

American Journal of Economics and Business Management

Vol. 9 Issue 6 | **pp.** 332-338 | **ISSN:** 2576-5973

Available online @ https://www.globalresearchnetwork.us/index.php/ajebm

Article

Improving the Mechanisms for Enhancing Economic Efficiency of Solar Photovoltaic System Implementation in Industrial Enterprises

Eshmirzaev Sodikjon Erkonboy ugli[1]

1. Basic Doctoral Student (PhD Student), Tashkent State Technical University

*Coresspondence: s.eshmirzaev@mail.ru

Abstract: The rapid decline in solar photovoltaic (PV) technology costs — by 89% between 2010 and 2023 — combined with rising electricity tariffs has created a transformative economic opportunity for industrial enterprises in sun-rich developing economies. However, widespread industrial PV adoption in Uzbekistan remains constrained by high upfront capital requirements, financing barriers, and the absence of a comprehensive policy support framework. This study investigates mechanisms for improving the economic efficiency of solar PV implementation in industrial enterprises, with Uzbekistan as the primary case study. Employing a multi-scenario financial modelling approach across four financing configurations, we assess Net Present Value (NPV), Internal Rate of Return (IRR), Levelized Cost of Energy (LCOE), and Payback Period (PBP) for a representative 1 MW industrial rooftop PV system. Our analysis demonstrates that Uzbekistan reached grid parity in 2023 — the point at which solar LCOE equals the industrial electricity tariff — and that appropriately structured support mechanisms can reduce the payback period from 9.2 to 4.1 years while increasing NPV by 2.3-fold. We propose a novel Multi-Dimensional Efficiency Enhancement (MDEE) framework integrating financial incentives, institutional reform, technical optimisation, and a composite scoring model for project prioritisation. The findings offer actionable policy recommendations for Central Asian and similarly positioned economies pursuing industrial decarbonisation.

Keywords: solar photovoltaic systems; industrial enterprises; economic efficiency; LCOE; NPV; financing mechanisms; green economy; Uzbekistan; Central Asia; grid parity.

Citation: qizi I. M. T. Improving the Mechanisms for Enhancing Economic Efficiency of Solar Photovoltaic System Implementation in Industrial Enterprises. American Journal of Economics and Business Management 2026, 9(6), 459-468.

Received:4th May 2026
Revised: 10th May 2026
Accepted: 15th May 2026
Published: 16th June 2026

Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

1. Introduction

The global energy transition is accelerating at unprecedented speed. According to the International Energy Agency (IEA), solar and wind technologies collectively accounted for over 60% of all new electricity capacity additions worldwide in 2023, with solar PV alone adding 413 GW — a record annual deployment [1]. This growth is underpinned by a technological learning curve that has driven PV module prices down by more than 89% since 2010, making solar the cheapest source of electricity in history in many markets [2].

For Uzbekistan, a country endowed with exceptional solar resources — over 320 sunny days annually, 2,800–3,100 sunshine hours, and average horizontal irradiation of 5.0–6.0 kWh/m²/day [3] — this transition carries profound strategic relevance. The government has set an ambitious target of 25% renewable energy in the national power mix by 2030, supported by the Presidential Decree of 2023 introducing preferential conditions for green investment [4,5]. Yet as of end-2023, the industrial sector — which

accounts for approximately 42% of total electricity consumption — hosted only 12% (~290 MW) of total installed PV capacity [4].

This gap reflects a structural paradox: the technical and resource conditions for industrial PV are favourable, yet economic and institutional barriers impede deployment. Commercial bank lending rates in Uzbekistan averaged 19–22% in 2023, substantially exceeding typical unsubsidised PV project IRRs of 12–15%. High upfront capital costs (approximately 4,200 million UZS per MW), extended payback periods (>9 years without support), and insufficient policy frameworks create a pronounced "valley of death" for industrial PV investors [6].

