A FIVE-ELEMENT GOVERNANCE FRAMEWORK FOR THE SECTORAL DEVELOPMENT OF PUBLIC–PRIVATE PARTNERSHIPS IN THE ENERGY SECTOR: EVIDENCE FROM UZBEKISTAN

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Abstract. Public-private partnership (PPP) policy in many developing economies is still organised around isolated projects rather than a coherent sectoral strategy, which limits its capacity to attract long-term private capital into capital-intensive industries such as energy. This article proposes a five-element governance framework — strategy, fiscal-legal basis, institutional governance, project process, and execution and monitoring — organised as a closed feedback loop around a PRISM risk-adjusted evaluation core, and tests it empirically against Uzbekistan's energy-sector PPP portfolio for 2015-2026. The framework is illustrated through a contract-level asset-return mechanism that raised the bank-guarantee ratio to residual investment obligations from roughly 1.4 to 10.0 percent (a 7.1-fold increase) and through a fiscal-legal architecture built around a 6.5 billion US dollar annual ceiling and a contingent-liability register. Statistical validation using Pearson correlation and multiple OLS regression (STATA 17) shows very strong associations ($|r| > 0.90$) between the PRISM index and its four components, with the risk-stability coefficient emerging as the dominant driver ($\beta = 1.4143$; $p < 0.001$); heteroskedasticity and

autocorrelation diagnostics (Breusch-Pagan, Durbin-Watson, Durbin's alternative test) support the reliability of the estimates, while a high degree of multicollinearity is explicitly flagged as a limitation. The findings support adopting the framework as a national methodological standard linking PPP monitoring to results-based payment.

Keywords: public-private partnership; energy sector; sectoral development strategy; PRISM index; fiscal risk management; contingent liabilities; Uzbekistan.

JEL Classification: H54, L94, O25, Q40.

1. Introduction

The gap between infrastructure investment needs and the fiscal capacity of national budgets has widened steadily over the past decade, and public-private partnerships (PPPs) have become the principal institutional response to this gap. World Bank data indicate that, between 2017 and 2025, 52 percent of global partnership investment was directed to the energy sector and 42 percent to transport, with all other sectors together accounting for only 6 percent (World Bank, 2017). Within the energy mix itself, coal accounted for 31 percent of PPP investment, hydropower 20 percent, wind 18 percent and solar 13 percent, indicating that the global energy transition through partnership finance remains far from complete.

Uzbekistan illustrates both the promise and the difficulty of this transition. Following the adoption of the Law "On Public-Private Partnership" in 2019, private-sector participation added 11.2 gigawatts of generation capacity and raised the private share of generation to 24 percent; the national PPP portfolio now comprises 2,812 registered projects worth 29,748.5 million US dollars. This scale of activity has outgrown the country's project-by-project management practice: partnership mechanisms are still applied as isolated transactions rather than as an integrated component of a sector-wide development strategy, which weakens fiscal discipline, currency-risk allocation and portfolio balance.

This article addresses that gap by proposing a five-element governance framework that repositions PPP from a project-level instrument into a sectoral development strategy, and by validating its evaluative core — the PRISM risk-adjusted integral index — against twelve years of sector-level data. The remainder of the article is organised as follows. Section 2 reviews the relevant theoretical and empirical literature. Section 3 describes the data and methods. Section 4 presents the proposed framework and its contract-level mechanism. Section 5 reports the statistical validation. Section 6 discusses the findings, and Section 7 concludes with policy recommendations.

2. Literature Review

The theoretical foundations of PPP rest on transaction-cost and incomplete-contract economics, which explain why bundling design, financing, construction and operation into a single long-term contract can generate efficiency gains through the transfer of risk to the party best able to manage it (Coase, 1937; Williamson, 1985; Hart, 1995). Building on this foundation, Grimsey and Lewis (2004, 2005) formalised the value-for-money (VfM) principle, arguing that value is created precisely through risk transfer rather than through accounting cost comparison alone, while Yescombe (2007) showed that project-finance structures depend fundamentally on the stability of contracted cash flows.

