **centrally cleared exchange-based system** leveraging the infrastructure of the Tel Aviv Stock Exchange.

7.1 Proposed Stages

Stage 1: Intermediate Hybrid Market (Years 1–3)
A controlled, scalable entry point combining bilateral flexibility with centralized transparency.
Core Components:

- **Central Trading Platform (OTC + Structured Products)**
  - Digital marketplace for bilateral energy derivatives (e.g., forwards, swaps)
  - Participation by utilities, IPPs, large consumers, and financial intermediaries
- **Gradual Contract Standardization**
  - Initial focus on a **limited set of high-demand contracts**:
    - Baseload electricity forwards
    - Peak/off-peak contracts
    - Renewable energy-linked contracts (solar profiles, storage-backed supply)
  - Standard terms: duration, settlement, delivery zones, pricing index
- **Central Information & Reporting Database**
  - Mandatory reporting of all transactions
  - Real-time monitoring for:
    - Price transparency
    - Market concentration
    - Systemic risk exposure

Expected Outcomes:

- Early liquidity formation
- Improved price signals for investment decisions (generation, storage)
- Reduced bilateral opacity and counterparty uncertainty

Stage 2: Full Market Integration & Central Clearing (Years 3–5)
Transition to a formal derivatives market integrated into national capital markets infrastructure.
Core Components:

- **Central Counterparty Clearing (CCP)**
  - Migration of standardized contracts to clearing via the Tel Aviv Stock Exchange
  - Margining, netting, and default management systems
- **Exchange-Traded Futures & Options**
  - Introduction of:
    - Electricity futures
    - Capacity contracts
    - Renewable energy certificates (RECs) derivatives
  - Alignment with global benchmarks and institutional investor requirements
- **Institutional Market Participation**
  - Entry of:
    - Pension funds
    - Insurance companies
    - Infrastructure funds

Expected Outcomes:

- Deepened liquidity and tighter spreads
- Investment-grade energy price benchmarks
- Scalable platform for energy transition financing

7.2 Implementation Pathway

7.2.1 Securities Offering Framework

Actions:

- Define **standard contract specifications**, including:
  - Contract size (MWh)
  - Delivery periods (monthly, quarterly, annual)
  - Settlement mechanisms (financial vs. physical)
  - Reference pricing (system marginal price, bilateral indices)
- Launch a **public consultation process** involving:
  - Ministry of Energy
  - Israel Securities Authority
  - Israel Electric Authority
  - Market participants (utilities, aggregators, large industrials)
- Implement **phased rollout**:
  - Phase 1: Pilot contracts (2–3 products)
  - Phase 2: Expanded product suite based on demand

Deliverables:

- Standardized contract rulebook
- Regulatory approval framework
- Market launch plan

7.2.2 Reporting and Transparency Infrastructure

Actions:

- Establish a **central transaction repository**:
  - Mandatory reporting of all OTC and exchange trades
  - Integration with regulator oversight systems
- Develop **real-time analytics dashboards**:

    - Price curves
    - Volume and liquidity indicators
    - Concentration and exposure metrics
- Enable **compliance and audit functionality**:
    - Automated regulatory reporting
    - Market surveillance for manipulation or abuse

Deliverables:

- National energy derivatives database
- Regulatory reporting protocols
- Transparency and disclosure standards
- Risk Management and Market Safeguards

7.2.3 Key Risks and Mitigation Measures

Speculative Activity

- Position limits and margin requirements
- Market surveillance tools
- Gradual opening to non-hedging participants

Market Liquidity

- Anchor participation from:
    - Israel Electric Corporation and major IPPs
    - Large industrial energy consumers
- Market-making incentives
- Initial government-backed liquidity support (if needed)

Counterparty Risk

- Early-stage: bilateral collateral requirements
- Final stage: CCP clearing with margining and default waterfall

Technology and Infrastructure

- Secure, scalable trading platform
- Integration with grid data and settlement systems
- Cybersecurity standards aligned with financial market infrastructure

Regulatory Coordination

- Clear division of responsibilities across:
    - Israel Securities Authority
    - Israel Electric Authority
    - Bank of Israel

8. Conclusion

The Israeli electricity sector, valued at approximately NIS 30 billion annually, is undergoing a fundamental transformation—from 84% government-controlled generation in 2014 to a projected 77% private production by 2030, alongside a dramatic shift from coal dependency to renewable sources targeted at 28% by 2030. These structural changes create both the urgency and the opportunity for financial market instruments to support the transition.

