Measuring Climate Policy Inconsistency under Coal Expansion: Evidence from Kazakhstan

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Abstract: Coal-dependent economies increasingly face a policy dilemma: ambitious carbon neutrality commitments coexist with continued expansion of coal-fired power generation. Quantitative approaches for measuring the consistency between climate commitments and actual energy policy remain limited. This study develops a novel Climate-Energy Policy Inconsistency Index (CEPII) and applies it to Kazakhstan, where the national carbon neutrality target coexists with a large-scale coal expansion program. The proposed framework combines structured policy analysis, scenario-based estimation of CO_2 emissions and carbon costs, and cross-country comparative assessment. The results indicate that the planned expansion would generate 19.5-33.3 Mt CO_2 annually, representing approximately 7-8% of Kazakhstan's current greenhouse gas emissions. At the current domestic carbon price, annual carbon costs remain negligible compared with those under the EU Emissions Trading System, explaining the continued economic attractiveness of coal investment. Cross-country comparison further demonstrates that Kazakhstan exhibits the highest level of climate-energy policy inconsistency among the selected coal-dependent economies, primarily due to the combination of ambitious climate commitments and weak carbon pricing. The proposed framework offers a reproducible analytical tool for evaluating policy coherence and supports the design of carbon pricing and energy transition policies in coal-dependent economies.

1 INTRODUCTION

Achieving carbon neutrality has become a central objective of national energy and climate policies worldwide. However, for many coal-dependent economies, the transition towards low-carbon energy systems remains constrained by concerns over energy security, industrial competitiveness, and the long operational lifetime of existing and planned coal-fired power plants. As a result, ambitious climate commitments increasingly coexist with continued investment in coal-based electricity generation, creating growing tensions between long-term decarbonization goals and short-term energy policy decisions.

This contradiction is commonly explained through the concept of carbon lock-in, which argues that capital-intensive fossil-fuel infrastructure creates technological, institutional, and economic path dependencies that persist for several decades (Unruh, 2000). Once new coal-fired capacity is commissioned, future emissions become embedded in the energy system, increasing the cost and complexity of subsequent decarbonization (Geels, 2002; Sovacool, 2016). Consequently, evaluating whether current investment decisions are consistent with declared climate objectives has become an increasingly important issue for both researchers and policymakers.

Kazakhstan represents a particularly informative case for such an assessment. The country has legally committed to achieving carbon neutrality by 2060 and, in January 2026, adopted an updated Nationally Determined Contribution (NDC) targeting an unconditional 17% reduction in greenhouse gas emissions by 2035 relative to the 1990 level. Less than two months later, the Government approved the National Project for Coal Power Development, providing for the construction of more than 5.3 GW of new coal-fired capacity and the modernization of approximately 2.5 GW of existing plants by 2030. Rather than interpreting this coexistence of climate ambition and coal expansion as a political paradox, this study considers it a measurable manifestation of climate-energy policy inconsistency.

Previous studies have extensively investigated carbon pricing, coal transition pathways, carbon lock-in, and decarbonization scenarios. Nevertheless, two important research gaps remain. First, empirical evidence from post-Soviet coal-dependent economies remains scarce compared with the extensive literature on China, India, the European Union, and South Africa. Second, existing studies typically assess climate ambition and energy policy separately, whereas quantitative approaches capable of measuring the consistency between declared climate commitments and actual energy investment decisions remain underdeveloped.

To address these gaps, this study develops a quantitative framework for assessing climate-energy policy inconsistency and applies it to Kazakhstan. The analysis addresses three research questions:

- RQ1. What annual CO_2 emissions and carbon costs are associated with the planned coal expansion under realistic operating scenarios?
- RQ2. To what extent does Kazakhstan's current carbon pricing system affect the economic attractiveness of new coal-fired power generation?
- RQ3. How can the consistency between climate commitments and actual energy policy be measured quantitatively?

To answer these questions, the study tests the following hypotheses:

- H1. The planned coal expansion generates annual CO_2 emissions that are sufficiently large to materially affect Kazakhstan's emissions trajectory and complicate the achievement of its 2035 climate target.
- H2. At the current level of carbon pricing, Kazakhstan's emissions trading system provides insufficient economic incentives to influence investment decisions in coal-fired power generation.
- H3. Kazakhstan exhibits a high level of climate-energy policy inconsistency, with weak carbon pricing representing the dominant source of this inconsistency.

The study combines structured policy analysis, scenario-based estimation of CO_2 emissions and carbon costs, and the development of a composite Climate-Energy Policy Inconsistency Index (CEPII), followed by an exploratory cross-country comparison.

This study makes three contributions to the literature. First, it provides a quantitative assessment of the emission and economic implications of Kazakhstan's 2026 coal expansion programme. Second, it introduces the Climate-Energy Policy Inconsistency Index (CEPII), a composite indicator designed to quantify the consistency between climate commitments and actual energy policy. Third, it demonstrates the applicability of the proposed framework through an empirical assessment of Kazakhstan and an exploratory comparison with other coal-dependent economies, providing a reproducible analytical approach for evaluating policy coherence during the energy transition.

2 LITERATURE REVIEW AND RESEARCH GAP

The theoretical foundation of this study integrates four complementary research streams explaining why coal-fired power generation continues to expand despite increasingly ambitious climate commitments.