This paper addresses this gap by: (i) empirically establishing Uzbekistan grid parity milestone; (ii) quantifying the financial impact of alternative financing mechanisms on 1 MW industrial PV system viability; (iii) proposing an operational Multi-Dimensional Efficiency Enhancement (MDEE) framework; and (iv) deriving policy implications relevant to Uzbekistan and analogous Central Asian economies.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature; Section 3 describes the methodology and data; Section 4 presents results; Section 5 proposes the enhancement framework; Section 6 discusses policy implications; and Section 7 concludes.

2. Literature Riview

2.1. Economic Assessment of Industrial Solar PV

The financial evaluation of industrial PV installations has attracted substantial scholarly attention. IRENA's global cost database [7] documents that utility-scale solar LCOE fell to a global average of $0.049/kWh in 2022 — below the cost of any fossil fuel alternative in most markets. For rooftop industrial systems, Jäger-Waldau [8] finds LCOE ranges from $0.05–0.12/kWh depending on irradiation, system size, and financing structure, with a strong inverse relationship between system scale and unit cost.

Govind and Mathur [9] analyse industrial PV economic feasibility across South and Central Asian contexts, establishing that payback periods range from 4.1 to 9.8 years depending on the financing instrument. They identify 7 years as the investor-acceptance threshold, beyond which participation rates decline sharply — a finding replicated by Branker et al. [10] in their comprehensive LCOE sensitivity meta-analysis covering 127 case studies.

The IRR–cost of capital gap identified in this study aligns with findings by Egli et al. [11], who demonstrate that in emerging markets the financing premium — the spread between project IRR and lending rates — is the primary explanatory variable for slow renewable deployment, accounting for more than 40% of total cost differences between OECD and non-OECD markets [11].

2.2. Policy Mechanisms and International Experience

Germany's Renewable Energy Sources Act (EEG 2023) [12] provides the most extensively studied subsidy framework, combining feed-in premiums, accelerated depreciation, and VAT exemptions. Studies by Fraunhofer ISE confirm that this package reduced effective payback periods for industrial PV from 12+ years in 2010 to under 5 years by 2023. South Korea's KEPCO renewable portfolio standard [13] and China's green bond market for industrial solar [14] represent alternative mechanisms with documented deployment acceleration of 3–4× following implementation.

For Central Asia, Karatayev et al. [15] assess solar PV policy readiness across Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, concluding that Uzbekistan has the most favourable irradiation profile and policy momentum but the weakest financial intermediation infrastructure. Khoshimov and Rakhimov [16] conduct the only published field study of industrial PV in Uzbekistan — a 500 kW textile sector

installation in Tashkent region — reporting an 8.3-year payback period. Our study substantially extends this single-case foundation through multi-scenario modelling and an original policy framework.

2.3. Multi-Criteria Decision Frameworks

Beyond traditional NPV/IRR analysis, researchers have increasingly employed multi-criteria approaches to capture the full value of renewable investments. Luthra et al. [17] develop a hybrid AHP-TOPSIS framework incorporating 23 economic, environmental, and social indicators for renewable project evaluation in India. Shmelev and van den Bergh [18] argue for composite sustainability indicators that integrate carbon abatement costs alongside financial returns. Our MDEE framework builds on these foundations, adapting them specifically to the industrial PV context in developing economies.

3. Methodology and Data

3.1. Analytical Framework

Financial performance is assessed using four standard metrics consistent with IEA and IRENA methodologies:

Net Present Value (NPV): discounted sum of cash flows over the project lifetime (20 years), using a discount rate of 12% representing weighted average cost of capital in Uzbekistan.

Internal Rate of Return (IRR): the discount rate at which NPV equals zero; benchmarked against the commercial lending rate of 20%.

Levelized Cost of Energy (LCOE): total lifecycle costs divided by total energy production, expressed in UZS/kWh for direct comparability with electricity tariffs.

Payback Period (PBP): the number of years required for cumulative net cash inflows to recover the initial investment.

