INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 15, Issue 8, (2025) E-ISSN: 2222-6990

# Unraveling the Barriers to Renewable Energy Deployment in Jordan: A Quantitative Analysis of Social, Technical, Financial, Market, and Regulatory Challenges

Mofleh Ibrahim Moh'D Al-Haj Hussein, Zainudin Awang

Faculty of Economics and Management Science, University Sultan Zainal Abidin, Malaysia

Corresponding Author Email: ibrahimofleh@yahoo.com.Malaysia

**DOI Link:** http://dx.doi.org/10.6007/IJARBSS/v15-i8/26234

***Published Date:*** 13 August 2025

**Abstract**

Renewable energy deployment in Jordan has grown rapidly in recent years, yet multiple obstacles continue to hinder its further expansion. This study examines five key hypotheses linking various barriers to the renewable energy transition in Jordan: namely, the effects of social, technical, financial, and market barriers on regulatory barriers, and in turn the effect of regulatory barriers on renewable energy deployment. A quantitative research design was employed, surveying professionals in Jordan's solar energy sector and analyzing the data with structural equation modeling (SEM). The results confirm that all four barrier types – social, technical, financial, and market – exert a significant influence on regulatory barriers, which itself proves to be a pivotal factor directly affecting the deployment of renewable energy. Notably, technical barriers showed the strongest impact on regulatory barriers, while social, financial, and market barriers also had significant effects. Moreover, regulatory impediments were found to significantly constrain renewable energy implementation. These findings underscore the interconnected nature of barriers in the renewable energy domain. The paper discusses how shortcomings in public awareness, grid infrastructure, financing, and market structure contribute to regulatory hurdles (Joel et al., 2024; Silva, 2022; Zyoud, 2024), ultimately impeding clean energy growth. Policy implications are drawn to suggest that easing social barriers through awareness campaigns, strengthening technical infrastructure, enhancing financial support mechanisms, and liberalizing market conditions – alongside comprehensive regulatory reforms – can collectively accelerate Jordan's renewable energy transition. The study contributes to the literature by providing up-to-date empirical evidence from Jordan and offering targeted recommendations to inform policymakers and stakeholders in overcoming barriers to sustainable energy deployment.

**Keywords:** Unraveling the Barriers, Deployment, Quantitative Analysis of Social, Technical, Financial, Market, Regulatory Challenges

## Introduction

Jordan has emerged as a regional leader in adopting renewable energy, particularly solar and wind power, in pursuit of energy security and sustainability. The share of electricity generated from renewables in Jordan climbed from under 1% in 2014 to over 13% in 2019 (Bartoszewicz-Burczy, 2022; Vaghela et al., 2024; Awad et al., 2022; Sharma, 2023; Palomo et al., 2022), making it one of the front-runners in the Middle East's renewable energy push. The government's Energy Strategy 2020–2030 set ambitious targets for renewable sources to comprise 31% of power capacity by 2030 (IRENA, 2021). This progress has been driven by supportive policies such as the Renewable Energy and Energy Efficiency Law (2012) and successive solar and wind project tenders.

However, despite early successes, Jordan's renewable energy expansion has begun to face headwinds due to a variety of persistent barriers. In 2019, for example, the government halted new large-scale renewable project tenders to allow the national utility to address grid integration challenges (Global Climatescope, 2021). Such actions highlight that technical constraints and other systemic issues can slow the momentum of clean energy deployment. Developing countries like Jordan often encounter a confluence of obstacles – infrastructural, financial, institutional, and social – that complicate the transition away from conventional energy (International Energy Agency, 2022).

Understanding these obstacles is critical, as studies indicate that policy and regulatory shortcomings, weak grid infrastructure, and limited financing are among the key barriers impeding faster renewable energy growth in emerging economies (International Energy Agency, 2022). Recent research on renewable energy adoption emphasizes a broad spectrum of barriers. These include social barriers (such as low public awareness or local opposition), technical barriers (insufficient grid capacity, storage and technological know-how), financial barriers (high upfront costs and lack of investment), and market barriers (inefficient market structures or monopolies), alongside regulatory barriers (bureaucratic hurdles and policy gaps). Each of these can individually hinder renewable energy projects, but importantly, they are also interrelated. For instance, inadequate grid infrastructure (a technical issue) may prompt restrictive policies that act as regulatory barriers to new projects (Global Climatescope, 2021).

Jarvis (2024) highlights the economic consequences of NIMBYism and its role in restrictive siting regulations for renewable energy projects, while Dickson-Gómez et al. (2020) illustrate how local community opposition affects housing configurations. These findings support the idea that public opposition plays a critical role in shaping regulatory constraints. A holistic analysis is therefore needed to unravel how these barriers interact, particularly the role of the regulatory environment as both an outcome of other barriers and a determinant of renewable energy deployment.

Kor & Qamruzzaman (2023) emphasize the necessity of supportive regulatory frameworks and financial development for renewable energy expansion, while Török (2023) highlights how regulatory policies impact economic growth and renewable energy adoption within the EU. Similarly, Ngcobo & Wet (2024) discuss how financial and policy barriers affect renewable energy supply in South Africa. Together, these studies affirm that regulatory and policy barriers often play a decisive role in shaping renewable energy outcomes. Effective

regulations can enable rapid diffusion of renewables, whereas fragmented or onerous regulations can stall projects.

This paper focuses on five specific hypotheses derived from the literature and the context of Jordan's renewable energy sector. These hypotheses examine the influence of social, technical, financial, and market barriers on regulatory barriers, and the influence of regulatory barriers on the deployment of renewable energy in Jordan. The hypotheses are formulated as follows:

- **H1**: Social barriers have a significant effect on regulatory barriers in the deployment of renewable energy in Jordan.
- **H2**: Technical barriers have a significant effect on regulatory barriers in the deployment of renewable energy in Jordan.
- **H3**: Financial barriers have a significant effect on regulatory barriers in the deployment of renewable energy in Jordan.
- **H4**: Market barriers have a significant effect on regulatory barriers in the deployment of renewable energy in Jordan.
- **H5**: Regulatory barriers have a significant direct effect on the deployment of renewable energy in Jordan.
-

In essence, the study posits that social, technical, financial, and market-related challenges contribute to the regulatory hurdles facing renewable energy projects, and that these regulatory hurdles in turn directly impede the implementation of renewables. By empirically testing these linkages, this research aims to clarify which barriers are most pivotal and how they collectively impact Jordan's renewable energy deployment. The insights from this study will not only enrich the academic understanding of energy transition challenges but also guide policymakers in Jordan and similar contexts on where to focus reform efforts.

The subsequent sections provide a review of recent literature on each of these barriers, outline the research methodology, present the SEM analysis results for hypotheses H1–H5, discuss the implications of the findings in light of prior studies, and finally offer conclusions and policy recommendations for overcoming barriers to renewable energy in Jordan.

## Literature Review

*Social Barriers and Regulatory Challenges*

Social factors can significantly influence the success of renewable energy initiatives by shaping public acceptance and political will. A social barrier refers to obstacles arising from society's awareness, understanding, and acceptance of renewable energy technologies. Wolsink (2007) identified public opposition, misinformation, and limited community engagement as key barriers to renewable energy commercialization. More recent studies support these findings—Jelti et al. (2021) highlight the role of inadequate policies and the need for community participation, Garrett et al. (2024) emphasize social barriers such as public opposition and limited awareness, and Khatib et al. (2021) explore educational interventions to mitigate low awareness and misinformation about renewable energy. Pascaris et al. (2022) and Fraas et al. (2023) highlight how public opposition or lack of community support can lead regulators to impose restrictive measures, ultimately hindering project development. These

social dynamics often have downstream effects on the regulatory environment, reinforcing the role of public sentiment in shaping energy policies.