The first research stream is based on the concept of carbon lock-in, which argues that long-lived carbon-intensive infrastructure creates technological, institutional, and economic path dependencies that constrain future decarbonization (Unruh, 2000). Subsequent work within the multi-level perspective on socio-technical transitions demonstrates that energy transitions are shaped not only by technological change but also by institutional inertia and policy stability (Geels, 2002; Sovacool, 2016). From this perspective, investments in new coal-fired generation should be evaluated not only by their current economic performance but also by their long-term implications for national emissions trajectories.

The second research stream concerns the concept of just energy transition. Previous studies show that the phase-out of coal generation creates substantial economic and social challenges, particularly in resource-dependent economies where coal industries remain major employers and taxpayers (Newell and

Mulvaney, 2013; Hoffart et al., 2024). Evidence from Germany suggests that successful coal transitions require predefined phase-out schedules, dedicated compensation mechanisms, and long-term regional development policies (Oei et al., 2020). These findings indicate that policy consistency depends not only on climate ambition but also on the institutional mechanisms supporting the transition.

The third research stream derives from the green paradox hypothesis, which suggests that expectations of stricter future climate regulation may accelerate fossil fuel extraction and investment while carbon costs remain low (Sinn, 2008). More recent studies further argue that supply-side policies frequently exert stronger influence on fossil fuel expansion than carbon pricing alone (Jakob et al., 2020). This perspective is particularly relevant for countries where governments continue providing institutional support for new coal investments despite adopting long-term decarbonization targets.

The fourth research stream focuses on carbon pricing and emissions trading systems. A broad body of empirical literature demonstrates that the effectiveness of carbon pricing depends primarily on carbon price levels, market coverage, and allowance allocation mechanisms. When carbon prices remain low, emissions trading systems generate only weak incentives for technological change and investment in low-carbon technologies. Evidence from Kazakhstan supports this conclusion, showing limited behavioural responses of coal-fired power producers to the national emissions trading system (Akhmetov and Howie, 2024). At the same time, energy system modelling studies indicate that deep decarbonization pathways for Kazakhstan are technically feasible, although they remain constrained by financial and institutional barriers (Zhakiyev et al., 2023; De Miglio and Bakdolotov, 2024; Zhakiyev et al., 2025).

Although these research streams provide substantial insights into coal transition and climate policy, an important methodological gap remains. Existing studies generally evaluate either climate ambition or energy policy separately, whereas quantitative methods capable of measuring their consistency remain limited. Likewise, empirical evidence from post-Soviet coal-dependent economies remains considerably less developed than that available for China, India, the European Union, or South Africa. Consequently, there is still no generally accepted quantitative framework capable of evaluating whether government investment decisions are consistent with declared climate objectives.

This study addresses these gaps by proposing the Climate-Energy Policy Inconsistency Index (CEPII), a composite indicator designed to quantify the consistency between climate commitments and actual energy policy. Using Kazakhstan's 2026 National Coal Power Development Programme as an empirical case, the study demonstrates how the proposed framework can translate climate-energy policy consistency from a qualitative concept into a measurable analytical construct suitable for comparative assessment across coal-dependent economies.

3 MATERIALS AND METHODS

3.1 Analytical Framework

This study adopts an embedded single-case study design (Yin, 2018), using Kazakhstan's 2026 National Coal Power Development Programme as the empirical case. Kazakhstan represents a particularly suitable case because legally binding carbon neutrality commitments coexist with a large-scale coal expansion programme adopted within the same policy cycle. This policy configuration enables a direct assessment of the consistency between declared climate objectives and actual energy policy decisions.

The analytical framework consists of three consecutive stages. First, national climate and energy policy documents are systematically analysed to identify climate commitments, coal expansion measures, and carbon pricing instruments. Documents were included in the analysis if they satisfied three selection criteria: (i) legal force, meaning formally adopted laws, government resolutions, or officially approved strategies rather than draft proposals; (ii) direct relevance to at least one of the three analytical categories defined below; and (iii) public availability in full text at the time of data collection (July 2026). Each qualifying document was then reviewed against three predefined analytical categories, climate commitments (targets, legal status, and timelines), coal expansion measures (planned capacity, investment volumes, and implementation schedules), and carbon pricing instruments (coverage, allowance allocation, and price levels), and coded for the presence, scope, and legal status of relevant provisions using a standardized extraction template applied consistently across all documents. Second, scenario modelling is applied to estimate future CO_2 emissions and associated carbon costs under alternative operating assumptions. Third, the proposed Climate-Energy Policy Inconsistency Index (CEPII) is calculated for

Kazakhstan and subsequently applied in an exploratory cross-country comparison.

3.2 Data

The empirical analysis combines primary policy documents, international energy statistics, and peer-reviewed scientific literature.

Primary data were obtained from Kazakhstan's 2026 National Coal Power Development Programme, the updated Nationally Determined Contribution (NDC), the Carbon Neutrality Strategy to 2060, and relevant provisions of the Environmental Code regulating the national emissions trading system. These documents provide information on planned generating capacity, investment schedules, climate targets, and carbon pricing mechanisms.

International datasets were used to characterize coal-fired power development and carbon pricing across countries. Coal capacity data were obtained from Global Energy Monitor (GEM), electricity statistics from the International Energy Agency (IEA), and carbon pricing information from the International Carbon Action Partnership (ICAP), OECD, and the European Commission.

Scenario assumptions were based on IPCC emission factors and Global Energy Monitor methodologies. Capacity utilisation factors ranged from 0.55 to 0.75, while specific emission factors ranged from 0.76 to 0.95 tCO_2/MWh, reflecting uncertainty associated with future operating conditions and coal quality.