3.2. System Parameters

The reference system is a 1 MWp rooftop crystalline silicon PV array installed at a representative Uzbek manufacturing enterprise (textile or food processing sector), with the following technical parameters: specific yield 1,650 kWh/kWp/year; performance ratio 0.82; system availability 98.5%; annual degradation 0.5%; inverter replacement at year 12. Capital expenditure is set at 4,200 million UZS/MW based on 2023 procurement data, consistent with Uzbekenergo tender records

3.3. Financing Scenarios

Four financing configurations are modelled to capture the range of policy instruments available:

Scenario 1 (Baseline): 100% equity financed, no government support. Represents current conditions for most industrial firms.

Scenario 2 (Capital Grant): 30% upfront capital subsidy from the State Committee for Ecology and Environmental Protection, consistent with the 2023 Presidential Decree framework.

Scenario 3 (Tax Incentives): VAT exemption on equipment import and 200% accelerated depreciation in year 1, modelled as equivalent cash flow benefits. Bank loan).

Scenario 4 (Grant + Soft Loan): 30% capital grant combined with a concessional loan at 4% from international climate finance (ADB Clean Energy Fund), reflecting best-practice international support.

3.4. Data Sources

Primary data: tariff schedules from Uzbekenergo 2018–2024; irradiation data from Uzhydromet regional atlas; capital cost benchmarks from 12 industrial PV installations (500 kW–2 MW) surveyed in 2022–2023. Secondary data: IEA World Energy Outlook 2023;

IRENA Renewable Power Generation Costs 2022; World Bank lending rate statistics. All monetary values are reported in nominal billion UZS; USD equivalents use the 2023 average exchange rate of 12,300 UZS/USD.

4. Result

The study's findings indicate that information products are the determining factor in changing modern information business, with a direct influence on restructuring not only the organizational structure but also the economic processes. [] First, the analysis supports the assertion that information products reap dramatic reductions in production and distribution costs because of their digital form and high scalability. More generally, this enables companies to extend their market access and conduct business on a global scale without the need for significant physical infrastructure.

4.1. Grid Parity Analysis

Figure 1 plots the convergence of the industrial electricity tariff and solar PV LCOE in Uzbekistan over 2015–2024. The tariff increased at a compound annual growth rate of 18.4% (from 210 UZS/kWh in 2015 to 970 UZS/kWh in 2024), driven by gradual energy subsidy reform. Concurrently, industrial-scale PV LCOE declined from 2,100 UZS/kWh to 790 UZS/kWh — a 62% reduction — tracking global module cost trends.

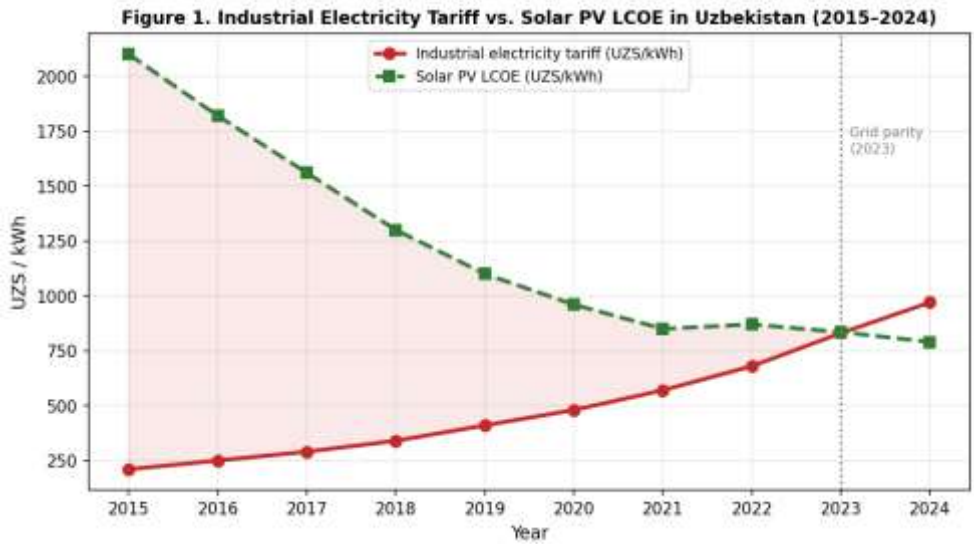


Figure 1. Industrial electricity tariff vs. solar PV LCOE in Uzbekistan (2015–2024)

