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Energy-saving policy and economic performance in Kazakhstan: A structured systematic-narrative review

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Abstract

This article examines the conditions under which energy-saving and energy-efficiency policies can improve economic performance in Kazakhstan. It applies a structured systematic-narrative review to 29 substantive peer-reviewed studies published from January 2021 to July 2026 in journals indexed in Scopus and/or the Web of Science. Three methodological sources informed the review design and reporting, while six official and institutional sources established the national energy and policy baseline. Candidate studies were identified through documented keyword combinations across publisher platforms and digital object identifier metadata, assessed against explicit eligibility criteria, and coded by research design, sector, outcome, evidential status, limitation, and relevance to Kazakhstan. The synthesis distinguishes causal results, associations, modelled effects, and untested mechanisms across six channels: production costs and productivity; investment and innovation; employment and skills; competitiveness and structural change; household welfare and distribution; and fiscal, environmental, and energy-security effects. Evidence generally links higher energy productivity to stronger firm performance and identifies potential employment and welfare gains, but effect sizes vary across sectors and institutions. Rebound, weak additionality, limited finance, regulated energy prices, and fragmented implementation can substantially reduce net benefits. These qualifications are material for Kazakhstan, where coal represented 47.2% of primary energy consumption in 2024 and gross domestic product energy intensity was approximately 0.304 tonnes of oil equivalent per thousand constant 2015 United States dollars. The review's novel contribution is an evidence architecture that connects policy instruments to verified savings and then to observable economic outcomes while assessing the transferability of international findings to Kazakhstan. It shows that energy-saving policy can support productivity, resilience, and welfare, but is not an automatic driver of economic growth. Based on the synthesis, the authors propose a Kazakhstan-specific policy agenda combining enforceable standards, quality audits, credible measurement and verification, targeted finance, gradual tariff reform with social protection, and domestic capability development. These recommendations and the associated monitoring indicators are interpretive outputs of the review; their combined effectiveness in Kazakhstan remains to be evaluated.

Keywords: energy efficiency, energy-saving policy, GDP energy intensity, economic growth, productivity, green economy.

Introduction

Energy-saving policy has become a question of economic performance rather than only technical conservation or emissions control. For an energy-exporting economy, lower energy use per unit of useful output may reduce operating costs, release fuels for alternative uses, defer supply-side investment, improve reliability, and limit exposure to price shocks. Efficiency investment may also create demand for engineering, construction, equipment, control systems, and finance. These gains are conditional: capital and transaction costs can offset bill savings, subsidised projects may include free riders, and lower service costs may induce additional energy demand. The relevant policy question is therefore when verified savings produce additional firm-level and economy-wide benefits (Brockway et al., 2021; Fowlie & Meeks, 2021; Saunders et al., 2021).

Kazakhstan is a salient setting because high energy intensity and fossil-fuel dependence coexist with ambitious targets and substantial implementation constraints. Coal supplied 47.2% of primary energy consumption in 2024, while gross domestic product (GDP) energy intensity stood at 0.304 tonnes of oil

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equivalent per thousand constant 2015 US dollars (Bureau of National Statistics [BNS], 2025). The 2023–2029 Energy Efficiency Concept establishes sector-specific targets and seeks to strengthen energy management, audits, and energy-service contracting (Government of Kazakhstan, 2023), while the 2060 Carbon Neutrality Strategy places efficiency within wider structural change (President of the Republic of Kazakhstan, 2023). Yet regulated prices, uneven enforcement, limited long-term finance, and competing affordability and energy-security objectives constrain implementation (Howie & Akhmetov, 2024; International Energy Agency [IEA], 2022; Mouraviev, 2021).

International scholarship provides substantial but compartmentalised evidence. Firm-level studies associate energy efficiency with productivity and profitability, but estimates vary by sector, design, and institutional setting (Caragliu, 2021; Montalbano et al., 2022). Studies of building investment and social policy identify employment, regional, and household-welfare effects that depend on modelling assumptions, labour-market capacity, and programme design (Jové-Llopis & Trujillo-Baute, 2024; Mikulić et al., 2021). Rebound research further shows that engineering savings and economy-wide reductions in energy use are not equivalent (Brockway et al., 2021). These studies identify relevant mechanisms, but their effect sizes cannot be transferred to Kazakhstan without considering domestic tariffs, industry, finance, governance, and import dependence.

Kazakhstan-focused research addresses related but different questions. Macroeconometric studies examine historical relationships among energy use, GDP, innovation, and emissions (Raihan & Tuspekova, 2022; Zhai et al., 2024), energy-system models explore conditional transition pathways (Zhakiyev et al., 2023), and governance or sector studies document financial, housing, and institutional constraints (Howie & Akhmetov, 2024; Shevyakova et al., 2022; Zhakiyev et al., 2025). Within the corpus reviewed here, these contributions do not causally evaluate the 2023–2029 programme or integrate the chain from policy instrument to verified additional saving and then to production costs, investment, employment, competitiveness, household welfare, and system outcomes. The gap is therefore not a general absence of energy-growth research, but the absence of a country-specific evaluative framework that keeps causal findings, associations, scenarios, and plausible mechanisms distinct.

Against this background, the article asks: under what conditions can energy-saving policy translate technical savings into measurable economic benefits in Kazakhstan? Three subquestions guide the review: (1) through which channels can energy-saving measures affect firm performance, investment, employment and skills, competitiveness, household welfare, and fiscal, environmental, and energy-security outcomes; (2) how strong and transferable is the evidence published between January 2021 and July 2026; and (3) how should Kazakhstan sequence and monitor policy so that reported savings can be related to additional and observable economic outcomes?

The contribution is integrative and policy-evaluative rather than econometric. First, the review organises heterogeneous evidence around six transmission channels and grades claims as causal results, associations, modelled effects, or mechanisms. Second, it assesses transferability by combining peer-reviewed findings with Kazakhstan's energy balance and policy architecture instead of importing foreign multipliers as domestic estimates. Third, it converts the synthesis into a sector-specific roadmap and monitoring framework that distinguishes gross from net savings, intensity from absolute use, and aggregate outcomes from distributional effects. This architecture makes the conditions, evidence limits, and data requirements of energy-efficiency policy explicit.

Methodology

Review design and scope

The study uses a structured systematic-narrative design because the evidence comprises programme evaluations, firm- and city-level econometric studies, macroeconomic analyses, modelling, qualitative governance research, and prior reviews. The systematic component defines the search window, eligibility rules, coding fields, and evidential categories; the narrative component compares heterogeneous findings that cannot be pooled defensibly. The unit of synthesis is the link between an energy-saving measure or implementation condition and an economic outcome. The procedure follows Sauer and Seuring (2023) and Turnbull et al. (2023).

