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The Effect of Shifting to Renewables on Social Welfare in Azerbaijan in the Context of Sustainable Economic Development

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Abstract. *The transition of the energy sector in Azerbaijan from oil and gas to renewable energy has significant implications for social welfare and sustainable development. Traditionally, oil and gas revenues have underpinned Azerbaijan's economy and public budgets, improving living standards and reducing poverty. However, declining hydrocarbon prospects and climate commitments have prompted new policies: Azerbaijan's national priorities emphasize green growth and clean energy (e.g., increasing renewable share to 30% by 2030). This article synthesizes recent post-2020 studies on how the energy transition affects Azerbaijan's social welfare (income, employment, health, equity). The results of this study show that a managed energy transition can enhance Azerbaijan's social welfare and sustainable development. Renewable energy projects create jobs, improve health, and diversify the economy, supporting long-term well-being. For example, wind and solar projects employ far more workers per unit of capacity than oil and gas, which can alleviate unemployment and support rural communities. Cleaner energy also lowers health costs and poverty by reducing greenhouse gases and energy bills. However, the transition poses challenges: weak legal frameworks and skill gaps in renewables threaten to slow gains. The key to success is aligning transition policies with social goals: training workers for green industries, ensuring energy affordability, and using oil revenues wisely (e.g., funding education, infrastructure, and clean tech). Thus, strategic investments in renewable energy – by reducing energy subsidy expenditures, increasing natural gas export capacity, diversifying tax revenues, and enhancing public financial sustainability – strengthen Azerbaijan's economic resilience. Further progress will depend on encouraging public-private partnerships and establishing robust financial and legal frameworks. Our review indicates that if Azerbaijan follows through on its renewable goals and green growth policies, it can mitigate the "resource curse" risk and achieve sustainable economic development.*

Keywords: *Azerbaijan, energy transition, social welfare, sustainable development, renewable energy.*

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Вплив переходу на відновлювані джерела енергії на соціальний добробут в Азербайджані в контексті сталого економічного розвитку

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Анотація. *Перехід енергетичного сектору Азербайджану від нафти і газу до відновлюваної енергії має значні наслідки для соціального добробуту та сталого розвитку. Традиційно доходи від нафти і газу були основою економіки та державних бюджетів Азербайджану, покращуючи рівень життя та зменшуючи бідність. Однак погіршення перспектив вуглеводнів та кліматичні зобов'язання спонукали уряд до нової політики: національні пріоритети Азербайджану наголошують на зеленому зростанні та чистій енергії (наприклад, збільшення частки відновлюваної енергії до 30% до 2030 року). У цій статті синтезовано результати нещодавніх досліджень про те, як енергетичний перехід впливає на соціальний добробут Азербайджану (дохід, зайнятість, здоров'я, рівність). Результати дослідження показують, що керований енергетичний перехід може покращити соціальний добробут та сталий розвиток Азербайджану. Проєкти відновлюваної енергетики створюють робочі місця, покращують здоров'я та диверсифікують економіку, підтримуючи довгострокове благополуччя. Наприклад, проєкти вітрової та сонячної енергетики залучають набагато більше працівників на одиницю потужності, ніж нафта і газ, що може зменшити безробіття та підтримати сільські громади. Чиста енергія також знижує витрати на охорону здоров'я та бідність, зменшуючи викиди парникових газів та рахунки за електроенергію. Однак, перехід супроводжується проблемами: слабка правова база та прогалини в кваліфікації працівників у сфері відновлюваної енергетики загрожують уповільнити досягнення прогресу. Ключем до успіху є узгодження політики переходу із соціальними цілями: навчання працівників для «зелених» галузей промисловості, забезпечення доступності енергії та розумне використання доходів від нафти (наприклад, фінансування освіти, інфраструктури та чистих технологій). Таким чином, стратегічні інвестиції у відновлювану енергетику – шляхом скорочення витрат на енергетичні субсидії, збільшення експортних потужностей природного газу, диверсифікації податкових надходжень та підвищення стійкості державних фінансів – зміцнюють економічну стійкість Азербайджану. Подальший прогрес залежатиме від заохочення державно-приватного партнерства та створення надійної фінансової та правової бази. Цей огляд показує, що якщо Азербайджан виконає свої цілі політики «зеленого» зростання, він може пом'якшити ризик «ресурсного прокляття» та досягти сталого економічного розвитку.*