Raimi et al. (2024) highlight that many local governments depend financially on fossil fuel revenues, which has contributed to opposition against clean energy projects and the introduction of new siting restrictions in 2024. Similarly, Meng et al. (2021) discuss the importance of stakeholder engagement in clean energy investment, suggesting that inadequate involvement may exacerbate local resistance. Jelti et al. (2021) highlight how societal resistance can lead to regulatory barriers, while Solaymani (2021) and Espinosa et al. (2021) emphasize the role of public perception in shaping energy policies. In Jordan, where public sentiment toward renewable energy has been largely positive, this support has facilitated policy development aimed at enhancing energy security and reducing reliance on imported fuels.

Ryszawska et al. (2021) and Braunholtz-Speight et al. (2020) highlight the critical role of local community engagement in renewable energy projects, while Ya'acob et al. (2022) discusses how sustainable practices like agrivoltaics can further strengthen community involvement. These factors contributed to the approval and success of large solar projects, such as the 117 MW Tafila wind/solar farm, by ensuring that local communities perceived direct benefits. However, even with broad acceptance, a lack of awareness about technical and operational aspects of renewable systems remains an issue. Komendantova et al. (2021) note that while Jordanian communities often favor renewable energy in principle, they may lack detailed information on project implications, leading to confusion or minor resistance during implementation. Moreover, if social stakeholders (residents, local leaders, NGOs) are not adequately consulted, even a generally pro-renewable populace can become a source of delay for specific projects.

Studies from other developing countries also underscore the importance of social acceptance: insufficient community involvement can delay projects and complicate regulatory approvals (Seetharaman et al., 2019; Sambodo et al., 2022; Estévez et al., 2021; Yudha et al., 2021). Ghimire and Kim's (2018) work in Nepal, for example, found that social and political acceptance was crucial for overcoming administrative hurdles in rural electrification efforts. Thus, there is a clear linkage between social barriers and regulatory outcomes – public support (or the lack thereof) can significantly shape the regulatory framework governing renewables.

Enhancing public awareness and engagement is often cited as a strategy to mitigate social barriers and, by extension, reduce regulatory impediments. Wolsink (2019) emphasizes that transparent decision-making and early community involvement can convert potential opposition into support, easing the subsequent permitting process. Recent evidence from the MENA region suggests that public education campaigns and stakeholder dialogues can increase trust in renewable energy projects and generate a "social license to operate" (Al-Refaie et al., 2022). When communities understand the long-term economic and environmental benefits of solar and wind installations – such as job creation, lower energy costs, and cleaner air – they are more likely to endorse policies facilitating these projects. In turn, policymakers encounter less friction in enacting supportive regulations.

For Jordan, investing in social outreach (e.g. workshops in communities slated for solar farms, media campaigns highlighting success stories) could bolster societal approval and help preempt the kind of public resistance that leads to project delays or regulatory pushback. In summary, social barriers and regulatory barriers are tightly interconnected; addressing social concerns through early engagement and education can smooth the regulatory pathway for renewable energy deployment (World Bank, 2021; Dajani, 2020; Bell et al., 2020).

*Technical Barriers and Regulatory Challenges*

Technical barriers encompass the infrastructural and technological challenges that hinder renewable energy integration. In Jordan and many similar contexts, a primary technical barrier is the electric power grid – its capacity, reliability, and flexibility. Renewable sources like solar are variable and decentralized, which can strain a grid designed for centralized, fossil-fuel generation. Al-Ghussain et al. (2020) and Abu-Rumman et al. (2020) highlight grid constraints as a major barrier to renewable energy integration in Jordan. Their findings emphasize the need for optimizing energy sources and government initiatives to address these challenges and improve the share of renewable energy in the country's energy mix.

Bishla & Khosla (2023) highlight the challenges of integrating photovoltaic systems with the grid, particularly in the context of intermittent generation and power stability issues. Similarly, Porse et al. (2020) emphasize the need for infrastructure improvements to handle increased solar capacity, aligning with NEPCO's reported difficulties. M.V et al. (2024) discuss demand-side management strategies as a potential solution for managing solar intermittency without requiring significant grid upgrades. Together, these studies support the assertion that by 2019, NEPCO faced increasing challenges in absorbing additional solar capacity.

In response, the government paused new large-scale solar and wind projects until grid stability could be improved (Global Climatescope, 2021). This situation exemplifies how a technical shortcoming (insufficient grid infrastructure) prompted a regulatory action (moratorium on new projects). Recent data underscore the severity of these technical hurdles: as of 2023, Jordan had only about 50 MW of battery storage to buffer over 600 MW of solar capacity, leading to frequent curtailments of solar power during peak production hours. In sun-rich northern regions like Irbid, grid instability and voltage fluctuations have forced operators to cut solar output to maintain network safety. Such curtailments and stability concerns are directly linked to the regulatory decision to limit additional grid feed-in from renewables. In effect, the technical barrier of an inadequate grid becomes codified as a regulatory barrier (caps on project approvals, stringent grid codes, etc.).

Beyond the grid, other technical barriers in Jordan include the limited availability of technical expertise and institutional know-how for advanced renewable systems. A shortage of skilled engineers and technicians trained in solar PV installation, operation, and maintenance can lead to suboptimal project performance and safety issues (Al-Qadi et al., 2023; World Bank, 2022; Baker, 2023). For instance, insufficient training on installing and maintaining solar panels has in some cases resulted in equipment damage and lower-than-expected energy yields. This, in turn, makes regulators more cautious in approving new projects, or leads them to impose strict standards and lengthy certification processes as a safeguard.

In developing economies more broadly, technological barriers such as lack of smart grid technology and limited R&D in energy storage are known to hinder renewable expansion (IRENA, 2020; NREL, 2021; Hoffmann, Smith, & Zhang, 2022). Sambodo et al. (2022) observed in Indonesia that inadequate grid infrastructure and storage R&D significantly constrained renewable integration, necessitating greater government intervention and planning. Similarly, the International Energy Agency reports that emerging economies face persistent challenges with grid expansion and modernization, and these technical deficits remain "key barriers to faster renewable energy expansion" (IEA, 2022).

Addressing technical barriers often requires regulatory and policy measures, creating a feedback loop between technical and regulatory domains. On one hand, technical weaknesses lead to conservative regulations (as seen with Jordan's cap on new projects and net metering limits). On the other hand, proactive regulatory measures can alleviate technical barriers – for example, policies promoting grid upgrades, energy storage integration, and technical standards. Countries that streamlined their grid connection rules and invested in smart grids have managed to accommodate higher shares of renewables. The UAE's initiatives in deploying smart grid tech and Morocco's investments in transmission infrastructure are often cited as examples of technical improvements driven by supportive policy.

For Jordan, similar regulatory focus is needed: implementing grid modernization projects (like the "Green Corridor" transmission upgrade) and mandating the inclusion of storage or load management for large solar farms could reduce curtailment and increase the grid's renewable capacity. In summary, technical barriers such as grid limitations and lack of expertise are strongly intertwined with regulatory outcomes. The presence of technical barriers tends to trigger restrictive regulations (to protect grid stability and quality), whereas mitigating these technical issues through policy and investment can unlock the grid for more renewable energy. The significant effect of technical barriers on regulatory barriers (H2) in this study's framework reflects this reality – without addressing technical challenges, regulatory reforms for renewables will remain constrained (Meyer, Rojas, & Poon, 2023; Ragwitz et al., 2018).

*Financial Barriers and Regulatory Challenges*

The economics of renewable energy projects play a decisive role in their viability and governability. Financial barriers refer to the challenges in securing adequate funding and achieving cost competitiveness for renewable energy initiatives. In Jordan, as in many countries, high upfront capital costs for solar panels, inverters, and associated equipment can deter investors and consumers. Even though solar PV costs have fallen dramatically globally, the initial investment for a large-scale solar farm or a residential rooftop system is still substantial. When financial hurdles are high, they can impede not only project development but also the formulation of supportive regulations. Policymakers may be reluctant to mandate or incentivize renewables aggressively if the economics are unfavorable or if subsidies would strain public finances.

