

INVESTMENT MECHANISMS FOR GREEN ENERGY DEVELOPMENT AND STRENGTHENING THE ECONOMIC RESILIENCE OF AZERBAIJAN'S REGIONS

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Summary. This study examines technical and economic approaches to managing ecological restructuring of production in Azerbaijan within the framework of sustainable regional development. An integrated economic-geographical approach is applied, considering natural resources, production structures, environmental pressures, investment, technological modernization, and environmental monitoring. System-structural, mathematical-statistical, GIS-based, and monitoring methods are used to assess the relationship between industrial development and environmental protection. The findings highlight the importance of efficient resource use, modernization of production technologies, closed-cycle and low-waste systems, emission reduction, and specialized treatment facilities. Particular attention is given to industrial and environmental conditions in the Absheron Peninsula, Baku, Sumgayit, and other production areas. The analysis indicates that technological modernization and water-reuse systems can reduce resource consumption and environmental pressure while improving production efficiency. The study concludes that effective ecological restructuring requires an integrated management framework combining technological innovation, resource efficiency, pollution prevention, environmental investment, scientifically based monitoring, and territorial planning.

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1. Introduction

Renewable-energy deployment requires substantial upfront capital, long repayment periods, grid access and credible revenue arrangements. Financing conditions and risk allocation therefore strongly influence project implementation and electricity costs. International evidence shows that green finance and financial-market development can support renewable-energy investment, while policy stability and institutional quality remain important determinants of effectiveness (Al Mamun et al., 2022; Alharbi et al., 2023; Anton & Afloarei Nucu, 2020).

Green bonds and public-private partnerships (PPPs) address different financing needs. Green bonds channel debt proceeds towards eligible environmental activities and require transparent use of proceeds, reporting and external review (Flammer, 2021; Zerbib, 2019). PPPs and independent power producer (IPP) arrangements combine private capital and expertise with public regulation, grid access and long-term power-purchase agreements, with effective risk allocation being essential to project performance (Taghizadeh-Hesary & Yoshino, 2020).

Renewable-energy investment may also support regional resilience through spatial and technological diversification, reduced fuel dependence, grid reinforcement and demand for local services. However, these channels should not be equated with observed changes in regional economic resilience, which requires direct evidence on variables such as employment, regional output and post-shock recovery (Boschma, 2015; Martin & Sunley, 2015). Accordingly, this study evaluates only measurable project-level resilience-relevant channels.

Azerbaijan provides an important case because hydrocarbons remain central to its energy economy despite substantial solar and wind resources (IEA, 2023; IRENA, 2019; World Bank Group, 2023). Garadagh Solar became operational in 2023 and Khizi-Absheron Wind in January 2026, while Bilasuvar and Neftchala add 760 MW of planned solar capacity supported by EBRD, ADB and AIIB financing (Asian Development Bank,

2024; Asian Infrastructure Investment Bank, 2024; European Bank for Reconstruction and Development, 2024a, 2024b, 2024c; President of the Republic of Azerbaijan, 2023, 2026).

The Sustainable Finance Roadmap for 2023–2026 and Azerbaijan’s Green Taxonomy strengthen the institutional framework for green finance (Central Bank of the Republic of Azerbaijan, 2023, 2024). At the international level, the ICMA Green Bond Principles establish requirements for use of proceeds, project evaluation and selection, management of proceeds and reporting, complemented by external review and the Climate Bonds Standard (Climate Bonds Initiative, 2025; ICMA, 2025, 2026a). Building on previous research on Azerbaijan’s renewable-energy potential (Mustafayev et al., 2022; Vidadili et al., 2017), this study evaluates project costs and output, PPP and multilateral financing, green-bond readiness, diversification and sensitivity to financing rates, cost overruns and output shortfalls.

2. Materials and methods

2.1. Research design and data

The study uses a multi-source observational design with a data cutoff of 30 June 2026. Generation projects were included when capacity was at least 200 MW and public records reported location, technology, total cost and annual output. Four projects met these criteria. The sample is purposive and disclosure-based rather than statistically representative of all renewable-energy investment in Azerbaijan. The Azerbaijan Scaling-Up Renewable Energy Project (AZURE) was assessed separately because it finances transmission rather than generation.