The review covers publications issued between 1 January 2021 and 31 July 2026. The starting year aligns the synthesis with the 2021 baseline used in Kazakhstan’s 2023–2029 Energy Efficiency Concept and provides a policy-relevant window spanning the period before and after the adoption of this framework (Government of Kazakhstan, 2023). It also includes recent reassessments of energy-efficiency economics,

implementation barriers, and economy-wide rebound that inform the analytical framework of this review (Brockway et al., 2021; Fowlie & Meeks, 2021; Saunders et al., 2021). This boundary prioritises contemporary evidence without implying that the relevant mechanisms or policy debates originated in 2021.

The upper boundary of 31 July 2026 defines the publication cut-off; it does not represent complete coverage of the 2026 calendar year. The restriction applies to publication dates rather than the observation periods of the underlying studies. Consequently, the review provides a synthesis of recent evidence relevant to Kazakhstan's current policy framework, rather than a comprehensive historical account of energy-efficiency research.

Information sources and search strategy

Candidate publications were identified for the period 1 January 2021 to 31 July 2026 through publisher-platform and digital object identifier (DOI) metadata searches. Two complementary query blocks were used, with syntax adapted to each interface. The context block combined "energy efficiency", "energy saving", "energy intensity", or "energy productivity" with "Kazakhstan" or "Central Asia". The mechanism block combined the energy terms with productivity, costs, investment, finance, innovation, employment, skills, competitiveness, trade, welfare, energy poverty, rebound, co-benefits, or energy security. Substantive evidence was limited to English-language journal articles published in journals indexed in Scopus and/or the Web of Science at the time of review. Official sources were identified separately and used only for statistics, legal targets, and institutional context.

Eligibility and corpus construction

A study was eligible when it examined energy efficiency, energy saving, energy intensity, or a closely related instrument; reported an economic outcome or an implementation mechanism relevant to at least one transmission channel; and described its data or analytical method sufficiently for interpretation. Technical equipment studies without an economic or policy outcome, editorials, conference abstracts, duplicate reports, and renewable-energy studies without an identifiable efficiency mechanism were excluded. Titles and abstracts were assessed first and relevance was confirmed against the full text. The final analytical corpus contained 29 substantive peer-reviewed studies: 11 focused on Kazakhstan or Central Asia and 18 supplied international mechanism or comparator evidence (Table 1). Three methodological sources informed review design and reporting, and six official or institutional sources established the national context; these nine sources were not counted as evidence of policy effects.

Figure 1 presents literature identification, screening, retrieval, eligibility assessment, and final inclusion using a PRISMA-style flow structure (Page et al., 2021). The search identified 123 candidate publications, all of which entered screening. Across screening and eligibility assessment, 94 publications were excluded and 29 were retained for synthesis: 11 concerning Kazakhstan or Central Asia and 18 providing international evidence. Counts refer to unique substantive publications, irrespective of the number of transmission channels to which they contribute. Methodological references and official or institutional sources are recorded separately and are not included in the analytical corpus.

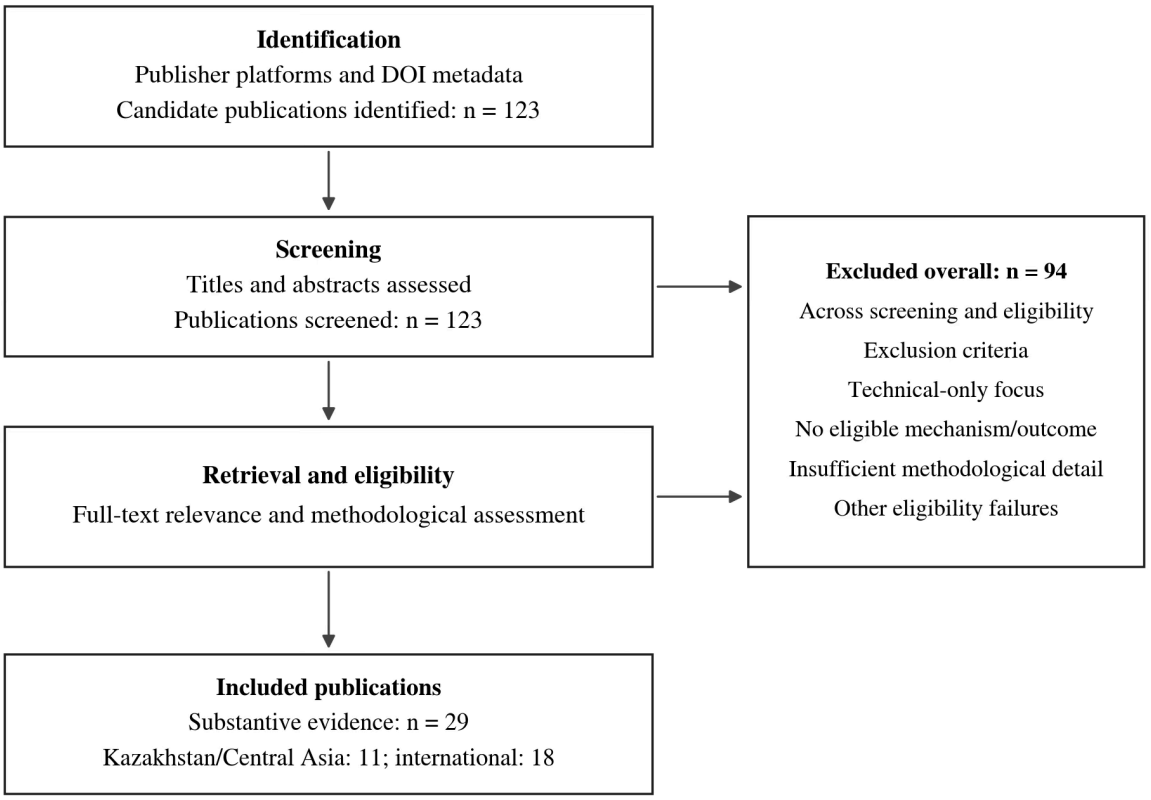


Figure 1. PRISMA-style flow diagram of literature selection

Source — authors' compilation; flow structure adapted from Page et al. (2021). Note — 123 publications were identified and screened; 94 were excluded and 29 included. The 94 exclusions are reported jointly across screening and eligibility assessment. Stage- and reason-specific exclusion counts are not disaggregated.