3.3 Scenario Analysis

Annual CO_2 emissions from planned coal-fired power plants were estimated using a scenario-based approach:

$$E = C \times 8760 \times KIUM \times EF, \qquad (1)$$

where C is installed generating capacity, KIUM is the capacity utilisation factor, and EF denotes the specific CO_2 emission factor.

Three utilisation scenarios (0.55, 0.65, and 0.75) and three emission intensity scenarios (0.76, 0.85, and 0.95 tCO_2/MWh) were considered. The selected emission factors are consistent with IPCC default ranges and Global Energy Monitor methodologies while accounting for the relatively high ash content of Ekibastuz coal.

Annual carbon costs were estimated as:

$$CC = E \times P, \qquad (2)$$

where P represents four alternative carbon price scenarios corresponding to Kazakhstan's ETS, China's ETS, an intermediate carbon price, and the lower range of the EU Emissions Trading System.

3.4 Climate-Energy Policy Inconsistency Index (CEPII)

To quantify the consistency between declared climate commitments and implemented energy policy, this study develops the Climate-Energy Policy Inconsistency Index (CEPII).

The index is defined as:

$$CEPII = A \times D, \qquad (3)$$

where A represents the level of climate ambition and D measures the degree of inconsistency between declared climate objectives and implemented policy measures.

The multiplicative specification was selected because policy inconsistency emerges only when ambitious climate commitments coexist with contradictory policy actions. If climate ambition is absent ($A = 0$), inconsistency cannot arise regardless of energy policy decisions. Conversely, complete policy alignment ($D = 0$) results in a zero inconsistency score.

The ambition component consists of two indicators:

- existence of a legally binding carbon neutrality target;
- relative ambition of the national emission reduction target.

The inconsistency component comprises three indicators:

- carbon price differential relative to the EU ETS;
- share of freely allocated emission allowances;
- scale of planned coal expansion relative to installed national generating capacity.

All indicators receive equal weights in the baseline specification. Robustness was assessed using alternative weighting schemes and aggregation methods. Across all specifications, Kazakhstan's CEPII varies between 0.43 and 0.53, indicating that the principal findings are robust to alternative model assumptions.

4 RESULTS

4.1 Global Trends in Coal Power Development and Carbon Pricing

Despite increasingly ambitious climate commitments, global coal power development remains highly uneven. Since the adoption of the Paris Agreement, the global installed capacity of coal-fired power plants has continued to increase, although coal-fired electricity generation and its share in the global electricity mix have gradually declined. Most new coal-fired capacity has been commissioned in China and India, whereas new investments in other regions have remained comparatively limited. At the same time, coal phase-out has proceeded more slowly than previously announced, reflecting the growing importance of energy security following the global energy crisis of the early 2020s.

Against this background, carbon pricing has become one of the principal factors differentiating national energy transition pathways. Although many countries pursue similar long-term decarbonization objectives, the economic incentives created by carbon pricing systems vary substantially. As shown in Figure 1, carbon prices range from approximately USD 75 tCO_2^{-1} under the EU Emissions Trading System to around USD 12.5 tCO_2^{-1} in China's national ETS, USD 6.3 tCO_2^{-1} in the Korean ETS, and approximately USD 1 tCO_2^{-1} in Kazakhstan's emissions trading system.

The comparison demonstrates that differences in carbon pricing are substantially greater than differences in long-term climate ambitions. Consequently, the strength of carbon pricing rather than the existence of climate targets largely determines the economic attractiveness of new coal investments. Within this international context, Kazakhstan represents a particularly relevant case because ambitious climate commitments coexist with one of the lowest effective carbon prices among coal-dependent economies.

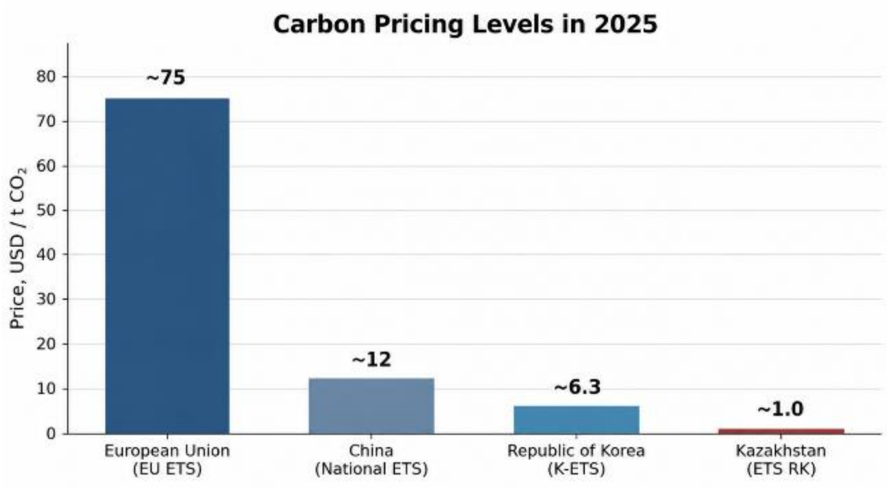

Figure 1: Carbon prices across selected emissions trading systems (USD tCO_2^{-1}, 2025).