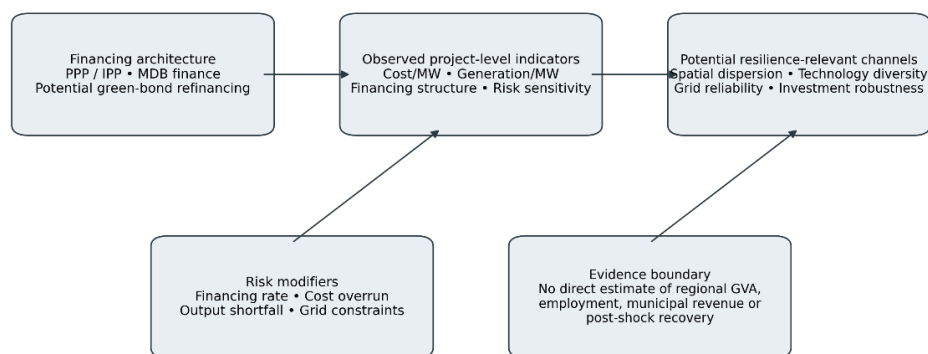
Government communications, project-company disclosures and multilateral development-bank documents were prioritised. When environmental estimates differed, project-company values were applied consistently because they reported generation and avoided emissions on the same basis. Values for plants under construction are documented ex ante expectations rather than audited outcomes; no missing regional employment, income or supplier-spending observations were imputed. The project-level dataset, including location, technology, installed capacity, investment cost, expected annual generation, avoided CO₂ emissions, and operational status, is presented in Table 1. The analytical framework linking financing arrangements, project-level indicators, risk factors, and potential regional resilience channels is illustrated in Fig. 1.

Table 1

Project-level dataset used in the analysis

Project	Location	Technology	Capacity (MW)	Cost (USD m)	Annual generation (GWh)	Avoided CO ₂ (kt/year)	Status
Garadagh Solar PV	Garadagh, Baku	Solar PV	230	262	500	200	Operational
Khizi-Absheron Wind	Khizi and Absheron	Wind	240	340	1000	400	Operational
Bilasuvar Solar PV	Bilasuvar	Solar PV	445	383	961	393	Under construction
Neftchala (Banka) Solar PV	Neftchala	Solar PV	315	283	686	280	Under construction

Note. Bilasuvar and Neftchala values are ex ante estimates. The Khizi-Absheron avoided-emissions value conservatively represents an official estimate of more than 400 kt/year. Capacity, generation and emissions values were cross-checked against project-owner disclosures (Masdar, n.d.-a, n.d.-b, n.d.-c).



Interpretation: project-level channels and proxies are assessed; causal regional resilience impacts are not estimated.

Fig. 1. Analytical framework linking financing variables to project-level indicators and potential regional resilience channels. Regional resilience itself is not estimated as an outcome.

2.2. Indicator construction

Capital intensity and expected generation yield were calculated as:

$$CI_i = \frac{I_i}{C_i}$$

$$EGY_i = \frac{G_i}{C_i}$$

where I_i is investment in USD million, C_i is capacity in MW and G_i is expected annual generation in GWh. Avoided-emissions intensity uses the same denominator.

Portfolio concentration was measured with the Herfindahl-Hirschman Index and its diversification complement:

$$HHI = \sum_{i=1}^n s_i^2, \quad DIV = 1 - HHI$$

where s_i is the capacity share of a location or technology.

No project-level labelled green-bond proceeds were identified. A standards-aligned Green Bond Readiness Index (S-GBRI) was therefore constructed as a documentary pre-issuance screen. The seven criteria are mapped to the ICMA Green Bond Principles (GBP), the 2026 ICMA external-review and impact-reporting guidance, the Azerbaijan Green Taxonomy and, as a consistency check, the Climate Bonds Standard v4.3 (Climate Bonds Initiative, 2025; ICMA, 2025, 2026a, 2026b).

$$S-GBRI_i = \sum_{j=1}^7 w_j s_{ij}, \quad s_{ij} \in \{0, 0.5, 1\}, \quad \sum_{j=1}^7 w_j = 1$$

For each criterion, the documentary score equals 0 when no public evidence was identified, 0.5 when evidence was partial or not bond-specific, and 1 when the criterion was fully evidenced. The weighting is standards-based rather than an equal seven-way split: the four GBP core components jointly receive 0.80 (0.20 each), while external review receives 0.20 as a separate key-recommendation pillar. Where a core component contains two operational criteria, its 0.20 weight is divided equally. The index is a documentary readiness screen, not a credit rating, certification or validated predictor of issuance success; no arbitrary high/medium/low thresholds are imposed.

Table 2

Standards-aligned criteria and weights for the S-GBRI

Criterion	Standards basis	Weight	Documentary coding focus
Eligible green use of proceeds	GBP: Use of Proceeds; Azerbaijan Green Taxonomy	0.10	Renewable activity is taxonomy-consistent and eligible for green financing.
Identifiable project / asset pool	GBP: Use of Proceeds	0.10	Assets and financing need can be clearly identified and ring-fenced conceptually.
Project evaluation and selection process	GBP: Project Evaluation and Selection	0.20	Public evidence of environmental objectives, eligibility screening and material risk assessment.
Management and tracking of proceeds	GBP: Management of Proceeds	0.20	Bond-specific account, sub-account or equivalent internal tracking mechanism.
Allocation reporting framework	GBP: Reporting	0.10	Commitment and mechanism to report allocation of proceeds until full allocation.
Impact-reporting readiness	GBP: Reporting; ICMA 2026 impact framework	0.10	Comparable quantitative indicators, methods and assumptions for energy and GHG impacts.
External review	GBP key recommendation; ICMA 2026 External Reviews	0.20	Independent pre-issuance review/certification and appropriate post-issuance verification plan.