Table 1. Review protocol and audit trail

Element	Specification
Purpose	Link energy-saving instruments and implementation conditions to economic outcomes in Kazakhstan; no new causal estimate.
Search window and sources	1 January 2021–31 July 2026; publisher platforms and DOI metadata for journal evidence; official portals for the national baseline.
Query blocks	Context terms (Kazakhstan/Central Asia) and mechanism terms (productivity, investment, employment, competitiveness, welfare, rebound, co-benefits, and energy security).
Eligibility and exclusion	English peer-reviewed journal article indexed in Scopus and/or Web of Science, direct economic or implementation relevance, and interpretable method; technical-only, editorial, conference, duplicate, and unrelated renewable-energy records excluded.
Final corpus	29 substantive studies (11 Kazakhstan/Central Asia; 18 international), plus 3 methodological sources and 6 official/institutional sources recorded separately.

Extraction and appraisal	Coding by geography, sector, instrument, design, indicator, outcome, finding, inferential limit, and transferability; design-sensitive appraisal without a pooled score.
Synthesis and boundary	Six-channel narrative synthesis; causal, associative, modelled, and mechanism claims distinguished; foreign estimates not used as Kazakhstan effect sizes.

Note — substantive studies were counted once in the corpus even when coded to more than one channel. Methodological and official sources were recorded separately and were not treated as evidence of policy effects.

Data extraction, appraisal and synthesis

For each retained study, a structured matrix recorded geography, sector, intervention or exposure, research design, data, energy indicator, economic outcome, principal finding, inferential limit, and relevance to Kazakhstan. Methodological credibility was appraised through design-sensitive domains: transparency of data and sample, validity of measures, alignment between method and claim, treatment of confounding or uncertainty, robustness analysis, and transferability. No composite quality score was imposed across unlike designs. Instead, the appraisal determined the evidential label and the strength of language used in the synthesis.

Four evidential labels were applied. "Causal result" was reserved for designs supporting causal identification; observational estimates were described as associations; simulation findings as modelled effects; and plausible but unquantified pathways as mechanisms. Studies were compared within six deductive channels and across geography, sector, design, direction of effect, and limitation. Rebound, additionality, and uncertainty were treated as cross-cutting qualifications. No meta-analysis was attempted because interventions, baselines, units, outcomes, and time horizons were not commensurable. Kazakhstan-specific findings were interpreted separately, and international estimates were not presented as domestic effect sizes. Statements reporting source findings retain these evidential labels. Assessments of transferability are the authors' interpretations, while the proposed policy packages and monitoring indicators are presented separately as recommendations whose combined effectiveness in Kazakhstan remains to be evaluated.

Literature Review and Analytical Framework

Conceptual boundaries and competing expectations

Energy saving, energy efficiency, and energy intensity are related but non-equivalent concepts. Energy saving is an observed reduction from a defined baseline; energy efficiency is useful service or output per unit of energy; aggregate energy intensity is energy use relative to economic output. The last measure can change because of technology, but also because of industrial composition, capacity utilisation, weather, prices, or GDP valuation (Hajiyev et al., 2023; Saunders et al., 2021). A policy effect therefore cannot be inferred from an intensity trend alone: evaluation must connect a specified instrument to normalised physical savings and subsequent economic outcomes.

Two competing expectations structure the literature. The efficiency-gap perspective holds that cost-effective investments remain unrealised because firms and households face imperfect information, credit constraints, split incentives, uncertain savings, transaction costs, and disruption risks. Standards, audits, finance, and energy-service contracts may therefore improve investment, productivity, and welfare (Fowlie & Meeks, 2021). The countervailing literature emphasises that engineering savings do not automatically become net economy-wide savings. Lower energy-service costs may increase utilisation, output, and expenditure on other energy-using goods, producing direct, indirect, and economy-wide rebound effects (Berner et al., 2022; Brockway et al., 2021). Together, these perspectives require a distinction among gross technical saving, additional saving attributable to policy, and net saving after behavioural and economic adjustment.

Firm performance, innovation, and finance

Firm-level findings are broadly positive but differ in inferential strength. Montalbano et al. (2022) report a positive cross-country association between energy efficiency and productivity, although better-managed firms may be more able to invest. Caragliu (2021) presents more policy-specific evidence from Italy's white-certificate programme, but selection into participation remains relevant. China's Top-10,000 Enterprises programme further shows that recorded savings may combine within-firm efficiency

with production changes (Shi et al., 2023). The studies support output-normalised indicators, but not a common effect size transferable to Kazakhstan. Investment research similarly shows that policy incentives and access to credit can facilitate adoption (García-Quevedo & Jové-Llopis, 2021; Zhang et al., 2025), yet subsidised finance may fund non-additional projects or generate limited domestic value when equipment and specialist services are imported. Returns therefore depend on finance, management capability, and implementation quality.

Employment, distribution, and co-benefits

Employment and welfare evidence is favourable in direction but methodologically heterogeneous. Input-output modelling of building renovation estimates direct and regional spillovers, whereas city-level evidence reports an association between efficiency and employment; neither design establishes a Kazakhstan-specific net employment multiplier (Chen et al., 2023; Mikulić et al., 2021). Co-benefit studies show that employment, health, reliability, and environmental gains can change the social ranking of measures, but modelled gross jobs are not equivalent to observed net jobs (Berger et al., 2025; Chatterjee et al., 2022). Household studies examine potential welfare effects of renovation and income support while identifying split incentives, take-up barriers, and unequal distribution of benefits (Darmais et al., 2024; Jové-Llopis & Trujillo-Baute, 2024; Papantonis et al., 2022).

Kazakhstan-specific evidence and the research gap

Kazakhstan and Central Asian research is stronger in diagnosing structural conditions than in identifying programme effects. Macroeconometric studies examine relationships among energy use, output, innovation, and emissions, but do not isolate individual efficiency instruments (Kuziboev et al., 2024; Raihan & Tuspekova, 2022; Zhai et al., 2024). Energy-system modelling estimates transition pathways conditional on assumptions rather than observed impacts (Zhakiyev et al., 2023). Institutional and sectoral studies document low-price incentives, financing constraints, fragmented governance, ageing infrastructure, and implementation difficulties (Filipović et al., 2024; Howie & Akhmetov, 2024; Mouraviev, 2021; Shevyakova et al., 2022; Zhakiyev et al., 2025). Project-level building evidence demonstrates technical feasibility without establishing national scalability or economy-wide returns (Dyussembekova et al., 2022).