Ключові слова: *Азербайджан, енергетичний перехід, соціальний добробут, сталий розвиток, відновлювана енергетика.*

INTRODUCTION

Historically, Azerbaijan's economy has been shaped by oil and natural gas. Since regaining independence in 1991, hydrocarbon exports have quadrupled GDP and dramatically improved living standards (Asian Development Bank, 2019). State oil revenues funded infrastructure, education, and poverty reduction programs. However, this dependence also created vulnerability to oil price shocks and resource depletion. For example, the 2014–2015 price collapse slowed growth and budget revenues, exposing fiscal stress (International Energy Agency, 2021). In response, recent national policies emphasize economic diversification and green growth. The "Azerbaijan 2030" Socio-Economic Development plan explicitly prioritizes a clean environment and renewable energy expansion. Under this plan, the government aims to increase renewables in the energy mix (targeting ~30% by 2030) and designate liberated territories (e.g. Karabakh) as green energy zones. Azerbaijan also updated laws on renewable electricity (2021) and energy efficiency (2021). International commitments reinforce this shift: Azerbaijan's Paris Agreement pledges (35% GHG reduction by 2030, 40% by 2050) rest on expanding clean energy (Hajiyev, 2024).

The global energy transition, driven by climate change goals, is seen as an opportunity for Azerbaijan. Hajiyev (2024) notes that a green economy that values social equity and environmental health is a central component of sustainable development. In this view, shifting from fossil fuels to wind, solar, hydro, and biomass cuts emissions and improves social welfare through job creation and healthier communities (EU Neighbours East, 2024). For example, independent analyses show that clean energy policies can reduce poverty and raise living standards by boosting economic activity in new industries (Mustafayev et al., 2022). In oil-rich countries, developing renewables can preserve export income (through green exports) while reducing carbon exposure (Gasimli et al., 2024). In Azerbaijan, the Caspian Sea offers vast offshore wind potential (~157 GW), and the country enjoys substantial solar resources. These could secure new exports (via planned Europe-bound cables) and domestic power if harnessed, thereby sustaining growth as oil wanes (GEZAP, 2022). Gasimli et al. (2024) argue that such renewable projects would bolster post-oil economic sustainability and create political, social, and environmental benefits.

Despite these opportunities, the social implications of energy transition are complex. Rapid changes in the energy sector can disrupt established industries and labour markets. In Azerbaijan's context, moving away from oil and gas raises concerns about maintaining funding for social programs. Some studies warn that without careful planning, subsidy removal or privatization could hurt low-income households (International Energy Agency, 2021). On the other hand, broad clean energy deployment (especially in rural areas) can improve energy access and reduce utility costs for vulnerable populations.

In this article, we examine the literature on the social welfare impacts of Azerbaijan's energy transition, framed by the country's goals for sustainable development. We focus on evidence and analysis from 2020 onward using data from academic journals, IEA/OECD reports, and other institutional sources. Our study aims to assess how shifting to renewables affects employment, income, health, equity, and overall well-being in Azerbaijan, as well as what the implications are for its long-term economic resilience.

LITERATURE REVIEW

Studies on the impact of the transition to renewable energy on social well-being highlight the balance between short-term adaptation costs and long-term increases in income, employment, improved health, and equality for citizens.

Nguyen et al.'s (2023) study examine how renewable energy can boost human development across 77 countries, including high-income and 33 middle-income, from 2000 to 2019. Their results reveal a positive link between renewable energy adoption and human development across three dimensions-health, education, and income. This connection holds for various renewable sources like hydropower, solar, and wind energy. Researchers highlight the importance of renewable energy for human development but emphasize the need for tailored approaches considering income levels and specific renewable energy sources.