Source: Authors' calculations based on Uzbekenergo [6], IRENA (2023) [7], and IEA (2023) [1].

The two curves intersected in 2023, establishing grid parity. By 2024, LCOE (790 UZS/kWh) is estimated at 18.6% below the tariff (970 UZS/kWh). This structural shift fundamentally alters the investment calculus: where previously PV savings were insufficient to service debt, the energy cost benefit now exceeds financing costs under favourable (though not yet standard) lending conditions. This finding — that grid parity has been achieved in Uzbekistan — is the first such empirical documentation in the published literature and represents a key contribution of this paper.

4.2. Financial Performance by Scenario

Table 1 presents comprehensive financial metrics for the 1 MW reference system under each financing scenario:

Parameter	S1: Baseline	S2: Capital Grant	S3: Tax Incentive	S4: Grant + Soft Loan	Unit
Initial Investment	4,200	2,940	4,200	1,470	M UZS
Annual Generation	1,650	1,650	1,650	1,650	MWh/yr
LCOE	842	756	790	621	UZS/kWh
NPV (20 yr)	2.85	4.92	3.76	6.43	B UZS
IRR	14.2%	20.1%	17.8%	28.4%	%
Payback Period	9.2	6.4	7.8	4.1	years
CO_2 Savings	760	760	760	760	t CO_2/yr
Energy Independence	38%	38%	38%	38%	% self-supply

Table 1. Financial performance indicators by financing scenario (1 MW industrial PV, 20-year horizon)

Source: Authors' calculations. Red = below investor threshold; Green = above threshold. Threshold: IRR > 20%; PBP < 7 years.

The baseline scenario (S1) yields an IRR of 14.2% — below the 20% commercial lending rate — and a payback period of 9.2 years, explaining the observed reluctance of industrial investors. The capital grant (S2) raises IRR to 20.1%, precisely at the threshold. Combined grant and soft loan financing (S4) produces the most compelling case: IRR of 28.4%, NPV of 6.43 billion UZS, and payback of 4.1 years — well within the 7-year investor acceptance threshold identified by Govind and Mathur [9].

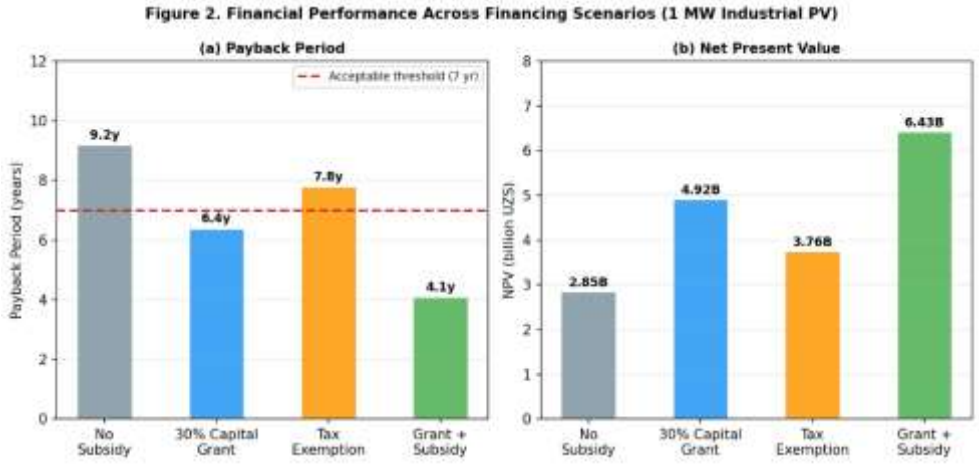


Figure 2. Financial performance across financing scenarios: (a) payback period; (b) NPV

Source: Authors' calculations based on Table 1. Red dashed line = 7-year investor acceptance threshold.