The review integrates these evidence streams through the conceptual evidence architecture presented in Figure 2. The framework links policy instruments to technology adoption, investment, energy management, and organisational behaviour. Verified project energy savings require comparison of measured consumption with a baseline adjusted for relevant factors such as weather, production, or occupancy. Establishing net additional savings further requires attribution to the policy intervention and assessment of rebound and persistence. These savings may contribute to economic outcomes across the six transmission channels examined in this review (Table 2). Investment, employment, and implementation costs can also arise directly during project delivery, before verified savings materialise.

Tariffs, access to finance, institutional capacity, skills, domestic supply capability, and industrial structure moderate implementation and the translation of savings into economic outcomes. The architecture is the authors' conceptual synthesis of the reviewed literature. Its arrows represent proposed relationships for investigation; they do not indicate that every relationship has been causally established or quantified for Kazakhstan.

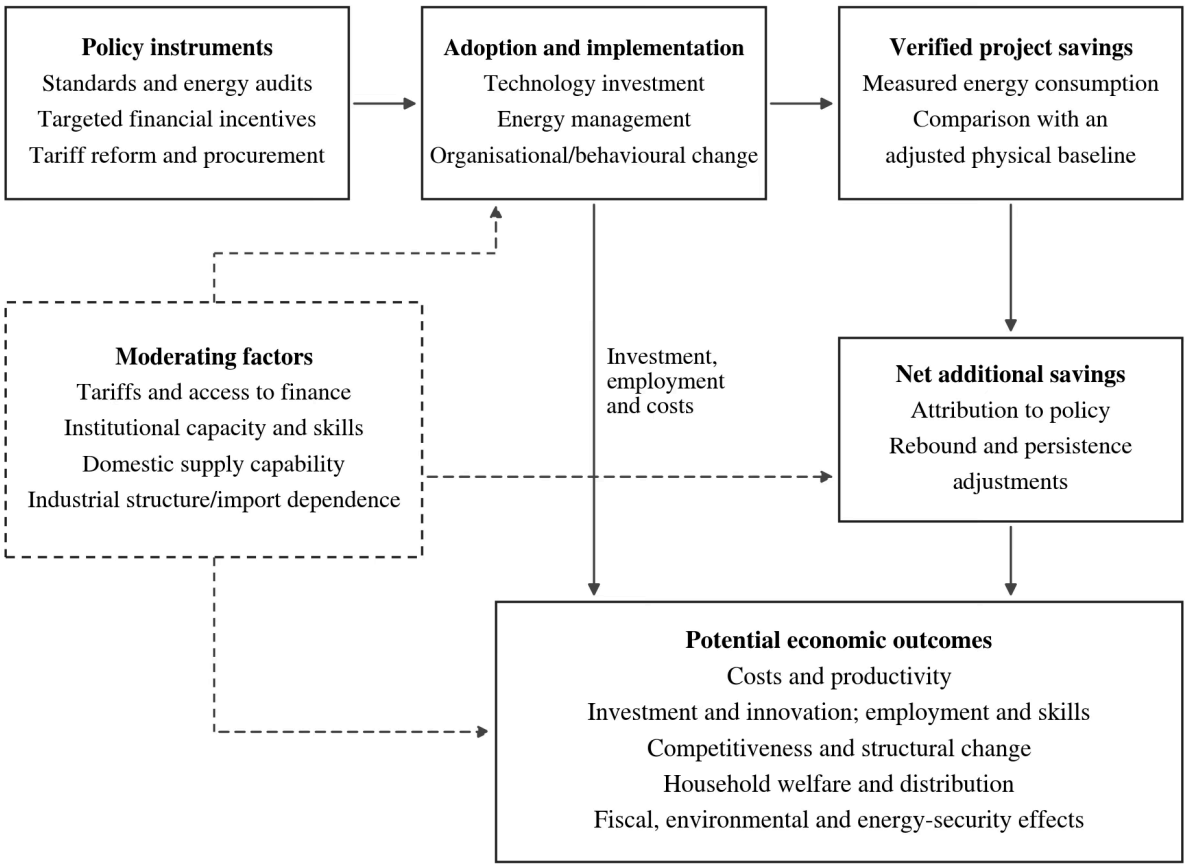


Figure 2. Proposed evidence architecture linking energy-saving policy to economic outcomes in Kazakhstan

Source — authors' conceptual synthesis of the reviewed literature. Note — solid arrows indicate proposed transmission pathways; dashed arrows indicate moderating influences. The direct pathway from implementation to economic outcomes captures investment, employment, and implementation costs arising before savings are realised. Verified project savings are distinguished from net additional savings attributable to policy. Economic outcomes may be positive or negative and require separate empirical assessment.

Table 2. Economic transmission channels and evaluation risks

Channel	Mechanism	Observable outcomes	Principal qualification
Productivity	Lower input; better control, reliability and quality	Energy/output, unit cost, downtime, productivity	Selection, output and other investment affect estimates
Investment	Equipment, construction, software, finance and skills	Capital, private leverage, innovation, supplier value added	Imports, crowding out and free riders reduce domestic gain
Employment	Direct, supply-chain and induced activity	Full-time-equivalent job-years, wages, vacancies, and regional and skill distribution	Temporary jobs, displacement, imports and capacity constraints
Competitiveness	Lower unit cost and exposure to tariffs or carbon requirements	Exports, margins, product carbon intensity, market access	Rebound can expand output and total energy use

Households	Bills, comfort, reliability and health	Energy burden, service, arrears, take-up by income/tenure	Split incentives; regressive untargeted support
System and fiscal	Avoided fuel, losses, peak capacity and external costs	Peak-demand reduction, outages, subsidy cost, emissions, and public cost per verified saving	Benefits exist only when capacity or real resources are actually avoided

Source — authors' synthesis of the reviewed literature.

Kazakhstan's energy-efficiency context

Energy balance and intensity trend

In 2024, Kazakhstan consumed 74.304 million tonnes of oil equivalent (Mtoe) of primary energy and 44.647 Mtoe of final energy. Coal supplied 47.2% of primary consumption, followed by natural gas (33.1%) and oil products (17.4%). Final demand was distributed across oil products, natural gas, heat, electricity, and coal (BNS, 2025). This mix makes efficiency relevant to direct fuel use, electricity, and district heat rather than to the power sector alone (Fig. 3).