Ahn et al. (2021) find that a 10 percentage point rise in renewables' share correlates with modest short-run welfare declines yet leads to net positive welfare outcomes within five to seven years as economies adjust to cleaner energy systems.

Beyond macroeconomic welfare metrics, grid-scale renewable integration reviews document substantial health and environmental benefits. Farghali et al. (2023) synthesize evidence from peer-reviewed studies showing that replacing fossil fuel-based generation with wind and solar power yields marked reductions in air pollutants – translating into lower healthcare costs, fewer respiratory illnesses, and improved quality of life in affected regions. Their review also highlights potential social trade-offs, such as land use conflicts and the need for targeted worker retraining, indicating that timely policy interventions are critical to maximizing net social gains (Farghali et al., 2023).

At the household level, consumer-focused research demonstrates how renewables can alleviate energy poverty and support educational and economic opportunities. Surveying low-income communities in Malaysia, Fazal et al. (2023) show that improved access to solar and small-scale renewable systems reduces monthly energy expenditures, enhances indoor air quality, and extends productive hours – particularly for women and children studying after dark. Their findings stress the importance of affordability, reliable technology, and environmental awareness in driving adoption and ensuring that renewable deployment yields tangible welfare improvements (Fazal et al., 2023).

Finally, firm-level case studies illustrate broader socio-economic transformations driven by renewable investments. Santos' (2025) research confirms that Portugal's renewable energy transition has positively influenced employment trends, gender equity, and financial resilience. In particular, renewable energy ventures generate more local jobs per megawatt than traditional energy sectors, improve firms' resilience to market shocks, and foster community engagement initiatives that address social equity concerns. Santos (2025) argues that models adapted to local regulatory and labor market conditions offer a blueprint for leveraging renewables as sustainable development and social welfare enhancement engines.

Thus, results from previous studies provide a robust foundation for assessing the effects of Azerbaijan's energy transition on social welfare. Studies in different countries prove that with well-designed policies to mitigate short-term disruptions, invest in workforce development, and ensure inclusive access, a shift to renewable energy can yield significant benefits in income security, public health, and equitable growth.

RESEARCH METHODOLOGY

This study synthesizes recent research data on Azerbaijan's energy transition and social welfare. We have systematically searched academic databases and institutional repositories for publications (peer-reviewed articles, energy policy reviews) since 2020. Keywords included "Azerbaijan", "energy transition", "renewable energy", "sustainable development", and "social welfare". Sources were evaluated for relevance and credibility; non-peer commentary (news or blogs) was used sparingly. The review integrates quantitative data (e.g., renewable potential, employment factors) with qualitative assessments of policy effects, following methods similar to those in prior systematic reviews of renewable deployment.

RESULTS

IEA data (2023) show that as of 2021, the final energy consumption of Azerbaijan was overwhelmingly from fossil fuels (gas ~43%, oil ~39%). Electricity generation is also gas-dominated (>90%), with hydro providing most of the small renewables share. Despite an abundant fossil fuel endowment, the country's oil reserves are finite (estimated R/P ~24 years). Azerbaijan's leaders have stressed diversification into non-oil sectors (tourism, agriculture, services) and green energy to sustain growth beyond the hydrocarbon era. The 2021 IEA Energy

Policy Review recommends gradually liberalization of energy markets and the removal of subsidies to improve efficiency and attract investment. Critically, it advises cushioning social impacts by supporting low-income households during this transition. Thus, the current strategy is to link energy transition with broader social goals – for example, enhancing rural employment and avoiding energy poverty.

Renewable potential and projects

Azerbaijan has significant untapped renewables: IEA and researchers estimate solar potential around 23 GW and wind ~160 GW in favorable areas. The technical renewable capacity is estimated at ~292 GW. National targets call for increasing renewables from ~17% (2021) to 30% power capacity by 2030. The government plans major projects like a 4 GW undersea cable to Europe for Caspian wind exports. Agreements with EU partners and companies (Masdar, Fortescue, EBRD) are mobilizing investments for solar parks and wind farms. In electricity supply, wind and solar reached only ~100 MW by 2020, but new tenders in 2020–2024 aim for hundreds of MW of new capacity. These projects are expected to accelerate electrification and stabilize the power grid, indirectly benefiting social welfare by improving service quality (Mammadli, 2024).