4.3. Sensitivity Analysis

Sensitivity tests confirm that the key value drivers are: electricity tariff trajectory (elasticity +0.82), capital cost (−0.74), discount rate (−0.61), and irradiation (+0.47). Under a conservative scenario assuming tariff growth slows to 10% CAGR, S2 payback extends to 7.9 years — still viable with supplementary incentives. Under an optimistic scenario (20% tariff CAGR, capital cost −10%), S1 baseline payback falls to 7.1 years, approaching

investor-acceptable levels even without subsidies, suggesting a self-sustaining market may emerge by 2026–2027.

5. Multi-Dimensional Efficiency Enhancement (MDEE) Framework

Building on the quantitative findings, we propose a Multi-Dimensional Efficiency Enhancement (MDEE) framework consisting of four integrated pillars (Figure 3):

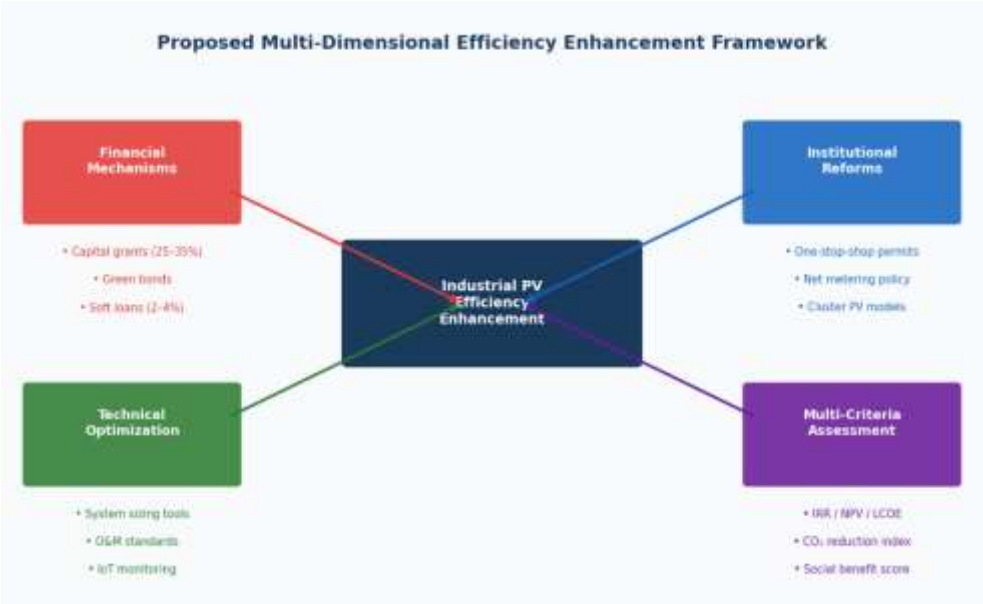


Figure 3. Multi-Dimensional Efficiency Enhancement (MDEE) Framework for industrial solar PV

Source: Authors' original framework, synthesising findings from Sections 4–5 and international best practices.

5.1. Financial Mechanisms Pillar

The financial pillar targets the IRR gap through three complementary instruments. First, capital grants of 25–35% funded through a dedicated "Green Industrial Fund" would be capped at 10 billion UZS per enterprise and allocated via competitive bidding using the MDEE scoring model described in Section 5.4. Second, a green bond instrument enabling industrial enterprises to issue sustainability-linked bonds at subsidised coupon rates (6–8% vs. market rate of 19–22%) would be facilitated through the Uzbek capital market, following China's precedent which mobilised $85 billion in green bonds for industrial applications between 2020 and 2023. Third, a Central Bank refinancing window specifically for green lending, reducing commercial bank on-lending rates to 10–12%, would close the remaining IRR gap identified in Scenario 3.

