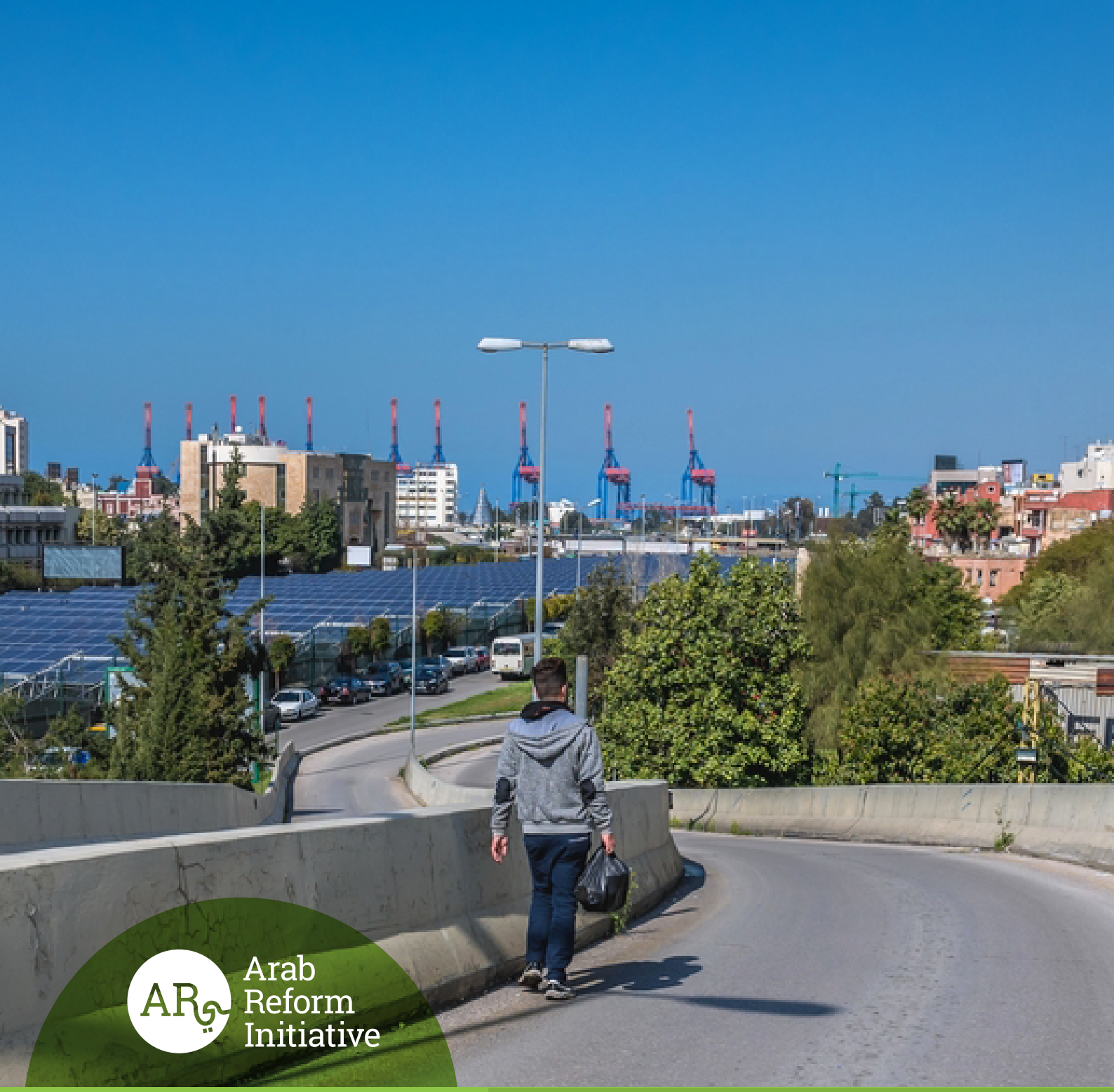

Arab Reform Initiative

ENVIRONMENTAL POLICIES SERIES

# SOLAR POWER EQUITY IN LEBANON

Ibrahim Olleik

## About the Author

Ibrahim is an engineer and policy professional with a passion for sustainable solutions to the global energy and environmental challenges. He utilises his engineering and policy expertise to promote environmental justice and a cleaner future.
Ibrahim graduated from the American University of Beirut.



