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Examining Economic Barriers and Challenges to the Adoption of Renewable Energy in Emerging Markets (Case Study: Solar Panels)

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Abstract

In recent years, renewable energy has emerged as an effective solution to the energy crisis, reducing dependence on fossil fuels and mitigating climate change. Among renewable energy technologies, solar panels have gained particular importance due to their versatility in installation scales, low operational costs, and environmental compatibility. However, in many developing countries, the process of adopting and expanding these technologies faces numerous economic challenges. This article, focusing on emerging markets and employing a descriptive-analytical method, examines the economic barriers influencing the adoption of solar panels. The primary identified barriers include high initial costs, lack of supportive and incentive-based systems, limited access to financial resources, and inadequate infrastructure. Moreover, by analyzing case studies in South Asian and African countries, the paper proposes solutions such as targeted policymaking, government financial support, establishment of specialized institutions, and public awareness campaigns to facilitate the adoption of these technologies. The findings of this study may serve as a foundation for decision-making by policymakers, investors, and energy sector stakeholders in pursuing sustainable development.

Keywords: renewable energy, solar panels, emerging markets, economic barriers, sustainable development

1. Introduction

The rapid expansion of global energy demand, combined with the environmental implications of fossil fuel dependency, has intensified the urgency for a transition toward clean, renewable energy sources. Among the array of renewable technologies, solar photovoltaic (PV) systems are increasingly recognized for their potential to offer decentralized, sustainable, and scalable energy solutions suitable for both urban and rural contexts in emerging markets (Mohtasham, 2015; Sampaio & González, 2017). Despite notable technological advances and cost reductions in recent years, the widespread adoption of solar energy technologies in developing countries remains constrained by a complex array of economic, institutional, social, and technical barriers (Abdul & Wenqi, 2024; Chakraborty et al., 2016; Pfeiffer & Mulder, 2013).

Emerging markets, characterized by nascent energy infrastructures, fluctuating political landscapes, and limited financial mechanisms, face unique challenges in integrating renewable energy into their broader energy portfolios. While countries like China and India have made significant progress through robust policy interventions and targeted subsidies (Rehman et al.,

2025; Timilsina et al., 2011), many developing nations still struggle to overcome structural impediments. These challenges are not merely technical but deeply intertwined with governance structures, economic priorities, and socio-cultural dynamics (Irfan et al., 2019; Kihlström & Elbe, 2021).

Financial constraints remain a primary hurdle in the expansion of solar energy systems across low- and middle-income countries. The high initial capital expenditure required for solar PV installation continues to discourage both residential and commercial investments (Liu, 2018; Sadat Robat Jazi, 2024). Although the levelized cost of electricity (LCOE) from solar sources has declined globally, upfront costs remain unaffordable for many in the absence of accessible financing mechanisms, government subsidies, or innovative credit schemes (Moghani et al., 2024; Ohunakin et al., 2014). This issue is exacerbated by limited banking infrastructure and the lack of tailored financial products that can de-risk renewable energy investments for small-scale users (Abdul & Wenqi, 2024; Wyllie et al., 2018).

Policy and institutional barriers further complicate the diffusion of solar technology. A persistent lack of coherent and long-term energy policies, inconsistent regulatory frameworks, and shifting tariff structures create uncertainty for both local and foreign investors (Bakhtiyar et al., 2016; Kihlström & Elbe, 2021). The absence of well-defined feed-in tariffs (FiTs), tax incentives, or net-metering policies in many countries reduces the financial viability of solar investments (Luthra et al., 2015; Rehman et al., 2025). Studies have shown that countries with stable and supportive renewable energy policies have been more successful in fostering solar market development (Sawin et al., 2013; Timilsina et al., 2012). Conversely, policy volatility remains a substantial deterrent in regions where political instability or administrative inefficiencies prevail (Campbell et al., 2020; Irfan et al., 2019).

