INSTITUTIONAL AND PRICING FRAMEWORKS FOR CARBON MARKET DEVELOPMENT IN EMERGING ECONOMIES: EVIDENCE FROM UZBEKISTAN

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Annotation. This study examines the institutional prerequisites and pricing frameworks necessary for establishing carbon markets in emerging economies, using Uzbekistan as a case study. The research employs comparative institutional analysis across five operational emissions trading systems (EU ETS, China ETS, K-ETS, Kazakhstan ETS, and the RGGI), cost-benefit analysis, marginal abatement cost curve modeling, and scenario analysis. The findings reveal that Uzbekistan, which emits approximately 209 million tonnes of CO_2 annually with 64% from the energy sector and emission intensity more than twice its Central Asian peers, possesses both the imperative and the emerging institutional capacity for carbon market development. The country's pioneering iCRAFT project – the world's first policy crediting program – has demonstrated the feasibility of carbon market mechanisms by generating USD 15 million for 1 million tonnes of verified emission reductions. Three development scenarios are modeled: a low-ambition scenario (energy sector only, USD 5–10/tCO_2) yielding 8–12 million tonnes CO_2/year reduction; a medium-ambition scenario (energy plus industry, USD 10–20/tCO_2) yielding 15–22 million tonnes; and a high-ambition scenario (economy-wide, USD 20–40/tCO_2) yielding 25–35 million tonnes. Cost-benefit analysis indicates a benefit-cost ratio of 3.5–5.0 over the 2028–2040 period. The study proposes a three-phase institutional roadmap and contributes to the literature on carbon market design for emerging economies with energy-intensive industrial structures.

Keywords: carbon market, emissions trading system, carbon pricing, institutional framework, emerging economies, climate policy, Paris Agreement, Article 6, Uzbekistan.

1. INTRODUCTION

Carbon pricing has emerged as the cornerstone instrument in the global policy architecture for greenhouse gas (GHG) emission reduction. By assigning a monetary cost to carbon emissions, carbon pricing mechanisms internalize the environmental externalities of fossil fuel combustion and industrial processes, thereby altering the relative economics of high-carbon versus low-carbon activities. As of 2024, 36 emissions trading systems (ETS) and 37 carbon taxes are operational worldwide, collectively covering approximately 23% of global GHG emissions and generating over USD 74 billion in annual revenue [1]. The International Carbon Action Partnership (ICAP) reports that an additional 22

jurisdictions are developing or considering ETS implementation [1], signaling sustained momentum in carbon market proliferation.

The theoretical foundations for carbon pricing rest on well-established principles of environmental economics. The Pigouvian tax approach, formalized by Arthur Pigou [2] and refined by William Nordhaus [3] through integrated assessment modeling, advocates for a carbon tax set equal to the social cost of carbon (SCC). The cap-and-trade approach, grounded in Ronald Coase's [4] theorem on property rights and transaction costs, and operationalized by Dales [5] and Montgomery [6], establishes tradable emission allowances that theoretically achieve emission reductions at minimum cost. Joseph Stiglitz and Nicholas Stern [7] have argued that efficient carbon pricing, at levels of USD 50–100/tCO_2 by 2030, is essential for meeting the Paris Agreement's temperature targets. The empirical evidence on carbon pricing effectiveness has expanded considerably: Green [8] conducted a meta-analysis of carbon pricing programs and found that they reduce emissions by 5–21% depending on price levels and design parameters.

For emerging economies, the carbon market development challenge is distinctive and multifaceted. Unlike developed countries that pioneered carbon pricing with established institutional infrastructure, reliable emissions data systems, and mature financial markets, emerging economies must often build these foundations simultaneously with market design. Doda and colleagues [9] have documented the specific institutional challenges that developing countries face in ETS implementation, including monitoring capacity constraints, data quality concerns, and political economy obstacles. Goulder and Schein [10] have demonstrated through computable general equilibrium (CGE) modeling that carbon pricing design parameters – including allocation methods, revenue recycling, and price controls – significantly influence both economic efficiency and distributional outcomes, with these sensitivities amplified in emerging economy contexts.

The experience of existing carbon markets offers critical lessons for emerging economies. The EU ETS, the world's oldest and largest carbon market, generated EUR 38.8 billion in auction revenue in 2023 at an average price of approximately EUR 65/tCO_2 [1, 11]. However, its early phases were plagued by overallocation and price collapse, demonstrating the importance of supply management mechanisms. China's national ETS, launched in 2021 as the world's largest by coverage volume (approximately 5 billion tonnes CO_2), initially adopted intensity-based benchmarks and 100% free allocation for the power sector, producing modest prices of CNY 70–80/tCO_2 (approximately USD 10) [12]. South Korea's K-ETS (2015) covers 74% of national emissions with 97% initial free allocation [1]. Kazakhstan's pilot ETS (2013–2016) – the first in Central Asia – was suspended due to institutional capacity constraints and data quality concerns, providing cautionary lessons for the region [1, 9].

Uzbekistan presents a particularly instructive case for studying carbon market institutional development. The country emits approximately 209 million tonnes of CO_2 annually, with the energy sector accounting for 64% of total emissions [13]. Emission intensity is more than twice the Central Asian average

and more than six times the global average [13]. The country's Nationally Determined Contribution (NDC) under the Paris Agreement commits to a 50% reduction in GHG emissions per unit of GDP by 2035 [14]. In a landmark development, Uzbekistan became the first country in the world to receive payment from the World Bank for reducing carbon emissions through a policy crediting program – the Innovative Carbon Resource Application for Energy Transition (iCRAFT) project – receiving USD 15 million for 1 million tonnes of verified CO_2 reductions [15]. In July 2025, Decree of the President of the Republic of Uzbekistan No. PD-110 "On measures for participation in the international carbon units market" was adopted to establish a regulatory framework for international carbon market operations based on Paris Agreement[16]. These developments signal both political commitment and emerging institutional capacity.

Despite the growing body of literature on carbon market design and implementation, several research gaps persist in the emerging economy context. First, most comparative studies focus on established markets (EU, California, China) with limited systematic analysis of institutional prerequisites for countries at earlier stages of carbon market development. Second, the interaction between energy subsidy reform – a defining feature of many emerging economies – and carbon market effectiveness remains underexplored. Third, the specific institutional and pricing framework requirements for energy-intensive emerging economies with significant industrial sectors have received insufficient attention. Fourth, the role of international carbon market mechanisms under Article 6 of the Paris Agreement as potential catalysts for domestic market development in emerging economies is not well understood empirically.

Research objective. This study aims to analyze the institutional prerequisites and pricing frameworks necessary for carbon market development in emerging economies, assess the economic efficiency of different carbon market design options, and propose a phased implementation roadmap. Uzbekistan serves as the primary case study, with comparative analysis drawing on the EU, China, South Korea, Kazakhstan, and the US Regional Greenhouse Gas Initiative (RGGI).