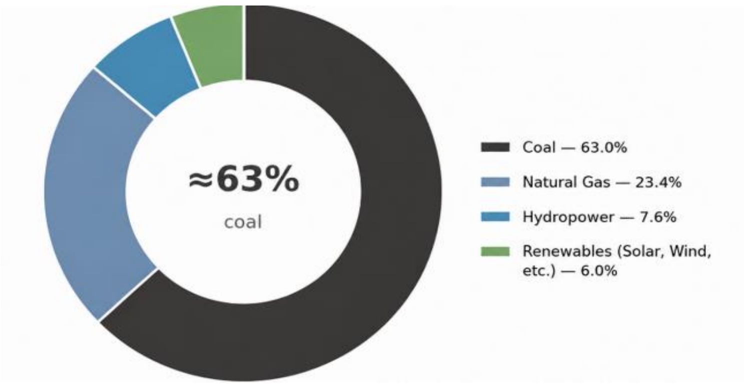

Figure 2: Structure of electricity generation in Kazakhstan.

4.2 Kazakhstan's Energy System and Policy Environment

Rising electricity demand associated with rapid economic expansion is one of the principal drivers of the planned coal capacity additions. Kazakhstan's nominal GDP grew from approximately USD 171 billion in 2020 to approximately USD 291 billion in 2024 [3], an increase driven substantially by rising commodity prices and currency valuation effects rather than by real output growth alone, which averaged approximately 4-5% annually over the same period. Kazakhstan's electricity system remains structurally dependent on coal-fired generation. As of early 2026, the national power system comprised 248 power plants with a total installed capacity of 26.8 GW, of which more than 20.5 GW operated on fossil fuels. Coal continues to account for approximately 60-66% of total electricity generation, making it the dominant source of baseload power (Figure 2).

The high share of coal generation reflects both resource endowment and the historical development of Kazakhstan's electricity sector. More than 90% of domestic coal reserves are concentrated in the northern and central regions of the country, where the largest thermal power plants are located. In addition, the existing generation fleet is characterised by considerable ageing. A substantial gap exists between installed and available generating capacity, while more than 2 GW of capacity remains unavailable because of equipment deterioration and operational constraints.

The current regulatory environment provides only weak economic incentives for decarbonization. Kazakhstan's emissions trading system, introduced in 2013, covers approximately half of national greenhouse gas emissions. However, emission allowances continue to be allocated almost entirely free of charge, secondary market activity remains limited, and regulated electricity tariffs restrict the pass-through of carbon costs into electricity prices. Previous empirical evidence confirms that the current ETS has had little measurable influence on investment behaviour in coal-fired power generation (Akhmetov and Howie, 2024).

Consequently, Kazakhstan combines relatively ambitious long-term climate commitments with a regulatory framework that imposes only limited economic constraints on continued coal investment. This institutional setting provides the basis for evaluating the consistency between climate objectives and subsequent policy decisions regarding coal expansion.

4.3 Characteristics of The Planned Coal Expansion

The 2026 National Coal Power Development Programme represents the largest planned expansion of coal-fired generation in Kazakhstan since the country's independence. The programme includes the construction of eight new coal-fired power plants with a combined installed capacity of approximately 5.3 GW together with the modernization of eleven existing generating units, adding approximately 2.5 GW of upgraded capacity.

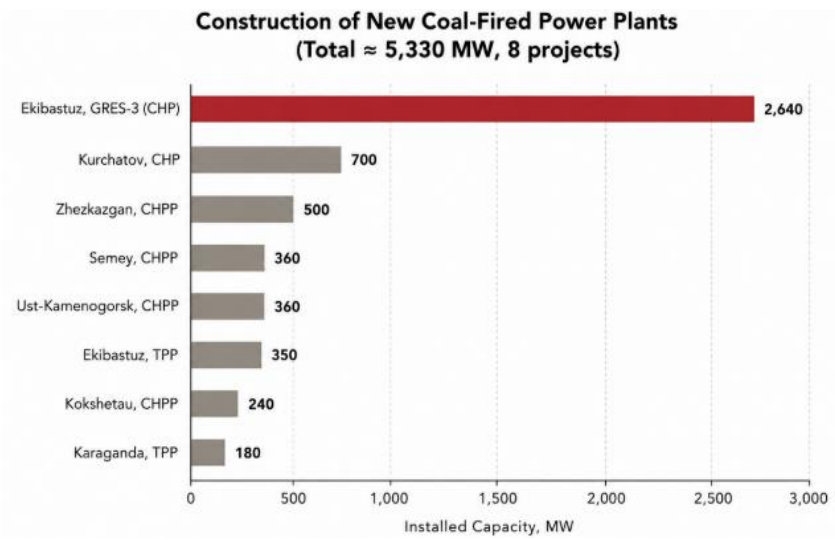

Figure 3: Planned coal-fired power projects included in the National Coal Power Development Programme.

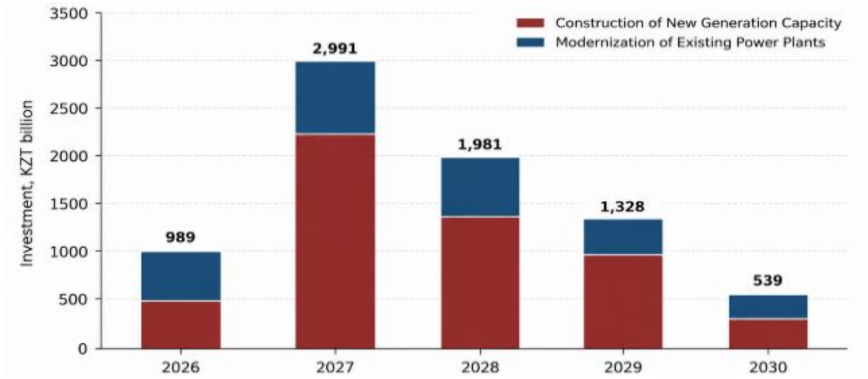

Figure 4: Annual investment profile of the National Coal Power Development Programme.