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# Executive Summary

This paper highlights the pressing need for a clean and equitable energy transition in Lebanon and is situated within the global context of energy security, equity, and sustainability. The aftermath of the COVID-19 pandemic and geopolitical tensions, resulting from the Russia-Ukraine conflict, have globally amplified the energy challenges, especially for countries that have an already struggling with their energy sector. In Lebanon, an inefficient and debt-ridden electric energy sector further exacerbates these issues, with the country's energy equity ranking among the lowest worldwide. The paper uses the aggregated Energy Equity Index (EEI) as a tool to assess accessibility, affordability, and economic development in Lebanon's energy landscape. Sensitivity analysis reveals that the integration of solar energy can significantly improve energy equity. The paper advocates for regulatory reforms in the private generator sector, increased solar energy adoption, and the implementation of smart metering to efficiently monitor and manage electric energy. By addressing these challenges and adopting these reforms, Lebanon can advance toward a just energy transition.

# Introduction

Driving a clean and just energy transition continues to be a complex problem. Balancing the dimensions of energy security, energy equity, and sustainability is essential to contributing towards maintaining thriving economies and ensuring the lifeline of modern societies.

The lasting impact of the COVID-19 pandemic and the Russia-Ukraine war on energy infrastructure is still noticeable, as energy supply struggles to meet growing demand, and fuel prices remain higher compared to the pre-pandemic period. In response to the ongoing Russia-Ukraine conflict, the EU has collectively decided to reduce its dependence on Russian natural gas imports from 45% to 10% by January 2023 (International Energy Agency, 2023). This resulted in damaging the energy supply chain, causing many EU countries to opt for alternatives from other parts of the world other than Russia, thus increasing the demand for oil and gas, which spiked fuel prices worldwide. The widespread repercussions of the escalating energy prices have had a ripple effect globally, leading to complex crises especially in the economies of the global south countries that were already living in a state of permanent energy crisis, lacking access to the clean and convenient forms of energy that are essential to healthy and productive lives in the society. Considering the above, the unprecedented surge in energy prices severely affected affordability, with poor households being most affected. High energy prices due to interconnected energy supply chains sparked food inflation, exacerbating the cost-of-living crisis in many countries. Moreover, emerging economies are under an increasing debt burden due to monetary policy responses to control inflation. This aggravates the challenge of attracting low-cost capital on a large scale to finance energy expenditures in emerging economies, thus slowing the rate of just transition of countries that aim to transition to cleaner and more affordable energy.

The World Energy Council (WEC) is a network of worldwide energy professionals that promote affordable, stable, and environmentally sensitive energy systems, thus facilitating the world's energy policy dialogue. The WEC's Trilemma Index is a tool designed to evaluate a country's energy sustainability performance through three key dimensions: Energy Security, assessing reliable and available energy supply; Energy Equity, considering accessibility and affordability for all; and Environmental Sustainability, evaluating the environmental impact of the energy system. By ranking countries annually, the aims to promote energy policies that effectively balance these dimensions, encouraging comprehensive approaches to address energy security, equity, and sustainability challenges on a global scale.

The core objective of the paper is to undertake an in-depth examination of energy equity in Lebanon. It seeks to identify possible opportunities and recommendations to utilize off-grid solar energy systems for Lebanese households to mitigate the current inequality in the electric sector. The paper aims to analyse the existing energy equity challenges through developing an Energy Equity Index (EEI), evaluate the performance of EEI, and propose recommendations to enhance energy equity.

# Overview of Lebanese electric energy sector

Lebanon's economic and financial crisis that afflicted Lebanon had its origins in a prolonged period of neglect since the civil war. While not the primary initiator of this crisis, issues within the power sector have played a substantial role in both exacerbating and exposing the underlying governance problems at the core of this crisis.