The research objectives are: (1) to systematize the institutional prerequisites for carbon market establishment in emerging economies; (2) to assess Uzbekistan's current institutional readiness for carbon market development; (3) to evaluate different carbon pricing scenarios using cost-benefit analysis and marginal abatement cost modeling; (4) to conduct comparative analysis of international ETS design experiences relevant to emerging economy contexts; and (5) to develop a phased institutional roadmap for carbon market establishment.

This study contributes to the literature in several ways. First, it provides the first systematic institutional analysis of carbon market development prospects in Central Asia since Kazakhstan's ETS suspension, incorporating the significant policy developments of 2022–2024. Second, it introduces empirical evidence from the iCRAFT project as a novel case of Article 6-based carbon market catalyst. Third, it develops scenario-specific CBA and MAC analysis calibrated to an energy-intensive transitional economy. Fourth, it proposes a phased roadmap that

synthesizes lessons from five international ETS experiences into actionable guidance for emerging economy policymakers.

The paper proceeds as follows. Section 2 describes the multi-method research design. Section 3 presents results across six subsections: institutional readiness, international ETS comparison, scenario analysis, CBA, MAC analysis, and the proposed roadmap. Section 4 discusses findings in the context of the broader literature on carbon market design, identifies scientific novelty, and acknowledges limitations. Section 5 offers conclusions and targeted recommendations for policymakers, industrial enterprises, and international partners.

2. RESEARCH METHODOLOGY

The study employs a multi-method research design integrating qualitative institutional analysis with quantitative economic modeling.

2.1. Comparative Institutional Analysis

Five operational emissions trading systems are analyzed to extract design lessons for emerging economies: the EU ETS (Phase 4, 2021–2030), representing the most mature carbon market with comprehensive institutional infrastructure; the China national ETS (2021–present), demonstrating how a large developing country with energy-intensive industry can implement an ETS; South Korea's K-ETS (2015–present), illustrating a middle-income economy's approach to carbon market development; Kazakhstan's pilot ETS (2013–2016, suspended), providing cautionary lessons about premature market launch; and the RGGI (2009–present), demonstrating a sub-national, sector-specific approach. The comparison dimensions include: legal and regulatory framework requirements; institutional capacity (regulators, MRV systems, registries); emission data infrastructure; allocation methodology (benchmarking vs. grandfathering, free allocation vs. auctioning); price management mechanisms (price floors, ceilings, market stability reserves); scope and coverage decisions; and revenue generation and recycling approaches.

2.2. Cost-Benefit Analysis (CBA)

A CBA framework is applied to assess the economic efficiency of carbon market implementation. Benefits are estimated across four categories: direct emission reduction benefits valued at the social cost of carbon (SCC), using the US EPA's central estimate of USD 51/tCO_2 (2020 dollars) [17] as the baseline, with sensitivity analysis at USD 30 and USD 80/tCO_2; health co-benefits from reduced air pollution, estimated using dose-response functions and value of statistical life parameters adapted from WHO methodology; energy efficiency gains monetized through reduced fuel import expenditure; and carbon market revenue for government budgets. Costs include: implementation costs (MRV system, registry, regulatory capacity); compliance costs for regulated entities (abatement investments, allowance purchases); administrative costs; and potential competitiveness impacts for trade-exposed industries. A 5% discount rate is

applied, with sensitivity analysis at 3% and 10%. The analysis period covers 2028–2040, assuming a 2028 pilot ETS launch.

2.3. Marginal Abatement Cost (MAC) Curve Analysis

A bottom-up MAC curve is constructed for the industrial and energy sectors, identifying specific emission reduction technologies and their associated costs. The analysis covers: energy efficiency measures in power generation (gas turbine upgrades, combined cycle conversion), estimated at USD 5–15/tCO_2; renewable energy deployment (solar, wind) replacing gas-fired generation, at USD 10–25/tCO_2; industrial process efficiency improvements (cement, chemicals, metallurgy), at USD 15–35/tCO_2; fuel switching (coal to gas, gas to renewables), at USD 20–40/tCO_2; and carbon capture, utilization, and storage (CCUS), at USD 40–80/tCO_2. The MAC curve enables identification of the least-cost emission reduction pathway and the carbon price level required to unlock specific technology deployments.

2.4. Scenario Analysis

Three carbon market development scenarios are modeled: Scenario A (Low Ambition) – ETS covering only the power sector, intensity-based benchmarks, 100% free allocation, price floor of USD 3/tCO_2, price ceiling of USD 15/tCO_2; Scenario B (Medium Ambition) – ETS covering energy and major industrial sectors, combination of benchmarking and auctioning (80% free, 20% auction), price floor USD 5/tCO_2, price ceiling USD 25/tCO_2; and Scenario C (High Ambition) – economy-wide ETS with gradual expansion, increasing auction share (starting at 70% free, declining 5% annually), price floor USD 10/tCO_2, price ceiling USD 50/tCO_2, linked to international markets via Article 6. Each scenario is assessed on: emission reduction potential, budget revenue generation, GDP impact, competitiveness effects on trade-exposed sectors, and institutional capacity requirements.

2.5. Data Sources

Primary data sources include: ICAP Status Reports on global carbon pricing [1]; World Bank State and Trends of Carbon Pricing reports [18]; IEA energy and emissions data for Uzbekistan [19]; UNDP Climate Public Expenditure and Institutional Review [13]; World Bank iCRAFT project documentation [15]; national GHG inventories from the National Committee of Ecology and Climate Change; and energy balance data from the Ministry of Energy.

3. RESULTS

3.1. Institutional Readiness Assessment

The assessment of Uzbekistan’s institutional readiness for carbon market development reveals a mixed picture of emerging strengths and persistent gaps. The analysis identifies seven critical institutional prerequisites and evaluates each.

Legal and regulatory framework. The 2019–2030 Green Economy Strategy [14] and Presidential Decree PD-436 (2022) [20] provide high-level policy mandates for emission reduction and carbon market development. Temporary regulations on international GHG trade implementation have been approved [21]. In addition, an important milestone in the formation of the national climate policy framework was the adoption of the Law of the Republic of Uzbekistan "On Limiting Greenhouse Gas Emissions" (No. LRU-1073, July 7, 2025). The law establishes the legal basis for regulating greenhouse gas emissions, including the introduction of national accounting and monitoring mechanisms, the establishment of emission reduction targets, and the development of "green" projects generating carbon units. It also provides for the creation of a national registry of carbon units and the verification of emission reductions generated by climate mitigation projects. These provisions create an important legal foundation for the potential development of domestic carbon pricing instruments and participation in international carbon markets under Article 6 of the Paris Agreement.