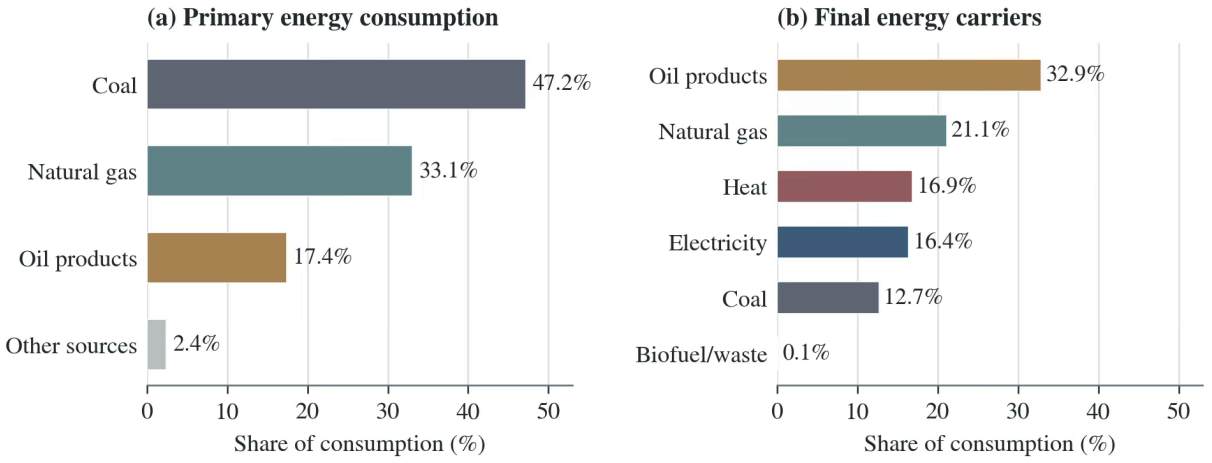


Figure 3. Kazakhstan's primary and final energy composition, 2024

Source — Bureau of National Statistics (2025), supporting energy-balance spreadsheets; authors' calculations from unrounded totals. Note — other primary sources comprise hydro, solar and wind, net electricity balance, and biofuel/waste.

Households were the largest final-energy users in 2024 at 16.3 Mtoe (36.5%), followed by transport (11.1 Mtoe) and industry (9.9 Mtoe). Within industry, iron and steel accounted for 33.6% of use, mining for 14.6%, and non-ferrous metallurgy for 10.8% (BNS, 2025). The distribution requires simultaneous attention to industrial competitiveness, household welfare, district heating, and mobility (Fig. 4).

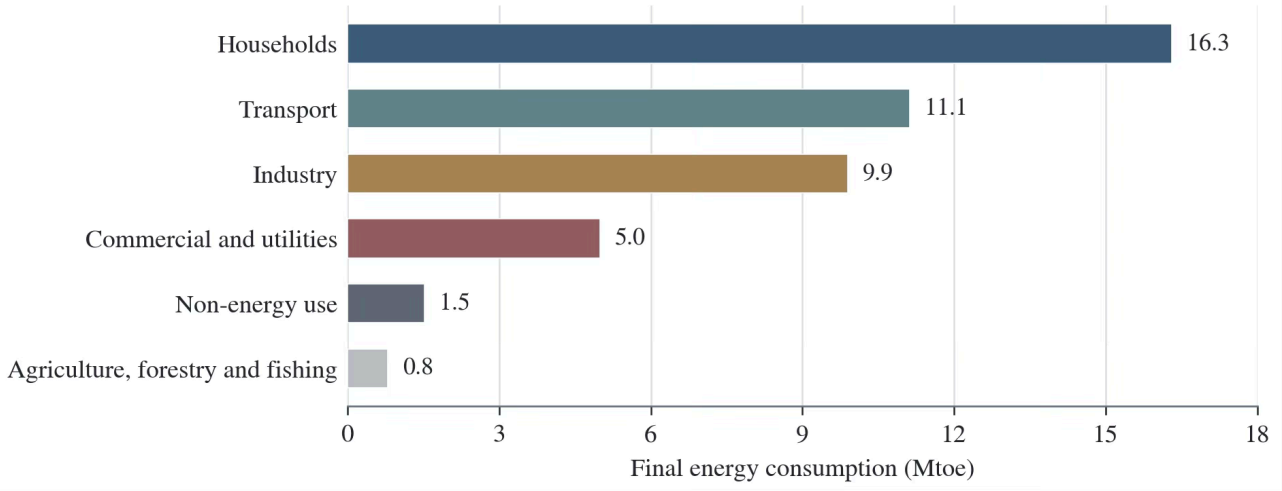


Figure 4. Final energy consumption by end-use sector in Kazakhstan, 2024

Source — Bureau of National Statistics (2025), supporting energy-balance spreadsheets. Values are plotted from the unrounded official Mtoe totals.

In the official constant-price series, GDP energy intensity fell from 0.367 tonnes of oil equivalent (toe) per thousand 2015 US dollars in 2018 to 0.317 in 2022, rose slightly to 0.318 in 2023, and fell to 0.304 in 2024 (BNS, 2025). The 2018–2024 reduction was approximately 17.2%, while the 2021–2024 reduction was 5.0%. The non-monotonic path cautions against treating the ratio as a direct policy score because output shocks, weather, industrial capacity utilisation, and statistical revisions also affect it. Targets must also be assessed with a consistent base year and price denominator.

International diagnostics nevertheless agree that Kazakhstan remains energy-intensive. The IEA (2022) attributes this to heavy industry, fossil-fuel dependence, low tariffs, and weak enforcement of building, appliance, transport, and industrial requirements. The World Bank (2022) reaches a similar conclusion while noting that cross-country rankings vary with purchasing-power and price methodology. Kazakhstan-specific econometric evidence finds a positive long-run association between energy use and GDP and a role for structural change, but these are historical relationships rather than policy-treatment effects (Zhai et al., 2024). Regional evidence also associates energy intensity with carbon emissions (Kuziboev et al., 2024).

Policy architecture and target consistency

Kazakhstan's existing energy-efficiency framework combines the State Energy Register, energy-management requirements, and periodic audits. The 2023–2029 Concept adds quantitative targets (Table 3), energy managers in large enterprises, stronger audits, and further development of energy-service company financing (Government of Kazakhstan, 2023). Efficiency is also integrated into infrastructure and environmental modernisation through the 2024–2030 Green Economy action plan (Government of Kazakhstan, 2024) and the long-term Carbon Neutrality Strategy (President of the Republic of Kazakhstan, 2023).