This study demonstrates how futures trading in electricity can advance the Israeli electricity sector towards a fully competitive market with diversified energy portfolios. International experience indicates that such trading is the state of the art in advanced electricity markets across North America, the European Union, the United Kingdom, Japan, and Australia.

Key Recommendations

1. Transition from bilateral trading to standardized trading with central clearing
2. Gradual opening of the financial energy transactions market to financial players who are not producers or suppliers
3. Listing futures contracts on the Tel Aviv Stock Exchange, leveraging existing clearing infrastructure
4. Integration of a carbon credit system with the carbon tax to create market-based incentives for emission reduction
5. Establishment of a central reporting obligation for all financial energy transactions to ensure transparency and prevent market manipulation
6. Development of an intermediate hybrid trading platform as a stepping stone toward full central clearing
7. Support mechanisms for Carbon Capture, Utilization, and Storage (CCUS) projects to complement the carbon tax framework
8. Alignment of Israel's carbon pricing framework with the EU's Carbon Border Adjustment Mechanism (CBAM) to protect the competitiveness of Israeli exporters

The 13-fold expansion in electricity storage capacity expected by 2030, combined with the rapid growth of virtual suppliers and private producers, underscores the need for sophisticated financial instruments to manage the risks inherent in this transition. Without these tools, the capital investment of approximately NIS 2.2 billion per year required to meet Israel's 2030 energy targets will remain difficult to attract.

Implementation of these recommendations is expected to bring about an efficient, competitive, and stable electricity market, while contributing to achieving renewable energy goals and carbon emissions controls. The financial innovations outlined in this report—drawing on proven models from the world's most advanced energy markets—offer Israel a clear pathway to a resilient, market-driven energy future.

Appendices

Appendix A — Glossary of Terms

Term	Definition
Base Load	A contract for purchasing a stable and fixed quantity of electricity from power plants operating continuously.
Peak Load	A contract for purchasing electricity during periods of high demand from expensive and flexible generation sources.
System Marginal Price (SMP)	The price determined by the most expensive generation unit required to meet demand.
Day-Ahead Market	A market for electricity trading based on supply and demand forecasts for 24 hourly blocks for the following day.
Futures Contract	A standardized financial contract traded on exchanges for purchasing electricity at a fixed price in the future.
Clearinghouse	An intermediary organization that assists in settling transactions and ensures compliance with contractual obligations.
Hedging	A risk management strategy for protection against price fluctuations.

Appendix B — International Comparison Tables

Table 1: Electricity Trading Details in Major Economies

Country/Region	Main Exchange	Day-Ahead	Futures	Spot
USA	CME	Yes	Yes	Yes
European Union	ICE, EEX	Yes	Yes	Yes
Britain	ICE	Yes	Yes	Yes
Japan	JEPX, JPX	Yes	Yes	Yes
Australia	ASX	Yes	Yes	Yes
China	CESM	Yes	No	Limited
India	IEX, PXIL	Yes	No	Yes

Table 2: Carbon Trading Systems by Country

Country	Trading Type	Regulator	Trading System
USA	Cap-and-Trade	EPA	RGGI, California
European Union	Cap-and-Trade	European Commission	EU ETS
Britain	Cap-and-Trade	BEIS	UK ETS
Canada	Output-Based	Provincial Authorities	Federal System
Japan	Cap-and-Trade	METI	Tokyo Cap-and-Trade
Australia	Baseline-Credit	CER	Safeguard Mechanism

Table 7: Carbon Trading Systems and Responsible Regulators by Country

Country	Responsible Regulator	Carbon Trading System
USA	EPA (Environmental Protection A ency) and State Regulators	State initiatives such as RGGI in 11 northeastern states and Cap-and-Trade in California
European Union	European Commission	EU ETS Emissions Trading System
Norway	Ministry of Climate	Participates in EU ETS
Britain	Department for Business, Energy and Industrial Strategy	UK ETS linked to EU ETS
Canada	Federal Authority and All Provinces	Output-based federal system, also at provincial level
Mexico	Ministry of Environment	Voluntary carbon trading, planned mandatory programs
Australia	Clean Energy Regulator	Emissions Reduction Fund, secondary markets