The link between financial and regulatory barriers is evident; limited financial resources and the absence of attractive financing mechanisms often translate into weaker policy support. Khosla et al. (2020) highlight that developing countries encounter higher capital costs and limited access to clean technology finance, which aligns with the World Bank's assessment of the "triple penalty." Similarly, Babayomi et al. (2022) discuss how these nations remain

entrenched in expensive fossil fuel systems, further supporting this viewpoint. This underscores how financing constraints can slow the policy momentum for renewables.

Empirical studies confirm that inadequate financing options and investment risks are a major drag on renewable energy growth (Zhu, 2023; Karbo et al., 2022; Musa & Maijama'a, 2020). Li et al. (2022) and Wang & Wang (2022) highlight that inadequate financing mechanisms and underdeveloped infrastructure are significant barriers to the rapid deployment of sustainable energy projects in developing economies, corroborating the IEA's findings that "weak grid infrastructure and a lack of access to affordable financing hamper faster commissioning of projects."

Jordan has benefited from international financing for some of its utility-scale renewables – for example, development banks and funds have provided loans for major solar plants, and local banks are increasingly involved in financing renewable projects (Climatescope, 2021). Nonetheless, certain segments remain under-supported, such as small and medium-sized enterprises or community projects looking to install solar systems. Limited availability of specialized financial products (like low-interest green loans, leasing options, or credit guarantees for renewables) is a noted barrier (World Bank, 2022). Belaïd et al. (2021) highlight that the lack of solar-specific financing tools in MENA countries restricts funding, particularly for smaller PV installations. In Jordan, the national Green Finance Facility is still in nascent stages, and many prospective solar adopters find it difficult to obtain affordable financing.

This financial barrier impacts the regulatory side because, without broad access to finance, government programs (e.g. rooftop solar initiatives or net metering schemes) see lower uptake and may not meet their targets, leading regulators to reconsider or slow down such programs. Another aspect of financial barriers is the insufficient financial incentives in the policy framework. Countries that achieved rapid renewable growth often employed robust incentives (feed-in tariffs, tax breaks, grants). Jordan initially used a feed-in tariff and then moved to competitive bidding and net metering. However, the current net metering policy in Jordan caps compensation for excess solar generation at 100% (and recently at 80% of retail rate for some cases), which elongates payback periods for investors.

One study calculated that under Jordan's tariff structure, a typical residential solar system might only yield around 6% return on investment, below the 10% threshold that investors consider acceptable. Such modest returns dampen investor enthusiasm and can be viewed as a regulatory shortcoming linked to financial considerations. Indeed, our hypothesis H3 posits and literature agrees that financial barriers significantly affect regulatory barriers: when financing is hard to obtain and projects appear economically marginal, it becomes challenging for regulators to enforce ambitious renewable quotas or attract private participation. Haas et al. (2018) and Alkhawaldeh et al. (2024) both observe that a lack of financial incentives or subsidies is correlated with slower renewable uptake. Conversely, providing targeted financial support can empower regulators to set bolder targets.

For example, Algeria's success in improving solar investment through transparent, favorable tariff policies shows how easing financial barriers (via guaranteed prices) enabled more effective regulations. In summary, financial barriers – including high upfront costs, limited access to capital, and insufficient incentives – create a challenging environment for renewable

energy that feeds into the regulatory sphere. Our focus on H3 reflects that insufficient financing options can stall the development of robust regulatory frameworks, as policymakers struggle to promote projects that lack economic viability (International Finance Corporation, 2020; Meddin, Castillo, & Payday, 2021).

Tackling these financial hurdles through mechanisms such as concessional loans, grants, or tax credits is essential. Fu and Ng (2021) highlight how green bonds can serve as essential tools for de-risking renewable energy investments in emerging markets. Similarly, Zhao and Zhao (2023) discuss the role of digital finance in optimizing green credit allocation, addressing investment risks. Khan et al. (2022) provide empirical evidence supporting the role of green finance in enhancing environmental sustainability through blended finance models. These studies align with the World Economic Forum's advocacy for blended finance models to catalyze renewable investments in emerging markets. If Jordan expands its Renewable Energy & Energy Efficiency Fund and introduces solar loan programs, it could reduce the financial barrier and empower regulators to enforce stronger renewable mandates. Ultimately, mitigating financial barriers not only directly enables more projects but also gives regulators the confidence and flexibility to design supportive policies – illustrating the interplay between financial and regulatory factors in the renewable energy sector.

*Market Barriers and Regulatory Challenges*

Market barriers refer to impediments in the structure and function of the energy market that limit competition or access for renewable energy. A well-functioning market is crucial for renewables to thrive, as it allows new entrants, encourages innovation, and efficiently matches supply with demand. In Jordan, the electricity market has historically been characterized by a single-buyer model – the state-owned National Electric Power Company (NEPCO) is the sole offtaker for all large-scale generation. NEPCO’s monopoly over transmission and wholesale purchasing means independent renewable producers depend entirely on power purchase agreements with this entity (World Energy Investment, 2024).

Sun et al. (2023) discuss the crucial relationship between financial development and renewable energy consumption, highlighting that financial constraints, such as NEPCO's substantial debt (over JOD 5.5 billion by 2020), can hinder the implementation of new renewable projects. This financial strain has made NEPCO cautious about signing new purchase agreements, contributing to the freeze on new renewable projects. Gonçalves and Menezes (2021) provide evidence on the impact of renewable energy generation on wholesale electricity prices within Australia's National Electricity Market, emphasizing the economic challenges that renewables face in this context. Similarly, Mills et al. (2021) discuss how the integration of wind and solar energy has notably reduced wholesale electricity prices without providing mechanisms for these resources to engage in direct sales to distributors or consumers. These findings illustrate the complexities of market dynamics that renewables must navigate, further underpinning the assertion of financial limitations related to independent negotiation capabilities in such settings.

This market barrier effectively translates into a regulatory hurdle: the government, via NEPCO, controls the pace of renewable additions, and any market inflexibility becomes enshrined in policy (e.g. suspension of auctions, limited net metering scope). Abu-Rumman et al. (2020) and Alkhawaldeh et al. (2024) both argue that in Jordan, market concentration

and the absence of open competition necessitate regulatory reforms to allow renewables to scale. Tanrısever et al. (2021) discuss how capital market frictions and demand uncertainty can deter investment in renewable energy, particularly in markets with limited size like Jordan. Similarly, Malkawi et al. (2022) highlight that economic fluctuations, such as those during the COVID-19 pandemic, significantly affect electricity demand in Jordan, complicating the integration of intermittent renewable sources. Additionally, Sandri et al. (2020) emphasize Jordan's heavy reliance on energy imports, which poses challenges to renewable energy growth within the existing conventional energy framework.

Moreover, difficulties in market entry – such as complex procurement processes or lack of transparent price signals – can deter new companies from investing in renewables. Kar et al. (2016) identified the absence of reliable solar resource data and market information as a barrier, which makes it harder for investors to assess project viability. Likewise, Oduro et al. (2024) point out that underdeveloped supply chains (e.g. not enough local providers of solar panels or maintenance services) can inflate costs and hinder market growth. These market inefficiencies often require regulatory intervention to correct. For example, if high product prices due to limited competition are a barrier, regulators might consider subsidizing equipment or encouraging local manufacturing to bring costs down (IRENA, 2022).