Table 3. Kazakhstan’s energy-efficiency baseline and official target architecture

Indicator	**Baseline/current status**	**Official target or implication**	**Source**
GDP energy intensity	0.367 toe per thousand constant 2015 US dollars (2018); 0.320 (2021); 0.304 (2024)	2018–2024: −17.2%; 2021–2024: −5.0% (not causal)	BNS (2025)
Energy Efficiency Concept	2021 baseline	GDP and industrial intensity −10% by 2029; energy sector −5%; energy/m² −10%; per-capita energy −5%	Resolution 264/2023

Green Economy Concept	2021 baseline	GDP energy intensity −15% by 2030, −25% by 2040 and −35% by 2050	Government of Kazakhstan (2024)
Target alignment	2021 baseline	2029 and 2030 targets should be monitored separately against their legal baselines	Government of Kazakhstan (2023, 2024)
Primary energy mix	2024: coal 47.2%; gas 33.1%; oil products 17.4%	Shows continued system value of coal and fuel savings	BNS (2025)
Final users	2024: households 36.5%; transport 11.1 Mtoe; industry 9.9 Mtoe	Requires a multi-sector programme	BNS (2025)
Carbon strategy	1990 emissions baseline	Greenhouse-gas emissions −15% by 2030 unconditionally and −25% conditionally; carbon neutrality by 2060	Decree 121/2023

Note — the 2029 and 2030 intensity targets are distinct legal benchmarks. Percentage changes are authors' calculations from the current BNS series; 2024 was marked preliminary in one official compendium. Mtoe = million tonnes of oil equivalent.

The implementation gap

Kazakhstan has strategic targets, but the literature identifies a persistent gap between formal policy and investment conditions. Regulated tariffs support short-term affordability while lengthening payback periods and weakening utility revenues for rehabilitation. The IEA (2022) identifies uneven enforcement and fragmented coordination. Housing and communal services face ageing infrastructure, incomplete metering, and limited finance (Shevyakova et al., 2022). An Almaty educational-building case shows that audits and simulation can identify feasible measures, but project-level feasibility does not resolve financing, ownership, or replication constraints (Dyussembekova et al., 2022).

Results

Thematic Synthesis

The analytical corpus comprises 29 substantive publications: 11 concern Kazakhstan or Central Asia, while 18 provide international evidence on relevant mechanisms and policy experiences. Kazakhstan-focused studies predominantly examine historical associations, conditional transition scenarios, and implementation constraints. International studies provide additional programme-, firm-, city-, and household-level evidence. The synthesis below reports source findings with their inferential limitations; assessments of their relevance to Kazakhstan are identified as interpretations. No pooled effect estimate is calculated.

Costs, output and productivity

Montalbano et al. (2022) report a positive association between energy efficiency and firm productivity, with differences across industries and regions. Caragliu (2021) reports improvements in firm performance in the context of Italy's white-certificate programme. These findings concern specific samples and institutional settings and do not establish an equivalent effect for Kazakhstan.

Shi et al. (2023) show that energy savings under China's Top-10,000 Enterprises programme involved both improvements within enterprises and adjustments in production scale. Thus, observed reductions in consumption cannot automatically be interpreted as technical efficiency gains. The relevance to Kazakhstan is interpretive: physical-output-normalised measures can help distinguish efficiency changes from changes in production, but their use does not itself identify a policy effect.

Investment, innovation and finance

The reviewed literature identifies credit constraints, information problems, transaction costs, uncertain savings, and organisational barriers as relevant to efficiency investment (Fowlie & Meeks, 2021). The distinction between engineering potential and realised returns reflects financing, installation, maintenance,

and disruption costs. These findings identify constraints on adoption without establishing that a single support instrument will resolve them across sectors.

García-Quevedo and Jové-Llopis (2021) report relationships between environmental policy instruments and efficiency investment decisions, while Zhang et al. (2025) examine the relationship between credit constraints and manufacturing energy efficiency. Kazakhstan-focused studies additionally identify financing and institutional obstacles to implementation (Shevyakova et al., 2022; Zhakiyev et al., 2025). This evidence establishes the relevance of financing conditions but does not demonstrate which financing package would be most effective in Kazakhstan.

Employment, skills and regional effects

Mikulić et al. (2021) estimate employment and regional economic effects of building renovation using input-output modelling. Berger et al. (2025) examine employment among the co-benefits of selected German efficiency policies. These contributions concern particular economic structures and policy settings; modelled activity and employment effects do not establish observed net employment gains for Kazakhstan.

The authors interpret domestic skills and supply capacity as conditions affecting the transferability of these employment findings. This interpretation is consistent with the implementation constraints discussed in Kazakhstan-focused research, but the reviewed corpus does not quantify how an expansion of training or certification would change programme employment outcomes in Kazakhstan (Zhakiyev et al., 2025).

Chen et al. (2023) report a positive association between energy efficiency and employment in Chinese cities. The study does not establish a national employment multiplier transferable to Kazakhstan. Across the reviewed corpus, evidence remains insufficient to quantify Kazakhstan-specific net and sustained job creation after accounting for imports, displaced activity, and the duration of employment.

Competitiveness, trade and structural change

Lower energy requirements per unit of output provide a plausible mechanism through which efficiency could affect operating costs and competitiveness. Within this review, however, the extension of this mechanism to Kazakhstan's export performance is an analytical interpretation rather than an identified policy effect. Changes in output, financing costs, and firms' capacity to comply with new requirements can alter the direction and distribution of the resulting benefits.

Zhai et al. (2024) examine relationships between energy consumption and GDP in Kazakhstan, including sectoral differences. Such relationships do not isolate the contribution of individual efficiency instruments or distinguish all technological changes from changes in economic structure and activity. Consequently, an observed decline in aggregate energy intensity is not treated here as direct evidence of improved industrial technology or policy-induced competitiveness.

Household welfare and distribution

Official statistics identify households as Kazakhstan's largest final-energy users in 2024, establishing the scale of their relevance to efficiency policy (BNS, 2025). This descriptive baseline does not establish the distributional effects of tariff reform or renovation programmes. The authors treat household income, tenure, housing conditions, and access to support as dimensions affecting the transferability of international welfare findings.

Jové-Llopis and Trujillo-Baute (2024) simulate the potential effects of income support and housing-efficiency measures in Spain under assumptions of universal coverage and optimal household behaviour. Their analysis indicates larger potential reductions in energy poverty from comprehensive renovation than from income support alone, with a smaller additional contribution from transfers after full renovation. These are scenario-dependent estimates rather than observed outcomes of a Kazakhstan programme. Papantonis et al. (2022) identify split incentives and implementation barriers in European private rented housing, while Darmais et al. (2024) examine equity provisions in the French energy-efficiency obligations programme. These studies inform the interpretation of targeting and access barriers without establishing an equivalent domestic effect.