However, comprehensive ETS legislation has not yet been enacted. International comparison reveals that all five benchmark ETS required dedicated primary legislation prior to market launch: the EU ETS Directive (2003/87/EC), China's Interim Regulations on Carbon Emissions Trading (2024), South Korea's Framework Act on Carbon Neutrality (2021), Kazakhstan's Environmental Code amendments (2011), and the RGGI Model Rule (2008) [1].

MRV system. The iCRAFT project is establishing monitoring, reporting, and verification infrastructure in line with Article 6 of the Paris Agreement [15]. This is a critical institutional building block, as robust MRV is universally identified as the single most important prerequisite for a functioning carbon market [9, 11]. The National Committee of Ecology and Climate Change publishes national GHG inventories, but facility-level emission reporting remains incomplete. China's experience is instructive: its national ETS was preceded by seven regional pilots (2013–2017) that served primarily to develop MRV capacity and accumulate facility-level emissions data [12]. For Uzbekistan, a mandatory facility-level emissions reporting requirement for large emitters should be considered a priority precursor to ETS launch.

Emissions data infrastructure. The energy sector's 64% contribution to total emissions [13] implies that a power sector-focused ETS could capture a majority of emissions with a manageable number of regulated entities. Based on available data, approximately 30–50 large power generation facilities account for the bulk of energy sector emissions. This concentrated emission profile is favorable for initial ETS implementation, as it reduces the administrative burden and data complexity compared to an economy-wide approach. For comparison, China's national ETS initially covered approximately 2,200 power generation facilities [12], while the EU ETS Phase 1 covered approximately 11,000 installations [11].

Market infrastructure. A carbon market requires trading infrastructure (exchange or over-the-counter platform), a registry system for tracking allowance

ownership and transfers, and clearing and settlement mechanisms. The Tashkent Stock Exchange provides a potential platform for allowance trading, and the experience with green bond issuance demonstrates emerging capital market capacity [22]. The iCRAFT project's carbon credit generation and verification process has established precedent for carbon asset creation and transaction [15].

Regulatory capacity. A designated competent authority with technical expertise in carbon market oversight is essential. Currently, the Ministry of Economy and Finance leads on carbon market development. The National Committee of Ecology and Cliimate Change manages GHG inventory and environmental regulation. Coordination between these institutions will be critical. China allocated its ETS oversight to the Ministry of Ecology and Environment, while South Korea created a dedicated Greenhouse Gas Inventory and Research Center [1]. For Uzbekistan, establishing a dedicated carbon market regulatory unit within Ministry of Economy and Finance as it is designated national authority for carbon trade, staffed with specialists in emission monitoring, allowance management, and market oversight, is a necessary institutional step.

Political economy and stakeholder engagement. Carbon pricing inherently creates winners and losers, and political sustainability requires proactive stakeholder management. The EU ETS experience demonstrates that initial overallocation to maintain industrial support, followed by gradual tightening, can build political acceptance over time [11]. China's approach of extensive stakeholder consultation through regional pilot programs created a constituency of experienced participants before national launch [12]. For Uzbekistan, where state-owned enterprises dominate key emission-intensive sectors, the government's dual role as regulator and owner creates both opportunities (direct influence over compliance behavior) and challenges (potential conflicts of interest in enforcement). The iCRAFT project's positive reception among government stakeholders [15] suggests that demonstrating tangible financial benefits from carbon market participation can build political support for broader carbon pricing.

Energy sector reform context. Uzbekistan's carbon market development occurs against the backdrop of comprehensive energy sector reform, including electricity and gas market liberalization, tariff adjustments, and the scaling of renewable energy investment. This context is both a challenge and an opportunity. On the challenge side, implementing carbon pricing simultaneously with energy price reform risks compounding cost impacts on industrial consumers and households. On the opportunity side, the institutional reforms underway in the energy sector – including unbundling, market operator establishment, and metering infrastructure development – create synergies with carbon market infrastructure needs. The planned energy market liberalization from 2026 will establish cost-reflective pricing that makes carbon price signals more effective: when energy prices reflect true costs, the incremental burden of carbon pricing is more easily absorbed, and the combined signal more strongly incentivizes clean technology investment. Deputy Minister Mamadaminov's statement that the energy industry accounts for 70% of emissions, representing "a lot of opportunities in the energy industry for carbon markets" [16], reflects this strategic alignment.

Overall, the institutional readiness assessment suggests that Uzbekistan meets several foundational prerequisites (political commitment, initial MRV experience through iCRAFT, emerging capital market infrastructure) while significant gaps remain in mandatory reporting systems, dedicated regulatory capacity, and comprehensive legal frameworks. The assessment supports a phased approach that builds institutional foundations before market launch, consistent with the sequencing lessons from international experience.

3.2. International ETS Design Comparison

Table 1 – Comparative Analysis of Emissions Trading System Design Parameters

Parameter	EU ETS Phase 4	China ETS	K-ETS	Kazakhstan ETS	RGGI
Launch year	2005	2021	2015	2013*	2009
Coverage (%GHG)	~40%	~40%**	74%	~50%	~20%
Allocation method	Auction + benchmark	Intensity benchmark	Grandfathering	Grandfathering	100% auction
Free allocation	~40% (declining)	100%	97% (declining)	100%	0%
Carbon price (2024)	€65/tCO_2	~$10/$tCO_2$	$8–10/$tCO_2$	N/A	$13–15/$tCO_2$
Revenue (2023)	€38.8 bln	~$0.2 bln	~$0.1 bln	N/A	~$1.4 bln
Price management	MSR	Price corridor	Reserve + ceiling	None	Floor + CCR

*Source: Compiled based on ICAP [1], EU Commission [11], Zhang [12]. * Suspended 2016. ** Power sector only.*

Table 1 reveals several design patterns relevant to emerging economy ETS development. First, all emerging economy ETS (China, South Korea, Kazakhstan) began with high free allocation rates (97–100%), in contrast to the RGGI's 100% auction approach. This reflects the political economy imperative of minimizing initial compliance costs for regulated industries during the transition period. Second, sectoral coverage decisions vary significantly: while China started with power sector only, South Korea adopted broad coverage from the outset. Third, price management mechanisms are present in all functioning systems except Kazakhstan's suspended ETS, suggesting that price predictability is essential for market stability, particularly in less liquid emerging economy markets. Fourth, the Kazakhstan experience – launch without adequate MRV infrastructure, data quality issues, and subsequent suspension – provides a direct cautionary lesson for Central Asian neighbors [9].

The RGGI model is particularly relevant for Uzbekistan's context. RGGI demonstrates that a sector-specific approach (power generation only) can be effective, administratively manageable, and politically feasible while generating

meaningful emission reductions and substantial revenue. RGGI's 100% auction approach, while atypical for emerging economies, has generated approximately USD 6.3 billion in cumulative revenue since 2009, invested primarily in energy efficiency and renewable energy programs [1]. This revenue recycling approach has enhanced rather than undermined political support for the program. For Uzbekistan, a power sector pilot with predominantly free allocation but a modest auction component (10–20%) could provide both political feasibility and initial revenue generation for green investment programs.