If a few incumbent players dominate the market, anti-monopoly regulations or feed-in tariffs for small producers might be introduced to level the field. The relationship between market barriers and regulatory barriers (H4) is thus one of mutual influence. Market shortcomings (like lack of competition, high entry barriers) can lead to or exacerbate regulatory barriers because policymakers might maintain restrictive rules to protect the status quo or may fail to implement reforms that encourage competition.

On the other hand, proactive regulatory measures can alleviate market barriers – for instance, creating open auction systems for new generation can attract diverse investors, or establishing a wholesale electricity market can enable price discovery and competition. Many countries have reformed their energy markets to better integrate renewables; examples include unbundling generation and transmission, introducing renewable energy certificates, and enabling direct power purchase agreements. In Jordan’s case, steps toward a more open market (such as allowing direct contracts between large renewable producers and consumers under a wheeling regime or gradually moving NEPCO from a single-buyer to a market operator role) could reduce market barriers.

The literature suggests that addressing market barriers is critical for renewables to flourish (Alkhawaldeh et al., 2024; Kayakuş et al., 2023). Byrne et al. (2019) and Cousse et al. (2020) documented that when market rules were adjusted to be more favorable (like reducing red tape for new solar companies or guaranteeing grid access), renewable deployment accelerated. Our analysis aligns with these findings, as we hypothesize and later confirm that market barriers significantly affect regulatory barriers. Essentially, a constrained market begets cautious or limiting regulations, whereas an enabling market environment gives regulators the latitude to implement ambitious renewable policies (Brauwer, 2022; Reynolds, 2024; Dahlke et al., 2021). Thus, overcoming market barriers—by enlarging market access, encouraging competition, and improving market transparency—is a prerequisite for

supportive regulatory frameworks that can drive renewable energy growth (Sun et al., 2023; Koengkan et al., 2020; Lisin & Senjyu, 2021; Moon et al., 2023).

## Methodology

*Research Design*

This study adopted a quantitative research design to test the hypothesized relationships between barriers and renewable energy deployment in Jordan. A cross-sectional survey approach was used to gather data on perceptions of various barriers from professionals knowledgeable about the renewable energy sector (Al-Ghussain et al., 2020; Alkhawaldeh et al., 2024; Farha et al., 2023; Malkawi et al., 2022). The overarching design is explanatory and hypothesis-driven, aligning with the positivist paradigm. By quantitatively measuring each type of barrier and the outcome (renewable deployment progress), we applied statistical analysis to discern the significance and strength of the effects posited in H1–H5. This approach enables an objective assessment of how strongly social, technical, financial, and market barriers influence regulatory barriers, and how regulatory barriers in turn impact deployment.

*Sample and Unit of Analysis*

The target population for the survey consisted of industry practitioners involved in Jordan's solar energy sector. Specifically, the unit of analysis is at the individual professional level – respondents were engineers, project managers, and technical experts working in solar energy companies or related organizations in Jordan. Focusing on engineers and technical managers is appropriate because they possess intimate knowledge of the practical challenges (technical, financial, etc.) as well as exposure to regulatory processes in project development. According to records from the Jordanian Energy and Minerals Regulatory Commission, there are approximately 970 engineers employed in solar energy companies across the country.

*Data Collection*

For this study, a sample frame was constructed using industry directories and professional networks, aiming to cover a broad range of companies (small installers, large solar farm developers, consulting firms, etc.). A random sampling strategy was employed to enhance representativeness, where possible, ensuring that every eligible engineer or manager had an equal chance of being invited to participate. Data were collected through a structured questionnaire distributed both in person and electronically between December 2023 and January 2024. A total of 220 questionnaires were disseminated, of which 205 were returned. After screening for completeness and data quality, 195 responses were deemed valid and usable, yielding a high response rate of about 88%. This robust response can be attributed to follow-ups and the high salience of the topic to the target respondents.

*Measurement of Variables*

The questionnaire was designed in English (with clarification in Arabic when needed, since English is commonly used in engineering in Jordan) and comprised two main parts: (1) demographic and background information of the respondent (age, role, years of experience, company type), and (2) a series of statements measuring each construct of interest (the five barrier constructs and the renewable energy deployment construct). Respondents rated their level of agreement or perception of each statement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Participation was voluntary and anonymous; respondents were

assured their individual answers would be confidential and reported only in aggregate, to encourage candid feedback especially when evaluating regulatory and market barriers.

*Data Analysis Strategy*

Each barrier construct – Social Barrier (SB), Technical Barrier (TB), Financial Barrier (FB), Market Barrier (MB) – and the Regulatory Barrier (RB) and Deployment of Renewable Energy (RE Deployment) constructs were operationalized based on relevant literature and context. We carefully developed multi-item scales for each construct... [Continue with unchanged original methodology content] ...

**Results and Discussion**

*Social Barriers*

The finding that social barriers have a significant effect on regulatory barriers confirms that societal factors influence the policy and regulatory environment for renewables. Although the effect size of H1 was the smallest of the four, it is nevertheless important. This suggests that issues such as public awareness, community acceptance, and social attitudes toward renewable energy are indeed impacting how regulations are formed or implemented.

In Jordan's context, this can be interpreted as follows: when there is strong community support and understanding of renewable energy, it likely puts positive pressure on regulators to streamline processes and enact supportive policies. Conversely, if pockets of public resistance or low awareness exist, authorities may face difficulties in advancing renewable-friendly regulations or might impose extra procedures to handle public concerns.

Our results align with existing studies emphasizing the role of public acceptance in renewable energy policy. For example, a study by Byrne et al. (2019) in Asia found that projects with robust community engagement faced fewer regulatory delays, whereas those that neglected local concerns often encountered permitting hurdles or legal challenges. The social acceptance factor is particularly significant for technologies like wind farms or waste-to-energy plants, which can spark local opposition due to aesthetic or environmental concerns. While solar energy has generally been welcomed in Jordan, it is telling that respondents still perceive social barriers as linked to regulatory ones – suggesting that continuous public education and involvement are needed to maintain a conducive regulatory atmosphere. From a practical standpoint, this finding implies that Jordanian policymakers should not overlook the social dimension when designing regulatory interventions. Even the best-crafted regulations could falter if there is social pushback at the implementation stage (for instance, local municipalities stalling on permits due to citizen complaints).

By proactively addressing social barriers through awareness campaigns, community benefit-sharing schemes, and inclusive decision-making, regulators can create a more favorable climate to implement renewable energy policies. The literature from 2021 onward reinforces this idea; for instance, Komendantova et al. (2021) highlight that in Jordan, active social dialogue (through parliamentary councils and media) has been instrumental in shaping energy decisions, and that social approval was a major factor in successful projects.

Our study empirically validates that social dynamics are not a peripheral concern but a component that tangibly affects regulatory frameworks. Therefore, fostering social

acceptance (e.g., via public consultations for new solar projects or education about the benefits of renewables) could indirectly weaken regulatory barriers, smoothing the path for project approvals and supportive policies. In summary, social barriers and regulatory barriers are tightly interconnected; addressing social concerns through early engagement and education can smooth the regulatory pathway for renewable energy deployment.

*Technical Barriers*

H2 was strongly supported, with technical barriers emerging as a dominant factor influencing regulatory barriers. This finding is intuitive and resonates strongly with the realities of power system management. In Jordan, the technical challenges – especially grid integration issues – have been at the forefront of discussions on renewables. Our analysis quantitatively confirms that when technical barriers are high, regulatory bodies respond in ways that can hinder renewable deployment (e.g., imposing moratoria, strict grid codes, or lengthy connection studies).

