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A quantitative analysis of the impact of wind energy penetration on electricity prices in Ireland

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Abstract

The maturity of wind technology combined with availability of suitable sites means Ireland is on course to generate 40% of its electricity from the wind by 2020. This work sets out to quantify, to what degree, if any, increased wind penetration translates into reduced wholesale and retail prices for electricity. The consensus from the literature is that increasing wind penetration reduces wholesale electricity prices, but views vary as to what degree this translates into reduced retail prices for the consumer.

This work demonstrates the effect of wind energy penetration on the price of electricity in Ireland using quantitative data from the market and grid operators. An analysis of the data reveals that increasing wind penetration is having little impact on average prices.

This work concludes that, due to the fact that imported UK gas powered generation is the main (48%) form of electricity generation in Ireland, the changes in Irish wholesale electricity prices are primarily determined by UK gas prices and that increases in wind penetration in recent years have not affected this relationship. This, and the presence of a minimum tariff received by producers, enables wind energy providers to compete on price, representing a sound commercial basis for investment in renewables, while continuing the trend of reduced, imported fossil fuel, dependence in Ireland.

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1. Introduction

Irish policy on electricity markets and targets for renewable generation are primarily directed by EU policy and international targets [1]. Ireland is seeking to supplant a large proportion of its, predominantly fossil fuel based, electricity generation capacity with renewables in order to fulfil its requirements under EU directive 2009/28/EC in which the EU is seeking to source 20% of its total primary energy requirement from renewable sources by 2020. In order to achieve the target, laid out under 2009/28/EC, the government of Ireland have set a target of 40% of electrical system demand to be met by renewable sources by 2020 [2]. Ireland's technical wind energy resource was estimated at 613 TWh per year compared to Ireland's annual electricity consumption of 27 TWh in 2003 [3]. Figures from the current work show that annualised wind energy generation met a mean of 18% of system demand in Ireland in 2013 [4].

The aim of this study is to examine the effect of wind energy penetration, wind generation as a percentage of demand, on both the wholesale and retail prices of electricity in Ireland.

A literature review will establish the extent of the impact of wind penetration on the price of electricity based on international and national studies.

This work shall then present historical trends in wind penetration and system marginal price (SMP), based on data gathered from the transmission system operator and single electricity market operator [4-6]. These are then averaged over daily, weekly and monthly periods. In addition data on UK natural gas prices is collected from the commodity trading website www.theice.com [7].

Historical trends in retail prices for the two most common price bands in Ireland will also be presented and compared with the retail prices in Denmark. This data is available from the sustainable energy authority of Ireland (SEAI) [8]. Denmark is chosen as it has a higher level of wind penetration than Ireland and current trends in Denmark may give an indicator of the future direction of the Irish market.

1.1. Background

48% of electricity produced in Ireland is from imported gas, while up to 80% is from imported fossil fuels [9]. Ireland has one of the highest dependencies on imported fossil fuels for electricity generation in Europe which is why its electricity prices are generally higher than other European countries, for example France, which has large amounts of nuclear, or Norway, which has large amounts of hydro. Since imported fossil fuels have such an influence on Irish electricity prices this suggests that there is a strong linkage between electricity prices and global oil prices. Table 1 shows that Ireland has a target of 40% of electricity production from renewable sources as a major contributor to achieving its overall target under its national renewable energy action plan (NREAP).

Table 1. Ireland's renewables share and targets under NREAP[10].

% of each Target												Targets	
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2010	2020
RES-E	4.9	4.1	5	6.8	8.6	9.4	11.9	14.4	14.8	16.8	19.6	15	40
RES-T	0	0	0	0	0.1	0.5	1.2	1.5	2.6	3.6	3.8	3	10
RES-H	2.6	2.1	2.4	3.5	3.6	3.7	3.6	3.9	4.4	5	5.2	5	12

1.2. Impact of renewable generation on electricity prices

The relative maturity of wind technology and ready availability of suitable sites means that wind energy will have the greatest impact on Irish electricity prices when compared to other renewable sources [11]. Due to the vagaries of wind, wind power comes at a cost [12] and, in general, the higher the commitment to wind power in a system, the more costly the uncertainty of wind generation becomes. This is because expensive fossil fuel powered plants must be ramped up at short notice [13, 14]. It has therefore been accepted that while wind energy will displace conventional thermal plant, it will only have a limited capacity, as in order to maintain system security and

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