Arab Reform Initiative

POLICY BRIEF

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Improving the Framework for Renewable Energy in Lebanon: Innovative Policies for Wheeling, Decentralized Energy Markets, and Carbon Offsetting

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Lebanon's energy sector suffers from fuel dependency, grid inefficiencies, and delayed reforms, despite legal progress through Laws 462/2002 and 318/2023. To address these challenges and enable a sustainable transition, this brief proposes standardized energy wheeling tariffs, blockchain-enabled peer-to-peer trading, and integration with carbon markets. Priority actions include cost-reflective tariffs and regulatory sandboxes to attract investment, improve resilience, and reduce reliance on diesel.

Context and Problem Statement

Lebanon's electricity sector suffers from chronic structural weaknesses: a heavy reliance on imported fossil fuels, limited generation capacity, an aging and inefficient grid, and persistent power shortages. Despite the adoption of Laws 462/2002 and 318/2023 to promote private-sector participation and renewable energy, these legal frameworks remain incomplete and poorly implemented. Key challenges include the absence of an independent regulator, the lack of transparent wheeling tariffs, the absence of operational peer-to-peer (P2P) trading systems, and the failure to leverage global carbon offset markets.

Meanwhile, decentralized renewable energy solutions have emerged in an uncoordinated and largely unregulated manner, leading to a fragmented transition that exacerbates inequality and excludes vulnerable communities. Lebanon also risks missing out on climate financing opportunities due to the lack of carbon credit integration in its energy strategy.

This paper addresses these gaps by proposing an integrated policy framework focused on three transformative pillars: standardized wheeling mechanisms, digital peer-to-peer energy trading platforms, and the integration of carbon offset markets. It also provides comparative insights, modeling-based tariff scenarios, and actionable recommendations to guide Lebanon toward a more resilient, inclusive, and climate-aligned energy future.

Lebanon's renewable energy transition is hindered by persistent structural and regulatory barriers, despite recent policy improvements. The lack of an independent electricity regulator has caused bureaucratic delays and limited private-sector involvement in renewable energy initiatives. Financial limitations further aggravate the situation because unclear pricing mechanisms and a lack of

investment incentives discourage both domestic and foreign parties from funding renewable energy projects.

Additionally, Lebanon's outdated electrical grid infrastructure limits the effectiveness of energy transfers and P2P energy transactions, making it unsuitable for the effective integration of decentralized renewable energy sources. Since many rural and impoverished communities still rely on expensive and highly polluting diesel generators, energy access disparity is another pressing issue. Furthermore, Lebanon is losing out on global climate funds and on attracting investments in renewable energy projects that support global efforts to reduce emissions since it has not yet fully tapped the potential of carbon offset markets.

With rural and underprivileged areas still depending on costly and extremely polluting diesel generators, there is a clear disparity in energy access. Besides, the decentralized and individualistic character of the current renewable energy initiatives has resulted in inefficiencies, highlighting the necessity of a more coordinated policy approach.[1] Laury Haytayan pointed out that during times of conflict, Lebanon's centralized electricity grid has shown itself to be vulnerable.[2] Communities can maintain dependable power in the event that the national system is disrupted by decentralizing energy production through localized microgrids.

The problems of a fragmented energy transition are addressed in current research and articles, but few practical solutions are suggested.

Standardized wheeling blockchain-based P2P trading and carbon offset integration provide fresh viewpoints on the present discussion and provide policymakers with a more comprehensive arsenal to address Lebanon's energy issues.

Let us examine specific legislative changes that can strengthen Lebanon's renewable energy system, increase private-sector investment, and increase grid efficiency. Stricter transmission and distribution laws, carbon funding, and a decentralized energy market can all hasten Lebanon's clean energy transition while ensuring long-term financial and ecological gains. In fact, extending blockchain-based P2P energy trading and standardized wheeling, both of which are encouraged by Law 318/2023, would further boost market transparency and flexibility in times of crisis. Furthermore, combining renewable energy projects with international carbon offset markets may improve access to climate finance while supporting infrastructure and the economy. These coordinated efforts will result in a strong energy framework that can endure future shocks and guarantee Lebanon's energy security and sustainability.