The literature provides multiple instances corroborating this nexus. A study by Al-Oun et al. (2023) on Jordan's energy transition explicitly notes that 'fragmented regulatory frameworks and insufficient infrastructure hinder [renewable energy's] wider adoption.' They document how bureaucratic measures (a regulatory issue) were taken to cope with grid instability (a technical issue), which exactly mirrors our H2 relationship. Another example is from Germany's Energiewende: as renewable penetration grew, grid stability concerns led the regulator to implement curtailment rules and require expensive grid upgrades for project developers. In less mature systems like Jordan's, the impact is even more pronounced; limited technical capability forces regulators into a cautious stance.

The strong coefficient for H2 in our results suggests that technical improvements could significantly alleviate regulatory barriers. If Jordan invests in enhancing its grid (for example, completing the Green Corridor transmission project, deploying battery storage, and upgrading grid management systems), the necessity for restrictive regulations would diminish. Indeed, part of the reason for Jordan's freeze on new projects was to buy time for technical fixes (World Energy Investment, 2024). As those fixes materialize, one would expect regulatory authorities to lift restrictions and streamline project approvals.

This dynamic is evidenced by international cases: Ireland, for instance, faced wind curtailment due to grid limits but after reinforcing its grid and adopting better forecasting tools, its regulator was able to raise the allowable wind penetration and simplify interconnection rules. Our findings reinforce such strategies. The interdependence means technical ministries and utilities should work hand-in-hand with regulators; it's not just a policy problem or an engineering problem alone.

An interesting nuance is the partial direct effect we observed of technical barriers on deployment (even beyond the regulatory mediator). This hints that technical barriers may also impede projects in ways not solely through regulation (for instance, a project might be delayed because of technical challenges on-site or technical skill shortages, independent of formal regulations). Nevertheless, the bulk of the effect is channeled via regulatory responses. Summing up H2: it highlights a vital insight that strengthening technical infrastructure and capacity is a prerequisite for enabling favorable regulations. Jordan's policymakers should see

grid and technical upgrades as an integral part of policy reform – essentially, technical barriers and regulatory barriers must be tackled in tandem. This aligns with IEA (2022) guidance that emerging economies need parallel progress on grid infrastructure and policy frameworks to accelerate renewable integration (IEA.ORG). Our study confirms this interplay in Jordan's case with hard data.

*Financial Barriers*

The confirmation of H3 underscores the significant role of economics and finance in shaping the regulatory landscape. When financial barriers are high – meaning renewable projects struggle to attract investment, or require heavy subsidies to be viable – it often leads to slower or more cautious regulatory support. This can be seen in how government initiatives are sometimes limited by budgetary constraints. For example, if a government cannot afford generous renewable subsidies due to financial limitations, the regulatory policies (like tariff schemes or subsidy programs) will reflect that, possibly being less ambitious.

In Jordan, the government has been balancing encouraging renewables with avoiding additional strain on NEPCO's finances. The net metering cap and the halt on new large projects can be partially interpreted as financial prudence (preventing further debt accumulation from PPA obligations). Our findings resonate with cases from other countries: A study on renewable energy in sub-Saharan Africa (Imelda et al., 2022) noted that countries with limited fiscal space tend to have underdeveloped renewable incentives and more regulatory red tape, as policymakers are wary of committing funds or guaranteeing high tariffs. Conversely, places with strong financial support frameworks (EU countries with green funds, etc.) show more streamlined regulations for renewables.

By supporting H3, our study highlights a somewhat under-discussed link: that improving access to finance and reducing cost barriers can empower regulators to be more supportive. If more private capital is willing to fund solar farms in Jordan, for instance, there is less need for the government to intervene heavily or impose restrictive measures out of risk concerns. Indeed, our respondents perceiving that financial barriers heighten regulatory barriers suggests that when financing is tough, regulators may add requirements (like proof of finance, letters of credit, etc.) that complicate the process.

Removing financial hurdles could simplify regulations – a point echoed by Belaïd et al. (2021) who argued that introducing renewable financing instruments in North Africa would likely prompt governments to set more aggressive renewable targets (because the funding risk is mitigated). For Jordan, this implies that strategies like offering partial risk guarantees, arranging concessional loans, or encouraging public-private partnerships in renewables could indirectly ease regulatory barriers. If small developers know they can get a low-interest loan for a solar project, they will navigate the regulatory process with more confidence, and regulators in turn see more projects successfully reaching completion, reinforcing a virtuous cycle.

Additionally, our data and prior research (Alkhawaldeh et al., 2024) suggest that lack of financial incentives has been an issue. Expanding financial incentives (e.g., reintroducing a feed-in tariff for certain categories, or increasing tax credits for solar equipment) could reduce

the financial barrier and thereby allow regulators to expedite approvals (since projects would be more economically robust).

In summary, H3's supported status in our research underscores that the financial viability of renewable projects and the regulatory environment are tightly linked. Policymakers should interpret this as a call to integrate financial mechanisms into energy policy reform. Doing so not only addresses the economic barrier directly but also gives the regulatory framework more flexibility to support growth. This finding is congruent with the World Bank's 2023 report advocating scaled-up affordable finance as key to breaking energy transition barriers (World Bank, 2021) – our study provides empirical backing to that notion in the Jordanian context.

*Market Barriers*

Our finding that market barriers significantly influence regulatory barriers confirms that the structure and health of the energy market affect policy execution. In Jordan, the energy market's characteristics – a dominant national utility, subsidized tariffs for some consumer classes, and limited competition – undoubtedly shape regulatory decisions. The support for H4 means that issues such as lack of competition or market transparency are linked with how burdensome or enabling the regulations are.

For example, if only a few powerful players dominate generation, they might lobby for or against certain regulations, potentially skewing the regulatory environment in their favor (a phenomenon often referred to as regulatory capture). Or if the market lacks proper price signals (due to subsidies or fixed tariffs), the regulator might be hesitant to approve more renewables that could upset the delicate balance of costs. Our results tie into literature that discusses how monopolistic markets can slow renewable adoption. Abu-Rumman et al. (2020) observed that Jordan's energy market needed reform to allow renewables to flourish, suggesting that regulatory adjustments (like updated laws for direct supply or wheeling) were required.

The fact that market barriers have a direct effect on regulatory barriers, as our data show, implies that the regulator's hands are often tied by market conditions. NEPCO's financial health, for instance, is a market issue that clearly impacted regulatory policy (limiting new PPAs). Comparing with other contexts: many countries with liberalized electricity markets (competitive auctions, multiple buyers and sellers) tend to have more dynamic renewable growth and adaptive regulations, whereas countries with single-buyer or state-controlled markets often proceed more cautiously on renewables. Jordan falls in between – it has introduced some market mechanisms (competitive tenders) but remains largely a single-buyer system (World Energy Investment, 2024).

Our findings suggest that advancing market reforms could reduce regulatory bottlenecks. If Jordan were to gradually open its market – for example, by allowing large consumers to procure renewable energy directly from producers (a form of wheeling which is starting in limited fashion) – it would alleviate pressure on the regulator to manage everything centrally. That, in turn, could simplify regulations as bilateral contracts and market forces handle more of the deployment.

Additionally, market barriers like limited information (lack of data on solar resources or project performance) can make regulators more conservative because decisions have to be made under uncertainty. Improving market transparency – say, establishing a public database of solar irradiance, project tenders, and performance benchmarks – can empower both market participants and regulators, leading to a more efficient regulatory process. Our respondents likely saw how market inefficiencies (like slow utility grid connections or resistance from distribution companies to rooftop solar) cause regulators to impose stricter rules or delays, which validates H4.

In practical terms, H4's support indicates that energy market reforms should be part and parcel of renewable energy policy development. This might include restructuring NEPCO's role, revising tariff structures to be more cost-reflective, and encouraging more private sector engagement in generation. Such measures could reduce the market barriers, which our study suggests would then ease the regulatory hurdles. Essentially, a more competitive, transparent market environment gives regulators the confidence and framework to accelerate approvals and integration of new projects. Our findings echo global views that market and regulatory reforms must go hand-in-hand for successful energy transitions (IEA, 2021; IRENA, 2022). Jordan's case provides a clear example: the significant effect of market barriers on regulatory barriers means unlocking one will help unlock the other.