New Zealand	Ministry of Environment	NZ-ETS Emissions Trading Scheme
Country	**Responsible Regulator**	**Carbon Trading System**
Brazil	Ministry of Environment	Sao Paulo Climate Exchange, international markets
Chile	Ministry of Energy	PRE program for emission reduction and additional initiatives
Japan	METI	Cap-and-Trade under Tokyo Protocol
China	Ministry of Ecology and Environment	Regional pilot programs, national roadmap
India	Ministry of Environment	State programs and voluntary initiatives

Appendix C — Proposed Specification for Electricity Futures Contract

Table 4: Typical Specification for a Quarterly Baseload Electricity Futures Contract

Parameter	Description
Contract Name	Quarterly Baseload Electricity Futures — Base Load
Contract Type	Financial (cash settlement), or with physical delivery (depending on market choice)
Contract Size	1 MWh × number of hours in the quarter
Underlying Asset	Electricity price in the baseload day-ahead market by daily average price per quarter
Settlement Price	Average price of electricity in NIS/MWh terms in the day-ahead market during the quarter
Currency	NIS (New Israeli Shekel)
Trading Venue	Tel Aviv Stock Exchange
Trading Hours	Sunday–Thursday, 9:45–17:35
Daily Settlement	Mark-to-Market, daily
Final Settlement Price	Arithmetic average of electricity prices in the DAM

Table 5: Contract Types Offered for Trading

Duration	Load Profile	Contract Size	Expiration Date
Annual	Base/Peak	1 MW × 8,760 hours	End of calendar year
Quarterly	Base/Peak	1 MW × 2,160 hours	End of calendar quarter
Monthly	Base/Peak	1 MW × 720 hours	End of calendar month

Table 6: Additional Technical Parameters

Parameter	Description
Minimum Price Change	NIS 0.01/MWh
Minimum Trading Quantity	One (1) contract
Volatility Limits	±10% to ±20% from opening price
Order Types	Market, Limit, IOC, FOK
Last Trading Day	3 trading days before end of period