As illustrated in Figure 3, the programme is highly concentrated. Nearly half of all planned new capacity is associated with a single project—Ekibastuz GRES-3 (2.64 GW)—indicating that the successful implementation of the programme largely depends on a limited number of strategically important projects.

The principal characteristics of the programme are summarized in Table 1.

Table 1: Main characteristics of Kazakhstan's National Coal Power Development Programme.

Category / Indicator	Value
Implementation period	2026-2030
New power generation facilities	8 projects, approximately 5,330 MW
Modernization of existing power plants	11 facilities, approximately 2,485 MW
Total investment	KZT 7,839.5 billion (off-budget/private financing)
— Construction of new facilities	KZT 5,381.2 billion
— Modernization of existing facilities	KZT 2,447.1 billion
— Workforce sustainability measures	KZT 11.1 billion
Reduction in equipment wear	from 65.1% (2026) to 52.5% (2030)
Reduction in pollutant emissions concentration	from 6,980 to 4,563 mg/Nm³
Jobs created	34,909 permanent and temporary jobs
Additional demand for thermal coal	approximately 20 million tonnes per year (for new power plants)
Source: compiled by the authors based on the Decree of the Government of the Republic of Kazakhstan No. 184 of March 20, 2026.	

The programme combines capacity expansion with modernization of existing coal-fired generation. Alongside the construction of new plants, it aims to reduce equipment depreciation and improve local air pollutant control through the deployment of supercritical technologies. Nevertheless, these technological improvements do not fundamentally alter the carbon intensity of the electricity system. According to the programme documentation, the planned expansion will require approximately 20 million tonnes of additional coal annually, thereby increasing long-term carbon exposure despite improvements in conventional pollutant emissions.

The investment schedule is presented in Figure 4.

The investment profile is strongly front-loaded, with capital expenditure peaking in 2027. This financing structure reflects the government's objective of rapidly addressing the projected electricity supply deficit while simultaneously increasing implementation risks through the concentration of substantial capital requirements within a relatively short period.

Together, these characteristics indicate that the programme is designed primarily to strengthen electricity supply security rather than to support long-term decarbonization objectives. The coexistence of rapid coal expansion and ambitious climate commitments therefore provides the empirical basis for the quantitative assessment presented in the following sections.

4.4 Scenario Assessment of CO_2 Emissions

The scenario analysis indicates that the planned coal expansion would generate substantial additional greenhouse gas emissions under all considered operating conditions. Estimated annual CO_2 emissions range from 19.5 Mt under the most conservative operating assumptions to 33.3 Mt under the highest utilisation scenario, with a central estimate of 25.8 Mt CO_2 per year.

Table 2: Estimated annual CO_2 emissions under alternative operating scenarios.

Capacity Utilisation Factor (CUF)	Low-emission scenario	Baseline scenario	High-emission scenario
0.55 (25.7 TWh)	19.5	21.8	24.4
0.65 (30.4 TWh)	23.1	25.8*	28.8
0.75 (35.0 TWh)	26.6	29.8	33.3
Source: Baseline scenario: CUF = 0.65; emission factor = 0.85 t CO_2/MWh. Based on authors' calculations.			

Across all scenarios, annual emissions remain sufficiently large to materially affect Kazakhstan's national emissions trajectory. Under the baseline scenario (capacity utilisation factor = 0.65; emission factor = 0.85 tCO_2/MWh), the planned expansion produces approximately 25.8 Mt CO_2 annually, corresponding to 30.4 TWh of electricity generation. Even under the lowest emission scenario, additional annual emissions exceed 19 Mt CO_2, indicating that technological improvements alone do not fundamentally alter the carbon implications of the programme.

The distribution of scenario outcomes is illustrated in Figure 5.

Comparison with Kazakhstan's current greenhouse gas emissions (approximately 340 Mt CO_2-eq) shows that the baseline scenario represents 7-8% of total national emissions. This magnitude is particularly significant because Kazakhstan's updated Nationally Determined Contribution requires emissions reductions of approximately 30 Mt CO_2 relative to current levels by 2035. Consequently, the projected emissions from the planned coal expansion are broadly comparable to the total reductions required to achieve the national climate target.

The net impact on future emissions will ultimately depend on the retirement schedule of existing coal-fired generating units. However, neither the National Coal Power Development Programme nor associated policy documents specify a legally binding timetable for plant retirement. The absence of a formal coal phase-out schedule therefore introduces substantial uncertainty regarding the country's long-term emissions trajectory and limits the credibility of a managed transition strategy.

Overall, the scenario analysis supports Hypothesis 1. The planned coal expansion creates an additional emissions burden of a magnitude comparable to the reductions required under Kazakhstan's climate commitments, making the achievement of these targets unlikely without additional mitigation measures or accelerated retirement of existing coal-fired capacity.