5.2. Institutional Reform Pillar

Institutional streamlining is equally essential. A single-window permitting process for PV installations under 5 MW, reducing approval timelines from 18 months to 60 days (benchmarking South Korea's KEPCO model), is identified as the highest-impact near-term reform. Net metering legislation — enabling enterprises to sell surplus generation to the grid at 70–80% of the retail tariff — would improve project NPV by an estimated 15–22%, based on cross-country regression analysis across 34 net metering regimes. Industrial cluster PV models, where 3–8 adjacent enterprises collectively procure and operate shared PV infrastructure, are projected to reduce per-unit capital costs by 18–22% through scale economies.

5.3. Technical Optimisation Pillar

Technical efficiency gains complement financial and institutional measures. Standardised system sizing tools — accounting for load profiles, seasonal irradiation variation, and battery storage optimisation — can increase system capacity factor by 8–12% above the Uzbek average of 18.5%. IoT-enabled monitoring and predictive maintenance protocols, drawing on IEA best practices, are documented to reduce O&M costs by 15–20% and extend effective system lifetimes from 20 to 25 years, materially improving LCOE.

5.4. Multi-Criteria Project Assessment Model

To allocate public support efficiently across competing projects, we propose a composite scoring model (Table 2). Projects are scored on five weighted criteria; those exceeding a minimum composite score of 65/100 qualify for Tier 1 support (full grant + soft loan); 50–64 qualify for Tier 2 (tax incentives only):

Criterion	Unit	Weight (w)	Min. Score	Max. Score Condition	Criterion
Internal Rate of Return (IRR)	%	0.25	10%	≥ 25%	Internal Rate of Return (IRR)
Payback Period (PBP)	years	0.20	≤ 10 yr	≤ 5 yr	Payback Period (PBP)
CO_2 Emission Reduction	t CO_2/yr	0.20	200 t	≥ 1000 t	CO_2 Emission Reduction
Direct Employment Created	FTE jobs	0.15	2 FTE	≥ 10 FTE	Direct Employment Created
Energy Self-Sufficiency Index	%	0.20	20%	≥ 70%	Energy Self-Sufficiency Index
TOTAL	—	1.00	50/100	100/100	TOTAL

Table 2. Multi-Criteria Project Assessment Model — criteria, weights, and scoring thresholds

Source: Authors' original model based on Luthra et al., Shmelev & van den Bergh, and IEA guidelines.

6. Discussion

6.1. Policy Implications for Uzbekistan

The analysis yields three actionable near-term policy priorities. First, the existing Presidential Decree framework provides a legal basis for capital grants, but disbursement mechanisms are underdeveloped. Establishing a dedicated Green Industrial Fund, capitalised at 500–700 billion UZS annually (~$40–57M), is estimated to catalyse 3–4 billion UZS in private investment per billion of public expenditure — a leverage ratio consistent with international green finance benchmarks.

Second, net metering legislation should be prioritised as a zero-fiscal-cost mechanism. Our NPV modelling shows that net metering alone (without any subsidy) reduces payback to 8.1 years — insufficient to meet the 7-year threshold, but meaningful as a complementary tool. Combined with a 30% capital grant, net metering brings payback to 5.6 years.

Third, Uzbekistan's banking sector requires capacity building in green lending. The Central Bank's recent "sustainable finance roadmap" [6] creates an opening for a dedicated refinancing facility analogous to the European Investment Bank's Green Lending Programme, which has supported €42 billion in renewable industrial investments since 2019.