The Lebanese public utility (Electricite Du Liban), the state-owned utility, holds a monopoly on electricity generation, transmission, and distribution, excluding hydroelectric concessions. EDL facing, amounting to approximately $1.5 to $2 billion per year over the past decade. These deficits have contributed significantly to Lebanon's public debt, with the energy sector's spending and subsidies accounting for approximately 40% of the total debt since 1992. It is worth mentioning that the primary objective of these subsidies was to shield low-income individuals from the volatility of fuel prices. However, it is widely recognized that such subsidies tend to disproportionately benefit the wealthiest segments of a country's population due to their higher consumption levels.

One exception exists under the private concession which permits EDL to contract the private company, Electricity of Zahle (EDZ), to generate and supply electricity for 24 hours within the geographical area of Zahle, where the 24-hour power supply from the government is absent all over Lebanon. EDZ has achieved a high-quality electricity service amidst a dysfunctional and corrupt national electricity system. EDZ stands out as one of the largest privately managed concessions in Lebanon, covering vital economic areas and consistently providing 24/7 electricity coverage. However, questions arise regarding its sustainability through using private gensets. The EDZ case also highlights potential rent-seeking practices and sparks debates on decentralization within the country's power sector. Despite EDZ's success in navigating the challenges of a dysfunctional national electricity system, concerns about its long-term viability and the broader implications for Lebanon's power sector remain.

In contrast to the relative success of EDZ, the broader power sector in Lebanon faces significant problems. Unfortunately, government budget support has primarily focused on fuel and operational expenses, rather than effectively addressing the widening gap between supply and demand that is covered by polluting and expensive diesel generators. As a result, the sector suffers from inefficiencies, underinvestment, and poor management practices.

Furthermore, the absence of a stable regulatory framework has hindered the successful implementation of ambitious renewable energy plans in Lebanon that offer a rare opportunity to transform the sector positively. Law No. 462, passed in 2002 by the parliament, aimed to reform the electricity sector to break the monopoly held by the EDL over the generation, transmission, and distribution of electricity. The establishment of this law aimed to unbundle the power sector with the involvement of private producers and an authority to regulate the market, the independent Electricity Regulatory Authority (ERA). However, the ERA has never been created, which hindered the implementation of the Decentralized Renewable Energy (DRE) law that was introduced in 2022. Through this law, electricity produced from less than 10 MW renewable energy systems could be fed into the main grid or sold between customers through peer-to-peer trading.

Amid the global efforts of energy policy leaders to harmonize the pursuit of an equitable transition alongside security and sustainability dimensions, Lebanon's ranking in their assessment stands as the lowest among the 127 scrutinized nations. This weak performance is primarily attributed to the significant dependence on energy imports.

Lebanon possesses substantial untapped potential in renewable energy sources, yet merely 7.83% of the nation's energy mix is derived from renewable sources, including hydropower. The governmental target of reaching 30% of its energy generation through renewables could potentially lead to annual savings of around $250 million by eradicating the necessity for fossil fuel imports.

For almost 30 years, Lebanese authorities have failed – through unsustainable policies and neglect – to properly manage the electricity system, resulting in widespread blackouts that are violating the right of Lebanon's population to electricity and adequate standard of living as well as damaging the tourism industry where many hotels were forced to close in 2022 due to the continued electricity crisis. This weakened Lebanon's ability to set up an equitable energy system.

Energy equity concept, grounded in principles of social justice, asserts that access to affordable and reliable energy is not only a fundamental human right but also a crucial element in alleviating poverty and enhancing our overall quality of life. Unfortunately, this fundamental right is notably lacking in Lebanon, as underscored by the findings of the Human Rights Watch.

# Development of the Index

The question of how to enable an effective, modern, global energy transition is gaining significant interest in both academic and policy-making communities. Composite statistical indices have emerged as a useful class of tools to offer policy-makers additional insights into the state and trajectory of energy transitions around the world. For this purpose, the World Economic Forum developed the Energy Transition Index (ETI) to capture both the energy transition and transition momentum of energy systems of countries around the world. ETI involves the energy equity dimension that assesses a country's performance in providing reliable access to affordable energy which will in turn benefit economic prosperity, especially for underserved and marginalized populations. The selection of the metrics that constitute the energy equity dimension is determined by conceptual relevance to the energy system. The equity dimension is represented by the following indicators: energy access, energy affordability, and economic development.