Proposed Solutions and Analysis

Tariff Design and Wheeling Reforms

Cost-reflective tariff design is a central principle to ensure the financial sustainability of system operators while promoting efficiency and transparency. A focus on non-discriminatory access, where all users are treated equally in accessing transmission and distribution networks, is crucial.

In regulated electricity transmission and distribution systems, remuneration methodologies are essential tools used by regulatory authorities to simulate

1 Laury Haytayan, "Renewable Energy in Lebanon: Chaos, Individualism, and the Drive for Survival" Arab Reform Initiative, 11 October 2024, https://www.arab-reform.net/publication/renewable-energy-in-lebanon-chaos-individualism-and-the-drive-for-survival/

2 "Energy Series | Interview with Laury Haytayan: War and the Future of the Energy Sector in Lebanon" interview by Dala Osseiran, Arab Reform Initiative, 7 March 2025, https://www.arab-reform.net/publication/interview-with-laury-haytayan-war-and-the-future-of-the-energy-sector-in-lebanon/

market conditions, ensure fair returns for operators, and align economic incentives with public policy objectives. These methodologies typically combine cost-based approaches covering capital expenditure (CAPEX), operational expenditure (OPEX), depreciation, taxes, and a fair return on equity with incentive-based mechanisms that promote efficiency, innovation, and improved service quality. By defining "allowed revenues," regulators enable companies to recover their efficient costs while protecting consumers from excessive pricing through transparent and predictable tariff-setting processes. Additionally, the tariffication framework shall account for peak demand and network usage as major cost drivers, and it should ensure transparency and predictability in tariff-setting to enable long-term investment planning and fair cost recovery in the context of evolving electricity markets, including wheeling services.

A well-designed remuneration framework balances multiple goals: it encourages timely investment in infrastructure, ensures cost recovery, attracts private capital, and supports long-term sector sustainability. The calculation of the Weighted Average Cost of Capital, incorporating variables such as gearing, risk-free rates, market risk premiums, and tax rates, is central to defining fair returns. In practice, countries like Portugal apply these principles with adaptations such as indexation mechanisms linked to financial market indicators to maintain regulatory stability while responding to evolving economic conditions. This structured approach ensures that remuneration systems support not only economic efficiency but also broader goals such as decarbonization and energy transition. In the case of energy wheeling, the costs associated with using the transmission and distribution network must reflect these regulated components to ensure fairness and non-discrimination. Proper allocation of wheeling charges based on actual network usage helps maintain cost-reflective tariffs and supports the financial sustainability of grid operators.

In Türkiye's electricity market, regulated tariffs are defined through a structured legal and regulatory framework grounded in the Electricity Market Law No. 6446 and supporting secondary legislation. Tariffs are categorized across transmission, distribution, retail, last resort supply, connection, and market operation services. These tariffs are designed to be cost-reflective, ensuring recovery of justified expenditures, including OPEX, targeted energy losses, and regulated profit margins. Transmission and distribution tariffs follow principles of non-discrimination and are shaped by network topology, peak demand projections, and cost structures, with differentiated charges across voltage levels and user categories. Retail tariffs vary by consumer consumption levels, encouraging larger consumers to transition to competitive markets through higher last resort tariff rates, thus promoting market liberalization.

The revenue requirement setting for all market actors, including system operators and the market operator, relies on predefined methodologies involving allowed costs and efficiency benchmarks. Notably, the market operation tariff allocates revenue needs across electricity market segments based on workload and participation volume. Like in other regulated frameworks, energy wheeling in Türkiye involves charges embedded within the transmission and distribution tariffs. These costs are critical for recovering network investment and operational expenses related to the use of infrastructure for wheeling electricity across regions or between third parties.