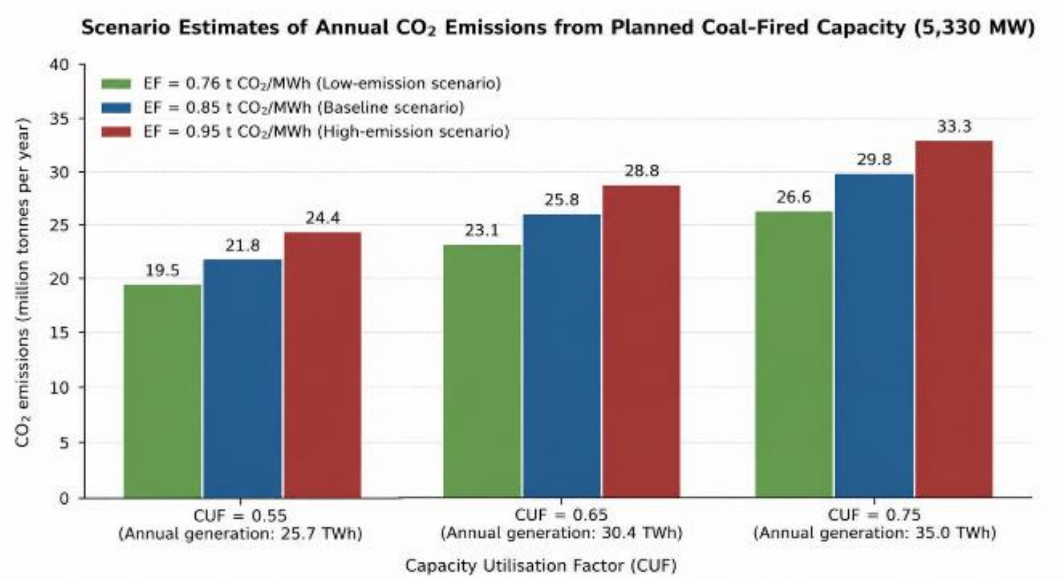

Figure 5: Scenario estimates of annual CO_2 emissions from planned coal-fired power plants.

4.5 Carbon Pricing and Investment Incentives

The estimated annual carbon costs under alternative carbon pricing scenarios are presented in Table 3.

Table 3: Estimated annual carbon costs under alternative carbon pricing scenarios.

Carbon price (USD tCO_2^{-1})	Reference system	Low-emission	Baseline	High-emission
1	Kazakhstan ETS	20	26	33
12.5	China ETS	244	322	416
40	Intermediate scenario	781	1,032	1,331
75	EU ETS (lower range)	1,464	1,935	2,495
Source: Authors' calculations.				

At Kazakhstan's current carbon price (approximately USD 1 tCO_2^{-1}), annual carbon costs under the baseline scenario amount to only USD 26 million. Increasing the carbon price to the current level of China's national ETS raises annual costs to USD 322 million, while prices comparable to the lower range of the EU ETS increase annual costs to approximately USD 1.94 billion. Thus, changing only the carbon price increases the economic value of emissions by almost two orders of magnitude.

To evaluate the significance of these values, annual carbon costs were compared with total programme investment. The planned investment of approximately KZT 7.84 trillion corresponds to about USD 16.7 billion at the official exchange rate of the National Bank of Kazakhstan (July 2026). Under the current domestic carbon price, annual carbon costs represent only 0.16% of total programme investment. Under EU ETS price levels, however, this proportion increases to approximately 11.6% annually.

These findings indicate that Kazakhstan's current emissions trading system provides only weak economic incentives for decarbonization. Carbon costs remain too low to materially influence investment decisions regarding new coal-fired power generation. By contrast, carbon prices comparable to those observed in mature emissions trading systems would transform carbon costs into a significant investment parameter and substantially alter project economics.

The difference between the current domestic carbon price and the EU ETS benchmark corresponds to approximately USD 1.9 billion annually under the baseline scenario. This difference represents the magnitude of the carbon price signal that is currently absent from Kazakhstan's electricity sector.

Overall, these findings support Hypothesis 2. Under the existing carbon pricing regime, carbon emissions impose only marginal additional costs on coal-fired electricity generation and therefore provide limited incentives for investment in lower-carbon alternatives.

4.6 Climate-Energy Policy Inconsistency Index (CEPII)

4.6.1 National Assessment

The Climate-Energy Policy Inconsistency Index (CEPII) was first calculated for Kazakhstan using the methodology described in Section 3.4. The resulting component scores are presented in Table 4.

Table 4: Calculation of the Climate-Energy Policy Inconsistency Index (CEPII) for Kazakhstan.

Compo-nent	Definition	Input	Score
A_1	Legally binding carbon neutrality target	Carbon neutrality law (2060 target)	1.00
A_2	Relative NDC ambition (benchmark = 55%)	−17% by 2035	0.31
A	Climate ambition sub-index (mean)	—	0.65
D_1	Carbon price differential (1 − P_{dom}/ P_{EU ETS})	1 / 75 USD tCO_2^{-1}	0.99
D_2	Share of freely allocated allowances	100%	1.00
D_3	Coal expansion intensity	7.8 GW / 26.8 GW	0.29
D	Policy inconsistency sub-index (mean)	—	0.76
CEPII	A × D	—	0.49
Source: Authors' calculations based on official policy documents.			

The ambition component reaches 0.65, reflecting the coexistence of a legally binding carbon neutrality target and a moderately ambitious Nationally Determined Contribution. The inconsistency component is considerably higher (0.76), indicating substantial divergence between declared climate objectives and implemented energy policy.