3.3. Scenario Analysis Results

The three carbon market development scenarios yield distinctly different outcomes across key assessment dimensions.

Scenario A (Low Ambition): ETS covering only the power sector with intensity-based benchmarks and 100% free allocation. Estimated carbon price range: USD 5–10/tCO_2. Projected annual emission reduction: 8–12 million tonnes CO_2 (4–6% of total national emissions). Annual budget revenue: approximately USD 0–50 million (minimal, as free allocation generates no direct revenue). GDP impact: negligible (-0.05 to -0.1%). Competitiveness impact: minimal, as power generation is non-traded. Institutional capacity requirement: moderate – MRV for 30–50 power facilities, basic registry, limited regulatory oversight. This scenario mirrors China's initial ETS approach and is achievable with current institutional capacity supplemented by targeted capacity building.

Scenario B (Medium Ambition): ETS covering energy and major industrial sectors (cement, metallurgy, chemicals) with combination benchmarking/auctioning (80% free, 20% auction). Estimated carbon price range: USD 10–20/tCO_2. Projected annual emission reduction: 15–22 million tonnes CO_2 (8–11% of total). Annual budget revenue: USD 150–400 million (from auction revenues and potential carbon tax on uncovered sectors). GDP impact: -0.15 to -0.3%. Competitiveness impact: moderate for cement, metallurgy (trade-exposed sectors requiring transitional protection). Institutional capacity requirement: substantial – MRV for 100–200 industrial facilities, sectoral benchmarks, expanded regulatory capacity. This scenario requires 2–3 years of additional institutional preparation beyond Scenario A.

Scenario C (High Ambition): Economy-wide ETS with gradual expansion, increasing auction share (starting 70% free, declining 5% annually), linked to international markets via Article 6. Estimated carbon price range: USD 20–40/tCO_2. Projected annual emission reduction: 25–35 million tonnes CO_2 (13–18% of total). Annual budget revenue: USD 500 million–USD 1.2 billion. GDP impact: -0.3 to -0.6%, partially offset by revenue recycling. Competitiveness impact: significant for trade-exposed industries; CBAM-like border adjustment measures may be needed. Institutional capacity requirement: very substantial – comprehensive MRV, sophisticated market oversight, international linking protocols. This scenario represents a long-term aspiration requiring 5–10 years of institutional development.

The scenario comparison reveals an important non-linearity: Scenario B (Medium Ambition) delivers disproportionately more emission reductions per dollar of GDP impact than Scenario A, suggesting that the marginal efficiency of carbon pricing improves with broader sectoral coverage. This reflects the fact that including industrial sectors unlocks additional low-cost abatement opportunities not available in a power-sector-only system. However, the institutional capacity jump from Scenario A to B is substantial, reinforcing the case for a phased approach that uses the pilot period to build capacity for subsequent expansion.

A sensitivity analysis on the GDP impact estimates explores the role of revenue recycling. Under Scenario B, if carbon market revenue is recycled through targeted reductions in distortionary taxes (such as payroll taxes or corporate income taxes), CGE modeling literature suggests that the net GDP impact can be reduced from -0.15 to -0.3% to approximately -0.05 to -0.15% – a potential "double dividend" effect where environmental improvement is accompanied by economic efficiency gains from tax reform [10]. This finding has significant policy implications: the design of revenue recycling mechanisms is nearly as important as the design of the carbon pricing mechanism itself.

The implications of each scenario for NDC compliance are also noteworthy. The NDC target of 50% reduction in GHG emissions per unit of GDP by 2035 [14] implies that emission intensity must decline significantly even as the economy grows. Under Scenario A, carbon pricing contributes approximately 15–20% of the required NDC emission reductions; under Scenario B, this contribution rises to 30–40%; and under Scenario C, to 50–65%. This suggests that carbon pricing alone is insufficient to meet NDC targets under any scenario – complementary policies (renewable energy deployment, energy efficiency standards, transport sector measures) remain essential. However, carbon pricing creates a cross-cutting incentive that enhances the effectiveness of sector-specific policies, consistent with the OECD's recommendation of comprehensive policy packages rather than single-instrument approaches [21].

3.4. Cost-Benefit Analysis

The CBA evaluates the net economic impact of carbon market implementation under the medium-ambition scenario (Scenario B), which offers the most instructive balance of ambition and institutional feasibility.

Benefits (2028–2040 cumulative, present value at 5% discount rate): Direct emission reduction benefits, valued at the social cost of carbon (USD 51/tCO_2), total approximately USD 5.2–7.8 billion. Health co-benefits from reduced particulate matter (PM2.5), sulfur dioxide (SO_2), and nitrogen oxide (NOx) emissions associated with fossil fuel combustion reduction are estimated at USD 1.5–2.5 billion, using WHO air pollution health impact methodology. Energy efficiency gains, monetized through reduced natural gas consumption (estimated at 3–5 billion cubic meters cumulative savings), contribute USD 1.2–2.0 billion. Carbon market revenue provides USD 1.5–3.5 billion in fiscal benefits. Total quantifiable benefits: approximately USD 9.4–15.8 billion.

Costs (2028–2040 cumulative, present value at 5% discount rate): MRV system development and operation: USD 80–120 million. Registry and market infrastructure: USD 30–50 million. Regulatory capacity building: USD 50–80 million. Industry compliance costs (abatement investments and allowance purchases): USD 2.0–3.5 billion. Administrative costs: USD 40–60 million. Total quantifiable costs: approximately USD 2.2–3.8 billion.

The resulting benefit-cost ratio ranges from 3.5 to 5.0, indicating that the economic benefits of carbon market implementation substantially exceed the costs under reasonable assumptions. Sensitivity analysis reveals that the results are robust: even at the lowest SCC estimate (USD 30/tCO_2) and highest discount rate (10%), the benefit-cost ratio remains above 2.0. The primary driver of positive net benefits is the social cost of avoided emissions, followed by health co-benefits. These findings align with the Stern Review's [23] central conclusion that the costs of climate inaction far exceed the costs of mitigation action.

3.5. Marginal Abatement Cost Analysis

The MAC curve analysis identifies the least-cost emission reduction opportunities across sectors, providing crucial information for carbon price level determination and ETS design.