Employment and income effects

A significant social benefit of renewable energy is job creation. Renewables are more labor-intensive per unit of energy than fossil fuels. Table 1 summarizes estimated jobs per megawatt (MW) for various energy sectors. In particular, solar PV generates roughly 20 jobs per MW during construction and manufacturing, versus ~2 jobs per MW for oil and gas. Wind power (onshore) also creates ~8 jobs/MW (vs ~2 for oil/gas).

Table 1. Employment intensity (jobs per MW) in selected energy sectors (construction, manufacturing, O&M)

Sector	Construction & Installation	Manufacturing	Operation & Maintenance
Solar PV	13.0	6.7	0.7
Wind (onshore)	3.2	4.7	0.3
Wind (offshore)	8.0	15.6	0.2
Hydro (large)	7.4	3.5	0.2
Oil & Gas	1.3	0.93	0.14
Coal	11.2	5.4	0.14

Source: Mustafayev et al. (2022).

These estimates (adapted from Mustafayev et al., 2022) imply that scaling up renewables in Azerbaijan could generate significantly more construction and manufacturing jobs than continuing with fossil fuels. Given high unemployment in some regions, particularly rural areas, the transition is expected to boost local incomes and livelihoods. Solar and wind projects often require local labor and can spur related industries (turbine assembly, panel manufacturing). Government and international analysts note supporting non-oil job creation is crucial for sustainable development. For example, the IEA (2021) finds that shifts toward renewable infrastructure would attract new investments and jobs, aiding economic diversification. Mustafayev et al. (2022) similarly report that renewable energy development has a "positive impact on economic growth, social welfare, and employment" (citing IRENA and other global studies).

Poverty reduction and equity

Increased employment and income from green industries can help reduce poverty. In Azerbaijan, previous oil-based growth has lifted many out of poverty, but economic shocks show that resource wealth alone is unstable. Investing oil revenues into education and green technology can provide more inclusive growth. Moreover, renewable energy projects can directly serve marginalized communities. For example, EU-supported initiatives installed solar panels on social service buildings in Ganja, cutting energy bills and improving services for vulnerable women and children. In one case, a 1.1 kW solar system at a women's shelter eliminated power outages and saved ~870 kgCO_2 emissions annually. At a children's rehabilitation center, solar lighting reduced bills by 90 manats annually, enhancing care quality for over 180 children. These local examples illustrate how renewables can directly improve welfare by lowering energy costs for social institutions and enhancing service continuity.

On a systemic level, cleaner energy reduces health and environmental costs. Mustafayev et al. (2022) highlight that renewables can improve health by reducing air pollution, which benefits all citizens. A cleaner environment also cuts medical expenses and increases productivity. Stable and diverse energy supplies also help shield low-income households from price volatility. Fossil fuel markets are subject to booms and busts; in contrast, distributed renewables (especially decentralized solar) can empower remote communities with affordable energy. Thus, the transition aligns with the Sustainable Development Goals (SDGs) by addressing poverty (SDG1), health (SDG3), and energy access (SDG7) simultaneously.

Economic resilience and public finance

Azerbaijan's growing investments in renewable energy are positively impacting public finances, thereby enhancing economic resilience. This transformation alleviates subsidy expenditures, supports natural gas exports, and diversifies tax revenues, promoting long-term economic growth (International Energy Agency [IEA], 2023).

The energy transition can stabilize Azerbaijan's economy by diversifying away from hydrocarbons. Gasimli et al. (2024) argue that developing renewable exports (e.g., via trans-Caspian and Black Sea cables) could partly substitute oil revenue in the long term. They estimate that deploying ~7 GW of wind and solar by 2030 would sustain exports and GDP as oil wanes. If successful, this would help maintain government revenues and social spending beyond the oil era. Furthermore, many analysts note that Azerbaijan's current fossil-fuel-dominated energy model is unsustainable: domestic gas and oil feed the grid at subsidized prices, straining budgets. Transitioning to cost-reflective pricing (with social support for the needy) could free funds for development and reduce fiscal risk.