Note. The four ICMA GBP core components receive 0.20 each; Use of Proceeds and Reporting are each divided into two 0.10 subcriteria. External review receives 0.20 because it is a distinct ICMA key recommendation and a central integrity safeguard. The weights are normative and transparent rather than empirically estimated.

Multilateral mobilisation was measured as disclosed MDB finance divided by published project cost. Grid-enabling leverage was calculated as:

$$PLR = \frac{I_{private}}{L_{public}}$$

2.3. Operationalisation of resilience-relevant channels

Regional resilience is operationalised only at the channel/proxy level, not as an outcome variable. Four observable dimensions are used: (i) location diversification (DIV(L)) as a proxy for exposure to single-node concentration; (ii) technology diversification (DIV(T)) as a proxy for correlated technology/resource concentration; (iii) AZURE private-investment leverage (PLR(AZURE)) as a proxy for the enabling role of transmission investment; and (iv) CRC sensitivity to financing-rate, cost-overrun and output shocks as a measure of project-finance vulnerability. These indicators describe conditions that may support or constrain resilience, but they do not measure regional income stability, employment recovery, firm survival or other direct economic-resilience outcomes. Accordingly, the empirical language below is limited to observed project-level results and plausible resilience-relevant channels.

2.4. Financing-risk scenarios

For a 20-year recovery period, the capital recovery factor and capital-recovery component were calculated as:

$$CRF(r, n) = \frac{r(1+r)^n}{(1+r)^n - 1}$$

$$CRC = \frac{I \times CRF(r, n) \times 10^6}{G \times 10^3}$$

Scenarios use financing rates of 6%, 8% and 10%, plus 10% and 20% cost overruns and a 10% generation shortfall. These assumptions are sensitivity tests, not observed weighted average costs of capital. Because operating expenditure, taxes, degradation and curtailment are excluded, CRC is not a complete levelised cost of electricity.

3. Results

3.1. Portfolio scale and efficiency

Within the four-project sample, total capacity is 1,230 MW and disclosed investment is USD 1.268 billion. Expected full-operation output is at least 3.147 TWh annually, with avoided emissions of at least 1.273 million tonnes of CO₂. Solar accounts for 990 MW (80.5%) and wind for 240 MW. At the cutoff date, 470 MW was operational and 760 MW was under construction; the latter values are therefore ex ante project expectations rather than realised performance.

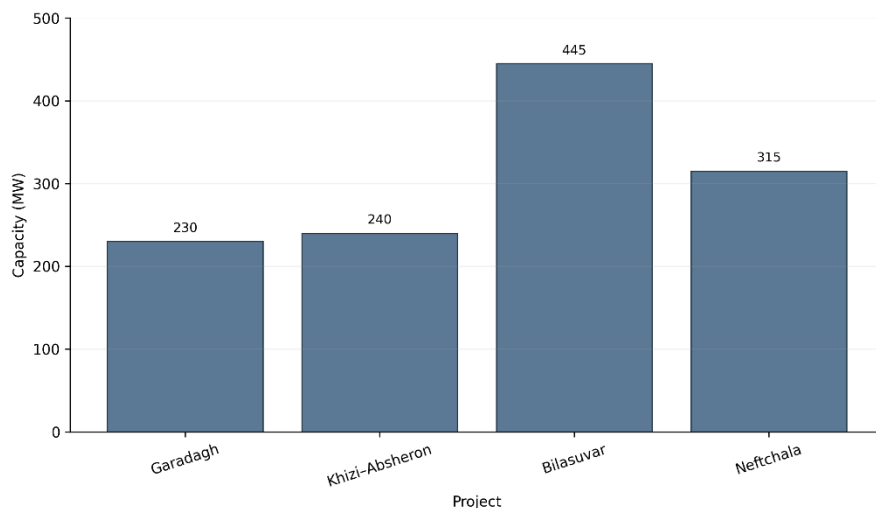


Fig. 2. Installed or planned capacity of the four renewable-energy projects in the disclosure-based sample

As shown in Fig. 2, Bilasuvar Solar PV has the largest capacity among the four projects (445 MW), followed by Neftchala Solar PV (315 MW), Khizi-Absheron Wind (240 MW), and Garadagh Solar PV (230 MW).

