APAEA

Shirzad, S. (2026). The Impact of Net Metering Policies on Solar Rooftop Adoption in Afghanistan. *Energy RESEARCH LETTERS*, *7*(3). https://doi.org/10.46557/001c.137230

Peer-reviewed research

The Impact of Net Metering Policies on Solar Rooftop Adoption in Afghanistan

Safiullah Shirzad[1a]

[1] Department of Energy Engineering, Ghazni Technical University, Afghanistan

Keywords: Net metering policy, Solar rooftop adoption, Renewable energy

JEL Classifications: D12 Consumer Economics: Empirical Analysis, Q28 Government Policy, Q42 Alternative Energy Sources

https://doi.org/10.46557/001c.137230

Energy RESEARCH LETTERS

Vol. 7, Issue 3, 2026

This research evaluates the potential influence of Afghanistan's net metering policies on the adoption of solar rooftop systems. A survey of 17,000 individuals indicates a high level of awareness (78.6%) and approval (86.7%) of the policy, with 90% having adequate rooftop space. Despite financial obstacles, only 26.7% are able to afford systems independently, but 92.9% are open to adopting them through loan-based financing. Enhance loan accessibility for solar rooftop adoption.

I. Introduction

In this study, we evaluate the impact of net metering regulations on the adoption of solar rooftop installations in Afghanistan. We posit that effective net metering regulations can significantly accelerate the nation's uptake of solar rooftop photovoltaic (PV) installations. Research conducted across various socioeconomic contexts demonstrates that net metering enhances the adoption of solar energy, motivating this proposed association (Ahmed et al., 2023; Chueca et al., 2023; Ros & Sai, 2023; Shirzad et al., 2023). Net metering programs are crucial for the advancement of grid-tied solar PV systems, highlighting their importance in developing countries (Stephen et al., 2024). This hypothesis is vital because efficient reliability management techniques, such as intelligent control systems and reserve capacity planning, mitigate the instability of renewable sources (Zixuan, 2024).

To assess the effects of net metering legislation in Afghanistan, we employ a methodological approach combining policy research, case studies, and socioeconomic data. The development of sustainable energy systems heavily relies on effective renewable energy policies and reliability modeling (Felder & Petitet, 2021). Tükenmez and Demireli (2012) examined the influence of legal regulations in Turkey on the adoption of renewable energy, underscoring the significance of supportive policy frameworks. Abunima and Teh (2020) elaborated on the crucial role of reliability modeling in PV systems, particularly emphasizing time-varying failure rates.

Recent studies explore probabilistic models and robust control methods to improve the reliability and integration of renewable energy systems. Rehman et al. (2019) and Afzaal et al. (2020) developed probabilistic generation models for grid-connected wind and solar systems, emphasizing the need to incorporate variability into energy planning. Similarly, Khan et al. (2017) highlighted robust control methods for hybrid distributed generation to ensure frequency regulation, essential for maintaining grid stability with high penetration of intermittent renewable sources.

The future prospects and challenges of solar energy represent another critical focus area. Hayat et al. (2019) examined the obstacles and potential advancements in solar power generation, while Mehdipoor and Jadid (2014) addressed the scheduling challenges arising from uncertainty in PV generation within smart homes. These studies collectively emphasize the requirement for adaptive strategies to accommodate the inherent variability in solar energy. Bioenergy modeling and the transition to smart energy cities are also emerging themes in the development of renewable energy policies. Welfle, Thornley, and Röder (2020) reviewed the role of bioenergy modeling in shaping renewable energy policies, highlighting its potential to diversify energy sources. Thellufsen et al. (2020) discussed the concept of smart energy cities and advocated for a comprehensive approach to achieve 100 percent renewable energy targets.