As of 2023, the country's total electricity generation capacity is approximately 8,320 MW, with about 1,687 MW (20%) derived from renewable sources. Of this, 1,300 MW is hydroelectric, and 347 MW is from solar and wind energy. The goal is to add 1,500 MW by 2030, increasing the renewable share to 30% (IEA, 2023).

A significant project, the 230 MW Garadagh Solar Power Plant, generates 500 million kWh annually, saving 110 million cubic meters of natural gas and reducing carbon dioxide emissions by 200,000 tons (Area.gov.az, 2023; IEA, 2023).

This level of direct savings helps reduce the state's energy subsidy burden, which reached 2.6 billion USD (5.8% of GDP) in 2018 (IEA, 2023).

Furthermore, in 2024, the European Bank for Reconstruction and Development (EBRD), Asian Development Bank (ADB), and Asian Infrastructure Investment Bank (AIIB) provided 670 million USD in financing for solar projects in Bilasuvar and Neftchala, totaling 760 MW. These plants are expected to produce 1.7 billion kWh annually and save approximately 380 million cubic meters of gas (Ministry of Energy, 2024).

Macroeconomic analyses indicate that doubling the renewable energy share could increase GDP by 1.1%, welfare by 3.7%, and create about 1 million jobs, thereby enhancing tax revenues and protecting the public budget from hydrocarbon fluctuations (IEA, 2023).

Table 2 Impact of Renewable Energy on Azerbaijan's Public Finance (2023-2024)

Indicator	Value / Estimate	Impact on Public Finance
Electricity installed capacity	~8,320 MW	Current baseline; +1,500 MW needed to reach 30% renewable target
Renewable capacity	~1,687 MW (20%; 1,300 MW hydro + 347 MW solar/wind)	Ensures energy source diversification
Garadagh Solar production	500 million kWh; 110 million m^3 gas savings; 200,000 tons CO_2 reduction	Direct subsidy reduction; environmental benefit
Energy subsidies (2018)	2.6 billion USD (5.8% of GDP)	High fiscal expenditure burden
760 MW solar investment agreement	670 million USD	Public-private financing model
Economic multiplier effect	+1.1% GDP; +3.7% welfare; +1 million jobs	Increased tax revenue & public revenue diversification

Sources: Data from Area.gov.az (2023), Ministry of Energy (2024), and IEA (2023).

Long-term financing through public-private partnerships (PPPs) and power purchase agreements (PPAs) mitigates risks, making these projects sustainable (IEA, 2023; Reuters, 2024).

These data (Table 2) demonstrate that renewable energy investments not only increase electricity generation but also alleviate subsidy burdens, enhance tax revenues, and contribute to sustainable economic growth.

Additionally, Azerbaijan's Nationally Determined Contribution (NDC) plan aims to reduce greenhouse gas emissions by 35% by 2030 compared to 1990 levels. Renewable energy strategies are crucial for achieving these targets (IEA, 2023).

Thus, strategic investments in renewable energy – by reducing energy subsidy expenditures, increasing natural gas export capacity, diversifying tax revenues, and enhancing public financial sustainability – strengthen Azerbaijan's economic resilience. Further progress will depend on encouraging public-private partnerships and establishing robust financial and legal frameworks.

Challenges and social safeguards

Despite the benefits, the shift to renewables is not automatic. Researchers warn of institutional gaps. Mustafayev et al. (2022) find that Azerbaijan's legal framework for renewables is still weak and that expertise in this sector is limited. This could delay project implementation and thus postpone social gains. Moreover, energy reform must balance social protection: the IEA (2021) emphasizes that subsidy removals or market reforms require support measures for vulnerable groups. For example, phasing out cheap energy tariffs for all could hurt low-income families; hence, policies like targeted cash transfers or tariff exemptions may be needed. Maintaining public trust is crucial. In Azerbaijan, participatory initiatives (like NGO-led "Green Energy" coalitions) are emerging to raise awareness and involve citizens in the transition. This civil engagement can help ensure that the benefits of green growth (jobs, cleaner air, stronger social services) reach all layers of society.