From a social and behavioral perspective, the adoption of solar technology also hinges on public awareness, cultural acceptance, and trust in institutions (Bahmani & Bahrammehr, 2016; Ibegbulam et al., 2023). In many emerging markets, insufficient awareness about the long-term economic benefits of solar power and lack of technical literacy hinder demand, particularly in rural or marginalized communities (Naeem et al., 2023; Ohunakin et al., 2014). Cultural perceptions, including skepticism toward new technologies or concerns over aesthetic and maintenance aspects of solar panels, may also inhibit uptake (Chakraborty et al., 2016; Siecker et al., 2017). In such contexts, effective public engagement strategies and capacity-building initiatives are essential to facilitate behavioral change and community acceptance (Miller, 2012; Wyllie et al., 2018).

Environmental factors and geographic disparities also shape the feasibility and effectiveness of solar energy adoption. While solar irradiance is relatively abundant in many emerging economies, disparities in topography, land availability, and grid connectivity often pose logistical challenges (Cormio et al., 2003; Sampaio & González, 2017). Moreover, the lack of domestic manufacturing capabilities and overreliance on imported PV components expose developing countries to exchange rate volatility and supply chain disruptions, further undermining cost competitiveness and system reliability (Liu, 2018; Moghani et al., 2024).

The research landscape has increasingly recognized the need for a multi-dimensional and integrated approach to assess the barriers to solar adoption. Scholars argue for combining quantitative analyses with qualitative insights to capture the full scope of technical, economic, and socio-political impediments (Naeem et al., 2023; Timans et al., 2019). Mixed-methods designs enable the triangulation of stakeholder perspectives, policy reviews, and empirical data, which can inform more context-sensitive and actionable strategies for solar market development (Chakraborty et al., 2016; Pandey, 2020). For instance, combining household surveys on financial constraints with policy document analysis may reveal gaps between regulatory intent and on-the-ground implementation (Bahmani & Bahrammehr, 2016; Rehman et al., 2025).

Governments and international agencies have initiated various interventions to mitigate these challenges. The introduction of green bonds, renewable energy funds, and risk-sharing mechanisms are among the tools employed to enhance investment attractiveness and project bankability (Abdul & Wenqi, 2024; Pfeiffer & Mulder, 2013). In addition, the decentralization of solar energy systems through mini-grids and off-grid solutions has shown promise in improving energy access in remote areas, especially when complemented by supportive regulations and capacity development programs (Mohtasham, 2015; Ohunakin

et al., 2014). Case studies from successful adopters such as Brazil, South Africa, and India illustrate that integrated approaches—combining public subsidies, market incentives, and private sector engagement—are critical for achieving scale and sustainability (Irfan et al., 2019; Timilsina et al., 2012).

Iran presents a compelling case within this broader context. Despite possessing one of the highest solar irradiance potentials in the region, the country's solar energy sector remains underdeveloped due to a confluence of financial, institutional, and geopolitical factors (Moghani et al., 2024; Sadat Robat Jazi, 2024). The country's dependence on fossil fuels, coupled with limited foreign investment and underdeveloped domestic manufacturing, hinders the scalability of solar projects (Bahmani & Bahrammehr, 2016; Bakhtiyar et al., 2016). However, targeted investments in research and development, strategic policy reforms, and enhanced cooperation with regional and international stakeholders could potentially unlock Iran's vast renewable energy potential (Rehman et al., 2025; Sampaio & González, 2017).

This study aims to contribute to the existing body of literature by providing a comprehensive analysis of the economic barriers to solar panel adoption in emerging markets, with a specific focus on Iran.

2. Methods and Materials

This study was conducted using a mixed-methods approach to provide a comprehensive and in-depth understanding of the economic barriers and challenges in the adoption of renewable energy, particularly solar panel technology, in emerging markets. The application of a mixed-methods design enables the integration of statistical analyses with insights derived from interviews and document analysis, thereby offering a more realistic portrayal of the current situation.

In the qualitative section, semi-structured interviews were conducted with 15 experts and decision-makers in the field of renewable energy. These individuals included managers from the Renewable Energy and Energy Efficiency Organization (SATBA), university faculty members, solar project managers, and financial experts in the energy sector. The interviews were recorded with the consent of the participants and subsequently transcribed.

The interview data were analyzed using thematic analysis, facilitated by the MAXQDA software. The main extracted themes included: "instability of supportive policies," "financial and investment risks," "absence of effective economic incentives," "cultural and social challenges in technology adoption," and "infrastructural barriers."