The resulting CEPII score of 0.49 suggests a comparatively high level of climate-energy policy inconsistency. Decomposition of the index shows that the dominant contribution originates from the carbon pricing component (D_1 = 0.99), reflecting the exceptionally large gap between Kazakhstan's domestic carbon price and the EU ETS benchmark. By comparison, the contribution of planned coal expansion (D_3 = 0.29) is considerably smaller, indicating that policy inconsistency is driven primarily by weak economic incentives rather than by the scale of expansion alone.

4.6.2 Cross-Country Comparison

To place Kazakhstan's results into an international perspective, the CEPII was calculated for six additional coal-dependent economies using the same methodological framework. The comparative results are presented in Table 5.

Table 5: Cross-country comparison of the Climate-Energy Policy Inconsistency Index (CEPII).

Country	Climate ambition (A)	Policy inconsistency (D)	CEPII
Kazakhstan	0.65	0.76	0.49
India	0.50	0.74	0.37
South Africa	0.75	0.48	0.36
Australia	0.89	0.40	0.36
Indonesia	0.50	0.71	0.35
China	0.50	0.66	0.33
Poland (EU ETS)	1.00	0.00	0.00
Source: Authors' calculations based on ICAP, OECD, Global Energy Monitor, and UNFCCC data.			

Note: The cross-country comparison should be interpreted as exploratory because several institutional variables were harmonized using explicit coding conventions.

Because several institutional variables were harmonised using explicit coding conventions, the comparative assessment should be interpreted as an exploratory application of the proposed index rather than a definitive international ranking.

The results indicate that Kazakhstan exhibits the highest CEPII score among the selected countries. While China and Indonesia continue expanding coal-fired generation, lower inconsistency scores reflect either less ambitious climate commitments or relatively stronger carbon pricing mechanisms. Conversely, Poland records the lowest CEPII value because participation in the EU Emissions Trading System substantially reduces the carbon pricing gap despite continued reliance on coal-fired electricity generation.

These findings demonstrate that policy inconsistency is determined not only by the scale of coal expansion but also by the interaction between climate ambition and the economic incentives created by carbon pricing. In Kazakhstan, the combination of relatively ambitious climate commitments and one of the lowest carbon prices among the analysed countries results in the highest observed inconsistency.

Overall, the empirical assessment supports Hypothesis 3 and demonstrates that the proposed CEPII provides a practical instrument for quantitatively evaluating the consistency between climate commitments and energy policy across coal-dependent economies.

4.7 External Carbon Pricing Implications

The results presented above indicate that Kazakhstan's current carbon pricing system generates only weak domestic incentives for emissions reduction. Under these conditions, an increasing share of carbon costs is likely to be transferred from the domestic economy to external markets through the European Union's Carbon Border Adjustment Mechanism (CBAM).

CBAM applies to six carbon-intensive sectors, iron and steel, aluminium, cement, fertilisers, hydrogen, and electricity, with coverage that differs by sector: for iron and steel, aluminium, and hydrogen, only direct emissions embedded in the product are priced, whereas for cement and fertilisers both direct and indirect emissions (including those from carbon-intensive electricity used in production) are included. Because Kazakhstan's exports to the EU are dominated by aluminium, iron, and steel, most of the country's current CBAM exposure therefore stems from direct product-embedded emissions rather than from the carbon intensity of domestic electricity generation; this exposure would expand further if indirect-emissions coverage were extended to additional sectors in future revisions of the mechanism. The EU accounted for approximately 44% of Kazakhstan's exports by value in 2025, and more than half of the country's aluminium exports are destined for EU markets, underscoring the trade significance of CBAM compliance [14]. Available estimates prepared by the International Trade Centre (ITC) and QazTrade indicate that exports of steel and aluminium products from Kazakhstan to the European Union could face annual CBAM payments of approximately EUR 114 million under default emission values. Iron and steel exports face particularly high exposure, with estimated payments reaching approximately EUR 108 million under default values, equivalent to a substantial share of the value of some steel export contracts; fertiliser exports, subject to both direct and indirect emissions coverage, are also identified as a sector of significant exposure. The introduction of verified emissions reporting reduces this amount to approximately EUR 57 million, demonstrating that improvements in monitoring and verification alone can substantially reduce compliance costs.

The comparison highlights a broader policy implication. While Kazakhstan currently captures only a negligible share of the carbon price signal through its domestic emissions trading system, CBAM increasingly transfers this signal to export markets. Consequently, strengthening domestic carbon pricing would not only increase incentives for decarbonization but also retain a larger proportion of carbon-related revenues within the national economy instead of shifting them abroad.

Taken together, the results suggest that external carbon pricing mechanisms reinforce rather than replace domestic climate policy. For coal-dependent economies with export-oriented industries, the effectiveness of national carbon pricing therefore becomes increasingly important not only for emissions reduction but also for maintaining long-term international competitiveness.

5 DISCUSSION

5.1 Interpreting Climate-Energy Policy Inconsistency

The empirical results demonstrate that climate-energy policy inconsistency cannot be explained solely by continued investment in coal-fired power generation. Rather, it arises from the interaction between long-term climate ambitions and the economic mechanisms designed to support their implementation. Kazakhstan illustrates this contradiction particularly clearly. Although the country has legally committed to achieving carbon neutrality by 2060 and adopted updated Nationally Determined Contributions, the planned expansion of coal-fired generation is accompanied by one of the lowest carbon prices among comparable coal-dependent economies.

