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Flexible Operation of Renewable Fuel Production Navigating Long-Term Offtake Contracts

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Extended Abstract

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Abstract Summary

This study addresses the challenge of operating renewable fuel plants profitably while meeting long-term contractual obligations for both power procurement and fuel delivery.

Renewable fuel production is expensive and highly exposed to electricity price volatility. While long-term contracts help stabilize cash flows and attract financing, they risk reducing the operational flexibility that producers need to respond to market opportunities. From an energy systems perspective, flexible operation is also essential for aligning power-to-X consumption with variable renewable generation.

To tackle this, the authors develop a rolling horizon decision-making framework built around a key concept: the internal strike price (ISP). A heuristic that estimates the opportunity cost of producing fuel versus selling electricity, derived from a production-weighted price duration curve. This ISP-guided strategy is benchmarked against three alternative planning approaches and a hindsight-optimal solution.

Applied to a 250 MW electrolyzer plant in Portugal with 50% of ammonia output under an annual offtake contract, the ISP strategy achieves 78% of optimal earnings - only 0.3 percentage points below the most sophisticated model, but at roughly 1/14th of the computational cost. This demonstrates that a well-calibrated opportunity cost metric can effectively guide day-to-day production planning without heavy optimization overhead.

The study further shows that introducing a ±10% buffer on contracted volumes increases obtained profits by 7.9%, while simultaneously enabling more flexible, energy system supportive operation.

The authors conclude that contract design and accurate opportunity cost estimation can reconcile commercial stability with operational flexibility, which are crucial steps toward making green fuel production economically viable at scale.

Presenting Author Biography

Frederik Skou Fertin is a graduate from the Technical University of Denmark. He received the M.Sc. degree in Sustainable Energy Systems with a focus on optimization and linear programming, as well as energy system analysis. He participated in the 2025 conference on Agent Based Modelling for Energy where he introduced his work on system dynamics modelling of Europe's prospective hydrogen adoption.