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# Analysis of the impact of wind on electricity prices based on selected European countries

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**Abstract**

This paper presents an analysis of how wind farms affect electricity prices in four European countries, which although they have invested heavily in wind power differ from each other in the number and type of operational power plants. The countries selected were: Poland, the UK, France and Italy. The approach focused on short-term analysis of market and generation data, to determine if there are behaviors typical for all countries. The results showed that, despite differences in the power mix, all of the countries present similarities in price fluctuations – high power demand and cold weather in the winter period usually overlaps with low wind farm generation levels and electricity can become 2 or even 3 times more expensive. This paper clearly demonstrates the need to develop sufficient means for energy storage hand-in-hand with commissioning increased wind farm capacity.


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Keywords: Electricity, wind, wind farms, production, energy prices

## 1. Introduction

Wind farms are a common sight nowadays, but how is the rise of the weather-dependent wind turbine impacting our energy systems and everyday life?

This issue has caught attention of researchers – e.g. Sáenz de Miera et al. [1] in 2008 checked how the growing number of wind farms is affecting Spain. Taking into consideration the cost of governmental help in the form of feed-in-tariffs, as well as the lower demand for energy from conventional power plants they showed that electricity prices can be lowered by 25%, which is felt by industry and the regular consumer. Similarly, O'Flaherty et al. [2] in 2014 checked the impact of wind farms on the Irish energy system, and compared it with the Danish system. They concluded that while there was a small increase in Irish electricity prices, it is hard to pinpoint definite correlations, whereas in the compared Danish system, which had a much bigger share of RES (and wind farms), there was no visible increase in electricity prices. Katterer [3] in 2014 and Baker et al. [4] in 2015 presented a different approach on the topic – while analyzing respectively the situation in Germany and the UK, they pointed out the need for a well thought through support mechanism to enhance the overall status of an energy system featuring unreliable energy sources such as wind farms. Another approach was taken by Mearns [5], who in 2015 published calculations on the possibility of constructing an enormous hydroelectric pumped-storage plant in


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Scotland with capacity in excess of 100 GW – an idea that could in theory revolutionize the British power system, providing an ability to store practically any amount of energy produced by wind farms (among others). All of the articles cited above analyzed a relatively long period of time (multiple months and years). A different approach was selected by Parkinson [6] in 2014, when he searched for possible correlations between Australian electricity prices and wind farm generation in a timeframe of just 5 days. Parkinson showed the massive impact of wind farm generation on electricity prices, where prices could change their value 4-times in just a few hours.

This article takes an approach similar to Parkinson's and looks at how wind farm power generation affects electricity prices in four countries (Poland, France, UK and Italy) whose power mix differs in terms of type of power plants. The analysis is based on data from January 2016.

## 2. The impact of variable wind farm generation on electricity prices

Born of a desire to reflect the diversity that countries around the world feature in terms of regulation and dominant types of power plants, the data subject to analysis comes from four contrasting countries: Poland, France, Italy and the UK. The time period of the analysis was January 2016 and the data compared are market electricity prices together with wind farm generation figures, and the typical means of regulation used in these energy systems are commented.

Table 1 Character of installed capacities in selected countries. Our study, based on: [8] [9] [10] [11] [12] [13] [14] [15] [16]

| Country | Poland | France | UK | Italy |
|---|---|---|---|---|
| **Data for (year for wind capacity data)** | **2014 (2015)** | **2015 (2015)** | **2014 (2015)** | **2014 (2015)** |
| Unit | | | MW | |
| **Plant type:** | | | | |
| Nuclear | - | 63 130 | 9 937 | - |
| **Coal-fired** | **29 511** | **3 007** | **24 838** | |
| Gas-fired (natural gas, oil, CCGT units) | 927 | 10 901 | 35 571 | ~71 000 |
| **Hydroelectric (pumped)** | **2 207 (1700)** | **25 421 (12 000)** | **4 311 (2 744)** | **~22 500 (>5 000)** |
| Wind | 5100 | 10 358 | 13602 | ~8 958 |
| **Solar** | **no data** | **6 191** | **no data** | **~18 000** |
| Other | 2192 | 10 348 | 4747 | ~5 200 |
| **Total** | 39 937 | **129 365** | **93 006** | **125 658** |
| **Demand level [GW]** | **10 - 25** | **40 - 70** | **25 - 40** | **25 - 40** |

A cursory comparison Polish system appears the least prepared to incorporate a massive amount of variable wind farm power (as it has the lowest storage capacity) – this should be reflected in highest price fluctuations accompanying changes in wind farm generation. In contrast, in France the change in prices should be close to zero. However, these are just vague speculations – precise conclusions become visible after completing the analysis.

Below are presented diagrams of wind farm generation levels from January 2016 for the selected countries – in order: UK, France, Italy, Poland – which will be analyzed. The graph for the UK is