Weighted capital intensity is USD 1.031 million/MW. Bilasuvar has the lowest disclosed capital intensity; Khizi-Absheron has the highest cost per MW but the strongest generation yield. Consequently, at an 8% financing rate, the wind project has the lowest capital-recovery component per MWh. The calculated capital intensity, generation yield, avoided CO₂ intensity, and capital-recovery components for the analyzed projects are summarized in Table 3.

Table 3

Derived project indicators

Project	Capital intensity (USD m/MW)	Generation yield (GWh/MW)	Avoided CO ₂ intensity (kt/MW)	CRC at 8% (USD/MWh)
Garadagh Solar PV	1.139	2.174	0.870	53.4
Khizi-Absheron Wind	1.417	4.167	1.667	34.6
Bilasuvar Solar PV	0.861	2.160	0.883	40.6
Neftchala (Banka) Solar PV	0.898	2.178	0.889	42.0
Portfolio weighted value	1.031	2.559	1.035	41.0

3.2. Diversification and financing structure

Location concentration is HHI(L) = 0.270, giving DIV(L) = 0.730; the analysed capacity is therefore distributed across several project nodes. Technology concentration is higher (HHI(T) = 0.686; DIV(T) = 0.314) because solar dominates capacity. These are concentration metrics, not direct measures of regional economic resilience. Spatial dispersion may reduce single-location concentration, while technology concentration increases the potential value of wind, storage, flexible demand and transmission reinforcement. PPP/IPP structures are the principal delivery model. Garadagh combines foreign investment, a PPA and a grid agreement. Khizi-Absheron received a USD 197.1 million EBRD-arranged syndicated loan, about 58.0% of reported cost (European Bank for Reconstruction and Development, 2023). EBRD, ADB and AIIB commitments for Bilasuvar and Neftchala total approximately USD 481 million, or 72.2% of their combined USD 666 million cost. In this sample, multilateral finance provides long tenor, due diligence and risk sharing at substantial scale. AZURE illustrates the complementary role of public grid investment. A USD 173.5 million World Bank loan is expected to unlock USD 384 million of private renewable investment (World Bank, 2025):

$$PLR_{AZURE} = \frac{384}{173.5} = 2.21$$

Table 4

Financing arrangements and resilience-relevant channels

Project/programme	Principal financing structure	Quantitative financing evidence	Potential resilience-relevant channel
Garadagh Solar	Foreign-invested PPP/IPP with PPA and grid agreement	USD 262 m project cost	Operational capacity, gas savings and investment demonstration
Khizi-Absheron Wind	BOO company with syndicated debt and PPA	USD 197.1 m loan; about 58.0% of cost	Technology diversification and high output across two districts
Bilasuvar-Neftchala Solar	Sponsor equity plus EBRD, ADB and AIIB finance	About USD 481 m; 72.2% of cost	Regional capital formation and infrastructure demand
AZURE	Sovereign grid investment enabling private generation	USD 173.5 m loan; USD 384 m mobilisation	Grid reliability and lower connection and curtailment risks

As summarized in Table 4, the analyzed projects rely on different financing arrangements, including public-private partnerships, syndicated loans, and multilateral financing, which may support renewable-energy deployment through investment mobilization, technological diversification, and grid development.

3.3. Green-bond readiness and risk sensitivity

The standards-aligned scoring produces the same preliminary documentary profile for the four projects on the public evidence reviewed. Green eligibility and asset identification are fully evidenced (1.0 each). Project evaluation and selection receives a partial score (0.5) because environmental and MDB due-diligence documentation exists, but no issuer-level green-bond framework defining a formal bond selection process was identified. Impact-reporting readiness also receives 0.5 because generation and avoided-CO₂ metrics are publicly available, but several values are ex ante and no bond-specific impact-reporting commitment exists. Management of proceeds, allocation reporting and external review receive 0 because no labelled green-bond framework or issuance was identified. With the Table 2 weights:

$$S\text{-}GBRI = 0.35$$

The S-GBRI value of 0.35 is not assigned to a high, medium or low category because no validated threshold exists. It indicates partial pre-issuance documentary readiness: the underlying assets are identifiable and environmentally eligible, but the issuer-level architecture required for a credible labelled bond—proceeds tracking, allocation reporting and independent external review—has not yet been evidenced. The result therefore supports only a cautious proposition that the assets could become candidates for future refinancing or aggregation after those requirements are established.

Increasing the assumed financing rate from 6% to 10% raises the portfolio CRC from USD 35.1/MWh to USD 47.3/MWh, a 34.7% increase without any engineering change. The sensitivity of the aggregate portfolio's capital-recovery component to alternative financing-rate assumptions is presented in Table 5. The increase in the portfolio's capital-recovery component under financing-rate scenarios of 6%, 8%, and 10% is illustrated in Fig. 3.