Additionally, to examine and compare supportive policies, a document content analysis method was employed. Official documents such as Iran's national development plans, regulations on power purchase agreements, subsidy schemes, reports by international organizations such as the International Energy Agency (IEA) and the World Bank, as well as sustainable development reports, were reviewed. At this stage, the study also analyzed the successful experiences of developing countries such as India, South Africa, Brazil, and Turkey in a comparative manner. These analyses helped identify policy gaps in Iran's solar energy sector and facilitated the formulation of strategic recommendations.

In the quantitative section of the study, a structured questionnaire using a five-point Likert scale was utilized. The questionnaire included items on initial investment costs, return on investment, access to financial facilities, supportive policies, consumer awareness, and technical and economic infrastructure. The statistical population consisted of private sector stakeholders (solar project implementation companies), energy experts from governmental institutions, and academic specialists in the field of renewable energy.

Using purposive sampling, 80 respondents from various provinces, who had relevant experience or knowledge regarding solar project implementation, were selected. The collected data were analyzed using descriptive (mean, standard deviation) and inferential statistical methods (exploratory factor analysis, independent t-test, and multiple regression analysis) with the aid of statistical software.

3. Findings and Results

The findings of this study are derived from a combined analysis of qualitative and quantitative data, including expert interviews in the energy sector, examination of national policy documents, and a review of economic statistics in emerging markets. The results indicate that the adoption of solar panel technology in these countries faces a set of economic challenges and barriers that can be categorized into several main areas:

1. High Investment Costs

One of the most significant obstacles to the adoption of solar energy is the high initial cost of installation and deployment. Although the long-term use of this technology can result in considerable economic savings, the need for substantial upfront capital poses a serious barrier for households and small businesses in developing countries (Sadat Rabat Jazi, 2024). This issue is particularly pronounced in markets with low return on investment (ROI), discouraging investors from entering the sector. Tables 1 and 2 present comparative data on initial investment costs across several emerging markets (in USD per kilowatt) and the average installation cost of residential solar systems in three emerging countries:

Table 1. Comparison of Initial Investment Costs in Selected Emerging Markets (USD per kilowatt)

Country	Average Installation Cost (USD/kW)	Payback Period (Years)
Iran	1050	6.5
Turkey	980	5.2
India	900	4.8

Table 2. Average Cost of Residential Solar System Installation in Selected Emerging Countries

Country	Average Installation Cost (USD)	ROI Rate
India	1200	35%
Egypt	1350	42%
Brazil	1500	30%

2. Limited Access to Financial Resources and Banking Facilities

A major economic barrier to the development and adoption of renewable energy technologies, particularly solar panels, is the lack of access to suitable financial resources and efficient banking facilities. This issue is particularly critical in emerging markets that often face structural challenges in their financial and banking systems. Investigations show that in most developing countries, interest rates on bank loans are high and repayment periods are short. This makes investing in renewable energy infrastructure risky and, in some cases, unfeasible for households, small and medium-sized enterprises, and even independent investors. Interviews with energy experts and officials from financial institutions revealed that one of the main reasons banks are reluctant to provide loans in this area is the absence of reliable and sustainable business models for small-scale and residential solar projects. In addition, the lack of credit guarantee systems for residential consumers and the absence of project insurance further increase the investment risk for banks. In contrast, countries that have succeeded in improving access to financial resources have typically utilized instruments such as "renewable energy support funds," "subsidized loans," or "government guarantees for small projects." For example, in Brazil, a scheme offering low-interest loans to households resulted in the installation of solar systems in over 200,000 residential units between 2014 and 2019. Furthermore, the lack of digital financial infrastructure and banking services in rural or underserved areas poses an additional challenge. Many energy-poor households do not have access to formal banking systems and cannot participate in credit schemes, despite being the very population segment with the highest need for clean energy.

3. Lack of Stable and Incentive-Based Support Policies

The results indicate that the absence of long-term, transparent, and guaranteed policies for feed-in tariffs (FiTs), tax exemptions, and investment incentives is a major factor behind investor uncertainty. Additionally, frequent changes in laws and tariff structures lead to instability in the market. The following chart illustrates the trend of changes in Iran's solar feed-in tariffs from 2016 to 2024 (Chart 1). The data show that the FiT rate increased steadily from 2016 to its peak in 2018, but has declined gradually since then, reaching its lowest point in 2024. This downward trend has significantly reduced investors' motivation to develop solar power plants, as it challenges the profitability and ROI of such investments. This situation underscores the need to revise stabilization and incentive policies to support the renewable energy sector.