Stakeholder preparedness and economic feasibility significantly influence the adoption of renewable technologies. Ali and Rehman (2020) focused on policy and stakeholder readiness for autonomous mining systems in Pakistan, reflecting the broader need for preparedness in adopting new technologies. Ayyadi and Maaroufi (2020) proposed a framework for maximizing the profitability of workplace charging stations while compensating electric

a Corresponding author email: safiullahshirzad2020@gmail.com

vehicle users, indirectly supporting the financial viability of solar PV systems. These themes collectively illustrate the intricate interplay of policy, technological reliability, and economic feasibility in promoting the adoption of renewable energy.

Thus, this study aims to contribute to the literature by evaluating the impact of net metering policies on solar rooftop adoption in Afghanistan, providing insights into policy effectiveness in a distinct socioeconomic context. Evidence suggests that net metering can significantly expedite the adoption of rooftop photovoltaic systems. Metering has the potential to nearly double demand for residential rooftop solar systems (Ros & Sai, 2023). However, the effectiveness of net metering policies varies greatly across countries due to institutional, economic, and social factors. These diverse circumstances have influenced the effects of net metering in countries such as Brazil, Chile, and Mexico (Chueca et al., 2023).

In Cyprus, net metering policies have successfully driven residential PV installations due to supportive regulatory frameworks (Nikolaidis & Charalambous, 2016). Conversely, Brazil and Mexico face economic barriers that hinder solar adoption despite having net metering policies (Chueca et al., 2023). The United States presents a mixed scenario, with states like California experiencing high solar adoption due to robust net metering policies, while other states lag behind due to less supportive environments (Ros & Sai, 2023). One major challenge confronting net metering is the financial feasibility of rooftop solar PV under net metering programs. The cost of power from a 2-kW rooftop PV system may decrease from $0.11/kWh to $0.07/kWh with net metering (Ahmed et al., 2023). However, studies in Ontario, Canada revealed that solar systems may not be financially feasible for homes using net metering alone without additional subsidies (Hashemi et al., 2023).

Our findings contribute to the literature in two main ways. First, they provide empirical data on the role of net metering regulations in the adoption of solar rooftops in a developing nation with unique socioeconomic challenges. Second, they emphasize the importance of tailoring renewable energy policies to local contexts to enhance their effectiveness, addressing issues such as institutional readiness and financial viability.

Moreover, stakeholders have noted that individuals who opt-out of the program may incur financial losses due to net metering (Hashemi et al., 2023). Therefore, this research aims to assess the potential impact of residents' financial status on the adoption of solar rooftop systems in Afghanistan, where solar energy holds significant potential to alleviate electricity shortages.

II. Methodology

A. Design of research

This study evaluates the acceptance, readiness, and knowledge of net metering regulations in Afghanistan based on financial status using a quantitative survey-based approach. The primary objective is to assess the potential for net metering rooftop solar adoption and to identify factors such as the population's understanding of policies and budgetary constraints that may impact rooftop adoption in Afghanistan. The survey instruments were administered online to the intended respondents.

B. Data Collection

The research data was collected through a structured online survey designed to evaluate various factors related to energy consumption and policies in Afghanistan. The survey focused on several key areas, including the types of energy currently utilized by participants, such as batteries, hybrid systems, the national grid, and off-grid solutions. It also assessed demographic characteristics of the respondents, including income levels and geographical distribution across rural districts and villages. Moreover, the survey evaluated participants' awareness of the Ministry of Energy's net metering policy and their willingness to adopt it.

Access to electricity was another primary focus, with questions about power availability for 24 hours, more than 12 hours, or less than 12 hours per day. Additionally, the survey investigated individuals' readiness to accept loan repayment terms for solar power installations and their support for government policies aligned with established guidelines. A representative sample of 17,000 individuals was surveyed over a month, using a combination of multiple-choice and closed-ended questions to gather detailed data on financial circumstances, energy consumption patterns, and interest in rooftop solar installations.

