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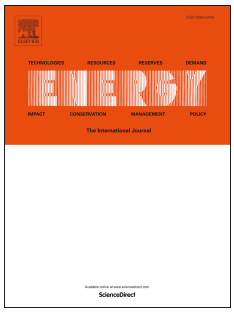

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Heat coupling of the pan-European vs. regional electrical grid with excess renewable energy

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Abstract

The feasibility of heating sector integration into future highly renewable electrical grid is examined for a regional and pan-European network. A novel geographical weather dependent model for calculating the heat demand using a temporal resolution of an hour with a spatial resolution of 40x40km^2 and an optimized solution for the utilization of excess renewable generation with least energy needs is presented. Heating sector is modeled and coupled separately with two different heat coupling models, heat-pump coupling and electric-resistance coupling, both having heat-storage and gas-boiler. Results show coupling with the regional network requires least heat-storage capacity and coupling with an individual country network requires the least gas-boiler capacity. However, coupling with the pan-European network results in least balancing energy needs. It is found that heat-pump coupling provides more benefit than the electric-resistance coupling, with 4 times more heat-storage energy and 38% less requirement for the gas-boiler energy. Optimum energy mix between the heat-storage energy and gas-boiler energy suggests that the present amount of excess generation is not enough to fully support the heating sector, but if the renewable energy generation is increased by 50% then heat-storage will play an important role.

Keywords: Renewable energy; excess generation; heat pump; heat coupling; heat storage; district heating.

1. Introduction

With recent environmental and health concerns, there is an immense increase in the integration of decentralized generation into the electrical grid. In 2009, the European Union (EU) set an ambitious target of achieving an 80% reduction in greenhouse gas (GHG) emissions by the year 2050 from the level recorded in 1990 [1]. In the recent report titled 'energy roadmap 2050', the EU has proposed six different strategies which focus on the electrification of the heating sector [2]. Furthermore, several researchers have suggested that it

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