Financing-rate sensitivity of the aggregate portfolio

Table 5

Financing rate	Capital recovery factor	Annualised capital cost (USD m)	Capital-recovery component (USD/MWh)
6%	0.0872	110.6	35.1
8%	0.1019	129.1	41.0
10%	0.1175	148.9	47.3

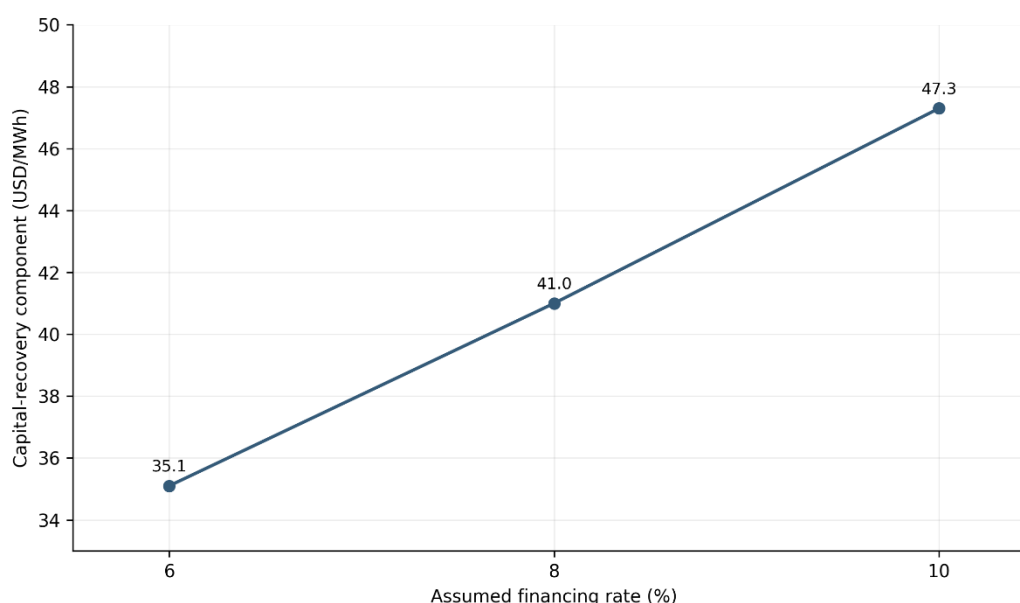


Fig. 3. Sensitivity of portfolio capital-recovery cost to assumed financing rates (scenario analysis; the rates are not observed WACC)

A 10% cost overrun adds USD 126.8 million and a 20% overrun adds USD 253.6 million. A 10% generation shortfall removes 314.7 GWh of annual output and at least 127.3 kt of expected CO₂ savings. Project value therefore depends on financing cost, construction discipline and realised performance, not capacity announcements alone.

4. Discussion

Within the selected projects, Azerbaijan's utility-scale renewable expansion relies primarily on PPP/IPP arrangements and multilateral project finance rather than domestic labelled green bonds. PPAs and dedicated project companies provide revenue predictability, while multilateral financing contributes long-term capital, due diligence and risk sharing. The Bilasuvar–Neftchala financing structure and the Khizi–Absheron syndicated facility demonstrate the role of these mechanisms in mobilising investment without placing the full financing burden on the public sector.

The results identify several resilience-relevant channels but do not establish a causal effect on regional economic resilience. Spatial diversification is relatively strong ($DIV(L) = 0.730$), whereas technology diversification remains limited ($DIV(T) = 0.314$) because solar accounts for 80.5% of the analysed capacity. This concentration highlights the potential importance of wind, storage, flexible demand and transmission reinforcement. The AZURE programme further demonstrates the enabling role of grid investment in supporting private renewable generation.

Financing conditions are also important for project economics. Increasing the assumed financing rate from 6% to 10% raises the portfolio CRC from USD 35.1/MWh to USD 47.3/MWh, while cost overruns and generation shortfalls further weaken project performance. Effective risk allocation, predictable regulation, bankable PPAs and adequate grid infrastructure are therefore important components of renewable-energy financing.

Green bonds could complement existing financing through refinancing or portfolio aggregation; however, the S-GBRI score of 0.35 shows that eligible renewable assets alone are insufficient. A credible labelled green-bond structure would additionally require an issuer-level Green Bond Framework, proceeds tracking, allocation and impact reporting, and independent external review in line with ICMA principles (ICMA, 2025, 2026a, 2026b).

These findings should be interpreted within the study's limitations. The analysis covers only four large, disclosure-rich projects; Bilasuvar and Neftchala data are ex ante; detailed tariffs and debt terms are unavailable; and consistent regional employment, output and post-shock recovery data are absent. Consequently, the study identifies project-level resilience channels rather than causal regional-resilience effects. Future research should compare expected and realised project performance and incorporate direct regional economic indicators.