A parallel and more critical literature has questioned whether PPPs genuinely relax fiscal constraints. Engel, Fischer and Galetovic (2001, 2014) demonstrated that partnership financing does not loosen the government budget constraint but merely postpones the payment burden, so that apparent fiscal space is, in important respects, an accounting illusion unless contingent liabilities are recognised transparently. The International Monetary Fund (2021) reinforced this concern empirically, finding that twenty-two countries were in or near debt distress in part because of unrecognised PPP-related contingent obligations, and the World Bank (2022) documented similar patterns of fiscal distress associated with PPP portfolios in South Asia. Hodge and Greve (2005, 2021), synthesising

evidence across many countries, concluded that the empirical record on whether PPPs deliver superior value for money remains genuinely mixed, which points to the continuing need for sector- and context-specific evaluation methods rather than universal claims of PPP superiority.

A separate strand of research has examined PPP application in energy specifically. Pal (2026) links PPP investment in energy to inclusive growth outcomes, Sial (2022) reviews regional PPP experience in energy infrastructure against the backdrop of the global energy crisis, and Tahir et al. (2024) provide a critical analysis of PPP models in energy-from-waste projects, noting that generic evaluation tools frequently fail to capture production-technological effects specific to capital-intensive energy assets. Cruz and Marques (2012) and Cheah and Liu (2006) have advanced probabilistic and real-options extensions of the Public Sector Comparator, improving its treatment of uncertainty but still stopping short of integrating production and social outcomes into a single risk-adjusted metric. This is the methodological gap the PRISM index and the associated governance framework are designed to close.

3. Data and Methods

The empirical analysis uses an annual time series for 2015-2026 (t = 1, ..., 12) covering Uzbekistan's energy-sector PPP portfolio, compiled from the official statistics of the National Statistics Committee, the Ministry of Energy, the Central Bank, and the 2026 national PPP project registry. The evaluative core of the proposed framework is the PRISM index, defined as:

$$PRISM = (w_1 \cdot Em + w_2 \cdot Eb + w_3 \cdot Ei + w_4 \cdot Ej) \cdot Kr$$

where Em, Eb, Ei and Ej are, respectively, the financial-commercial, budgetary, production-technological and socio-economic efficiency components (each normalised to [0,1]); w1 to w4 are weighting coefficients summing to one (set at 0.30, 0.25, 0.25 and 0.20 for industrial PPP projects); and Kr is a risk-stability coefficient, Kr = (1 − R)·S, where R is a weighted integral risk coefficient

covering construction, demand, financial and institutional-political risks, and S is a composite stability indicator. The multiplicative form is a deliberate methodological choice: it ensures that a project with strong financial returns but weak risk stability cannot receive a high overall score, directly addressing the fiscal-illusion critique raised by Engel, Fischer and Galetovic (2014).

Associations between PRISM and its components were estimated using Pearson correlation coefficients (STATA 17, pwcorr command), and their joint effect was estimated through multiple ordinary least squares (OLS) regression (regress command). Model reliability was checked with the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity and with the Durbin-Watson statistic and Durbin's alternative test for serial correlation, given the time-series structure of the data. Forecasts for 2027-2031 were generated using trend extrapolation: a logistic (Gauss-Newton NLS) model for the financial-commercial component, which has empirically saturated at 1.0 since 2023, and a linear OLS trend for the budget-efficiency component.

4. A Five-Element Governance Framework

Uzbekistan's shift from managing PPP as a set of isolated transactions to treating it as an instrument of sectoral development is formalised here as a closed-loop framework of five interdependent elements: strategy, fiscal-legal basis, institutional governance, project process, and execution and monitoring, all connected through bidirectional linkages around a central PRISM evaluation core. The five elements are not functionally equal: strategy is the ordering element, since it sets the fiscal ceiling and sectoral targets that discipline all other elements, while the remaining four operationalise, finance, govern and execute that strategy.

4.1 Fiscal-Legal Basis

The fiscal-legal basis translates strategic intent into binding financial constraints. For Uzbekistan's energy sector this consists of a 6.5 billion US dollar annual

ceiling for new PPP commitments set for 2026, a contingent-liability register that records the government's real fiscal exposure under each contract, and a tariff formula that embeds a currency-risk-sharing corridor between the state and the investor. Together these instruments are designed to keep the fiscal burden of partnership commitments — which reached 4.9 percent of GDP in 2025 — at a manageable and transparent level, consistent with the IMF's (2021) recommendation that contingent liabilities be disclosed rather than left off-balance-sheet.