At a carbon price of USD 5–10/tCO_2 (Scenario A range), the economically viable abatement options include: operational optimization of existing power plants (estimated 3–5 $MtCO_2$/year at USD 2–8/tCO_2); industrial energy management improvements (2–4 $MtCO_2$/year at USD 3–9/tCO_2); and lighting and motor efficiency upgrades (1–2 $MtCO_2$/year at USD 5–10/tCO_2). At USD 10–20/tCO_2 (Scenario B), additional options become viable: combined cycle gas turbine conversions (4–7 $MtCO_2$/year at USD 10–18/tCO_2); utility-scale solar deployment (3–6 $MtCO_2$/year at USD 12–22/tCO_2); and industrial waste heat recovery (2–4 $MtCO_2$/year at USD 15–20/tCO_2). At USD 20–40/tCO_2 (Scenario C), higher-cost measures become economical: wind power deployment (2–4 $MtCO_2$/year at USD 20–30/tCO_2); cement production process modifications (1–2 $MtCO_2$/year at USD 25–40/tCO_2); and advanced energy storage (1–3 $MtCO_2$/year at USD 30–40/tCO_2).

The MAC analysis reveals an important finding: approximately 40–50% of potential emission reductions in the energy and industrial sectors can be achieved at abatement costs below USD 15/tCO_2. This suggests that a moderate initial carbon price can unlock substantial emission reductions without imposing prohibitive costs on regulated entities. The iCRAFT project's demonstration of USD 15/tCO_2 as a viable carbon credit price [15] further validates this price range as both achievable in international markets and sufficient to incentivize meaningful abatement action domestically.

3.6. Proposed Three-Phase Institutional Roadmap

Based on the institutional readiness assessment, international comparative analysis, and scenario modeling, a three-phase institutional roadmap for carbon market development is proposed (Figure 1).

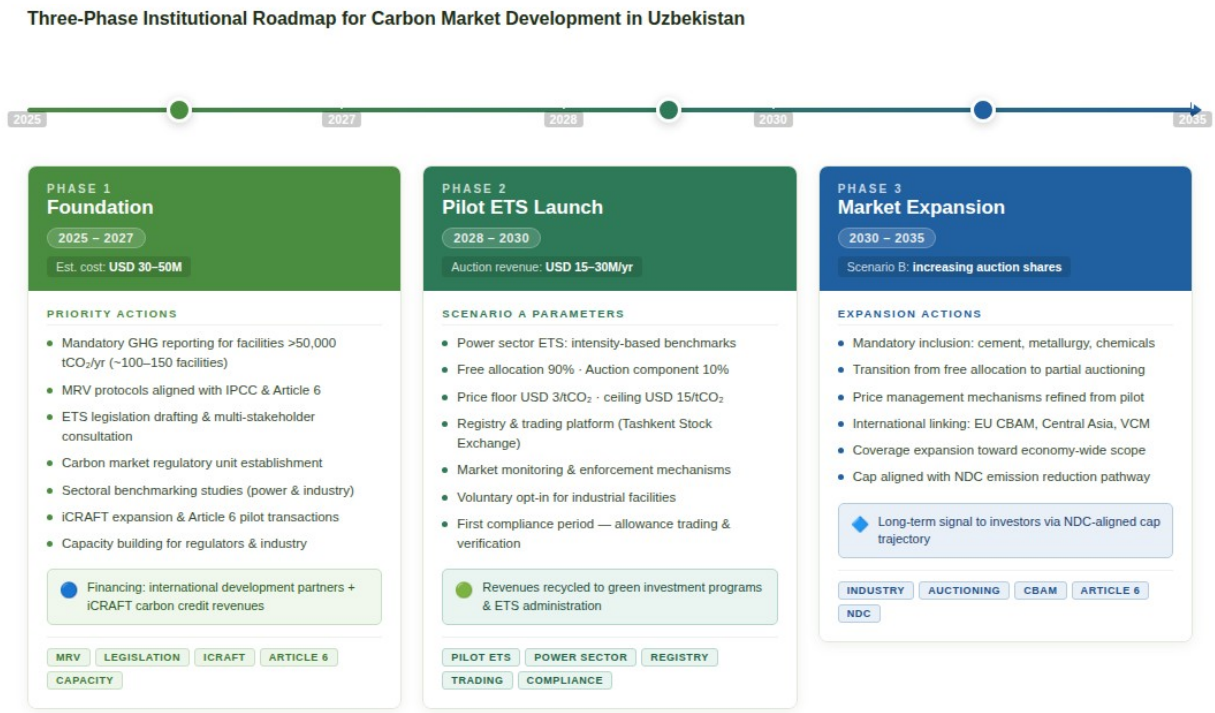

Figure 1 – Three-Phase Institutional Roadmap for Carbon Market Development

[Figure description: Timeline-based roadmap with three sequential phases. Phase 1 (2025–2027) – Foundation: mandatory facility-level emissions reporting for large emitters (power and industrial sectors), MRV system development and piloting, ETS legislation drafting and stakeholder consultation, carbon market regulatory unit establishment, capacity building programs, iCRAFT expansion and Article 6 pilot transactions. Phase 2 (2028–2030) – Pilot ETS Launch: ETS covering power sector (Scenario A parameters), registry and trading platform operationalization, market monitoring and enforcement mechanisms, voluntary expansion to industrial participants, revenue collection and recycling framework, first compliance period. Phase 3 (2030–2035) – Market Expansion: mandatory industrial sector inclusion, transition from free allocation to partial auctioning, price management mechanism refinement, exploration of international linking opportunities, coverage expansion toward economy-wide scope. Each phase includes milestones and decision gates for proceeding to the next phase.]

Phase 1 (2025–2027): Foundation Building. The priority actions in this phase are: enacting mandatory facility-level GHG emissions reporting for all sources exceeding 50,000 tCO_2/year (estimated 100–150 facilities); developing and piloting MRV protocols aligned with IPCC guidelines and Article 6 requirements; drafting comprehensive ETS legislation through multi-stakeholder consultation; establishing a dedicated carbon market regulatory unit within the Ministry of Economy and Finance as it is designated national authority for carbon trade market; conducting sectoral benchmarking studies for the power and major industrial sectors; expanding the iCRAFT project to generate additional Article 6-compliant carbon credits; and launching targeted capacity building programs for regulators, industry participants, and verification bodies. The cost of Phase 1 is estimated at USD 30–50 million, financed primarily through international development partner support and iCRAFT carbon credit revenues.

Phase 2 (2028–2030): Pilot ETS Launch. Building on the institutional foundation, a pilot ETS is launched covering the power sector using Scenario A

parameters: intensity-based benchmarks, predominantly free allocation (90%) with a modest auction component (10%), price floor of USD 3/tCO_2 and price ceiling of USD 15/tCO_2. Registry and trading infrastructure (potentially leveraging the Tashkent Stock Exchange) becomes operational. Market monitoring and enforcement mechanisms are established. Voluntary opt-in provisions allow industrial facilities to participate ahead of mandatory inclusion. The first compliance period (likely annual or biennial) provides real-world experience with allowance management, trading, and verification. Revenue from the 10% auction component (estimated USD 15–30 million annually) is allocated to green investment programs and ETS administration.