5. Conclusion

The four-project portfolio comprises 1,230 MW of renewable capacity, USD 1.268 billion of disclosed investment and at least 3.147 TWh of expected annual generation. The results show that PPP/IPP arrangements and multilateral co-financing are the principal financing mechanisms in the analysed projects. Multilateral commitments finance approximately **72.2%** of the combined Bilasuvar–Neftchala project cost, while the AZURE programme is expected to mobilise USD 2.21 of private renewable investment per dollar of public lending.

The analysis also reveals relatively strong spatial diversification ($DIV(L) = 0.730$) but limited technology diversification ($DIV(T) = 0.314$), alongside substantial sensitivity to financing conditions and project-performance risks. The S-GBRI score of 0.35 indicates that the projects contain eligible and identifiable green assets but currently lack key bond-specific mechanisms, particularly proceeds management, allocation reporting and external review.

Overall, Azerbaijan's current utility-scale renewable financing model is driven primarily by PPP/IPP and multilateral finance, while green bonds represent a potential complementary financing instrument if the required institutional and reporting architecture is established. These conclusions are limited to the analysed project sample; broader claims regarding regional economic resilience require direct regional outcome data.

REFERENCES

- Al Mamun, M., Boubaker, S., & Nguyen, D.K. (2022). Green finance and decarbonization: Evidence from around the world. *Finance Research Letters*, 46, 102807. <https://doi.org/10.1016/j.frl.2022.102807>
- Alharbi, S.S., Al Mamun, M., Boubaker, S., & Rizvi, S.K.A. (2023). Green finance and renewable energy: A worldwide evidence. *Energy Economics*, 118, 106499. <https://doi.org/10.1016/j.eneco.2022.106499>
- Anton, S.G., & Afloarei Nucu, A.E. (2020). The effect of financial development on renewable energy consumption: A panel data approach. *Renewable Energy*, 147, 330-338. <https://doi.org/10.1016/j.renene.2019.09.005>
- Asian Development Bank. (2024, November 16). *ADB, Masdar sign \$160 million deal to build two of the largest solar power plants in Azerbaijan*. <https://www.adb.org/news/adb-masdar-sign-deal-build-two-largest-solar-power-plants-azerbaijan>
- Asian Infrastructure Investment Bank. (2024). *Azerbaijan: Banka and Bilasuvar 760 MW solar PV power project*. <https://www.aiib.org/en/projects/details/2024/approved/Azerbaijan-Banka-and-Bilasuvor-760-MW-Solar-PV-Power-Project.html>
- Boschma, R. (2015). Towards an evolutionary perspective on regional resilience. *Regional Studies*, 49(5), 733-751. <https://doi.org/10.1080/00343404.2014.959481>
- Climate Bonds Initiative. (2025). Climate Bonds Standard Version 4.3.