4.2 Institutional Governance

Institutional governance addresses a diagnostic finding that the technical capacity of contracting government agencies frequently lags behind the complexity of the projects they oversee, reducing them to formal signatories rather than active counterparties. The governance element therefore comprises a competence centre, standardised approval procedures and template contract clauses, intended to shift stakeholder engagement from a reactive posture — responding to complaints after the fact — to a proactive one.

4.3 Project Process and Execution

The project-process and execution elements form the operational testing ground of the framework, covering screening, tendering and risk allocation on one side and PRISM-based monitoring, results-based payment and reporting on the other. Empirical evidence from Uzbekistan's initial cohort of projects shows this linkage functioning as intended: construction risk fell from 0.55 in 2020 to 0.16 in 2025, while the stability coefficient rose from 0.62 to 0.90 over the same period. At the same time, monitoring flagged a warning signal — capacity utilisation fell to 37.5 percent in 2025 — illustrating the framework's diagnostic value in surfacing underperformance that a purely financial metric would miss.

4.4 Contract-Level Asset-Return Mechanism

At the individual contract level, the framework is operationalised through a build-operate-transfer-style mechanism (referred to in the underlying research as UzBOT) that ties a guaranteed offtake arrangement during the operating period to a phased, upgraded-condition return of assets to the state at contract close. Applying this mechanism raised the ratio of bank guarantees to residual investment obligations from approximately 1.4 percent to 10.0 percent — a 7.1-fold increase — substantially strengthening the state's practical recourse if an investor defaults on its handback obligations.

5. Statistical Validation

Table 1 reports the PRISM index and its four components for selected years of the 2015-2026 period.

Table 1

PRISM index and component values, 2015-2026 (selected years)

Year	PRISM	Em	Eb	Ei	Ej	R	Kr
2015	0.028	0.572	0.000	0.158	0.219	0.725	0.110
2018	0.096	0.736	0.078	0.350	0.379	0.560	0.238
2020	0.170	0.833	0.214	0.475	0.479	0.470	0.329
2022	0.315	0.967	0.300	0.640	0.596	0.330	0.489
2024	0.481	1.000	0.406	0.792	0.706	0.218	0.649
2025	0.554	1.000	0.455	0.847	0.756	0.180	0.713
2026*	0.618	1.000	0.488	0.886	0.796	0.145	0.770

* 2026 value is a forecast. Source: author's calculations based on National Statistics Committee, Ministry of Energy and Central Bank data.

The index rose from 0.028 in 2015 (the lowest tier of a four-tier interpretation scale: high ≥0.75, good 0.55-0.75, satisfactory 0.40-0.55, unsatisfactory <0.40) to 0.554 in 2025 — the "good" tier — with a forecast value of 0.618 for 2026. The improvement is driven mainly by the rise in budget efficiency from 0.000 to 0.488 and the decline in integral risk from 0.725 to 0.145 over the period.

Table 2 presents Pearson correlation coefficients between PRISM and each of its underlying components.

Table 2

Correlation between the PRISM index and its determinants

Factor	r	Strength of association
Financial-commercial efficiency (Em)	0.9078	Very strong, positive
Budget efficiency (Eb)	0.9781	Very strong, positive
Production-technological efficiency (Ei)	0.9787	Very strong, positive
Socio-economic efficiency (Ej)	0.9776	Very strong, positive
Integral risk coefficient (R)	−0.9759	Very strong, negative
Risk-stability coefficient (Kr)	0.9951	Very strong, positive

All coefficients exceed 0.90 in absolute value, classified as "very strong" associations. This confirms the internal consistency of the PRISM construct but also signals a high degree of multicollinearity that must be addressed explicitly at the regression stage.

Table 3 reports the results of the multiple OLS regression of PRISM on its determinants.