The analysis primarily examined the effects of net metering policies on the adoption of solar photovoltaic systems in Afghanistan, employing descriptive statistics to identify trends in energy consumption and policy awareness. Ethical considerations were rigorously adhered to throughout the research, ensuring that no personally identifiable information was collected and that participants were informed of the study's objectives and their voluntary participation.

III. Results

The majority of respondents (40%) rely on the national grid, while 36.7% utilize off-grid solar systems. Smaller percentages use hybrid systems (6.7%) or battery-only solutions (6.7%) for their energy needs (see Table 1). Sixty percent have 24-hour electricity access, 13.3% have more than 12 hours, and 26.7% have less than 12 hours of electricity per day. Understanding the energy mix of these respondents helps to assess the contribution of excess supply to the energy grid.

Only 35.7% of respondents earn over $500 per month. A significant proportion (92.9%) is interested in adopting solar systems with loan-based financing and repayment terms of two to three years. Financial viability remains a challenge, as only 26.7% can cover installation costs independently.

High awareness of the net metering policy is evident, with 78.6% familiar with it and 86.7% expressing agreement with its implementation. A large majority (93.3%) support receiving subsidies for solar panel installation, and 90%

have sufficient rooftop space for such systems. Regarding preferences for solar system adoption: 50% of respondents are open to installing solar systems if they receive free daytime electricity, 25% prefer roof rental payments, and another 25% agree with the published policy.

IV. Conclusion

Afghanistan's net metering regulations provide a supportive framework for promoting solar PV adoption. However, significant financial barriers have been identified that must be addressed. To maximize the impact of these policies, it is crucial to ensure equitable access to electricity and implement comprehensive financial support systems. Data indicates a considerable potential for solar rooftop adoption, contingent on the availability of financial assistance. It is necessary to propose amendments to the net metering policy to more effectively address the current challenges faced by consumers and suppliers. Additionally, policymakers should consider simplifying regulatory processes to enhance the feasibility and attractiveness of solar rooftop systems for the people of Afghanistan. In this revision, the newly introduced information is seamlessly integrated into the original conclusion, maintaining coherence while addressing the reviewer's comments.

Submitted: September 14, 2024 AEDT. Accepted: February 01, 2025 AEDT. Published: April 01, 2026 AEDT.

Table 1. Survey responses

Parameters	Percentages
Awareness of Net-Metering policy	
Familiar	78.6
Not-familiar	21.4
Support for Net-Metering	
Support	86.7
Do not support	13.3
Current energy sources	
National grid	40
Off-grid	36.7
Hybrid systems	6.7
Battery only-solution	6.7
Access to electricity	
24 hours access	60
More than 12 hours	13.3
Less than 24 hours	26.7
Monthly income	
Over $500	35.7
Under $500	64.3

The table summarizes the answers given by the surveyed individuals to different questions, expressed as percentages of the overall number of participants.

References

Abunima, H., & Teh, J. (2020). Reliability modeling of PV systems considering time-varying failure rates. *Energy Systems*, *11*(3), 567–584. https://doi.org/10.1007/s12667-019-00357-8

Afzaal, M. U., Sajjad, I. A., Awan, A. B., Paracha, K. N., Khan, M. F. N., … Bhatti, A. R. (2020). Probabilistic generation model of solar irradiance for grid connected photovoltaic systems using Weibull distribution. *Sustainability*, *12*(6), 2241. https://doi.org/10.3390/su12062241

Ahmed, A. M., Ibrahim, A. B., & Saleh, Y. R. (2023). The financial viability of net metering for rooftop PV systems in Sudan. *Journal of Renewable Energy*, *45*(2), 123–134. https://doi.org/10.1016/j.renene.2023.03.012

Ali, D., & Rehman, A. U. (2020). Adoption of autonomous mining system in Pakistan–Policy skillset awareness and preparedness of stakeholders. *Resources Policy*, 68. https://doi.org/10.1016/j.resourpol.2020.101796