In addition to the institutional steps outlined above, the long-term effectiveness of the ETS will depend on the establishment of a transparent and predictable emissions cap trajectory. A gradual cap decline aligned with the national climate targets should be introduced once the pilot phase demonstrates operational stability. Based on international experience, a linear reduction factor of approximately 1.5–2% per year could provide a balanced pathway for Uzbekistan during the early stages of market development. Such a trajectory would allow regulated entities sufficient time to adapt their investment strategies while ensuring that emission reductions remain consistent with the country's Nationally Determined Contribution (NDC) commitments. Establishing a clear long-term cap trajectory would also strengthen investor confidence by providing predictable carbon price signals for low-carbon technologies and energy efficiency investments.

Phase 3 (2030–2035): Market Expansion. Based on pilot experience, the ETS is expanded to include major industrial sectors (cement, metallurgy, chemicals). The allocation method transitions from predominantly free allocation to increasing auction shares (Scenario B parameters). Price management mechanisms are refined based on pilot experience. International linking opportunities are explored, potentially through Article 6 cooperative approaches with EU (CBAM interaction), Central Asian neighbors, or global voluntary carbon markets. The cap trajectory is aligned with the NDC emission reduction pathway, providing a clear long-term signal to investors and industry.

4. DISCUSSION

The findings of this study contribute to the literature on carbon market design for emerging economies while revealing several important dynamics specific to energy-intensive transitional contexts.

The sequencing imperative. Perhaps the most significant finding is the critical importance of institutional sequencing. Kazakhstan's experience of launching an ETS without adequate MRV infrastructure and data systems, leading to market suspension, provides a direct cautionary lesson [9]. In contrast, China's deliberate approach – seven regional pilots over four years, extensive data collection, and gradual expansion – produced a more sustainable national market [12]. The three-phase roadmap proposed in this study embodies this sequencing principle: institutional foundations first, market operations second, and market

expansion third. This finding aligns with Doda et al.'s [9] recommendation that developing countries prioritize MRV development and data accumulation before ETS launch. The proposed 2–3 year foundation-building phase (2025–2027) before pilot launch (2028) provides sufficient time for institutional preparation while maintaining reform momentum.

The energy subsidy–carbon pricing interaction. A distinctive feature of Uzbekistan's context is the ongoing energy subsidy reform process. Historically subsidized electricity and natural gas prices have suppressed the economic incentive for energy efficiency investment and reduced the potential effectiveness of carbon pricing. The planned energy market liberalization from 2026 creates a window of opportunity for carbon pricing: as energy prices rise toward market levels, the incremental burden of a carbon price becomes more manageable, and the combined price signal more strongly incentivizes clean technology investment. This interaction has important design implications: the carbon price level should be calibrated in conjunction with the energy subsidy reform trajectory, not in isolation. Goulder and Schein's [10] CGE modeling framework supports this integrated approach, demonstrating that the welfare effects of carbon pricing depend critically on the pre-existing policy landscape.

Article 6 as a development catalyst. The iCRAFT project's success – generating USD 15 million for 1 million tonnes of verified emission reductions [15] – demonstrates that international carbon market mechanisms under Article 6 of the Paris Agreement can serve as catalysts for domestic carbon market development. Beyond revenue generation, the iCRAFT project has contributed institutional capacity (MRV systems, verification protocols), demonstrated political feasibility (positive government engagement), and created awareness of carbon market opportunities among industrial stakeholders. This finding suggests that Article 6 engagement should be viewed not merely as an emission reduction financing mechanism but as an institutional capacity-building tool. The experience aligns with Marcu's [24] analysis of Article 6 as a driver of climate ambition in developing countries. For other emerging economies considering carbon market development, early engagement with Article 6 mechanisms – through either policy crediting programs (like iCRAFT) or project-based cooperative approaches – can accelerate institutional readiness while generating near-term benefits.

The CBAM imperative for emerging economy carbon markets. The EU's Carbon Border Adjustment Mechanism (CBAM), entering full implementation from 2026, introduces a powerful external incentive for carbon pricing in exporting countries. Under CBAM, importers of iron, steel, cement, aluminum, fertilizers, and hydrogen into the EU must purchase CBAM certificates corresponding to the carbon price that would have been paid under the EU ETS. However, CBAM certificates can be reduced to the extent that a carbon price has been paid in the country of origin [11]. This creates a direct financial incentive for emerging economies to implement domestic carbon pricing: without it, the carbon revenue flows to the EU budget through CBAM certificate purchases; with domestic carbon pricing, revenue is retained domestically. For Uzbekistan's metallurgical and chemical sectors, which export to EU markets, this represents a

concrete fiscal case for domestic carbon market establishment, independent of environmental considerations. The CBAM effect thus transforms carbon pricing from a purely environmental policy into a trade and fiscal policy instrument.

Price management in thin markets. A critical design challenge for emerging economy ETS is ensuring price stability in markets that may be significantly less liquid than the EU ETS. With fewer regulated entities, lower trading volumes, and less sophisticated market participants, emerging economy carbon markets are vulnerable to price volatility, manipulation, and illiquidity. The study's proposed price floor and ceiling mechanism addresses this directly: a price floor prevents collapse (which undermined early EU ETS credibility), while a ceiling limits cost exposure for regulated entities. The RGGI's Cost Containment Reserve (CCR) and Emissions Containment Reserve (ECR) provide a proven model for managing prices in a smaller, less liquid market context [1]. For Uzbekistan's pilot ETS, a price corridor of USD 3–15/tCO_2 with automatic supply adjustment at boundary prices would provide both market stability and cost predictability.

Competitiveness and carbon leakage. The risk that carbon pricing may disadvantage domestic industry relative to unpriced competitors is a persistent concern in carbon market design. This risk is particularly acute for energy-intensive, trade-exposed (EITE) sectors such as cement, steel, and chemicals [10]. Free allocation is the primary tool for addressing competitiveness concerns in the transition period: by providing allowances equal to or near benchmark emissions levels, the direct cost impact on EITE sectors is minimized while the marginal incentive for emission reduction is maintained. China's 100% free allocation approach reflects this logic, though it also limits revenue generation and environmental ambition [12]. The proposed phased approach – high free allocation initially, gradually transitioning to increased auctioning – balances competitiveness protection with progressive ambition escalation. As more countries in the region implement carbon pricing, the competitiveness differential diminishes, enabling faster transition to auctioning.