In this research, a thorough assessment is conducted focusing on the Lebanese situation from 2013 to 2023. This timeframe was selected to encompass all the relevant and available data on the three indicators under consideration.

The energy accessibility indicator assesses the percentage of the population with electricity access in Lebanon. For energy affordability, electricity costs were analyzed, focusing on the rate for private generator subscriptions, as Lebanon's public utility provision is extremely limited, and many bills go unpaid. Finally, the economic prosperity dimension is gauged through GDP per capita.

In constructing the index, metrics were normalized on a 0-1 scale for consistency. Then, a weighting scheme is applied, considering the indicators' relevance to Lebanon's energy equity objectives. Further details on data and methodology can be found in Appendix A.

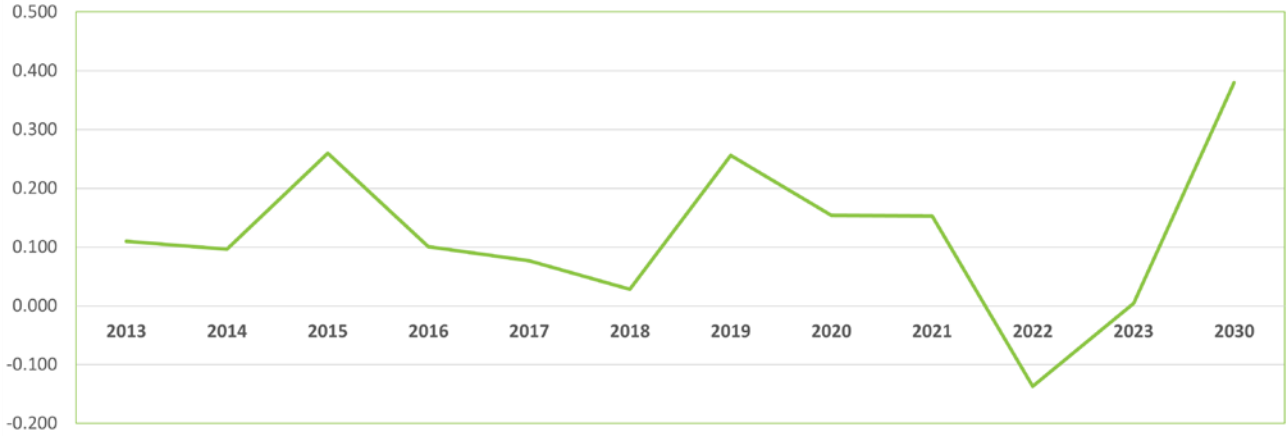
## Sensitivity Analysis

Conducting a sensitivity analysis by varying the affordability indicator is a crucial step in predicting potential changes in the Energy Equity Index. This analysis involves systematically adjusting electricity prices used in the index calculations, providing valuable insights into how fluctuations in energy costs can impact the overall equity of an energy system. It is worth mentioning that the current and previous electricity prices represent the average private generator prices as priced by the Ministry of Energy and Water in Lebanon, while the projected price of electricity used for 2030 represents the price of off-grid solar energy.

Renewable energy, especially solar power, offers significant benefits to electricity consumers, including cost savings and environmental benefits. In Lebanon, solar power adoption has surged by 2500% in the last decade, driven by factors like the economic crisis, the end of diesel subsidies, and EDL's power generation challenges. While solar has high upfront costs, its low and predictable operating expenses provide consumers with protection against price fluctuations and private generator monopolies in Lebanon.

The projected electricity price for 2030 is $0.045 per kilowatt-hour (kWh), representing the cost of solar energy from off-grid systems, the most common solar setup in Lebanon. Access to electricity for Lebanese citizens is expected to remain at 2023 levels in this projection, while economic development is forecasted to increase by 8% from 2023 to 2030.

