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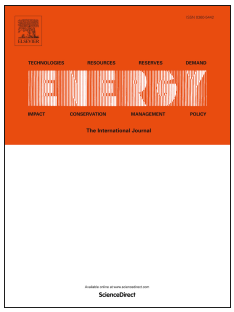

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Benefits of DSM measures in the future Finnish energy system

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Abstract:

Increasing the share of renewable and nuclear energy has been some of the key ingredients in the Finnish energy and climate strategy for de-carbonising the energy mix. Integrating large shares of variable renewable energy generation to a system with a large share of inflexible generation, such as nuclear power, can however lead to a decrease in system efficiency as the availability of variable renewable energy and demand can be in mismatch, further leading only to sub-optimal economic dispatch of generation units. The focus of this paper is on demand shifting in the residential and commercial sector. We estimate the hourly flexible demand potential and model the management of this end-user demand-side resource according to availability of variable RES generation. Moreover, to analyse the implications of demand shifting on energy system level, we model the Finnish energy system in future scenarios with large amounts of wind power, photovoltaics and nuclear power. Results indicate that in most cases studied demand response can provide an efficient means to integrate RES, improve security of supply and reduce energy system costs.

Keywords:

Energy market, Energy system analysis, Demand side management, Power system flexibility, Variable renewable energy.

1. Introduction

Use of renewable energy sources (RES) has increased significantly in the European Union (EU), especially in the electricity market. Furthermore, EU has ambitious plans for further integration of RES electricity to de-carbonise the electricity generation mix, and subsequently to reduce greenhouse gas emissions [1]. Thus far the rapid growth, and plans for further deployment, of RES capacity has mainly been driven by national energy and climate policies (i.e. feed-in tariffs, quota systems, green certificates, subsidies and other cost incentives) instead of market-driven logic [2]. This policy-driven logic to achieve ambitious RES targets may, however, overlook the technical and market challenges that are inherent with variable RES generation, i.e. stochastically varying generation can experience substantial inter-temporal variations and is only partially predictable. Integrating large shares of variable RES into the energy system can therefore influence the short-term operation of the system, as well as the long-term development of the generation portfolio and energy system infrastructure.

In the short-term, large-scale integration of variable RES can cause hourly supply and demand imbalances, which can lead to a decrease in system efficiency, as economic dispatch of generation units may be operated only in a sub-optimal level. Previous research has shown the effect of large-scale integration of variable RES generation on the higher requirements for more flexible