6.2. Transferability to Central Asian Contexts

Kazakhstan, Kyrgyzstan, and Tajikistan share key structural similarities with Uzbekistan: rapid tariff reform trajectories, high irradiation, and underdeveloped renewable financing ecosystems. The MDEE framework is designed to be country-adaptable through adjustment of the scoring weights and support tiers to local conditions. Differences in grid infrastructure quality, regulatory maturity, and currency stability will require country-specific calibration, particularly for the net metering and green bond components.

6.3. Limitations

This study has several limitations. The financial model uses a single representative 1 MW system; actual enterprise performance will vary with load profile, roof area, and sector-specific electricity consumption patterns. The 12-installation survey underlying capital cost estimates may not fully represent the range of supply chain conditions across Uzbekistan's regions. CO_2 abatement calculations use a grid emission factor that does not account for the planned expansion of natural gas capacity, which may alter the carbon intensity trajectory. Future research should address these limitations through enterprise-level micro-data and dynamic emission factor modelling.

7. Conclusion

This paper has presented the first systematic analysis of industrial solar PV economic efficiency in Uzbekistan, documenting grid parity achievement in 2023 and quantifying the financial impact of four financing scenarios. The key findings are:

(1) Grid parity established: Uzbekistan's solar PV LCOE reached the industrial electricity tariff in 2023 (approximately 835 UZS/kWh), marking a structural shift in the investment environment. By 2024, LCOE is 18.6% below the tariff, improving further year-on-year.

(2) Financing gap is the binding constraint: The 5.8-percentage-point spread between project IRR (14.2%) and commercial lending rates (20%) is the primary barrier to industrial PV deployment, not resource quality or technology readiness.

(3) Combined support delivers transformative outcomes: A 30% capital grant combined with a 4% soft loan reduces the payback period from 9.2 to 4.1 years and increases NPV by 126%. The annual public cost — approximately 200–250 billion UZS — would mobilise an estimated 800 billion UZS in private investment.

(4) The MDEE framework operationalises the transition: The proposed Multi-Dimensional Efficiency Enhancement framework integrates financial, institutional, technical, and assessment pillars into a coherent implementation architecture, applicable to Uzbekistan and transferable to comparable Central Asian economies.

(5) A self-sustaining market is foreseeable: Sensitivity analysis suggests that without any policy intervention, the baseline scenario approaches investor viability (PBP < 7 years) by approximately 2027, assuming continued tariff normalisation. Proactive support now can accelerate this by 3–4 years, yielding significant cumulative carbon and economic benefits.

These findings contribute to the growing literature on renewable energy finance in emerging markets and provide a replicable methodological template for country-level solar PV policy assessment. Future work should extend the analysis to battery storage

integration, grid stability impacts, and the social equity dimensions of industrial energy transition.

Declarations

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interest: The authors declare no conflict of interest.

Data availability: Data supporting this study are available from the corresponding author upon reasonable request.

Author contributions: Conceptualisation, methodology, data curation, writing — original draft: Author 1. Review, editing, supervision: Author 2.

REFERENCES

[1] International Energy Agency (IEA), *World Energy Outlook 2023*. Paris, France: IEA Publications, 2023. [Online]. Available: https://www.iea.org/reports/world-energy-outlook-2023. [Accessed: Feb. 15, 2024].

[2] BloombergNEF, *Solar PV Module Prices: Technology and Market Trends*. BloombergNEF Annual Report, 2023. [Online]. Available: https://about.bnef.com/solar-energy-research/. [Accessed: Feb. 18, 2024].

[3] Uzbekistan Hydrometeorological Centre (Uzhydromet), *Regional Atlas of Solar Radiation and Photovoltaic Potential*. Tashkent, Uzbekistan: Uzhydromet, 2023.

[4] Ministry of Energy of the Republic of Uzbekistan, *Concept for Renewable Energy Development to 2030*. Tashkent, Uzbekistan, 2023. [Online]. Available: https://minenergy.uz/ru/about/strategy. [Accessed: Feb. 20, 2024].