In Lebanon, energy wheeling, for instance, is permitted by Law 318/2023; however, investors are concerned because there are no implementation criteria or fixed costs. It is necessary to implement a nationwide wheeling tariff structure, which is part of the regulator's role, among other duties, that includes real-time energy flow monitoring and distance-based pricing models that vary according to voltage levels. Grid usage fees would be determined transparently as a result. Furthermore, regulatory supervision is essential to preventing monopolistic practices and maintaining fair and cost-reflective rates. The regulatory certainty needed to promote

greater private-sector participation and facilitate the widespread integration of renewable energy would be provided by an open and consistent wheeling system. To monitor energy flows and ensure that grid use rates are determined transparently, a real-time monitoring system must be put in place.

The implementation of electricity wheeling in Lebanon requires a transparent and economically viable tariff structure that ensures fair cost recovery while encouraging private-sector participation in renewable energy. In European markets, such as Germany, France, and Spain, wheeling costs range between 3 to 8 US¢/kWh, accounting for 15–30% of renewable energy prices and 15–25% of conventional tariffs. In the MENA region, wheeling costs tend to be lower in absolute terms, with Jordan, Egypt, and Morocco reporting values between 0.6 and 1.4 US¢/kWh, representing 10–28% of RE prices and 5–10% of conventional prices.

The wheeling fee, expressed in USD per kilowatt-hour (kWh), is shaped by several interdependent variables, particularly the cost of technical losses, the wheeling distance, the regulatory (Energy Regulatory Authority) fee, and the volume of energy transmitted. An in-depth sensitivity analysis of these parameters provides insight into their respective impacts on overall tariff levels and highlights critical considerations for tariff design. The following section presents the key findings from the sensitivity analysis conducted to evaluate the cost components influencing the wheeling fee.

Technical losses represent one of the primary cost drivers of wheeling. These losses occur naturally during the transmission and distribution of electricity and are valued based on the marginal cost of energy production. In the modeling, the assumed loss rate varies by voltage level: 9% at 11 kV, 6% at 33 kV, 4% at 66 kV, and 2% at higher voltages (≥220 kV). When applying a 6% loss rate at 33 kV, a transmission distance of 50 km, and 1 GWh of annual wheeled energy, the wheeling fee increases from approximately 0.1 to over 2.5 USD cents/kWh as the cost of each kWh lost rises from 0 to 39 USD cents /kWh. As a result, when the marginal cost of generation is high due to fuel scarcity or other market factors, the wheeling fee can consume a significant portion of a low feed-in tariff (e.g., 5.7 USD cents/kWh), posing a potential barrier to economic viability for renewable energy producers.

Wheeling distance also exerts a linear influence on the tariff, primarily through its impact on operation and maintenance costs and associated technical losses. At 11 kV and a constant loss cost of 3 USD cents/kWh (with a 9% loss rate), the wheeling fee increases from 0.32 to 0.57 USD cents/kWh as distance expands from 0 to 145 km. This corresponds to an increase of approximately 0.1 USD cents/kWh for every additional 10 km. At higher voltage levels, such as 220 kV, the effect of distance is more modest due to reduced losses. Under similar conditions, the fee increases from just 0.09 to 0.329 USD cents/kWh across the same distance range, indicating a more predictable and manageable cost trajectory for long-distance transmission when operating at higher voltages.

In accordance with Law 462/2002, the Energy Regulatory Authority (ERA) is legally empowered to recover regulatory costs through fixed fees applied to end-users' electricity bills, conditioned to be less than 1% of the total bill. In the context of wheeling, the ERA fee can be modeled as a fixed annual amount distributed proportionally across total wheeled energy. When the ERA fee increases from 13 to 200 USD/year and the wheeled volume remains constant at 1 GWh/year, the wheeling fee rises only modestly from 0.307 to 0.372 USD cents/kWh. Although relatively small in absolute terms, the fee can represent up to 6.5% of the total wheeling cost when energy volumes are low. This highlights the need to size the ERA fee proportionately and transparently, especially during early market development, to avoid deterring participation.

