The Drivers of Power System Emissions: An Econometric Analysis

Amy O'Mahoney[1] (omahonea@tcd.ie), **Benjamin Hobbs**[2] **(**bhobbs@jhu.edu),
Mark O'Malley[3] (mark.omalley@ucd.ie)**, Eleanor Denny**[1] (dennye@tcd.ie)
[1]*Trinity College Dublin* [2] *Johns Hopkins University* [3] *University College Dublin*

Introduction

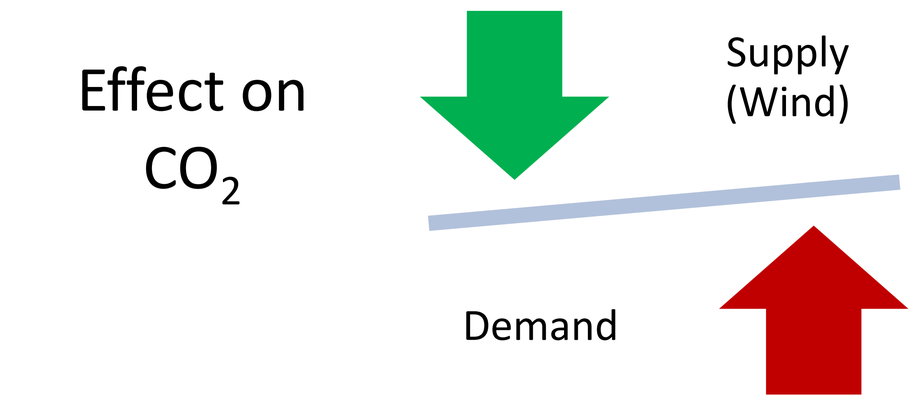
- This research compares the effectiveness of two emissions reduction policies in the Republic of Ireland, considering the historic impact of wind and demand reduction on emissions output

Objectives:

- **Model the historic drivers of power system emissions**
- **Identify the factors most effective in reducing power systems emission levels**
- **Compare the forecast errors associated with both wind and demand to identify whether one form of error results in higher levels of CO_2 emissions than the other**

Methodology

- Time series regression analysis approach

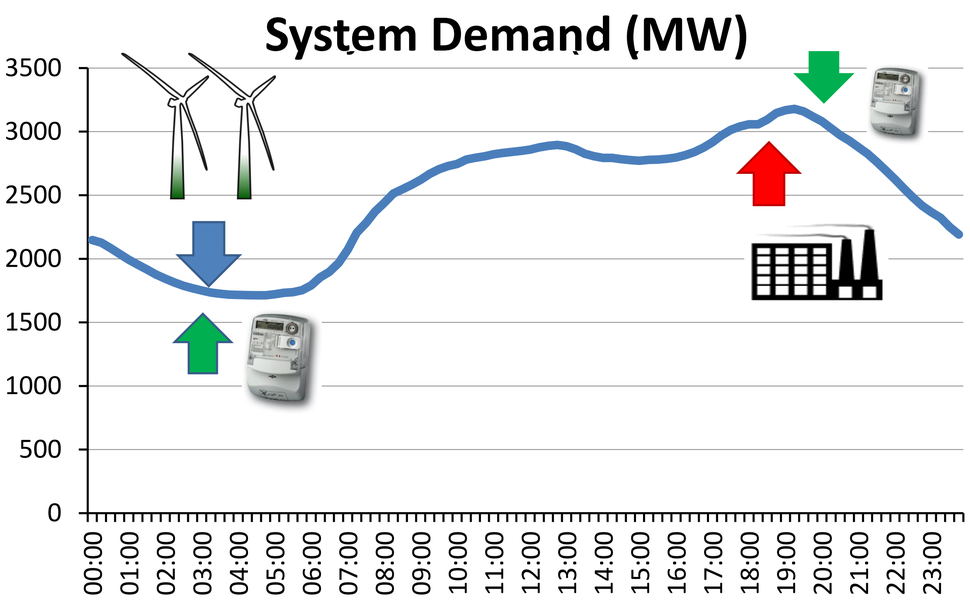


Data

- Half hourly data from the Republic of Ireland from January 2010 to September 2012