DISCUSSION

Azerbaijan stands at an energy crossroads. Its rich hydrocarbon endowment has financed decades of development, but falling reserves and global climate pressures mean the oil-and-gas model cannot be the sole path forward (International Energy Agency, 2023). Recent literature underscores that embracing renewable energy and efficiency is vital for sustainable economic development in Azerbaijan. Empirical and policy studies agree that renewables offer multiple social welfare benefits: they can generate new jobs, reduce energy poverty, improve public health, and support rural communities. These benefits align with Azerbaijan's national development plan ("Azerbaijan 2030"), which calls for a "green growth" economy that meets the needs of present and future generations (Ministry of Energy of the Republic of Azerbaijan, 2023).

For example, our review found that renewable energy sectors (solar, wind) have much higher employment intensities than oil or gas production (Hajiyev, 2024). Expanding these sectors could thus absorb workers displaced from the petroleum industry, boosting incomes and local development. Community-scale solar projects already demonstrate concrete welfare gains: shelters and rehabilitation centers now rely on clean power to serve vulnerable groups without interruption, saving costs (EU Neighbour East, 2024). On the macro level, green energy investment diversifies exports and revenue streams, enhancing fiscal stability. As the IEA analysis notes, transitioning from subsidized, state-run fossil energy towards a more open, competitive energy market (with social support cushions) will help Azerbaijan sustainably finance its social programs and achieve SDGs (Mammadov, 2024).

However, the transition is not cost-free. Institutional readiness and inclusive policies are critical. Azerbaijan must strengthen its renewable energy laws, grid infrastructure, and workforce training to fully realize social benefits (Onea & Rusu, 2019). The literature repeatedly highlights the need for 'just transition' measures: protecting low-income consumers as tariffs adjust, and retraining oil-sector employees for green jobs. Though concrete data on these social challenges in Azerbaijan are scarce, international studies warn that neglecting social safeguards can exacerbate inequalities (Hamidova et al., 2022). Thus, Azerbaijan's policymakers are urged to incorporate social welfare metrics (poverty rates, employment data, health outcomes) into energy planning. Cross-sector collaboration – between government, private sector, and civil society – can ensure that the energy shift uplifts all parts of society, not just urban or technical elites.

In conclusion, the post-2020 literature portrays Azerbaijan's energy transition as necessary and opportunity-rich for social welfare. Moving aggressively towards renewables appears to be a prerequisite for long-run prosperity: it addresses climate commitments while unlocking jobs and better living conditions. Our review indicates that if Azerbaijan follows through on its renewable goals and green growth policies, it can mitigate the "resource curse" risk and achieve sustainable economic development. To thoroughly examine the impact of renewables on social welfare, future studies should collect primary data (e.g., household energy costs, employment by sector, health indicators) and evaluate projects over time. Nevertheless, today the evidence is clear that the expansion of renewable energy in Azerbaijan can support poverty reduction, improved public health, and equitable growth, thereby advancing the nation's sustainable development agenda (Guliyev, 2024).

CONCLUSION

The results of this study show that a managed energy transition can enhance Azerbaijan's social welfare and sustainable development. Renewable energy projects create jobs, improve health, and diversify the economy, supporting long-term well-being. The key to success is aligning transition policies with social goals: training workers for green industries, ensuring energy affordability, and using oil revenues wisely (e.g., funding education, infrastructure, and clean tech). Hajiyev (2024) notes that Azerbaijan's energy strategy now explicitly integrates social equity and ecological sustainability. Our findings reinforce this vision: transitioning to green energy is a linchpin for Azerbaijan's sustainable and inclusive economic growth, provided social welfare considerations remain central.

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