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How heat pumps and thermal energy storage can be used to manage wind power: A study of Ireland

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Abstract

Although energy for heating and cooling represents the largest proportion of demand, little progress towards meeting environmental targets has been achieved in these sectors. The recent rapid progress in integrating renewable energy into the electricity sector however, can help in decarbonising heat by electrification. This paper investigates the impacts and benefits of heat electrification in a wind dominated market by considering two options; with heat pumps, and with direct electric heating, both operated with energy storage. The Irish all-island electricity market is used as a case study. Modelling results reveal the significant potential of heat pump electrification, delivering at least two and three times less carbon emissions respectively, when compared with conventional options such as gas or oil for 20% of domestic sector of the All Ireland market. Heat electrification using direct, resistive heating systems is found to be the most carbon intensive method. Energy storage systems combined with heat pumps could deliver potentially significant benefits in terms of emissions reductions, efficient market operation and mitigating the impacts of variable renewable energy on baseload generation. The main barrier to heat electrification in the all island market is the absence of appropriate policy measures to support relevant technologies.

Key words: heat electrification, heat pumps, direct resistive heating, thermal storage, electricity market model

1. Introduction

In order to decarbonise the energy system, strict measures have to be applied in its three sectors: heating and cooling, transport and electricity. Most progress to date has been achieved in electricity. Heating and cooling however, is the largest area of energy demand, consuming around 50% of final energy supply in the EU, with fossil fuels accounting for 75% (EU COMMISSION, 2016). In its heating and cooling strategy, therefore, the EU Commission has emphasised the requirement to increase the utilisation of renewable energy for heating and cooling, and to move towards smart, efficient and sustainable heating and cooling systems (*ibid.*).

The Northern Ireland (NI) and Republic of Ireland (RoI) domestic sectors are currently heavily dependent on oil heating, which supplies 62.8% (NISRA, 2015) and 43.8% (SEAI, 2013) of households in the two jurisdictions respectively. Despite the targets to achieve 12% of final heating demand from renewable sources in the Republic of Ireland (DCENR, 2009) and 10% (DETINI, 2010) in Northern Ireland by 2020, slow progress so far suggests that these targets are unlikely to be met. Given the absence of significant biofuel potential and limited gas networks in Ireland, combined with one of the best wind and tidal resources in the world, electrification could be a winning solution for the heating sectors in both jurisdictions (A. Chiodi, 2013).

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