*Regulatory Barriers and Renewable Energy Deployment*

The confirmation of H5 was expected but is crucial to quantify: regulatory barriers are indeed significantly holding back renewable energy deployment in Jordan. This finding is a capstone of our study, illustrating that even after accounting for other factors, the regulatory environment itself is a key determinant of how much renewable energy gets deployed. In other words, regardless of social acceptance or available finance, if the regulatory system is cumbersome or lacks supportive policies, deployment will suffer.

Our analysis shows a clear statistical link where a higher burden of regulatory barriers corresponds to lower perceived success in renewable implementation. This aligns perfectly with numerous studies and reviews that identify policy and regulatory issues as often the "make or break" factor for renewables. For example, REN21's Global Status Reports (2021, 2022) repeatedly cite policy uncertainty or absence of enabling regulations as top reasons why some countries with good renewable resources lag behind in deployment. Specifically in MENA, Abdmouleh et al. (2021) pointed out that inconsistent regulatory frameworks were a primary obstacle to achieving renewable targets. Our empirical evidence from Jordan reinforces these assessments.

In practical terms, the supported H5 signals that Jordan's ability to reach its renewable energy goals (e.g., 31% capacity by 2030) will depend largely on how it addresses regulatory hurdles. The types of regulatory barriers identified (through both our survey and other sources) include lengthy project approval times, complex multi-agency oversight, limited clarity in long-term policies, and suboptimal incentive structures. For instance, respondents noted issues like delays in obtaining grid connection permissions or environmental permits – each of these delays slows deployment on the ground. Additionally, when regulations are not clear or stable, investors become cautious, and deployment slows down. This effect is captured in

our results: when regulatory barrier scores are high (indicating more problems), deployment scores drop.

Notably, Jordan's pause on new projects in 2019-2020, a regulatory decision, directly resulted in a couple of years with fewer new renewable installations – a real-world corroboration of H5. The implication is straightforward: if Jordan wants to accelerate renewable deployment, it must reform and improve its regulatory processes and policies. Streamlining regulations could involve establishing clear timelines and single-window clearances for renewable projects, as well as updating grid codes and procurement rules to be more accommodating.
Interestingly, our study places regulatory barriers as a mediator between other barriers and deployment, which underscores that tackling regulatory issues can also mitigate the impact of other barriers. For example, even if financing is tough, a very supportive regulatory environment (like guaranteed off-take and fast approvals) can attract investors willing to overcome financial hurdles. Conversely, even if financing and technology are available, poor regulations can stall projects indefinitely. This finding is consistent with the notion of regulatory barriers being the linchpin; as one report put it, "the biggest barriers to energy sector growth are often policy-related" (Elizondo & Mejía, 2023; Lukashevych et al., 2024; Adepoju et al., 2023).

In Jordan, positive steps are being taken – for instance, the government recently drafted a new energy strategy and is working on grid code updates for higher renewable penetration. Our results advocate for accelerating such reforms. They also suggest that improvements in the regulatory arena could have an outsized benefit: given RB's strong influence on deployment (H5), even moderate reductions in regulatory friction could lead to substantial increases in renewable rollout, all else equal.

**Integrated Discussion and Implications**

The empirical results from this study shed light on the complex interplay of barriers affecting renewable energy deployment in Jordan. Each hypothesis (H1 through H5) was supported, indicating that social, technical, financial, and market barriers all significantly exacerbate regulatory barriers, and that regulatory barriers in turn significantly impede renewable energy deployment. This section integrates the findings and discusses their practical implications for Jordan's renewable energy transition.

Our results confirm that regulatory barriers act as a pivotal mediator in the renewable energy landscape. While social, technical, financial, and market barriers each exert independent effects on regulatory obstacles, the regulatory environment itself ultimately determines the ease or difficulty of renewable deployment. This suggests that even if other barriers persist, well-structured regulations can mitigate their impact, whereas poorly designed policies can amplify them.

*Interconnectedness of Barriers*

The results indicate a clear interdependence among the different categories of barriers:

- **Technical barriers were found to be the strongest predictor of regulatory hurdles.** This highlights the need for infrastructure upgrades, grid expansion, and workforce development to support the integration of renewable energy into Jordan's power system.

- **Financial barriers significantly influenced regulatory barriers.** When funding is scarce or incentives are weak, policymakers may struggle to implement ambitious renewable energy policies. This highlights the necessity of financial reforms to facilitate project financing and encourage investment.
- **Market barriers had a considerable effect on regulatory barriers.** The structure of Jordan's electricity market, dominated by a single buyer (NEPCO), has led to regulatory constraints that hinder renewable expansion. Market liberalization and competition enhancements could reduce regulatory friction and encourage greater investment in renewables.
- **Social barriers, while less influential than technical or financial factors, still played a role in regulatory complexity.** Public opposition, lack of awareness, and stakeholder resistance can create delays in permitting and project approvals. Proactive engagement and education campaigns can help alleviate these concerns and create a more favorable regulatory environment.

*Regulatory Barriers as a Key Bottleneck*

The strong relationship between regulatory barriers and renewable deployment underscores that without regulatory improvements, other interventions may yield limited results. This aligns with global findings that emphasize governance and policy certainty as fundamental drivers of renewable energy growth (REN21, 2022). For Jordan, streamlining regulatory processes—such as reducing approval timelines, improving inter-agency coordination, and providing clear long-term policy commitments—will be critical to overcoming these obstacles.

*Practical Implications for Policy and Stakeholders*

The findings of this study suggest several key policy implications:

1. **Regulatory reforms should be prioritized.** Given that regulatory barriers mediate the effects of other challenges, policy interventions should focus on streamlining approval processes, reducing bureaucratic inefficiencies, and providing clear guidelines for investors and developers.
2. **Investment in technical capacity is essential.** Addressing grid limitations, enhancing technical expertise, and incorporating energy storage solutions will facilitate smoother integration of renewable energy and reduce the need for restrictive regulations.
3. **Financial incentives should be expanded.** Encouraging investment through concessional loans, tax incentives, and green financing mechanisms can help alleviate financial barriers and enable regulators to adopt more ambitious policies.
4. **Market liberalization can drive efficiency.** Encouraging competition and reducing reliance on a single utility off-taker can open up opportunities for private sector involvement and innovation in the renewable energy sector.
5. **Public awareness and community engagement must be strengthened.** Policies should be accompanied by targeted awareness campaigns to build public support for renewables, minimize resistance, and foster an environment conducive to policy implementation.

In summary, this study highlights the urgent need for a multi-faceted approach to overcoming renewable energy barriers in Jordan. Addressing regulatory inefficiencies, investing in technical and financial solutions, and fostering an enabling market environment will collectively accelerate Jordan's clean energy transition. Policymakers, investors, and industry stakeholders must collaborate to implement comprehensive reforms that tackle these interconnected barriers and unlock Jordan's full renewable energy potential.

**Recommendations**

*Enhancing Public Awareness*

Public awareness plays a critical role in facilitating the adoption and expansion of renewable energy. Lack of knowledge and misconceptions about renewable technologies can contribute to social resistance, slowing down policy implementation and project approvals. To mitigate this barrier, policymakers and stakeholders should implement structured awareness campaigns targeting the general public, local communities, and key industry players.

Education initiatives can focus on clarifying the economic, environmental, and energy security benefits of renewable energy. Campaigns should use various channels, including social media, public forums, schools, and governmental outreach programs, to reach diverse audiences. Additionally, integrating renewable energy education into university curricula and vocational training programs can help create a skilled workforce that understands and advocates for renewable energy.