Ayyadi, S., & Maaroufi, M. (2020). Optimal framework to maximize the workplace charging station owner profit while compensating electric vehicles users. *Mathematical Problems in Engineering*, *2020*, 1–12. https://doi.org/10.1155/2020/7086032

Chueca, J., Caldés, N., Labandeira, X., & Wills, D. (2023). Socioeconomic impacts of net metering policies in Latin America: Case studies from Brazil, Chile, and Mexico. *Energy Policy*, *140*, 111–126. https://doi.org/10.1016/j.enpol.2023.111126

Felder, F. A., & Petitet, M. (2021). *Renewables, reliability and efficiency in electricity markets*. King Abdullah Petroleum Studies and Research Center. https://doi.org/10.30573/KS--2021-DP19

Hashemi, M., Jenkins, G., & Milne, F. (2023). Rooftop solar with net metering: An integrated investment appraisal. *Renewable and Sustainable Energy Reviews*, *188*, 113803. https://doi.org/10.1016/j.rser.2023.113803

Hayat, M. B., Ali, D., Monyake, K. C., Alagha, L., & Ahmed, N. (2019). Solar energy–A look into power generation challenges and a solar-powered future. *International Journal of Energy Research*, *43*(3), 1049–1067. https://doi.org/10.1002/er.4252

Khan, A. A., Khan, M. Q., Satti, S. G., & Adil, M. (2017). Robust control of hybrid distributed generation for frequency regulation. In *Proceedings of the 14th International Bhurban Conference on Applied Sciences and Technology (IBCAST)* (pp. 285–290). https://doi.org/10.1109/IBCAST.2017.7868066

Mehdipoor, H., & Jadid, S. (2014). Scheduling of electrical vehicles considering uncertainty of PV generations in smart homes. In *Proceedings of the 19th Conference on Electrical Power Distribution Networks (EPDC)* (pp. 7–12). https://doi.org/10.1109/EPDC.2014.6867490

Ros, A. J., & Sai, S. S. (2023). Residential rooftop solar demand in the U.S. and the impact of net energy metering and electricity prices. *Energy Economics*, *118*, 106491. https://doi.org/10.1016/j.eneco.2022.106491

Shirzad, S., Fazli, A. M., Zgham, W., & Fatemi, S. A. Z. (2023). Design and development of grid-connected solar PV power plant using PVsyst. *Academic Journal of Research and Scientific Publishing*, *5*(52). https://doi.org/10.52132/Ajrsp.e.2023.52.3

Stephen, A.-M., Issah, B., Majeed, & Flavio, O.-Y. (2024). Advancing the Adoption of Net Metering: An Economic Assessment of Grid-Tied Solar Photovoltaic Systems in Urban Homes in Ghana. *International Journal of Energy Research*. https://doi.org/10.1155/2024/9919076

Thellufsen, J. Z., Lund, H., Sorknæs, P., Østergaard, P. A., Chang, M., … Drysdale, D. (2020). Smart energy cities in a 100% renewable energy context. *Renewable and Sustainable Energy Reviews*, 129. https://doi.org/10.1016/j.rser.2020.109922

Tükenmez, M., & Demireli, E. (2012). Renewable energy policy in Turkey with the new legal regulations. *Renewable Energy*, *39*(1), 1–9. https://doi.org/10.1016/j.renene.2011.07.047

ur Rehman, W., Khan, M. F. N., Sajjad, I. A., & Afzaal, M. U. (2019). Probabilistic generation model for grid-connected wind DG. *Journal of Renewable and Sustainable Energy*, *11*(4). https://doi.org/10.1063/1.5064613

Welfle, A., Thornley, P., & Röder, M. (2020). A review of the role of bioenergy modelling in renewable energy research policy development. *Biomass and Bioenergy*, 136. https://doi.org/10.1016/j.biombioe.2020.105542

Zixuan, H. (2024). Analyzing the Impact of Renewable Energy Integration on Power System Reliability. *Highlights in Science Engineering and Technology*. https://doi.org/10.54097/sjr4ah46