Among all variables, the volume of energy wheeled exerts the strongest influence on the unit cost of wheeling. Fixed charges such as regulatory fees, metering, and monitoring costs are significantly

diluted over larger energy volumes. At very low levels of annual wheeled energy (e.g., 1,000 kWh/year), the wheeling fee can exceed 1 USD/kWh, making the service economically unfeasible. Assuming a renewable energy price of 5.7 US cents/kWh, the wheeling cost falls below 10% of this price when the energy wheeled exceeds 200 MWh. At volumes of 85 GWh/year, the fee falls to as low as 1% of the RE selling price for the 220 kV network. This sharp decline confirms the existence of strong economies of scale and underscores the importance of targeting large consumers or aggregated demand in the early stages of market development.

In light of these findings, a multi-component wheeling tariff structure is recommended. The proposed design includes a variable charge per kilometer to reflect distance-related grid use, a fixed regulatory and metering fee aligned with ERA's legal mandate, and a loss-adjustment factor based on voltage level and transmission distance. Such a framework promotes fairness, cost recovery, and market efficiency, while enabling broader integration of renewable energy sources and fostering private-sector investment in Lebanon's energy transition.

Peer-to-peer Trading

Regulatory oversight is also necessary to prevent monopolistic pricing practices and ensure that tariffs remain fair and economical. Lebanon might encourage the private sector to increase its contribution to the production of renewable energy and encourage the broad use of clean energy technology by standardizing and openly regulating the wheeling price. Specifically, a standardized wheeling method requires a clear, consistent wheeling tariff structure that can be tracked in real time.

P2P energy trading is specifically acknowledged by Law 318/2023 as a decentralized electricity exchange mechanism that permits independent producers and consumers to engage in business within a regulated environment. However, there are still no comprehensive implementation recommendations available. Creating a digital platform that uses smart contracts and blockchain technology to enable safe and transparent transactions is essential to the success of P2P energy trading. Direct energy sales would be possible with this platform, which would also ensure that grid operators receive just remuneration and save transaction costs. To provide precise guidelines for pricing, transaction fees, and grid operators' support of P2P exchanges, regulations must be improved. Lebanon should unleash the potential of decentralized energy trading by incorporating these measures within the legal framework of Law 318/2023. This would encourage investment in small-scale renewable projects and give customers competitive access to clean electricity.

More regulatory elaboration is needed to establish clear rules about pricing, transaction fees, and grid operators' participation in facilitating P2P exchanges. The regulatory authority should first establish standardized smart metering and data-sharing protocols to monitor energy flows among peers in order to facilitate successful adoption. The next step is to develop a license and registration procedure that covers pricing methods, transaction fees, and dispute resolution for P2P systems and users. In addition, grid operators must be required to provide both financial and technical assistance for P2P transactions, with remuneration plans that take into account their contribution to system stability. These actions would help establish the foundation for a transparent, safe, and expandable P2P energy market.

By fully integrating these measures within Law 318/2023's legal framework, Lebanon can achieve the promise of decentralized energy trading. In addition to giving customers access to reasonably priced, clean electricity, this will promote investment in small-scale renewable energy projects.

Initiatives using renewable energy have the potential to further under-serve disadvantaged groups while favoring a select few if they are not coordinated.

To ensure fair and sustainable local energy solutions, municipalities could contract private firms to supply renewable energy services using a standardized Power Purchase Agreement model. Furthermore, decentralized energy solutions can be evaluated and validated in a regulatory sandbox prior to widespread adoption, ensuring that these breakthroughs address both technological and socioeconomic problems.

Carbon Offset Integration

Finally, Lebanon has a fantastic opportunity to integrate its expansion in renewable energy with global carbon offset markets to allow local projects to generate certified carbon credits that can be sold to buyers elsewhere. Lebanon can create new revenue streams for its solar, wind, and micro-hydro projects by implementing international standards such as the Gold Standard or the Verified Carbon Standard. P2P energy trading networks may be incorporated into carbon credit markets, allowing decentralized renewable energy producers to benefit from lower emissions.