The scenario analysis further shows that the planned coal expansion is likely to generate substantial additional emissions throughout the operational lifetime of the new power plants, thereby increasing the risk of long-term carbon lock-in. These findings are consistent with previous studies emphasizing that carbon lock-in is driven not only by physical infrastructure but also by institutional and regulatory arrangements that reinforce fossil fuel dependence. However, the present study extends this literature by demonstrating that the consistency between climate commitments and energy policy can be evaluated quantitatively rather than described only qualitatively.

The analysis also highlights that the effectiveness of carbon pricing depends not merely on the existence of an emissions trading system but on the strength of its price signal. In Kazakhstan, the domestic carbon price remains too low to materially influence investment decisions in the electricity sector, limiting the ability of market-based instruments to support the country's long-term decarbonization objectives.

5.2 Scientific Contribution of the CEPII Framework

The principal contribution of this study is the development of the Climate-Energy Policy Inconsistency Index, which provides a transparent and reproducible framework for assessing the consistency between climate commitments and energy policy. Unlike existing studies that discuss policy coherence primarily through qualitative analysis or descriptive case studies, the proposed framework translates institutional characteristics into a quantitative indicator that enables systematic comparison across countries.

The proposed framework integrates two complementary dimensions of policy coherence: the ambition of national climate commitments and the degree of inconsistency between these commitments and actual energy policy implementation. By combining these dimensions within a single analytical structure, CEPII captures both policy intentions and implementation gaps, providing a more comprehensive assessment than indicators focusing exclusively on emissions, renewable energy deployment, or carbon pricing.

An important advantage of the framework is its reliance on publicly available policy and institutional data. Consequently, the methodology can be replicated for different countries, updated over time as policy conditions evolve, and incorporated into comparative assessments of climate governance. Beyond academic applications, the framework may also support governmental agencies and international organizations in monitoring the coherence of national energy transition strategies.

5.3 Policy Implications

The findings have several important policy implications for coal-dependent economies pursuing carbon neutrality while maintaining significant fossil fuel capacity.

First, strengthening domestic carbon pricing appears considerably more effective than relying exclusively on long-term climate commitments. Without economically meaningful carbon prices, ambitious decarbonization targets are unlikely to alter investment behaviour or accelerate technological transformation in the electricity sector.

Second, the results suggest that external carbon pricing mechanisms, particularly the European Union's Carbon Border Adjustment Mechanism (CBAM), increasingly transfer carbon costs from domestic regulatory systems to export markets. Under such conditions, strengthening national emissions trading systems would not only reinforce domestic decarbonization incentives but also retain a greater share of carbon-related revenues within the national economy.

Third, the analysis indicates that policy coherence should become an explicit objective of energy transition governance. Future national energy strategies should therefore evaluate major investment decisions not only from the perspective of energy security and electricity demand but also in terms of their consistency with legally adopted climate commitments and long-term decarbonization pathways.

5.4 Limitations and Future Research

Several limitations should be acknowledged when interpreting the findings of this study.

First, the proposed framework was tested using a limited sample of coal-dependent economies. Although these countries represent diverse institutional contexts, broader international validation would improve the robustness of comparative assessments.

Second, several institutional variables required harmonized coding assumptions to ensure cross-country comparability. While these assumptions were applied consistently across all cases, alternative coding approaches may produce slightly different index values.

Third, the scenario analysis assumes constant emission factors and stable capacity utilization rates throughout the operational lifetime of the planned coal-fired power plants. Future technological improvements, fuel quality changes, or operational adjustments may influence actual emissions.

Finally, the current version of CEPII focuses primarily on coal-fired electricity generation and carbon pricing. Future research could expand the framework by incorporating additional dimensions of energy transition, including renewable energy deployment, fossil fuel subsidies, methane emissions, investment in energy storage, and dynamic carbon pricing trajectories.

Overall, despite these limitations, the proposed framework provides a transparent analytical tool for evaluating climate-energy policy consistency and offers a foundation for future comparative research on energy transition governance.

6 CONCLUSIONS

This study developed a quantitative framework for assessing the consistency between climate commitments and energy policy using Kazakhstan as a case study. By integrating scenario-based emissions assessment, carbon cost analysis, and the proposed Climate-Energy Policy Inconsistency Index (CEPII), the research provides a systematic approach to evaluating the alignment between long-term decarbonization objectives and actual energy policy decisions.

The empirical findings support all three research hypotheses. First, the planned expansion of coal-fired generation is projected to generate substantial additional CO_2 emissions, increasing the risk of long-term carbon lock-in and complicating the achievement of Kazakhstan's climate targets. Second, the current level of carbon pricing provides only weak economic incentives for low-carbon investment and is therefore unlikely to influence investment decisions in the electricity sector. Third, the calculated CEPII indicates that Kazakhstan exhibits the highest level of climate-energy policy inconsistency among the countries included in the comparative assessment.

The principal contribution of this study lies in the development of a transparent and reproducible analytical framework for measuring climate-energy policy consistency. Unlike qualitative assessments of policy coherence, the proposed framework enables quantitative comparison across jurisdictions using publicly available policy and institutional data. As such, CEPII may serve as a useful instrument for comparative research, policy monitoring, and the evaluation of energy transition strategies in coal-dependent economies.

Several directions for future research remain. These include extending the empirical application of CEPII to a larger set of countries, testing alternative weighting schemes and institutional indicators, and validating the framework using econometric methods and longitudinal policy data. Such developments would further strengthen the robustness and applicability of the proposed framework across diverse institutional and regulatory contexts.

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