- https://www.climatebonds.net/files/documents/publications/Climate-Bonds_Climate-Bonds-Standard_V4.3_Aug-2025.pdf
- Central Bank of the Republic of Azerbaijan. (2023, February 22). *Central Bank approves Sustainable Finance Roadmap*. <https://www.cbar.az/press-release-4116/mrkzi-bank-dayaniqli-maliyy-uzr-yol-xritsini-tdiq-etmisdir?language=en>
- Central Bank of the Republic of Azerbaijan. (2024, November 13). *The Management Board of the Central Bank of the Republic of Azerbaijan approved the Green Taxonomy*. <https://www.cbar.az/press-release-4867/the-management-board-of-the-central-bank-of-the-republic-of-azerbaijan-approved-the-green-taxonomy?language=en>
- European Bank for Reconstruction and Development. (2023). *EBRD finances first utility-scale wind power plant in Azerbaijan*. <https://www.ebrd.com/home/news-and-events/news/2023/ebird-finances-first-utilitiescale-wind-power-plant-in-azerbaijan.html>
- European Bank for Reconstruction and Development. (2024a). *Banka Solar*. <https://www.ebrd.com/home/work-with-us/projects/psd/55494.html>
- European Bank for Reconstruction and Development. (2024b). *Bilasuvur Solar*. <https://www.ebrd.com/home/work-with-us/projects/psd/55493.html>
- European Bank for Reconstruction and Development. (2024c). *EBRD provides financing for Azerbaijan's largest ever solar projects at COP29*. <https://www.ebrd.com/home/news-and-events/news/2024/ebird-provides-financing-for-azerbajians-largest-ever-solar-projects-at-cop29.html>
- Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, 142(2), 499-516. <https://doi.org/10.1016/j.jfineco.2021.01.010>
- Ibrahimova, S.I., Jabarov, S.H., Aliyeva, N.A., & Aliyev, Y.I. (2021). Study vibrational and structural properties of Cu₃SeTe by Raman spectroscopy and XRD. *International Journal of Modern Physics B*, 35(27), Article 2150271. <https://doi.org/10.1142/S0217979221502714>
- International Energy Agency. (2023). *Azerbaijan energy profile*. <https://www.iea.org/reports/azerbaijan-energy-profile>
- International Renewable Energy Agency. (2019). *Renewables readiness assessment: Republic of Azerbaijan*. <https://www.irena.org/publications/2019/Dec/RRA-Republic-of-Azerbaijan>
- International Capital Market Association. (2025). *Green Bond Principles: Voluntary process guidelines for issuing green bonds*. <https://www.icmagroup.org/assets/documents/Sustainable-finance/2025-updates/Green-Bond-Principles-GBP-June-2025.pdf>
- International Capital Market Association. (2026a). *Guidelines for External Reviews*. <https://www.icmagroup.org/assets/documents/Sustainable-finance/2026-updates/ICMA-Principles-Guidelines-for-External-Reviews-June-2026.pdf>
- International Capital Market Association. (2026b). *Handbook - Harmonised Framework for Impact Reporting*. <https://www.icmagroup.org/assets/documents/Sustainable-finance/2026-updates/Handbook-Harmonised-Framework-for-Impact-Reporting-June-2026.pdf>
- Imrani, Z., & Jafarov, S. (2023). Strategic Objectives of Sustainable Development Model in Production and Education. *Journal of Law and Sustainable Development*, 11(7), e1328. <https://doi.org/10.55908/sdgs.v11i7.1328>
- Jafarov, S. (2024). Education Policy of 3rd Generation Universities. *Revista De Gestão Social E Ambiental*, 18(6), e05690. <https://doi.org/10.24857/rgsa.v18n6-007>
- Jafarov, S. (2024). Internationalisation and cultural aspects of online learning, training, and research. *Pakistan Journal of Life and Social Sciences*, 22(2), 6437–6452. <https://doi.org/10.57239/PJLSS-2024-22.2.00486>
- Martin, R., & Sunley, P. (2015). On the notion of regional economic resilience: Conceptualization and explanation. *Journal of Economic Geography*, 15(1), 1-42. <https://doi.org/10.1093/jeg/lbu015>
- Masdar. (n.d.-a). *315 MW Neftchala Solar PV Project*. Retrieved July 20, 2026, from <https://masdar.ae/en/renewables/our-projects/neftchala-solar-power-plant>
- Masdar. (n.d.-b). *445 MW Bilasuvur Solar PV Project*. Retrieved July 20, 2026, from <https://masdar.ae/en/renewables/our-projects/bilasuvur-solar-power-plant>
- Masdar. (n.d.-c). *Garadagh (Area 60) Solar Photovoltaic Power Plant*. Retrieved July 20, 2026, from <https://masdar.ae/en/renewables/our-projects/garadagh-area-60-solar-photovoltaic-power-plant>
- Mirzaev, N.A., Marinova, A.P., Mammadov, Kh.F., Temerbulatova, N.T., Kozempel, J., & Filosofov, D.V. (2020). Sorption of metal ions on an anion-exchange resin in an ammonium acetate solution. *Russian Journal of Physical Chemistry A*, 94, 1190–1194. <https://doi.org/10.1134/S0036024420060175>
- Mustafayev, F., Kulawczuk, P., & Orobello, C. (2022). Renewable energy status in Azerbaijan: Solar and wind potentials for future development. *Energies*, 15(2), 401. <https://doi.org/10.3390/en15020401>
- President of the Republic of Azerbaijan. (2023, October 26). *Ilham Aliyev attended official opening ceremony of 230 MW Garadagh Solar Power Plant*. <https://president.az/en/articles/view/61984>
- President of the Republic of Azerbaijan. (2026, January 8). *Official opening ceremony of 240 MW “Khizi-Absheron” Wind Power Plant was held in Baku*. <https://president.az/en/articles/view/71234>
- Taghizadeh-Hesary, F., & Yoshino, N. (2020). Sustainable solutions for green financing and investment in renewable energy projects. *Energies*, 13(4), 788. <https://doi.org/10.3390/en13040788>
- Vidadili, N., Suleymanov, E., Bulut, C., & Mahmudlu, C. (2017). Transition to renewable energy and sustainable energy development in Azerbaijan. *Renewable and Sustainable Energy Reviews*, 80, 1153-1161. <https://doi.org/10.1016/j.rser.2017.05.168>
- World Bank. (2025, March 27). *Azerbaijan to strengthen energy security and diversify its energy mix*. <https://www.worldbank.org/en/news/press-release/2025/03/27/azerbaijan-to-strengthen-energy-security-and-diversify-its-energy-mix>
- World Bank Group. (2023). *Azerbaijan country climate and development report*. <https://doi.org/10.1596/40622>
- Zerbib, O.D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, 98, 39-60. <https://doi.org/10.1016/j.jbankfin.2018.10.012>

