

Coupled Stochastic--Robust Multi-Objective Shale Development Scheduling Under Price and Carbon Policy Uncertainty

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Extended Abstract

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Abstract Summary

Shale oil and gas development decisions increasingly face coupled uncertainty from commodity prices, carbon-policy transitions, financing discipline, and operational constraints. This paper proposes a coupled stochastic--robust multi-objective optimization framework for strategic well scheduling over a 10-year field development horizon and a 20-year production life. The model simultaneously maximizes expected net present value (NPV), maximizes net present value ratio (NPVR), and minimizes expected emission intensity, while enforcing hard constraints on annual budget, rig capacity, cumulative inventory, minimum development scale, and a 95% conditional value-at-risk (CVaR) funding-gap limit. Commodity prices are simulated through correlated geometric Brownian motion (GBM) for gas and oil, while policy uncertainty is represented by regime-contingent carbon taxes, CAPEX inflation, OPEX shifts, inventory tightening, realized-price penalties, and development delays. Engineering production is modeled using type-specific hyperbolic decline curves and condensate-gas ratios. The resulting nonlinear, simulation-based, mixed-integer multi-objective problem is solved using Non-dominated Sorting Genetic Algorithm II. Results show a pronounced tri-lemma among scale, capital efficiency, and carbon performance. The maximum-profit strategy attains the highest expected NPV, the maximum-NPVR strategy materially reduces capital stress, and the minimum-emission-intensity strategy reconfigures the drilling mix toward lower-intensity well types rather than merely shrinking scale. The framework contributes an integrated decision-analytic architecture for shale project planning under joint market and regulatory uncertainty.

Presenting Author Biography

Energy professional with China National Petroleum Corporation (CNPC) since 2010, specializing in financial valuation modeling, risk assessment, and portfolio optimization for upstream oil and gas projects across Canada, Russia, Venezuela, Iran, Iraq, and Azerbaijan.

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