Figure 14: Detailed Environmental and Carbon Trading in Global Capital Markets

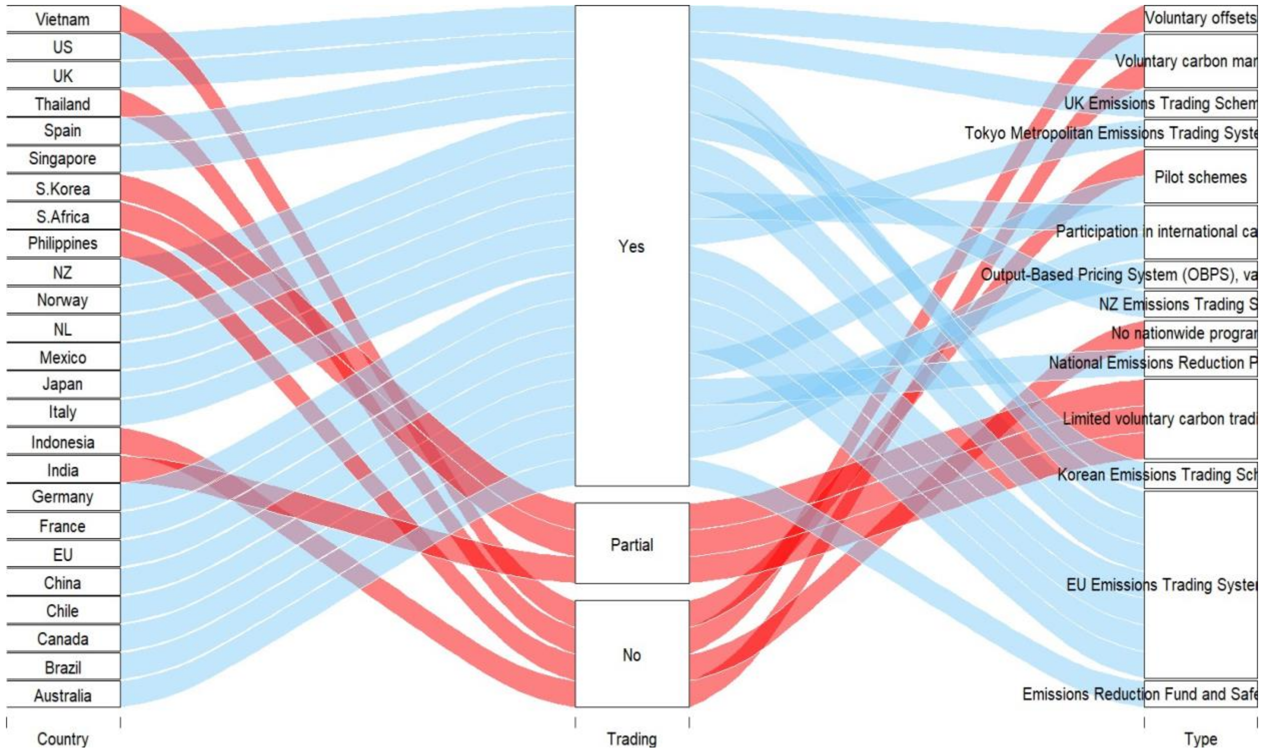


Table 8 presents an example of possible specifications for an electricity derivatives contract for Israeli Electricity Sectors. A full breakdown of all the various contract options is found in Appendix C.

Parameter	Description
Contract Name	Quarterly Baseload Electricity Futures — Base Load
Contract Type	Financial (no physical delivery), or with physical delivery (depending on market choice)
Contract Size	1 MWh × number of hours in the quarter. Example: Quarter 1 = 2,160 hours
Underlying Asset	Electricity price in the "baseload" day-ahead market by daily average price per quarter
Settlement Price	Average price of electricity in NIS/MWh in the day-ahead market during the quarter
Currency	NIS (New Israeli Shekel)
Trading Venue	Tel Aviv Stock Exchange
Trading Hours	Sunday–Thursday, 9:45–17:35
Initial Margin	Deposit of initial margin, in accordance with broker or exchange requirements
Settlement Method	Financial settlement — calculation of the difference between contract price and actual market price for each MWh hour
Delivery Period	Calendar quarter (January–March, April–June, etc.)
Delivery Date	23:59 on the last day of the quarter
Settlement Date	First business day after the end of the quarter
Special Adjustments	In case of Sabbath/holiday, delivery/settlement date is deferred to the next day

Table 8, continued.

Parameter	Description
Contract Name	Quarterly Baseload Electricity Futures — Base Load
Contract Type	Financial (no physical delivery), or with physical delivery (depending on market choice)
Contract Size	1 MWh × number of hours in the quarter. Example: Quarter 1 = 2,160 hours
Underlying Asset	Electricity price in the "baseload" day-ahead market by daily average price per quarter
Settlement Price	Average price of electricity in NIS/MWh in the day-ahead market during the quarter
Currency	NIS (New Israeli Shekel)
Trading Venue	Tel Aviv Stock Exchange
Trading Hours	Sunday–Thursday, 9:45–17:35
Initial Margin	Deposit of initial margin, in accordance with broker or exchange requirements
Settlement Method	Financial settlement — calculation of the difference between contract price and actual market price for each MWh hour
Delivery Period	Calendar quarter (January–March, April–June, etc.)
Delivery Date	23:59 on the last day of the quarter
Settlement Date	First business day after the end of the quarter
Special Adjustments	In case of Sabbath/holiday, delivery/settlement date is deferred to the next day

References

1. Nicollo, F., and F. Vona, "Energy Market Liberalization and Renewable Energy Policies in OECD Countries", Energy Policy, May 2019; Ribeiro, R.B. et al., "Carbon Trading Markets: Literature Review on Mechanisms, Accounting, and Market Models Coupled with Energy Markets," *Energy*, 2025.