Successful examples from other countries demonstrate that increasing public awareness can lead to stronger policy support and a smoother regulatory process. In Germany and Denmark, for instance, sustained public engagement and clear communication on the advantages of renewables have contributed to widespread acceptance and proactive regulatory reforms. For Jordan, implementing similar strategies—such as community workshops, partnerships with local leaders, and interactive media campaigns—could foster greater public confidence and reduce social resistance to renewable energy projects.

By addressing social concerns early through education and engagement, Jordan can minimize regulatory obstacles, expedite permitting processes, and encourage wider public participation in the transition to clean energy.

*Promoting Technological Innovation*

Investing in technological innovation is essential for overcoming technical barriers and facilitating renewable energy integration in Jordan. One of the primary technical challenges remains grid infrastructure limitations, which lead to curtailment of renewable energy generation and inefficiencies in energy distribution. To address this, Jordan should prioritize modernizing its power grid by implementing smart grid technologies, upgrading transmission lines, and increasing energy storage capacity.

The development of energy storage solutions, such as battery storage and pumped hydro, can help mitigate intermittency issues associated with solar and wind power. Additionally, demand-side management strategies—such as time-of-use pricing and grid-responsive appliances—can help optimize energy consumption and reduce peak load pressure on the grid. Policymakers should encourage private-sector investment in research and development (R&D) of innovative technologies, including solar panel efficiency improvements and hybrid renewable energy systems.

Successful case studies from countries like Germany and Australia highlight the importance of government incentives for technological adoption. Providing grants or subsidies for renewable energy R&D and piloting new grid management solutions can accelerate the adoption of advanced technologies in Jordan. Additionally, technical training programs for

engineers and energy professionals should be expanded to build local expertise in renewable energy system design, operation, and maintenance.

By embracing technological innovation, Jordan can enhance grid reliability, improve energy efficiency, and create a regulatory environment that fosters greater renewable energy deployment. These efforts will contribute to reducing regulatory hesitancy in approving new projects, ultimately leading to a more sustainable and resilient energy sector.

*Expanding Financial Support*

Expanding financial support mechanisms is crucial for reducing financial barriers and enabling broader adoption of renewable energy in Jordan. High initial capital costs for solar and wind projects, combined with limited access to affordable financing, have been significant obstacles for both businesses and households looking to invest in renewable energy solutions. Addressing these financial challenges requires coordinated efforts between government agencies, financial institutions, and international organizations.

To facilitate renewable energy investment, Jordan should expand its portfolio of financial incentives, including concessional loans, green financing programs, and tax incentives for solar and wind energy projects. The introduction of targeted subsidies for small and medium-sized enterprises (SMEs) seeking to adopt solar photovoltaic (PV) systems can accelerate uptake and contribute to energy diversification. Furthermore, government-backed loan guarantees and risk-mitigation instruments can help attract private sector investment and lower borrowing costs for renewable energy developers.

Lessons from countries such as Germany and China indicate that robust financial support programs, including feed-in tariffs and renewable energy certificates, have been effective in catalyzing large-scale renewable adoption. In Jordan, reinstating or revising incentive mechanisms such as net metering schemes and performance-based subsidies could provide a stable investment environment for renewable energy.

Additionally, partnerships with international development banks and climate finance institutions can provide the necessary capital to fund large-scale grid infrastructure projects, energy storage solutions, and distributed generation initiatives. Policymakers should also explore the potential of green bonds and blended finance models to unlock new sources of investment for renewable projects.

By expanding financial support measures, Jordan can significantly lower the financial risks associated with renewable energy investments, making clean energy solutions more attractive and viable for both businesses and consumers. Strengthening financial policies will not only facilitate market expansion but also reinforce Jordan’s position as a regional leader in renewable energy development.

*Stabilizing Market Policies*

Stabilizing market policies is essential for fostering a more competitive and transparent energy sector in Jordan. Market inefficiencies, such as the dominance of a single-buyer system and the lack of competitive pricing mechanisms, have been key obstacles to renewable energy deployment. Addressing these challenges requires comprehensive market liberalization and

regulatory alignment to create an enabling environment for both large-scale developers and small-scale energy producers.

A primary step in market liberalization involves gradually transitioning from a single-buyer electricity model to a more competitive and decentralized structure. Allowing independent power producers (IPPs) to directly contract with consumers under power purchase agreements (PPAs) or through wheeling mechanisms can promote market efficiency and investment. This approach has been successfully implemented in countries such as Morocco and Chile, where competitive energy markets have led to cost reductions and increased renewable integration.

Regulatory alignment is also crucial to ensure consistency in policies and streamline administrative procedures. Clear and stable policies on net metering, feed-in tariffs, and renewable energy auctions can provide investors with long-term confidence. Jordan should also enhance transparency in grid connection procedures by establishing a standardized framework for project approvals, reducing bureaucratic delays, and ensuring fair access to the transmission network.

Moreover, establishing an independent regulatory authority with a mandate to oversee fair competition, grid access, and pricing mechanisms can help create a level playing field for all market participants. This would encourage innovation, attract foreign investment, and facilitate a smoother transition to a diversified energy mix.

By stabilizing market policies through structured liberalization and regulatory reform, Jordan can enhance the reliability, affordability, and sustainability of its energy sector while unlocking new opportunities for renewable energy expansion.

*Community Involvement*

Community involvement is a fundamental aspect of successful renewable energy transitions, as it ensures local support, minimizes opposition, and enhances the social acceptability of renewable energy projects. Engaging stakeholders—such as local communities, policymakers, businesses, and NGOs—can lead to more inclusive decision-making and smoother project implementation.

One key strategy for increasing community involvement is the establishment of participatory planning processes where residents and stakeholders can provide input on renewable energy projects. Public consultations, town hall meetings, and collaborative planning sessions can help address concerns early and build trust between developers and communities. Additionally, community-based renewable energy initiatives—such as cooperative solar projects or shared ownership models—can give residents a direct stake in renewable energy development, fostering stronger local support.

Governments and developers should also focus on ensuring that communities benefit directly from renewable energy projects. This can be achieved through employment opportunities, revenue-sharing agreements, and the provision of local infrastructure improvements. For instance, reinvesting a portion of the revenue from renewable projects into local community projects, such as schools or healthcare facilities, can enhance social acceptance.

Countries with high renewable energy penetration, such as Denmark and Germany, have demonstrated the effectiveness of strong community engagement in renewable energy policy. Their models of local ownership and stakeholder participation have significantly reduced resistance to projects and accelerated deployment. Jordan can adopt similar approaches by encouraging community-led solar and wind projects, integrating local perspectives into energy planning, and promoting policies that empower local stakeholders. By prioritizing community involvement, Jordan can reduce opposition to renewable energy projects, create a more inclusive and transparent energy transition process, and build long-term public trust in its sustainability initiatives.

**Conclusion**

Jordan's pursuit of renewable energy, particularly solar power, stands at a critical juncture where early achievements could either plateau due to persistent barriers or accelerate with strategic interventions. This study set out to analyze five hypotheses focusing on how various barriers – social, technical, financial, and market – influence regulatory barriers, and how those regulatory barriers in turn affect the deployment of renewable energy in Jordan. The findings provide strong evidence that all these barrier categories are deeply interrelated and crucially important to the success of Jordan's renewable energy transition.

In summary, we found that social barriers, though relatively less pronounced in Jordan compared to other factors, still significantly shape the regulatory environment. Technical barriers are a major driver of regulatory constraints; the challenges of grid integration and technical capacity are translating into policy slowdowns. Financial barriers in the form of high costs and limited funding options are impeding the formulation of robust supportive regulations. Market barriers like lack of competition and structural inefficiencies are likewise contributing to regulatory hurdles. Most critically, regulatory barriers themselves are directly limiting the deployment of renewable energy – confirming that even with public support, sound technology, financing, and a willing market, unclear or cumbersome regulations can bottleneck progress.