Energy security, fiscal and environmental co-benefits

Avoided fuel use, losses, and coincident peak demand provide plausible pathways linking efficiency to energy security and infrastructure expenditure. These pathways are treated here as conditional mechanisms rather than verified Kazakhstan programme outcomes. Their economic value depends on the timing, location, and persistence of savings and on whether specific supply investments are actually reduced, delayed, or avoided.

Chatterjee et al. (2022) show how accounting for welfare, health, environmental, and other co-benefits can change the appraisal of efficiency measures. Kazakhstan-focused research examines relationships among

economic activity, energy sources, innovation, and emissions (Raihan & Tuspekova, 2022). This evidence identifies relevant outcome dimensions but does not quantify the health benefits, fiscal returns, or avoided infrastructure expenditure attributable to Kazakhstan's efficiency programmes.

Rebound, additionality and uncertainty

Brockway et al. (2021) and Berner et al. (2022) document substantial variation in economy-wide rebound estimates. Their findings distinguish engineering savings from changes in energy use after behavioural and economic responses. The reviewed evidence therefore does not support applying a single rebound coefficient to Kazakhstan. Together with differences in additionality, financing costs, and implementation conditions, this uncertainty limits the transfer of international effect sizes to domestic policy appraisal.

Discussion

The synthesis supports a conditional conclusion: energy-saving policy can improve economic performance, but its impact is not a single coefficient. Short-run effects depend on investment, import content, financing, and disruption; medium-run effects on productivity, capacity, prices, and behaviour; and long-run effects on technology, trade, and structural change. The reviewed corpus does not provide a transferable aggregate estimate of the GDP effect of energy-saving policy in Kazakhstan.

Kazakhstan-specific evidence is stronger on context and constraints than on causal programme effects. Country and regional studies identify fossil dependence, ageing infrastructure, policy uncertainty, regulated prices, finance, and skills as barriers (Filipović et al., 2024; Howie & Akhmetov, 2024; Radovanović et al., 2021; Zhakiyev et al., 2025). Econometric studies describe historical energy-GDP-emissions relationships, while system models explore conditional pathways (Raihan & Tuspekova, 2022; Zhai et al., 2024; Zhakiyev et al., 2023). None estimates the causal GDP or employment return of the 2023–2029 Concept; foreign multipliers cannot fill that gap.

Using the current BNS series, GDP energy intensity declined from 0.320 in 2021 to 0.304 in 2024, a 5.0% reduction. This indicates progress but neither identifies policy causality nor establishes a linear path to the 2029 and 2030 targets. Figure 5 therefore presents benchmark points rather than forecasts.

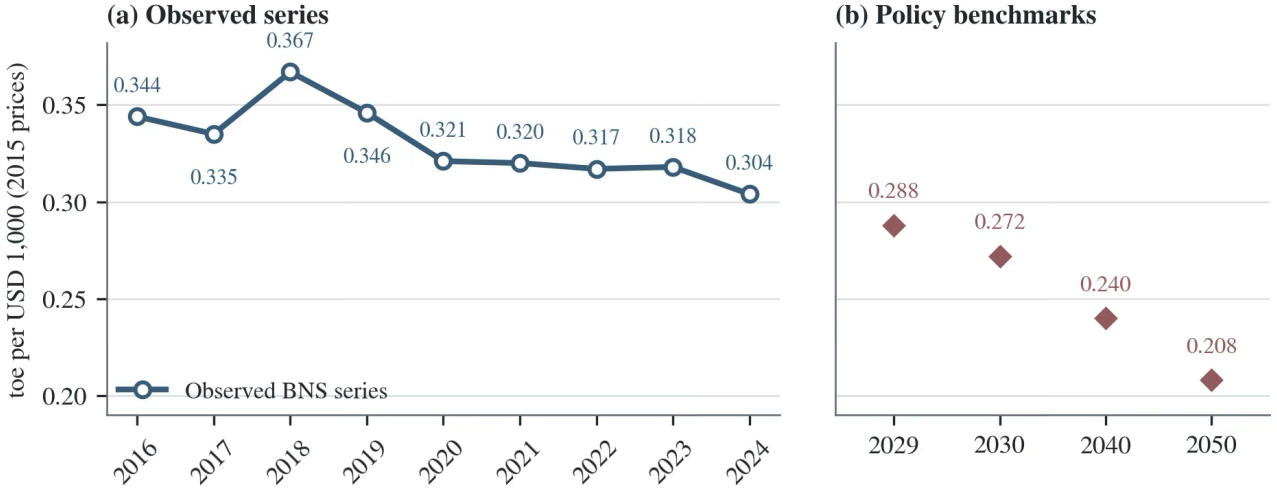


Figure 5. Observed GDP energy intensity and official policy benchmarks in Kazakhstan

Source — Bureau of National Statistics (2025); Government of Kazakhstan (2023, 2024); authors' calculations. Note — the 2029 point reflects the Energy Efficiency Concept; the 2030, 2040 and 2050 points reflect the Green Economy Concept. Benchmarks are arithmetic translations from the 2021 baseline, not forecasts or estimates of policy impact.

Policy implications and monitoring framework

The following recommendations are the authors' policy proposals, informed by the reviewed evidence and its interpretation in Kazakhstan's institutional context. The literature identifies relevant mechanisms, constraints, and evaluation risks; the selection and sequencing of instruments proposed here involve

additional policy judgments. The combined package has not been evaluated as an intervention in Kazakhstan. Its expected benefits are therefore presented as hypotheses for programme appraisal and subsequent evaluation, rather than as demonstrated domestic effects.

Sectoral priorities for Kazakhstan

Policy design must vary by sector because baselines, decision makers, payback periods, and measurement units differ. Industry requires output-normalised benchmarks and investment-grade audits; power and heat require loss, reliability, and avoided-capacity metrics; buildings require weather- and comfort-normalised performance; and transport requires energy per passenger- or tonne-kilometre alongside total travel. Table 4 consolidates these differences.