Table 3

OLS regression results (dependent variable: PRISM index)

Variable	β	t-statistic	p-value	Interpretation
Risk-stability coefficient (Kr)	1.4143	22.11	0.000	Significant
Socio-economic efficiency (Ej)	−0.5243	−5.23	0.001	Significant, sign reversed (multicollinearity)
Budget efficiency (Eb)	0.0903	1.80	0.116	Not significant (p>0.05)
Constant	0.1027	—	0.001	Significant

The model fit is formally very high (R^2 = 0.9998; F = 10328.49), but this must be interpreted cautiously given the multicollinearity identified in Table 2. The risk-stability coefficient (Kr) is the only consistently robust predictor (t = 22.11; 95% CI 1.263-1.566), corroborating the near-perfect correlation between PRISM and Kr reported in Table 2 (r = 0.9951). The negative and counter-intuitive sign on socio-economic efficiency, and the statistical insignificance of budget efficiency (p = 0.116), are best explained by coefficient sign reversal under multicollinearity rather than as genuine causal effects, and should not be interpreted as evidence that these dimensions are unimportant.

Diagnostic tests support the reliability of the standard errors underlying these estimates: the Breusch-Pagan/Cook-Weisberg test does not reject homoskedasticity ($p = 0.6284$), the Durbin-Watson statistic ($d = 2.47$) is close to the no-autocorrelation benchmark of 2, and Durbin's alternative test finds no statistically significant first-order serial correlation ($p = 0.4024$). Forecasts to 2031 based on a logistic trend (financial-commercial efficiency, saturated at 1.0 since 2023) and a linear trend (budget efficiency, $y = -0.0960 + 0.0494t$) indicate continued, gradual improvement in the underlying components of the index through the forecast horizon.

6. Discussion

The findings extend the value-for-money literature (Grimsey and Lewis, 2004, 2005) from the level of individual project appraisal to the level of sectoral monitoring, providing a risk-adjusted, multiplicative metric that is harder to game through selective reporting of favourable financial indicators alone. The dominance of the risk-stability coefficient in the regression results is consistent with Yescombe's (2007) emphasis on cash-flow stability as the foundation of project finance and lends empirical support to the theoretical claim of Engel, Fischer and Galetovic (2014) that fiscal sustainability, not headline profitability, should anchor PPP evaluation.

Two limitations should temper the strength of these conclusions. First, the high multicollinearity among the four PRISM components constrains causal interpretation of the individual regression coefficients; the correlation results in Table 2, rather than the regression coefficients in Table 3, should be treated as the primary evidence of the model's internal structure. Second, the framework has so far been empirically tested primarily on a single large energy portfolio, so the generalisability of the five-element loop — particularly the institutional-governance element, whose effects are the hardest to quantify directly — to smaller or differently structured projects has not yet been established. A phased validation across at least three projects of different size, planned for 2026-2027,

is recommended as the next empirical step, consistent with the incremental approach favoured in the PPP evaluation literature (Hodge and Greve, 2021).

7. Conclusion and Policy Recommendations

— A five-element governance framework — strategy, fiscal-legal basis, institutional governance, project process, and execution and monitoring — is proposed to reposition PPP management in the energy sector from isolated project appraisal to coordinated sectoral development, organised around a central, risk-adjusted PRISM evaluation core.

— Applied to Uzbekistan's energy-sector PPP portfolio for 2015-2026, the PRISM index rose from 0.028 to 0.554 (2025) and is forecast to reach 0.618 in 2026, while construction risk fell from 0.55 to 0.16 and the bank-guarantee-to-residual-obligation ratio increased 7.1-fold under the contract-level asset-return mechanism.

— Statistical validation confirms very strong internal consistency among PRISM's components ($|r| > 0.90$) and identifies the risk-stability coefficient as the dominant driver of overall performance ($\beta = 1.4143$; $p < 0.001$), while flagging multicollinearity as a constraint on causal interpretation.

— National PPP authorities and development-finance institutions are encouraged to adopt the framework as a methodological standard, linking results-based payment to PRISM thresholds (prioritising projects scoring ≥0.75), formalising contingent-liability disclosure, and piloting the framework across projects of varying size in 2026-2027 to test its generalisability.

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