**Figure 1. Aggregated EEI results by year**



# Results of the Index

The aggregated index results, presented in Figure 1, reveal fluctuations in the EEI, showing periods of improvement and decline. In the initial year of the study, 2013, the EEI stood at 0.11. It then experienced a steady increase, reaching its peak at 0.256 in 2019. Subsequently, the EEI declined to its lowest point at -0.137, which is primarily attributed to the increase in subscription costs for generators in Lebanon. It saw a slight increase to 0.004 in 2023, primarily due to the decrease in average annual subscription prices for generators during that year.

It is evident from the results of the EEI that energy equity in Lebanon is largely affected by the relatively high prices of electricity supplied through private generators.

# Sensitivity Analysis Results

The sensitivity analysis results provide valuable insights into the impact of integrating off-grid solar energy into Lebanese households on the EEI in Lebanon. Presently, the cost of an off-grid solar energy system in Lebanon stands at $0.049/kWh, with projections indicating a further reduction to $0.045/kWh by 2030.

The results reveal a remarkable EEI value of 0.38, as depicted in graph 1. This significant increase is attributed to the reduction in electricity prices resulting from the utilization of solar energy in Lebanese households, translating into substantial savings of 77% on electricity costs in Lebanese households.

# Recommendations

Lebanon has a unique opportunity to revolutionize its electricity sector, making it fairer, greener, and more inclusive. The current economic crisis has laid bare the weaknesses of the energy system, necessitating a set of policy recommendations to enhance energy equity and advance toward a just transition:

- Regulation of private generators: The average Lebanese household dedicates around 44% of its monthly income to private generator subscriptions, according to a 2023 Human Rights Watch report, straining budgets and risking financial stability. Therefore, the Lebanese authorities should enforce regulations on monopolistic private generators. Such regulations should protect consumers from unregulated tariffs and include mandates for meter installation and emission filters. Additionally, integrating these generators into a unified grid with photovoltaic (PV) panels could improve efficiency and sustainability.
- Solar energy transition: Recognizing the role of solar energy in mitigating high electricity costs and frequent blackouts, Lebanon should establish robust regulatory frameworks that ensure solar systems installations adhere to the latest technical standards of efficiency and safety as multiple system failure incidents occurred (such as fires, failure due to lightning strike, etc.) in Lebanese households recently due to the lack of safety measures. Furthermore, both Lebanon and international donors supporting the electricity sector should prioritize funding for a complete transition to renewable sources, with a particular emphasis on solar power.
- Smart meter implementation: The government should promote the deployment of smart meters capable of accurately monitoring energy production and consumption. The current EDL distribution network needs to be reformed and controlled to withstand the input from renewable resources. The meters will serve as the foundation for a peer-to-peer energy trading system, enabling broader participation in the renewable energy transition. This approach empowers those with limited rooftop space or financial resources to access and purchase surplus solar energy at competitive rates from their neighbors, reducing dependence on expensive private generators and conventional energy sources.

Addressing the challenges highlighted in this research and implementing strategic reforms can help Lebanon move towards a more efficient, sustainable, and resilient electricity sector, ensuring reliable and equitable access to electricity while minimizing environmental impact and alleviating the national budget.

## Appendix A

*Table 1. EEI indicators during the period studied.*

| | Energy Equity Dimensions | | |
|---|---|---|---|
| | **Energy Access** | **Energy Affordability** | **Economic Development** |
| Year Indicator | **Access to Electricity (%)[1]** | **Electricity prices ($/kWh)** | **GDP per capita ($)[2]** |
| 2013 | 99 | 0.27 | 8256 |
| 2014 | 99.7 | 0.28 | 7666 |
| 2015 | 99 | 0.16 | 7803 |
| 2016 | 99 | 0.14 | 8173 |
| 2017 | 99 | 0.18 | 8680 |
| 2018 | 99 | 0.25 | 9226 |
| 2019 | 100 | 0.26 | 8926 |
| 2020 | 100 | 0.2 | 5600 |
| 2021 | 100 | 0.14 | 4137 |
| 2022 | 100 | 0.51 | 6439 |
| 2023 | 100 | 0.35 | 5802 |
| 2030 | 100 | 0.045 | 6780 |

1 https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=LB

2 https://databank.worldbank.org/metadataglossary/statistical-capacity-indicators/

**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.

contact@arab-reform.net
Paris - Beirut - Tunis