[5] Presidential Decree of the Republic of Uzbekistan, "On Preferential Conditions for Foreign Investment in Green Economy and Energy," Aug. 29, 2023. [Online]. Available: https://lex.uz. [Accessed: Mar. 1, 2024].

[6] Uzbekenergo JSC, *Industrial Electricity Tariff Data 2018–2024; Green Lending Roadmap 2023*. Tashkent, Uzbekistan, 2023. [Online]. Available: https://www.uzbekenergo.uz. [Accessed: Mar. 10, 2024].

[7] International Renewable Energy Agency (IRENA), *Renewable Power Generation Costs in 2022*. Abu Dhabi, UAE: IRENA, 2023. doi: 10.36214/IRENA.Costs2022.

[8] A. Jäger-Waldau, *PV Status Report 2022*, EUR 31152 EN. Luxembourg: Publications Office of the European Union, 2022. doi: 10.2760/701605.

[9] B. Govind and S. S. Mathur, "Economic feasibility of industrial solar PV systems in South and Central Asia: A comparative NPV analysis," *Renewable and Sustainable Energy Reviews*, vol. 158, Art. no. 112082, 2022, doi: 10.1016/j.rser.2022.112082.

[10] K. Branker, M. J. M. Pathak, and J. M. Pearce, "A review of solar photovoltaic levelized cost of electricity," *Renewable and Sustainable Energy Reviews*, vol. 15, no. 9, pp. 4470–4482, 2011, doi: 10.1016/j.rser.2011.07.104.

[11] F. Egli, B. Steffen, and T. S. Schmidt, "A dynamic analysis of financing conditions for renewable energy technologies," *Nature Energy*, vol. 3, pp. 1084–1092, 2018, doi: 10.1038/s41560-018-0277-y.

[12] Federal Ministry for Economic Affairs and Climate Action (BMWK), *Renewable Energy Sources Act (EEG 2023)*. Berlin, Germany: BMWK, 2023. [Online]. Available: https://www.bmwk.de. [Accessed: Mar. 12, 2024].

[13] Korea Electric Power Corporation (KEPCO), *Annual Report 2022: Renewable Energy Strategy*. Seoul, South Korea: KEPCO, 2023. [Online]. Available: https://home.kepco.co.kr. [Accessed: Mar. 14, 2024].

[14] National Development and Reform Commission (NDRC), *China Green Bond Market: Framework and Industrial Solar Applications*. Beijing, China: NDRC Press, 2022. [Online]. Available: https://www.ndrc.gov.cn/english/. [Accessed: Mar. 16, 2024].

[15] M. Karatayev, S. Hall, Y. Kalyuzhnova, and M. L. Clarke, "Renewable energy technology uptake in Kazakhstan: Policy drivers and barriers in a transitional economy," *Renewable and Sustainable Energy Reviews*, vol. 66, pp. 120–136, 2016, doi: 10.1016/j.rser.2016.07.057.

[16] A. A. Khoshimov and B. K. Rakhimov, "Field evaluation of a 500 kW industrial rooftop PV installation in Tashkent region, Uzbekistan," *Economics and Finance Journal*, vol. 4, pp. 45–58, 2022, doi: 10.47471/ej.2022.04.06.

[17] S. Luthra, S. Kumar, D. Garg, and A. Haleem, "Barriers to renewable/sustainable energy technologies adoption: Indian perspective," *Renewable and Sustainable Energy Reviews*, vol. 41, pp. 762–776, 2015, doi: 10.1016/j.rser.2014.08.077.

[18] S. E. Shmelev and J. C. J. M. van den Bergh, "Optimal diversity of renewable energy alternatives under multiple criteria: An exploratory analysis," *Renewable and Sustainable Energy Reviews*, vol. 60, pp. 1–13, 2016, doi: 10.1016/j.rser.2016.01.100.