Table 4. Authors' proposed sector priorities and monitoring indicators for Kazakhstan

Sector	Priority package	Expected mechanism to be evaluated	Minimum indicators
Industry	Energy management, quality audits, process benchmarks, motors/drives, heat recovery, conditional finance	Lower unit cost, reliability, export and carbon resilience	Energy/physical output; total use; verified saving; productivity; downtime; private leverage
Power and heat	Plant efficiency, network rehabilitation, balancing, metering, demand response and integrated planning	Avoided losses, outages, fuel and peak capacity	Heat rate; technical losses; peak-demand reduction; outages; deferred capacity; lifetime cost
Buildings	Public portfolios, envelope and controls, one-stop renovation, appliance standards, targeted grants	Bills, comfort, public service, construction and skills	Weather-normalised kilowatt-hours per square metre; indoor service; cost; arrears; income/tenure; defects
Transport	Fuel-economy enforcement, fleet and logistics efficiency, public transport, rail and electrification	Lower fuel cost and import or supply exposure; better mobility service	Energy per passenger-kilometre and tonne-kilometre; vehicle-kilometres; load factor; fleet efficiency; service access

Source — authors' proposals informed by the review. Note — packages and expected economic mechanisms are untested in Kazakhstan; indicators require regional disaggregation and a baseline or counterfactual.

A sequenced policy package

First, national coordination should map every efficiency target to its legal source, baseline, unit, deadline, responsible body, and data release in one public dashboard. The 2029 Energy Efficiency Concept and 2030 Green Economy targets should remain distinct, and annual reports should explain revisions and decompose aggregate intensity rather than present only a traffic-light status.

Second, the State Energy Register should become an investment and evaluation platform. Covered entities should report machine-readable consumption, physical output, baseline adjustments, audit recommendations, implementation status, and verified savings. Risk-based quality checks should link repeated poor audit recommendations to accreditation consequences, while protected facility data can support anonymised benchmarks and public programme results.

Third, tariff reform should be gradual, predictable, metered accurately, and socially compensated. The authors propose targeted transfers or lifeline tariffs to protect essential consumption while replacing universal price suppression. Temporary support for firms should be conditional on credible improvement plans, while regulators should allow prudent recovery of efficiency and network investment through service-quality and loss-reduction incentives.

Fourth, minimum standards and enforcement should cover buildings, appliances, vehicles, and industrial equipment where project-by-project subsidies impose excessive transaction costs. Testing capacity, market surveillance, sanctions, and regular review are essential. Public procurement can create demand

through life-cycle energy requirements, while labels and awareness measures should complement rather than substitute for enforceable standards and finance.

A central trade-off concerns the timing of tariff and infrastructure reform. Higher prices introduced before reliable metering, finance, and social protection can create hardship and industrial shock; indefinite postponement suppresses investment and weakens utilities. A credible sequence establishes data and social registries, strengthens targeted support, announces a multi-year tariff path, provides finance and audits, and then tightens performance standards as feasible options expand.

The energy-efficiency-first principle is a decision rule, not a claim that demand measures always supersede supply (Mandel et al., 2022). Kazakhstan requires new and rehabilitated generation, heat, and networks. Planners should compare these investments with demand-side resources using consistent discount rates, reliability criteria, environmental values, and risk. Avoided capacity should be claimed only when savings occur at the constrained time and actually delay, reduce, or cancel supply investment.

Indicators for economic evaluation

Monitoring should move from activity counts to a results chain. Inputs comprise public expenditure, private finance and administrative resources. Outputs include audits, projects, installed equipment, renovated area and trained workers. Energy outcomes consist of normalised intensity, verified annual saving, peak-demand reduction and lifetime saving. Economic outcomes are net present value, productivity, operating cost, investment, value added and employment. Distributional indicators include beneficiary income, region, tenure, and changes in energy burden. Environmental and system outcomes include emissions, local pollutants, losses, outages and deferred capacity.

A counterfactual should be specified in every major programme. Randomised phase-in can be considered for information or small-business support. Quasi-experimental evaluation can be facilitated by threshold-based eligibility. Matched facilities, engineering baselines and interrupted time series may be more practical for large industrial projects. Adjustments to weather, production, occupancy and tariff should be pre-specified. An independent evaluator should be able to see anonymised meter, firm and administrative data and results should be published even if savings are not achieved.

Both gross and net results should be displayed. For example, an illustrative programme might report 100 units of engineering saving, 85 after technical and baseline adjustment, and 70 after estimated rebound and free-rider effects. The stages should not be collapsed: gross results show project delivery, while net results show additional impact. Sensitivity analysis should vary rebound, persistence, additionality, survival, and degradation assumptions.

Limitations and future research

The review is bounded by its configurative design. It reports the complete retained corpus, eligibility logic, query blocks, and coding categories, but does not claim exhaustive bibliometric coverage because publisher and DOI metadata can change over time. International estimates also arise from tariff systems, technologies, governance, and labour markets unlike Kazakhstan's. Domestic evidence remains strongest on energy-GDP-emissions relationships and institutional barriers, while causal evaluation of individual efficiency programmes is rare, particularly for employment, distribution, small-firm adoption, public buildings, and rebound. The selection flow reports aggregate counts, without a stage- or reason-specific breakdown of the 94 exclusions. The publication-date restriction also limits historical coverage, and the July 2026 cut-off leaves the final calendar year incomplete.

Future research should use programme-linked microdata and pre-specified evaluation plans. Industrial studies can combine metering, physical output, audit timing, and within-facility changes; building studies can use weather-normalised smart-meter data, indoor temperature, and staged renovation. Household studies should measure energy burden, comfort, and take-up by income, tenure, region, and climate. Employment studies require supplier surveys and administrative labour data to estimate net and sustained jobs. Economy-wide rebound should be estimated under Kazakhstan's regulated prices, trade structure, and spare-capacity conditions rather than imported from advanced economies.

Policy coherence is a further research priority. The 2029 and 2030 intensity targets, infrastructure modernisation, tariff reform, carbon pricing, and industrial support should be tested jointly through scenarios and ex-post evaluation. An open national evidence repository would permit comparable baselines, methods, and results across programmes and funding rounds.

Conclusion

The reviewed evidence identifies positive associations between energy efficiency and firm performance, modelled opportunities for employment and household-welfare gains, and substantial variation arising from financing conditions, implementation barriers, and rebound. These findings support a conditional assessment of the economic potential of energy saving. They do not establish a common effect size transferable to Kazakhstan or demonstrate the aggregate GDP and employment effects of its 2023–2029 Energy Efficiency Concept. Kazakhstan's observed energy-intensity changes likewise cannot be attributed to policy alone.

Building on these findings, the authors propose a policy and evaluation agenda centred on enforceable standards, quality audits, verified savings, targeted finance, gradual tariff reform with social protection, and skills development. This agenda represents the authors' contextual policy judgment rather than an empirically validated package. Its effectiveness requires programme-level evaluation that distinguishes gross from net savings, intensity from absolute consumption, temporary from sustained employment, and aggregate from distributional outcomes.

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