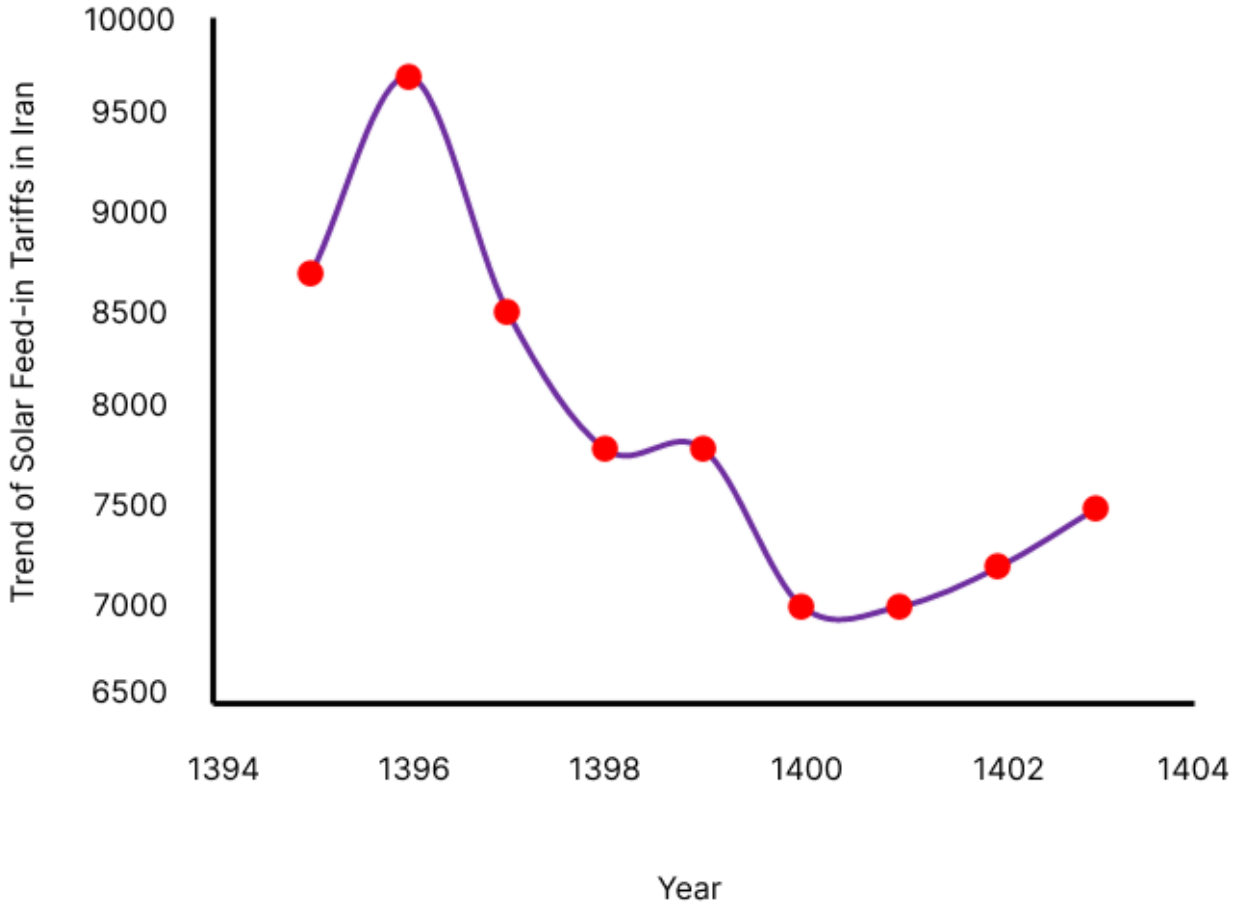

Figure 1. Trend of Solar Feed-in Tariffs in Iran (2016–2024)

The analysis of successful renewable energy adoption in countries like China and India offers valuable insights for other developing nations, including Iran. In these countries, comprehensive, integrated, and long-term policies combined with extensive government support have played a pivotal role in accelerating the deployment of renewable energy technologies.

