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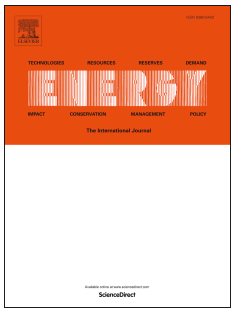

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Optimal Shale Oil and Gas Investments in the United States

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Abstract

We present a comprehensive supply chain optimization model to determine optimal shale oil and gas infrastructure investments in the United States. The model encompasses multiple shale plays, commodities, plant locations, conversion technologies, transportation modes and both local and foreign markets. The dynamic evolution of supply, demand and price parameters and the uncertainty in parameter realizations are fully taken into account. Imposing two different scenario sets over a time horizon of twenty-five years, the model maximizes the expected net present value of the entire undertaking. We analyze the features of the optimal infrastructure investments and associated operating decisions, perform case studies which highlight the importance of incorporating uncertainty into the model and analyze the stability of the stochastic solutions as the degree of uncertainty changes. The overall opportunity set of investments is sparse, and there is a tendency for over-investment in new liquefied natural gas capacity when the uncertainties in future oil prices are not taken fully into account.

Keywords: Shale oil and gas, Infrastructure investments, Supply chain optimization, Stochastic programming, Mixed-integer linear programming

1. Introduction

The energy landscape in the United States has been transformed with the growing production of oil and gas from shale rock formations in recent years. From 2008 to 2013, crude oil production grew from 5.0 to 7.4 million barrels a day, and dry natural gas production grew from 20.2 to 24.3 trillion cubic feet per year[1]. With these levels of growth, there has been an accompanying increase in

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