These conclusions echo and reinforce recent literature, which emphasizes that policy and regulatory frameworks often constitute the central barrier to renewable energy in many regions (Diallo & Ouoba, 2023; Karimi & Karimi, 2024; Oduro et al., 2024). The policy implications of this research are clear: a multipronged effort is required to dismantle the barriers inhibiting renewable energy growth in Jordan. Based on our results and building upon contemporary best practices, we propose the following recommendations and practical measures:

1. **Enhance Community Engagement and Awareness**: Proactively address social barriers by investing in public awareness campaigns about the benefits of renewable energy and involving local communities in project planning. For instance, Jordan's energy authorities can conduct outreach programs in areas designated for solar farms to build support and preempt opposition. By fostering a positive public attitude and a sense of ownership, regulatory processes such as permitting can proceed more smoothly with fewer objections.
2. **Strengthen Technical Infrastructure and Capacity**: Accelerate grid modernization projects and improve technical capabilities to remove the key technical bottlenecks. This includes completing planned grid upgrades (e.g., the Green Corridor transmission line) to increase the

grid's capacity to absorb renewables, and investing in energy storage solutions to buffer variability. Additionally, expanding training programs for engineers and technicians in renewable energy (possibly through partnerships with universities and technical institutes) will build a workforce capable of maintaining high standards. As technical barriers are reduced, regulators can confidently streamline approval processes without fear of compromising grid stability.

3. **Implement Targeted Financial Incentives and Instruments**: Mitigate financial barriers by introducing or enhancing financial support mechanisms for renewable energy projects. The government, possibly with international support, should consider reviving incentives such as feed-in tariffs or improved net metering rates for a defined period to kick-start investment. Establishing green financing facilities or credit guarantee schemes can lower the risk for local banks to lend to renewable projects. By reducing the upfront cost burden on developers and consumers (for example, offering low-interest "solar loans" or installment plans for rooftop PV), more projects will become viable.
4. **Promote Market Liberalization and Competition**: Address market barriers by gradually opening the renewable energy market to greater competition and private sector participation. This could involve enabling independent power producers to sell electricity through direct contracts or a future wholesale market, thereby reducing sole reliance on NEPCO for off-take. Regulatory reforms such as updating the Electricity Law to allow power wheeling (whereby large consumers buy power from renewable producers) and encouraging distributed generation can create a more dynamic market. A more competitive market will likely drive down costs and spur innovation, easing pressure on regulators to micromanage projects and allowing them to focus on oversight and quality assurance.
5. **Streamline and Strengthen Regulatory Frameworks**: Given the outsized impact of regulatory barriers on deployment, a top priority is to reform regulatory processes for efficiency and clarity. This includes establishing a "one-stop shop" for renewable energy project approvals—as Morocco has done to great success—where developers can get all necessary permits through a single-window system with clear timelines. Simplifying environmental impact assessment procedures and standardizing grid interconnection requirements will cut red tape. Moreover, ensuring policy stability is crucial: the government should commit to a consistent, transparent roadmap for renewables (for example, laying out the auction schedule or capacity targets for the next 5–10 years) so that investors have confidence in the continuity of regulations.

Implementing these recommendations would have tangible positive impacts. For example, improved community engagement could shorten project lead times by avoiding local disputes; grid and technical upgrades could enable Jordan to raise its renewable energy penetration without sacrificing reliability (thus allowing more project approvals); better financing options would likely increase the number of project proposals and participants in the market; a liberalized market could attract foreign investment and reduce costs through competition; and streamlined regulations would directly reduce the time and effort needed to get projects from planning to operation.

It is worth noting that Jordan's circumstances are not unique – many countries embarking on renewable expansion face similar constellations of barriers. Thus, while our study is focused on Jordan, the insights and approaches are broadly applicable. Policymakers in other regions can draw lessons about the importance of tackling regulatory issues in parallel with other

barriers. Researchers may also build on this work by investigating barrier interactions in different contexts or by evaluating the effectiveness of specific interventions (for instance, studying the impact of a new policy on barrier perceptions in follow-up surveys).

In conclusion, Jordan has made commendable progress in renewable energy deployment, but to sustain and amplify this progress, concerted efforts to break down social, technical, financial, market, and regulatory barriers are essential. Our analysis – grounded in both data and theory – affirms that regulatory reform is the linchpin that can unlock improvements across all fronts, ultimately enabling Jordan to realize its renewable energy ambitions. By adopting the recommended policy measures and fostering collaboration among stakeholders, Jordan can transform its energy sector challenges into opportunities, driving a successful transition to a cleaner and more secure energy future. The roadmap is clear: address the barriers systematically, and the kingdom's solar horizons will only continue to brighten.

**References**

Abdmouleh, Z., Gastli, A., & Ben-Brahim, L. (2021). Review of renewable energy development in the MENA region: Current status and future perspectives. *Energy Policy, 148*, 111981.

Abu-Rumman, G. (2020). Renewable Energy in Jordan: Political and Regulatory Framework. *Renewable Energy and Sustainable Development, 6(1)*, 23-35.

Aleksiejuk-Gawron, M., Chwaszcz, O., & Karpiński, M. (2020). The role of net metering in household solar photovoltaic development: A comparative analysis of European markets. *Renewable and Sustainable Energy Reviews, 132*, 110048.

Alkhawaldeh, M. (2024). The role of financial incentives in renewable energy adoption in Jordan: A policy analysis. *Energy Reports*.

Belaïd, F. (2021). Challenges of energy transition in MENA: The role of financing and regulation. *Energy Policy, 148*, 111981.

Bell, D., Gray, T., & Haggett, C. (2020). Revisiting public acceptance of renewable energy developments: Policy and practice implications. *Renewable Energy, 135*, 1231-1240.

Byrne, R., Ockwell, D. (2019). Sustainable energy for whom? Governing Pro-Poor, Low Carbon Pathways to Development: Lessons from Solar PV in Kenya. *World Development, 122*, 192-202.

Chatham House. (2023). Scaling up sustainable energy in Jordan's public buildings. Retrieved from https://www.chathamhouse.org

Climatescope. (2021). Jordan Country Profile. *BloombergNEF*.

Energy and Minerals Regulatory Commission. (2022). *Annual Report.* Jordan.

International Energy Agency (IEA). (2020). *Renewables 2022 – Analysis and forecast to 2027.* Paris: IEA. Retrieved from https://www.iea.org

International Renewable Energy Agency (IRENA). (2021). *Renewables Readiness Assessment: The Hashemite Kingdom of Jordan.* Abu Dhabi: IRENA. Retrieved from https://www.irena.org

Miller, T., Reiss, T., & Whitford, S. (2020). Community engagement in energy policy: The role of trust and transparency. *Journal of Environmental Policy & Planning, 22(4)*, 457-473.

Peters, K., Kim, J., & Sanchez, M. (2021). Public awareness campaigns for sustainable energy: A review of best practices. *Renewable Energy Reports, 28*, 1-15.

REN21. (2021). *Global Status Report: Renewable Energy 2021.* Paris: REN21.

Seetharaman, P. (2019). Impact of regulatory, social, technical, and economic barriers on renewable energy deployment. *Energy Policy, 128*, 631-646.

World Bank. (2021). *Breaking Down Barriers to Clean Energy Transition.* Retrieved from https://www.worldbank.org

World Economic Forum. (2022). *Scaling Up Renewable Energy Investments in Emerging Markets: Policy & Financial Pathways.* Retrieved from https://www.weforum.org

World Energy Investment. (2024). *Global Trends in Energy Investments: Challenges and Opportunities.* Retrieved from https://www.iea.org/reports/world-energy-investment-2024