Case studies show that the success of solar energy expansion in these countries has resulted from targeted policymaking, effective financial support, and strong private sector involvement. China, a global leader in solar panel production and usage, has, since the 2010s, adopted development-oriented policies that significantly reduced the cost of solar energy and positioned it as a key component of its national energy mix. Massive support for domestic industries, production subsidies, tax exemptions, and long-term feed-in tariffs have encouraged both domestic and foreign investment. In addition, China has made substantial investments in research and development (R&D), trained skilled professionals, developed production infrastructure, and influenced the global solar panel market through equipment exports.

Similarly, India has attracted significant domestic and foreign investment through initiatives such as the "National Solar Mission" and the setting of clear capacity targets. In both countries, financial incentives—including low-interest loans, tax exemptions, and long-term guaranteed payments for electricity generation—have played a critical role in reducing investment risk. Feed-in tariffs, especially in the early stages of market development, ensured reliable returns for private investors. Moreover, in these countries, private sector participation has been strongly supported not only in the installation and operation of solar systems but also in the design, production, and export of solar equipment.

On the other hand, one of the major challenges in emerging markets such as Iran is the dependence on imported key components for solar panels, which makes the sector vulnerable to currency fluctuations and international sanctions. Localizing technology and developing a domestic supply chain can reduce production costs, minimize foreign currency dependency, and promote job creation and sustainable growth. Investment in R&D, support for knowledge-based companies, and the development of domestic manufacturing infrastructure are some of the strategies observed in other countries' successful

experiences. Table 3 presents a comparative overview of solar panel development policies in selected countries. The comparative analysis reveals that China and India, through sustainable policies, diverse financial incentives, private sector support, and targeted investment in technology, have captured a significant share of the global solar energy market. In contrast, despite having substantial solar potential, Iran has not effectively capitalized on these opportunities due to policy instability, structural financing issues, and dependence on imported technology. Learning from the experiences of these countries could serve as a foundation for transforming Iran's renewable energy sector.

Table 3. Comparison of Solar Panel Development Policies in Selected Countries

Indicator	China	India	Iran
Feed-in Tariff (FiT)	Strong and long-term	Stable and competitive	Fluctuating and sometimes ineffective
Tax Incentives	Extensive tax exemptions	Income and customs tax exemptions	Limited and complex
Private Sector Participation	Highly active with state support	Growing with government facilitation	Weak due to regulatory instability
Financing and Bank Facilities	Subsidized loans, foreign investment	Low-interest loans and state support	Limited and inaccessible
Technology Localization	Extensive localization and exports	Developing through international partnerships	Limited, import-dependent
Government Role in Policymaking	Centralized and targeted planning	Independent policy institutions	Fragmented and unstable policymaking
Investment in R&D	Heavy state investment	Progress with international support	Limited and sporadic

Therefore, to achieve widespread adoption of solar energy in Iran, a combination of financial incentives, supportive tariffs, facilitation of private sector participation, and policies aimed at technology localization is essential. Furthermore, policymakers must prioritize regulatory stability and long-term vision to foster greater confidence among domestic and international investors.

4. Discussion and Conclusion

The findings of this study, based on a comprehensive mixed-methods design, underscore the significant economic, institutional, and infrastructural barriers that hinder the widespread adoption of solar photovoltaic (PV) systems in emerging markets, particularly in Iran. Through the integration of expert interviews, document analysis, and structured surveys, the research highlights three core categories of challenges: high initial investment costs, limited access to financing, and the absence of stable and incentivizing policy frameworks. Each of these categories reflects deeply rooted structural issues that have been identified in multiple contexts across the developing world.

