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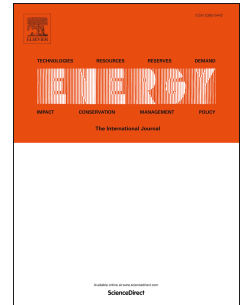
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Benefits of a Multi-Energy Day-Ahead Market

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Abstract

Energy system integration can bring several benefits to energy systems, notably to those that are in transition to high shares of renewable energy. Strategies are needed to realize the theoretical benefits of this approach in practice. Therefore, this paper proposes the organization and mathematical formulation of a multi-carrier day-ahead market in which electricity, gas and heat are traded simultaneously. This market set-up is applied to a conceptual test case to identify how - compared to a reference set-up mimicking the current practice - the multi-carrier market is able to unlock the benefits of energy system integration. It is quantitatively shown that the multi-carrier market (1) eliminates the need for forecasts of prices on subsequent markets and the consequences of the related errors, (2) allows to use the flexibility available in one carrier to facilitate the balancing in another, e.g. using the flexibility of a heat system to help balance the electricity system, and (3) enables specific market outcomes, unachievable in a sequential set-up, which increase the optimality of the market outcome.

Keywords: Renewable energy, Flexibility, Power system planning, Power system operation, Electricity storage

1. Introduction

1.1. Energy system integration

Energy system integration is receiving increasing attention of both the scientific and regulatory community, evidenced e.g. by the call for integrated approaches in the European Commission's winter package [1]. This attention is driven in part by practical evolutions, such as the increasing deployment of heating networks and the cost evolutions of certain technologies; in part by the promises energy system integration holds for

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