2. Newman, Yigal and R. Shmueli, Developing Options for Finance and Risk-Mitigation in the Israeli Electricity Market, *Milken Innovation Center Applied Research Solutions* Report, September 2025 (Hebrew); Deng, S.J. and S.S. Oren, "Electricity Derivatives and Risk Management", Energy, May-June 2006.

3. Kalantzis, F. G. and N. T. Milonas, "Analyzing the Impact of Futures Trading on Spot Price Volatility: Evidence from the Spot Electricity Market in France and Germany," *Energy Economics*, Vol. 36, 2013, pp. 454–463. DOI: 10.1016/j.eneco.2012.09.017; Wang, Y. et al., "Impact of Carbon Emission Trading and Renewable Energy Development Policy on the Sustainability of Electricity Market: A Stackelberg Game Analysis," *Energy Economics*, Vol. 118, 2024. DOI: 10.1016/j.eneco.2023.106977—demonstrates the importance of how carbon trading and renewable policies interact to integrate carbon credits with electricity derivatives.

4. Israel — Day-Ahead and Real-Time Electricity Market Operations, Clearing and Settlements.

5. Electricity Sector Status Report, Israel, September 2024, Ministry of Energy; World Bank, *State and Trends of Carbon Pricing 2025*, Washington, DC: World Bank Group, 2025.

6. Call for Comments — Principles for Bilateral Market Regulation, Electricity Authority, April 2024.

7. Carbon Pricing in Israel, Ministry of Environmental Protection, 2024.

8. Carbon Pricing in Israel, The Israel Democracy Institute, 2024.

Acknowledgments

We wish to thank all who provided insights, data, and assistance in preparing this Financial Innovations Lab Report.

In particular, we wish to thank the members of the Ministry of Energy and Infrastructure team supporting this initiative, including the former Chief Scientist Gideon Friedman, Dr. Yael Herman, Elad Kalfon, and Sagan, the Director General for Policy and Strategy, Sharon Hatsor.

In addition, thanks to Dr. Amit Mor of Eco-Energy and Reichman University; Rivka Laufer and Amitia Boroshit. Also: Ori Yogev, Alumma Infrastructure Fund; Eilan Gildan, Israel Securities Authority; Menachem Feder, Kaspi and Associates; Adam Ben Yehuda, Bank HaPoalim; Uri Yogev, Israel Electric Corporation and all participants in the Financial Innovations Session in January 2024 and September 2025.

And Milken Fellows Mirit Kuperwasser (Ministry of Environmental Protection/ Tel-Aviv University), Ran Shmueli (Ministry of Energy and Infrastrucutre / Hebrew University); Gil Vardi (Ministry of Finance/ Hebrew University) and Yaakov Furman (Jerusalem Ministry Planning / Hebrew University) who participated in the research and in the laboratory process.

This Lab’s work on climate finance and regional infrastructure is deeply informed by the pioneering insights of Richard L. Sandor, Paula DiPerna, and Frédéric Samama, whose scholarship and professional practice in shaping more efficient and regenerative markets have redefined how financial innovation can be mobilized in service of environmental and social goals. Their contributions to the design of environmental and carbon markets, and to diagnosing the political, behavioral, and institutional roots of climate inaction, have shaped our approach to aligning capital markets with planetary boundaries and long-term resilience.

- Sandor, Richard L. *Good Derivatives: A Story of Financial and Environmental Innovation*. Hoboken, NJ: John Wiley & Sons, 2012.
- Sandor, Richard L., and Paula DiPerna. *Carbon Hunters: Reflections and Forecasts of Climate Markets in the 21st Century*. Singapore: World Scientific Publishing, 2025.
- Samama, Frédéric. *The Enigma of Climate Inaction: Why Are We Doing Nothing (or Almost Nothing) in the Face of Catastrophe?* London: Routledge, 1st ed., 2025/2026.

This document was prepared by the Milken Innovation Center as part of a research grant from the Chief Scientist at the Ministry of Energy and Infrastructure of Israel. The opinions expressed in this document are those of the authors and do not necessarily reflect the position of the Ministry.