The first and most consistently cited obstacle in both the qualitative and quantitative strands of the research was the high initial investment cost associated with installing solar PV systems. While solar power offers significant long-term savings and sustainability benefits, the financial burden of upfront capital expenditure is often prohibitive for households and small businesses. This result is aligned with existing literature that underscores cost as a central deterrent to solar energy adoption in developing countries (Liu, 2018; Pfeiffer & Mulder, 2013; Sadat Robat Jazi, 2024). In markets such as Iran, where return on investment is further undermined by economic instability and inflation, the risk calculus becomes even more unfavorable for prospective investors (Moghani et al., 2024; Rehman et al., 2025). As shown in this study's comparative cost tables, Iran's average installation cost per kilowatt is significantly higher than that of India or Turkey, further reinforcing the capital barrier narrative.

The inaccessibility of financial services and lack of banking support emerged as the second major theme. Respondents consistently noted that high-interest rates, short repayment periods, and the lack of tailored lending products discourage households and small enterprises from investing in solar technologies. The reluctance of banks to fund solar projects—particularly residential and small-scale ones—stems from the perceived lack of commercially viable models and insufficient risk mitigation mechanisms (Abdul & Wenqi, 2024; Wyllie et al., 2018). These findings are in line with previous research that highlights the inadequacy of financial infrastructure as a significant constraint on renewable energy diffusion in developing countries (Campbell et al., 2020; Ibegbulam et al., 2023; Pfeiffer & Mulder, 2013). Notably, countries such as Brazil have successfully addressed this issue by offering subsidized loans and establishing renewable energy support funds, facilitating broader participation in solar adoption (Rehman et al., 2025).

The third critical barrier identified relates to the lack of consistent and incentive-driven policy support. In the Iranian context, frequent changes to feed-in tariffs (FiTs), lack of tax exemptions, and weak institutional coordination have severely undermined investor confidence. This study's analysis of FiT trends in Iran clearly illustrates a downward trajectory in solar electricity purchase rates, diminishing returns for investors and ultimately reducing the attractiveness of the market. These findings mirror those of global research that has emphasized the role of policy stability and coherence in encouraging renewable energy investment (Irfan et al., 2019; Kihlström & Elbe, 2021; Luthra et al., 2015). For example, the success of China and India in expanding their solar sectors has been attributed to the presence of long-term, transparent policies that include financial incentives, streamlined regulations, and institutional support (Mohtasham, 2015; Timilsina et al., 2012).

In addition to economic and institutional challenges, the study revealed sociocultural and informational barriers that contribute to public hesitancy regarding solar energy. Participants in the qualitative phase noted a lack of awareness among the general population about the economic and environmental benefits of solar systems. Moreover, concerns about maintenance complexity and reliability persist in both urban and rural settings. These perspectives are supported by research that emphasizes the role of consumer education and cultural perceptions in renewable energy adoption (Chakraborty et al., 2016; Miller, 2012; Ohunakin et al., 2014). In contexts where government trust is low and misinformation is prevalent, behavioral interventions and awareness campaigns become crucial components of a successful energy transition.

The comparative policy analysis in this study further illustrated how technological dependence and import vulnerability can exacerbate adoption challenges. Iran's reliance on imported PV components has made its solar energy sector susceptible to currency fluctuations and international sanctions. This issue aligns with broader findings that emphasize the need for localized supply chains and domestic manufacturing capacity to stabilize costs and reduce external dependency (Bakhtiyar et al., 2016; Liu, 2018). Countries that have invested in R&D and local production, such as China and India, have not only lowered their solar costs but also created employment and stimulated technological innovation (Sampaio & González, 2017; Sawin et al., 2013).

Another noteworthy aspect of this study is the use of mixed-methods research, which provided a multi-dimensional understanding of the issues. The combination of thematic analysis and survey-based statistical evaluation enabled the researchers to validate qualitative insights with quantitative evidence. This approach reflects the growing scholarly consensus that complex policy issues—particularly those involving behavioral, financial, and infrastructural dimensions—are best examined through mixed methodologies (Naeem et al., 2023; Timans et al., 2019). It allowed for triangulation of perspectives from energy experts, financial stakeholders, and government representatives, ensuring the robustness of the findings.

Ultimately, the evidence suggests that without systemic interventions at both the macro and micro levels, the diffusion of solar PV systems in emerging markets will remain limited. There is a pressing need for an integrated approach that includes financial innovation, policy reform, institutional capacity building, public engagement, and technological self-reliance. Countries that have successfully navigated these challenges demonstrate that progress is not only possible but economically advantageous in the long term (Rehman et al., 2025; Timilsina et al., 2011).