ИНВЕСТИЦИОННЫЕ МЕХАНИЗМЫ РАЗВИТИЯ ЗЕЛЁНОЙ ЭНЕРГЕТИКИ И УКРЕПЛЕНИЯ ЭКОНОМИЧЕСКОЙ УСТОЙЧИВОСТИ РЕГИОНОВ АЗЕРБАЙДЖАНА

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Резюме. В исследовании рассматриваются технические и экономические подходы к управлению экологической реструктуризацией производства в Азербайджане в контексте устойчивого регионального развития. Применяется комплексный экономико-географический подход, учитывающий природные ресурсы, производственные структуры, экологические нагрузки, инвестиции, технологическую модернизацию и экологический мониторинг. Для оценки взаимосвязи между промышленным развитием и охраной окружающей среды используются системно-структурные, математико-статистические методы, методы на основе географических информационных систем (ГИС) и экологического мониторинга. Результаты подчёркивают важность рационального использования ресурсов, модернизации производственных технологий, внедрения систем замкнутого цикла и малоотходного производства, сокращения вредных выбросов и создания специализированных очистных сооружений. Особое внимание уделяется промышленным и экологическим условиям Апшеронского полуострова, Баку, Сумгаита и других производственных территорий. Анализ показывает, что технологическая модернизация и системы повторного использования воды способны снижать потребление ресурсов и антропогенную нагрузку на окружающую среду, одновременно повышая эффективность производства. По результатам исследования установлено, что эффективная экологическая реструктуризация требует внедрения комплексной системы управления, объединяющей технологические инновации, ресурсную эффективность, предотвращение загрязнения, экологические инвестиции, научно обоснованный мониторинг и территориальное планирование.

Ключевые слова: зелёные облигации, государственно-частное партнёрство, финансирование возобновляемой энергетики, каналы укрепления устойчивости, инвестиционный риск

AZƏRBAYCAN REGIONLARINDA YAŞIL ENERJİNİN İNKİŞAFI VƏ İQTİSADI DAYANIQLIĞIN GÜCLƏNDİRİLMƏSİNİN İNVESTİSİYƏ MEXANİZMLƏRİ

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Xülasə. Tədqiqatda dayanıqlı regional inkişaf çərçivəsində Azərbaycanda istehsalın ekoloji restrukturizasiyasının idarə edilməsinə texniki və iqtisadi yanaşmalar araşdırılır. Təbii resurslar, istehsal strukturları, ekoloji təzyiqlər, investisiyalar, texnoloji modernləşmə və ekoloji monitorinq nəzərə alınmaqla kompleks iqtisadi-coğrafi yanaşma tətbiq edilmişdir. Sənayenin inkişafı ilə ətraf mühitin mühafizəsi arasındakı əlaqənin qiymətləndirilməsi üçün sistem-struktur, riyazi-statistik, coğrafi informasiya sistemlərinə (CİS) əsaslanan və monitorinq metodlarından istifadə olunmuşdur. Nəticələr resurslardan səmərəli istifadənin, istehsal texnologiyalarının modernləşdirilməsinin, qapalı dövriyyəli və az tullantılı sistemlərin tətbiqinin, zərərli emissiyaların azaldılmasının və ixtisaslaşdırılmış təmizləyici qurğuların yaradılmasının əhəmiyyətini göstərir. Abşeron yarımadasında, Bakı, Sumqayıt və digər istehsal ərazilərində sənaye və ekoloji şəraitə xüsusi diqqət yetirilmişdir. Təhlil göstərir ki, texnoloji modernləşmə və suyun təkrar istifadəsi sistemləri istehsalın səmərəliliyini artırmaqla yanaşı, resurs istehlakını və ətraf mühitə antropogen təzyiqi azalda bilər. Tədqiqatın nəticələrinə əsasən, səmərəli ekoloji restrukturizasiya texnoloji innovasiyaları, resurs səmərəliliyini, çirklənmənin qarşısının alınmasını, ekoloji investisiyaları, elmi əsaslandırılmış monitorinqi və ərazi planlaşdırılmasını birləşdirən kompleks idarəetmə sisteminin tətbiqini tələb edir.

Açar sözlər: yaşıl istiqrazlar, dövlət-özəl tərəfdaşlığı, bərpa olunan enerjinin maliyyələşdirilməsi, dayanıqlılığın gücləndirilməsi kanalları, investisiya riski