Revenue recycling and political economy. How carbon pricing revenue is used significantly influences both economic outcomes and political sustainability. The RGGI's investment of auction revenue in energy efficiency and renewable energy programs has generated economic benefits exceeding the cost of the program, creating a politically supportive constituency [1]. The EU ETS Innovation Fund (EUR 2.4 billion) and Modernization Fund (EUR 6.3 billion) similarly direct revenue toward green transition investments [11]. For Uzbekistan, the study recommends allocating carbon market revenue as follows: 70–80% to green technology investment and energy efficiency programs; 10–15% to social compensation for affected communities and workers; and 5–10% to administrative costs and institutional capacity. This allocation model creates visible, tangible benefits from carbon pricing while addressing equity concerns – both essential for sustaining political support.

Regional cooperation prospects. Central Asia's shared environmental challenges and interconnected energy systems create a potential basis for regional

carbon market cooperation. The proposed “Central Asia – Azerbaijan – Europe Green Energy Corridor” [16], through which Uzbekistan plans to export surplus green electricity to Europe via Azerbaijan starting in 2030, represents an early manifestation of regional clean energy cooperation that could eventually extend to carbon markets. Regional carbon market linking offers several potential advantages: larger market size increases liquidity and reduces price volatility; harmonized rules reduce compliance complexity for firms operating across borders; and regional approaches may be more attractive to international investors and development partners. However, the preconditions for successful linking – including comparable MRV standards, compatible regulatory frameworks, and similar ambition levels – require substantial coordination. The EU ETS’s successful linking with Switzerland (2020) and the abandoned Australia-EU linking process provide relevant positive and cautionary lessons, respectively [1]. For Central Asia, a more realistic near-term goal may be mutual recognition of carbon credits generated through Article 6 cooperative approaches, rather than full ETS linking.

Monitoring and evaluation framework. The phased roadmap requires a robust monitoring and evaluation framework with clear decision criteria for phase transitions. The study proposes the following key performance indicators for Phase 1 (Foundation): percentage of large emitters submitting verified emission reports (target: >90% by end of Phase 1); MRV system operational reliability (target: third-party verification success rate >85%); ETS legislation enacted and implementing regulations adopted; regulatory unit established with trained personnel. For Phase 2 (Pilot ETS): market functioning indicators (trading volume, bid-ask spreads, price stability within corridor); compliance rate (target: >95% of regulated entities meeting obligations on time); emission reduction performance against projected pathway; revenue generation and recycling effectiveness. These KPIs provide objective criteria for assessing readiness to proceed to subsequent phases and for identifying areas requiring additional support or adjustment.

Implications for other emerging economies. While this study focuses on Uzbekistan, the findings have broader implications for other emerging economies at early stages of carbon market consideration. The institutional sequencing framework – data first, institutions second, markets third – is generalizable across contexts. The role of Article 6 as an institutional capacity-building tool offers a pathway for countries lacking domestic carbon market experience to develop relevant skills and infrastructure through international cooperation. The CBAM imperative creates a convergent incentive structure for all countries with EU-exported industrial goods to develop domestic carbon pricing. The MAC analysis methodology, while calibrated to a specific country context, demonstrates a replicable approach for identifying least-cost abatement pathways and appropriate carbon price entry levels. These findings contribute to the growing body of evidence on carbon market design for diverse economic contexts, complementing the established literature focused on developed economy experiences [1, 8, 9].

Scientific novelty. This study’s contributions include: (1) first systematic analysis of carbon market institutional prerequisites for a Central Asian emerging

economy; (2) empirical assessment of iCRAFT as an Article 6 catalyst for domestic carbon market development; (3) scenario-based modeling of carbon pricing design options calibrated to an energy-intensive transitional economy; (4) integrated CBA demonstrating benefit-cost ratios of 3.5–5.0, providing an evidence base for policymaker decision-making; (5) a phased institutional roadmap incorporating lessons from five international ETS experiences.

Limitations. The study has several limitations. The MAC curve analysis relies on technology cost estimates that may change as markets evolve. The CBA uses the US EPA's SCC estimate, which may not fully reflect the specific vulnerability of Uzbekistan to climate impacts. Enterprise-level emissions data limitations constrain the precision of scenario modeling. The proposed roadmap is inherently forward-looking and subject to political, economic, and institutional uncertainties. Future research should pursue: empirical evaluation of the pilot ETS once operational; refined MAC curves using facility-level data; dynamic CGE modeling of economy-wide carbon pricing impacts; and comparative analysis across Central Asian countries pursuing carbon market development.

Unified carbon pricing (hybrid system). In addition to emissions trading systems, carbon taxation represents another widely used carbon pricing instrument. While ETS provides quantity certainty by setting an emissions cap, carbon taxes ensure price stability and are administratively simpler for sectors with diffuse emission sources. International experience shows that many countries increasingly adopt hybrid carbon pricing frameworks combining ETS for large industrial emitters with carbon taxes applied to transport and smaller emission sources. For Uzbekistan, such a hybrid approach may be particularly relevant given the concentration of emissions in large energy and industrial facilities alongside diffuse emissions in transport and residential sectors. A hybrid system could enhance policy flexibility while maintaining environmental effectiveness.

5. CONCLUSION AND RECOMMENDATIONS

This study has analyzed the institutional prerequisites and pricing frameworks necessary for carbon market development in emerging economies, using Uzbekistan as a primary case study with comparative evidence from five international ETS experiences.

The principal findings can be summarized as follows.

First, Uzbekistan possesses both the imperative and emerging institutional capacity for carbon market development. The country's high emission intensity (more than twice the Central Asian average), its 209 million tonnes CO_2 annual emissions, its ambitious NDC targets (50% reduction in GHG intensity per GDP unit by 2035), and the pioneering iCRAFT project experience all point to both the need for and feasibility of carbon pricing.

Second, international comparative analysis reveals that successful ETS implementation in emerging economies requires sequenced institutional development MRV systems and data infrastructure before market launch, gradual scope expansion, and robust price management mechanisms. The Kazakhstan

experience provides a direct cautionary lesson about premature launch without adequate institutional foundations.

Third, scenario analysis demonstrates that a power sector-focused pilot ETS (Scenario A) can achieve 8–12 million tonnes CO_2 annual reductions at manageable carbon prices (USD 5–10/tCO_2), while a more ambitious energy-plus-industry ETS (Scenario B) could yield 15–22 million tonnes at USD 10–20/tCO_2.

Fourth, cost-benefit analysis indicates a benefit-cost ratio of 3.5–5.0 under the medium-ambition scenario, driven primarily by the social value of avoided emissions and health co-benefits.

Fifth, the MAC analysis reveals that approximately 40–50% of potential emission reductions are achievable at abatement costs below USD 15/tCO_2.

Two recent developments further strengthen the case for accelerated action. The adoption of Presidential Decree PD-110 in July 2025 by establishing the legal basis for international carbon market participation, designating the Ministry of Economy and Finance as the Designated National Authority under Article 6.4 of the Paris Agreement, and mandating the development of implementing regulations which marks a decisive shift from policy aspiration to operational framework.