By linking wheeling and microgrid projects to emissions reduction targets through initiatives like the World Bank's Carbon Pricing Initiative and the Green Climate Fund, Lebanon can attract international climate investment in addition to directly producing carbon credits. Local private-sector companies striving to meet sustainability goals can be encouraged to purchase carbon credits from Lebanese renewable energy projects to further promote a domestic carbon market that stimulates additional investment in clean energy solutions.

Recommendations and Conclusions

The adoption of these policy changes will be extremely beneficial to Lebanese communities. If decentralized renewable energy sources were more widely accessible, they would drastically reduce the cost of electricity for individuals and businesses. P2P trading platforms and microgrids could reduce the country's reliance on diesel generators, which would lower the cost of importing fuel and reduce price volatility.

The growth of employment in the technology, energy services, and renewable energy sectors is another significant benefit of the transition to a more dynamic and decentralized energy market. Reducing the use of diesel fuel will also significantly lessen air pollution, enhancing public health and reducing the incidence of respiratory diseases, particularly in urban areas. Rural and impoverished communities, who have long experienced unreliable and costly electrical access, would particularly benefit from the provision of regular and affordable electricity through localized renewable energy solutions.

The proposed legislative changes will help Lebanon transition to a more resilient, decentralized, and market-driven energy system. Adopting a unified wheeling system will facilitate the integration of massive amounts of renewable energy into the grid and assist Lebanon in drawing in more investment. P2P energy trading networks would encourage competition and innovation by enabling small-scale producers to participate in the energy market. Allowing municipalities to build microgrids will increase energy security and provide long-term access to electricity for under-served communities.

Environmentally speaking, these measures will lead to a significant decrease in greenhouse gas emissions since renewable energy sources will take the position of fossil fuel-based electricity

generation. Furthermore, adding Lebanon's renewable energy projects to carbon offset markets would create new funding opportunities and ensure that the country benefits as much as possible from its energy transition in terms of both the economy and the environment. By assisting Lebanon in meeting its commitments under the Paris Agreement, these actions would strengthen its role in global efforts to slow down climate change.

To implement these reforms, a multi-stakeholder working group should be established, comprising representatives from the Ministry of Energy and Water, the private sector, and municipal authorities. Initial pilot projects should explore P2P energy trading, decentralized microgrid models, and wheeling mechanisms. Legislative adjustments should be made if necessary to align these developments with Lebanon's evolving energy environment. Finally, to help Lebanon secure foreign funding and raise its profile in the global transition to sustainable energy sources, aggressive steps should be taken to integrate renewable energy projects into carbon offset markets.

In summary, key recommendations include:

- Establishing standardized energy wheeling mechanisms with transparent, distance and loss-based tariffs to encourage private investment and fair grid access.
- Enabling P2P energy trading through blockchain-based platforms to facilitate decentralized electricity exchanges, as permitted under Law 318/2023.
- Integrating renewable energy with global carbon offset markets, allowing Lebanon to monetize emissions reductions and access climate finance.
- Proposing tariff structures to ensure cost-reflective pricing, incentivize efficiency, and provide predictable returns for investors, modeled after best practices in countries like Türkiye and Germany.
- Expanding decentralized microgrids to improve resilience in rural and vulnerable communities while reducing reliance on diesel generators.
- Creating regulatory sandboxes and standardized Power Purchase Agreements to pilot new technologies and ensure inclusive energy access.

About the Arab Reform Initiative

The Arab Reform Initiative is an independent Arab think tank working with expert partners in the Middle East and North Africa and beyond to articulate a home-grown agenda for democratic change and social justice. It conducts research and policy analysis and provides a platform for inspirational voices based on the principles of diversity, impartiality, and gender equality.

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