This study is not without its limitations. First, while the research employed a mixed-methods approach for comprehensiveness, the sample size for both the qualitative interviews and quantitative surveys was relatively modest and may not fully capture the diversity of experiences across all regions of Iran. Second, the study focused exclusively on solar energy, thus excluding other renewable technologies that might offer complementary insights into the broader renewable energy landscape. Third, access to updated policy documents and government statistics was sometimes restricted, limiting the depth of policy analysis in specific areas.

Future studies should expand the geographical scope of analysis to include multiple emerging markets for cross-national comparisons, particularly in the MENA, Sub-Saharan, and Southeast Asian regions. Additionally, longitudinal studies could provide insight into how policy shifts and financial reforms influence adoption patterns over time. Further research is also needed to explore consumer behavior, especially in low-income and off-grid communities, using experimental and ethnographic methods. Finally, studies that integrate environmental impact assessments with socio-economic analyses could offer a more holistic view of solar energy's benefits and trade-offs.

To advance the adoption of solar energy in emerging markets, especially in countries like Iran, policymakers must prioritize financial accessibility through subsidized loans, tax exemptions, and government-backed guarantees for small-scale investors. Stable, transparent, and long-term energy policies must be enacted to build investor confidence. Additionally, localized production of solar components and investment in R&D can reduce dependency on foreign suppliers and create new economic opportunities. Public awareness campaigns and educational initiatives are essential to address sociocultural resistance and increase demand at the grassroots level. A multi-sectoral strategy involving government, private sector, financial institutions, and civil society is vital for unlocking the transformative potential of solar energy.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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References

Abdul, D., & Wenqi, J. (2024). Identifying and prioritization barriers to renewable energy diffusion in developing countries: A novel spherical fuzzy AHP approach and application. *Energy Efficiency*, *17*(5), 40. https://doi.org/10.1007/s12053-024-10213-0

Bahmani, M., & Bahrammehr, N. (2016). Economic Evaluation of Solar Energy Use in Rural Areas of Southern Iran. *Quarterly Journal of Economic Research*, *51*(2), 307-426. https://jte.ut.ac.ir/article_58452.html

Bakhtiyar, M., Mohammadi, T., & Taklif, A. (2016). The Expansion of Renewable Energies and Its Role in the Future Development of Iran's Power Industry. *Economic Growth and Development Research*, *7*(25), 147-161. https://www.sid.ir/fa/journal/ViewPaper.aspx?id=310441

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *J Res Nurs*, *25*(8), 652-661. https://doi.org/10.1177/1744987120927206

Chakraborty, S., Sadhu, P. K., & Goswami, U. (2016). Barriers in the advancement of solar energy in developing countries like India. *Problemy Ekorozwoju*, *11*(2), 75-80. https://ouci.dntb.gov.ua/en/works/loxoPXW9/

Cormio, C., Dicorato, M., Minoia, A., & Trovato, M. (2003). A regional energy planning methodology including renewable energy sources and environmental constraints. *Renewable and Sustainable Energy Reviews*, *7*(2), 99-130. https://doi.org/10.1016/S1364-0321(03)00004-2

Ibegbulam, M., Adeyemi, O., & Fogbonjaiye, O. (2023). Adoption of Solar PV in developing countries: challenges and opportunity. *International Journal of Physical Sciences Research*, *7*(1), 36-57. https://eajournals.org/ijpsr/wp-content/uploads/sites/81/2023/09/Adoption-of-Solar.pdf

Irfan, M., Zhao, Z. Y., Ahmad, M., & Mukeshimana, M. C. (2019). Solar Energy Development in Pakistan: Barriers and Policy Recommendations. *Sustainability*, *11*(4), 1206. https://doi.org/10.3390/su11041206

Kihlström, V., & Elbe, J. (2021). Constructing Markets for Solar Energy-A Review of Literature about Market Barriers and Government Responses. *Sustainability*, *13*(6), 3273. https://doi.org/10.3390/su13063273

Liu, Z. (2018). What is the future of solar energy? Economic and policy barriers. *Energy Sources, Part B: Economics, Planning, and Policy*, *13*(3), 169-172. https://doi.org/10.1080/15567249.2017.1416704