Concurrently, at COP29 in November 2024, negotiators finally adopted the complete Article 6 rulebook, including binding guidance for both Article 6.2 bilateral cooperative approaches and the Article 6.4 centralized UN carbon market mechanism. As of early 2025, 97 bilateral agreements between 59 countries had been registered under Article 6.2, with 155 pilot projects recorded.

The launch of the Article 6.4 mechanism could significantly reshape global carbon trading, with demand from governments surging sharply following the adoption of new rules. For Uzbekistan, these developments create a window of opportunity by implementing regulation mandated by PD-110 can be designed from the outset to fully align with the finalized Article 6 rulebook, avoiding the uncertainty that constrained earlier movers.

The CBAM dimension has similarly crystallized. The EU's Carbon Border Adjustment Mechanism entered its definitive stage on 1 January 2026, becoming the first fully operational border carbon adjustment policy to charge costs based on the emissions intensity of imported goods.

The European Commission has launched a call for evidence on rules for the deduction of the carbon price paid in third countries, confirming that domestic carbon pricing in exporting countries can directly offset CBAM certificate obligations. For Uzbekistan's metallurgical and chemical exporters, this transforms domestic carbon market development from an environmental policy choice into a concrete trade competitiveness imperative.

Based on these findings, the following recommendations are formulated:

For government policymakers.

The regulations mandated by Decree PD-110 represent the most consequential near-term policy decision for Uzbekistan's carbon market trajectory. The study's findings, synthesized with international best practice, support the following specific provisions for inclusion:

A phased authorization framework for international carbon transactions comprising a preliminary Letter of No Objection for project screening, a binding Letter of Approval prior to activity commencement, and separate authorization for cooperative approach transfers would establish the procedural safeguards that differentiate Uzbekistan's approach from Kazakhstan's premature and underinstitutionalized market launch. This sequencing aligns with the authorization architecture now standardized under the COP29 Article 6.2 guidance.

An NDC retention norm, operationalized through explicit registry-level blocking of a defined share of verified units for sovereign NDC compliance use, is essential to prevent the overselling risk that has undermined credibility in earlier carbon market programs. The 20% retention threshold established in PD-110 should be given concrete technical implementation in the regulation, including clear rules on the conditions under which retained units may eventually be used or retired.

A fee structure for international transfers should be established to generate operational revenue for the regulatory infrastructure. Based on international experience with program administration costs and the price levels observed in the iCRAFT project (USD 15/tCO_2), a per-unit fee calibrated to sustain the National Registry and regulatory capacity without materially impairing project economics represents sound policy design. Revenue from this fee should, at a minimum, partially finance the institutional capacity building that Phase 1 of the roadmap requires.

A cancellation provision for global climate integrity retiring a modest percentage of authorized units to support overall mitigation of global emissions (OMGE), consistent with Article 6.4 mechanism requirements would align Uzbekistan's framework with the highest international standards and strengthen the credibility of its ITMO authorizations in acquiring country markets.

An approved standards list, explicitly enumerating the internationally recognized carbon crediting programs including Gold Standard, Verified Carbon Standard, REDD+, and the Article 6.4 mechanism as eligible for authorization within Uzbekistan's framework would reduce regulatory uncertainty for project developers and investors while maintaining quality control.

A competitive procurement mechanism for state-participation project service organizations through which private service companies bear all project development, verification, and sales costs in exchange for a contractually defined revenue share would mobilize private sector expertise without committing public resources, consistent with the value-for-money principles that international development partners supporting Uzbekistan's transition expect.

Beyond the regulation itself:

enact mandatory facility-level GHG emissions reporting for all sources exceeding 50,000 tCO_2/year as an immediate priority;

operationalize the National Carbon Units Registry as mandated;

coordinate carbon pricing development with the ongoing energy subsidy reform trajectory;

launch a pilot ETS for the power sector with intensity-based benchmarks, predominantly free allocation, and a price corridor mechanism; and develop a CBAM preparedness program for export-oriented enterprises in metallurgy and chemicals, who face quantifiable financial exposure under the EU mechanism beginning January 2026.

For industrial enterprises.

Begin voluntary emissions monitoring and reporting immediately to build internal data systems ahead of mandatory requirements the data accumulated in this period will directly reduce compliance costs when mandatory reporting takes effect. Conduct internal carbon pricing assessments to identify and prioritize cost-effective abatement opportunities; the MAC analysis indicates that 40–50% of abatement potential is available below USD 15/tCO_2, largely through operational efficiency measures accessible without major capital investment.

For export-oriented producers in steel, aluminum, cement, and fertilizers, establish carbon content documentation systems for EU-exported products, CBAM certificate obligations are now live and the deductibility of domestic carbon prices creates a direct financial incentive for carbon pricing engagement. Explore Article 6 carbon credit generation opportunities within the iCRAFT or successor frameworks, which offer a near-term revenue opportunity independent of the domestic ETS timeline.

For international partners and investors.

The COP29 Article 6 breakthrough and CBAM's full implementation have jointly created a more favorable environment for carbon market investment in Uzbekistan than at any prior point. The implementing regulation under PD-110, once adopted, will provide the contractual framework that bilateral carbon credit off-take agreements require, advance engagement with the Ministry of Economy and Finance during the regulation's development offers the opportunity to shape provisions relevant to project economics.

Technical assistance for MRV system development and registry operationalization represents the single highest-return institutional investment available the sequencing lessons from Kazakhstan, China, and the EU all confirm that data infrastructure quality is the binding constraint on market effectiveness. Regional carbon market cooperation in Central Asia, building on Uzbekistan's leading institutional position, offers a medium-term market integration opportunity as neighboring countries respond to the same CBAM incentives.

Carbon market development in emerging economies is not merely a climate policy instrument but a fundamental modernization strategy. By putting a price on carbon, governments create incentives for efficiency, innovation, and clean technology investment that transform the industrial base while generating fiscal revenue and health co-benefits. For Uzbekistan, the question is no longer whether to pursue carbon pricing, but how to design the implementing framework is now under active development in a manner that maximizes benefits while managing risks. The evidence presented in this study demonstrates a compelling benefit-cost proposition, and the institutional foundations are being actively laid through PD-110 and its forthcoming regulation.

The broader significance of this research extends beyond a single country. The iCRAFT experience provides a replicable model for leveraging international carbon finance to build domestic institutional capacity. The three-phase roadmap proposed here offers a template adaptable to different national contexts, provided that the core sequencing principle institutions before markets is maintained.

As the international community operationalizes the Article 6 rulebook adopted at COP29 and as CBAM reshapes the trade and climate nexus for industrial exporters globally, the demand for credible, well-designed carbon market frameworks in emerging economies will only intensify. Uzbekistan's early-mover position, if consolidated through a well-crafted implementing regulation, offers both domestic and international dividends that far exceed the institutional investment required to secure them.

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