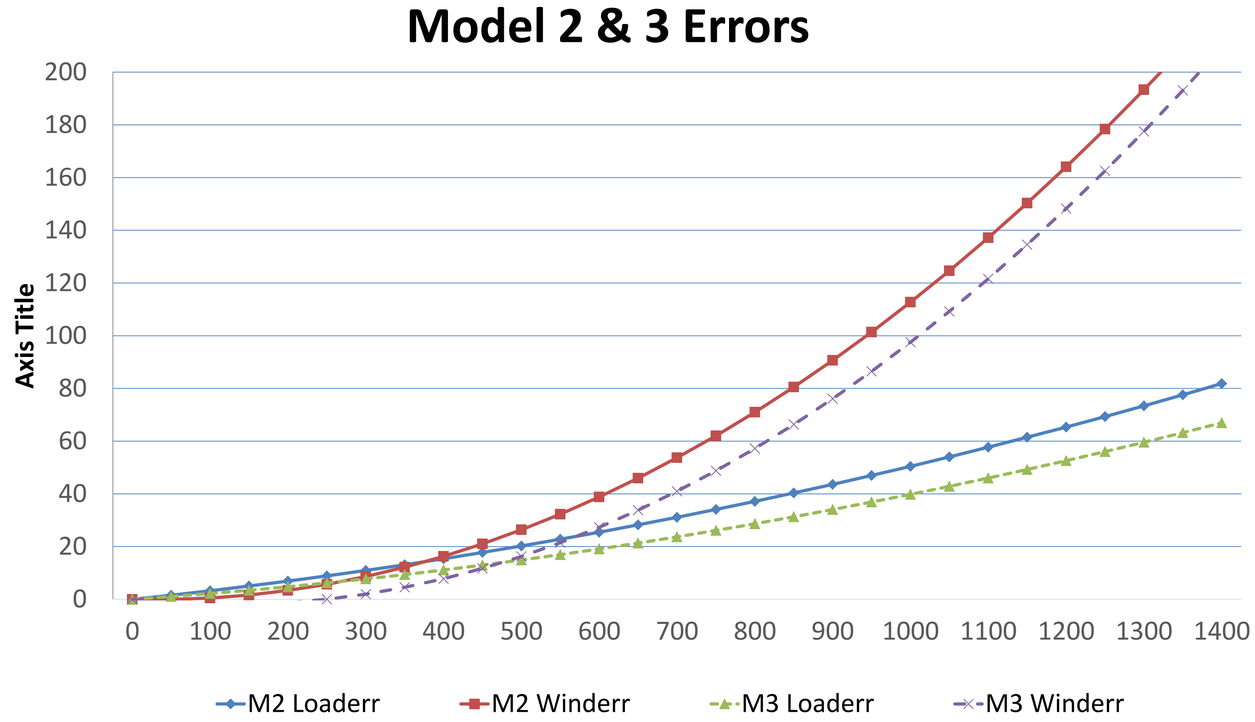
Table 1. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CO_2	32655	1405	360	533	2897
Netload	31973	2766	583	1481	4693
Loadfcast	32723	2980	639	1584	5144
Wind	32655	458	355	1	1474
Windfcast	32723	473	367	0	1523
Loaderr	32655	556	400	0	1301
Winderr	32655	89	85	0	1127



Results

- In all model specifications:
  - Netload increases emissions by 0.6 tonnes/MWh
  - Wind reduces emissions by 0.4 tonnes/MWh



- The effect of wind and load errors do not appear to be consistent in any model specification

Table 2 Regression Results

	Model 1	Model 2	Model 3	Model 4
Netload	0.3125***	0.3120***	0.3120***	0.3107***
Wind	-0.2018***	-0.2057***	-0.2062***	-0.2053***
Loaderr		-0.0305***	-0.0198***	
Loaderr2		-0.0000***	-0.0000***	
Winderr		0.0073	0.0325***	
Winderr2		-0.0001***	-0.0001***	
Error	-0.0276***			
Error2	-0.0000***			
Inter			-0.0001***	-0.0002***
Inter2				-0.0000***
Obs	32,041	32,041	32,041	32,041
R-squared	0.6335	0.6361	0.6363	0.6342
*** p<0.01, **p<0.05, *p<0.1				

Conclusions

- **The analysis indicates that wind is less effective than demand reduction in terms of reducing CO_2 emissions**
- **A 1 MW reduction in demand results in approximately a 0.3 tonne reduction in CO_2 emissions per 30 minute period, compared to 0.2 tonnes from wind**
- **Wind and load forecast errors do not appear to have comparable effects on power system emissions**

Acknowledgement

This work was conducted in the Department of Economics, Trinity College Dublin, and the Department of Geography and Environmental Engineering, Johns Hopkins University. This research is funded through a Teagasc Walsh Fellowship and the Electricity Research Centre, University College Dublin, Ireland, which is supported by Bord Gáis Energy, Bord na Móna Energy, the Commission for Energy Regulation, Cylon Controls, EirGrid, Electric Ireland, the Electric Power Research Institute (EPRI) (US), Energia, ESB International, ESB Networks, Gaelectric, Intel, SSE Renewables, and United Technologies Research Centre, Ireland (UTRCI).