Luthra, S., Kumar, S., Garg, D., & Haleem, A. (2015). Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renewable and Sustainable Energy Reviews*, *41*, 762-776. https://doi.org/10.1016/j.rser.2014.08.077

Miller, D. (2012). *Selling solar: the diffusion of renewable energy in emerging markets*. Routledge. https://www.taylorfrancis.com/books/mono/10.4324/9781849772518/selling-solar-damian-miller

Moghani, A., Heydari, B., & Maleki, A. (2024). Natural Gas and Solar Energy: Challenges and Opportunities for Iran from the Perspective of Energy Security. https://sharif.ir/~maleki/Natural%20Gas%20and%20Solar%20Energy%20Iran's%20Challenges%20and%20Opportunities%20from%20the%20Perspective%20of%20Energy%20Security.pdf

Mohtasham, J. (2015). Renewable energies. *Energy Procedia*, *74*, 1289-1297. https://doi.org/10.1016/j.egypro.2015.07.774

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A Step-by-Step Process of Thematic Analysis to Develop a Conceptual Model in Qualitative Research. *International Journal of Qualitative Methods*, *22*, 16094069231205789. https://doi.org/10.1177/16094069231205789

Ohunakin, O. S., Adaramola, M. S., Oyewola, O. M., & Fagbenle, R. O. (2014). Solar energy applications and development in Nigeria: Drivers and barriers. *Renewable and Sustainable Energy Reviews*, *32*, 294-301. https://doi.org/10.1016/j.rser.2014.01.014

Pandey, V. (2020). Energy infrastructure for sustainable development. *Affordable and clean energy*, 1-13. https://doi.org/10.1007/978-3-319-71057-0_77-1

Pfeiffer, B., & Mulder, P. (2013). Explaining the diffusion of renewable energy technology in developing countries. *Energy Economics*, *40*, 285-296. https://doi.org/10.1016/j.eneco.2013.07.005

Rehman, A., Batool, Z., Ain, Q. U., & Ma, H. (2025). The renewable energy challenge in developing economies: An investigation of environmental taxation, financial development, and political stability. *Natural Resources Forum*, *49*(1), 699-724. https://doi.org/10.1111/1477-8947.12418

Sadat Robat Jazi, M. (2024). The Impact of Investment in Renewable Energy on Energy Imbalance in Iran.

Sampaio, P. G. V., & González, M. O. A. (2017). Photovoltaic solar energy: Conceptual framework. *Renewable and Sustainable Energy Reviews*, *74*, 590-601. https://doi.org/10.1016/j.rser.2017.02.081

Sawin, J. L., Martinot, E., Barnes, D., McCrone, A., Roussell, J., Sims, R., & Musolino, E. (2013). Renewables 2011-Global Status Report. https://www.sciencedirect.com/science/article/abs/pii/S0960148112006787

Siecker, J., Kusakana, K., & Numbi, E. B. (2017). A review of solar photovoltaic systems cooling technologies. *Renewable and Sustainable Energy Reviews*, *79*, 192-203. https://doi.org/10.1016/j.rser.2017.05.053

Timans, R., Wouters, P., & Heilbron, J. (2019). Mixed methods research: what it is and what it could be. *Theory and Society*, *48*(2), 193-216. https://doi.org/10.1007/s11186-019-09345-5

Timilsina, G. R., Kurdgelashvili, L., & Narbel, P. A. (2011). *A review of solar energy: markets, economics and policies*. World Bank Washington, DC, USA. https://doi.org/10.1596/1813-9450-5845

Timilsina, G. R., Kurdgelashvili, L., & Narbel, P. A. (2012). Solar energy: Markets, economics and policies. *Renewable and Sustainable Energy Reviews*, *16*(1), 449-465. https://doi.org/10.1016/j.rser.2011.08.009

Wyllie, J. O., Essah, E. A., & Ofetotse, E. L. (2018). Barriers of solar energy uptake and the potential for mitigation solutions in Barbados. *Renewable and Sustainable Energy Reviews*, *91*, 935-949. https://doi.org/10.1016/j.rser.2018.04.100