COVER PHOTO:

The Ashalim Power Station in Israel's Negev Desert is a $1.13 billion public-private partnership structured as a 25-year Build-Operate-Transfer concession. It runs three competing solar technologies side by side — parabolic troughs, a 260-meter power tower, and photovoltaic arrays — generating operational data to drive down costs and de-risk future investment. Its molten-salt storage system enables 4.5 hours of post-sunset generation, addressing a key constraint in renewable energy finance: guaranteeing dispatchable power. Ashalim serves as a proof-of-concept for how structured finance and technology experimentation can together accelerate energy transitio

Financial Innovations Lab Participants List

Financial Innovations Lab Sessions — January 29, 2024 and September 5, 2025

Name	Affiliation
Adam Ben Yehuda	Bank Mizrahi — Project Finance
Amir Alscheich	Maron Renewal Energy
Amir Foster	Natural Gas Authority
Amir Shavit	Public Utilities Authority (PUA)
Amit Mor	Eco Energy
Asaf Vitman	IPM-BT
Aviv Rotem	Public Utilities Authority (PUA)
Chen Marcini	Noga ISO
Dan Yaron	Keystone Infrastructure Fund
Daniel Papakin	Marom Renewable Energy
Dorit Banet	Eilat Eilot
Eitan Parnas	GreenRG
Elad Shahrabani	Meitar Law Firm
Eli Asulin	Dorad Energy
Eugene Kandel	TASE — Chairman
Galit Cohen	INSS — Program Director, Climate Change and National Security
Gil Vardi	Hebrew University of Jerusalem (HUJI) — Fellow
Glenn Yago	Milken Innovation Center/ Hebrew University
Guy Laken	Hebrew University Ph.D Student / Former Capital Markets Authority
Hagit Ben Hamo	Ministry of Energy
Herut Hasid	Public Utilities Authority (PUA)
Igor Aharonovitch	Noga ISO
Igor Turbenski	Noga ISO
Ilan Gildin	Israel Securities Authority (ISA) — Chief Economist
Iliya Katz	Ministry of Finance — Deputy Director, Budget Division
Itai Gotgelik	Public Utilities Authority (PUA)
Itai Gutlanki	Public Utilities Authority (PUA)
Jenia Gutman	Ministry of Environmental Protection
Liat Simhayoff	EDEN — Deputy Director of Finance

Lior Galo	***Bank of Israel***
May Elin	***Ministry of Finance***
Menachem Feder	***Caspi Law Firm***
Michael Kashani	***Apollo***
Michael Lustig	***NYU Stern School of Business / Former BlackRock, Fixed Income/ Israel Forum for Impact Economy***
Mirit Kupervaser	***Ministry of Energy — Fellow***
Mor Segal	***Ministry of Finance***
Moshe Tzur	***AMTC***
Navot Bar	***Keystone Infrastructure Fund — CEO***
Noga Ben Zadok	***Noga ISO***
Ori Yogev	***Aluma Infrastructure Fund — Chair***
Oz Levi	***Public Utilities Authority (PUA)***
Rachel Segal	***Keystone Infrastructure Fund — CFO***
Ramaz Mahli	***Noga ISO***
Rivka Loifer	***Public Utilities Authority (PUA)***
Ron Shmueli	***Hebrew University/ Milken Innovation Center Fellow/ Ministry of Energy***
Rotem Haba	***Noga ISO***
Samer Haj Yehia	***Reichman University / Former Chairman, Bank Leumi***
Shai Reis	***Noga ISO***
Shany Yarmovski	***Ministry of Energy — Sustainable Energy Economics***
Shimon Sarousi	***Eco Energy***
Tzach Vazana	***EDEN***
Yael Herman	***Ministry of Energy***
Yair Friedman	***Reichman University***
Yakov Fruman	***Hebrew University MBA/ Jerusalem Municipality — Fellow***
Yehudit Greenberg	***Noga ISO***
Yigal Newman	***Hebrew University of Jerusalem***
Yohanan Ratner	***Ratener Energy***
Yoni Sapir	***Israel Planning Authority***
Yotem Ben Shitrit	***Ministry of Energy***
Yuval Ben Ami	***Marom Energy***

Milken Innovation Center
Van Leer Jerusalem Institute
43 Jabotinsky St, Jerusalem 9214116, Israel
Phone: +972.2.5605288
www.milkeninnovationcenter.org