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DO WIND FARMS REALLY REDUCE CO₂ EMISSIONS?

Greenhouse Gas Emissions Savings from Wind Power

R Camilla Thomson, Gareth P Harrison and John P Chick

Institute for Energy Systems, University of Edinburgh

c.thomson@ed.ac.uk



Tarong Coal-Fired Power Station

Background

There is currently no reliable estimate for the reduction in Greenhouse Gas (GHG) emissions attributable to wind power generation. It is normally taken to be the average emissions of UK electricity, despite acknowledgements that this is decreased by low-carbon nuclear energy (Fig. 1) while wind mostly replaces marginal carbon-intensive coal and gas-fired generation¹ (Fig. 2). This work estimates the true emissions savings for 2012 by carrying out a short-term marginal analysis of real data from the National Grid, taking into account the efficiency penalties for operating conventional plant at part load (Fig. 3). The method, based on that developed by Hawkes², examines the relationship between the half-hourly changes in power outputs and GHG emissions to extract the relationship between changing emissions and wind generation (Fig. 4).

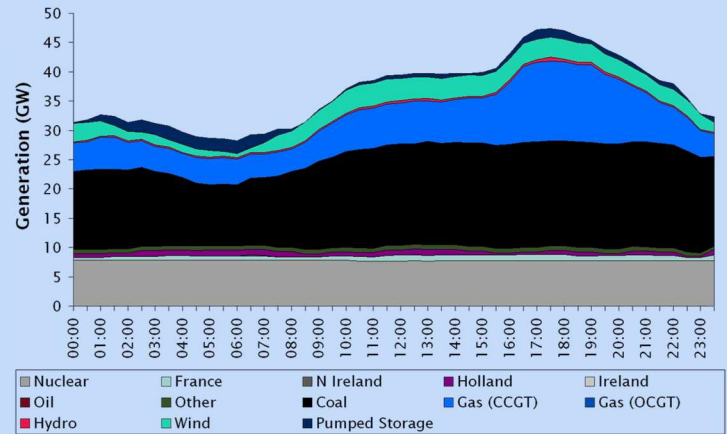


Fig. 2 – Total generation by fuel type, 9th December 2012

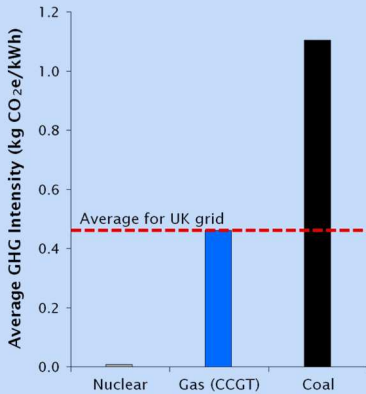


Fig. 1 – Comparison of GHG Intensities

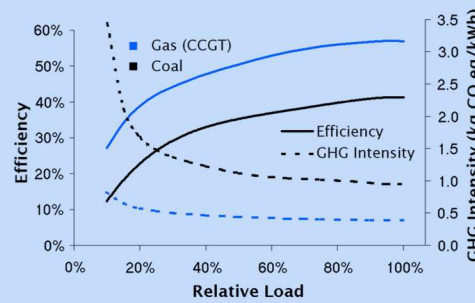


Fig. 3 – Effect of efficiency penalties on GHG intensity

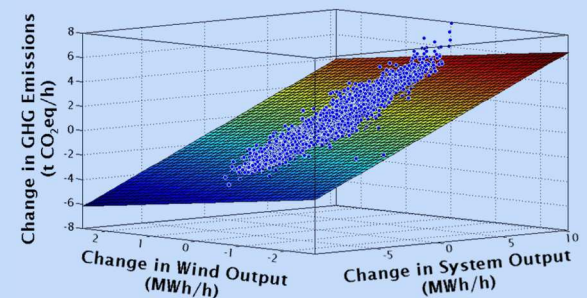


Fig. 4 – Planar fit to estimate marginal emissions savings

Results

- This analysis was based on historic generation data aggregated by fuel type, with part load curves for coal and CCGT plant developed from data from the Balancing Mechanism³.
- With fixed values applied for the GHG intensities, the average emissions savings were **0.72 kg CO₂e/kWh** for 2012 (Fig. 5)
- When efficiency penalties are considered (Fig. 3) the average emissions savings are found to be **0.51 kg CO₂e/kWh** for 2012.
- This work does not yet include a reliable model for start-up and shut-down situations, and thus may overestimate the efficiency penalties.

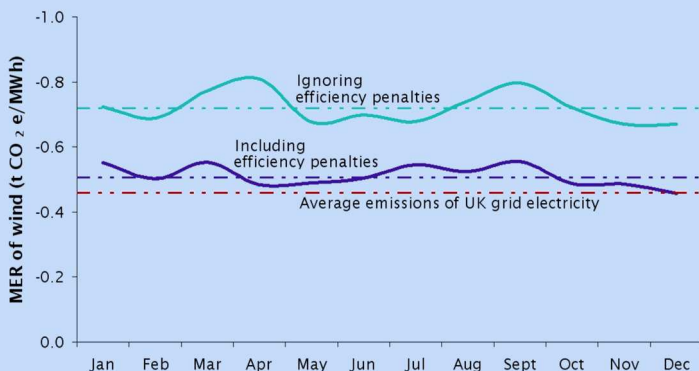


Fig. 5 – Comparing monthly and average emissions savings

Conclusions

- Reliable figures for the actual emissions savings of wind power will support carbon payback calculations and inform policy decisions.
- Wind power is mostly replacing carbon-intensive coal and gas-fired generation, but the efficiency penalties of operating these at part load mean that the GHG emissions savings are not as high as might be expected.
- The actual emissions savings are higher than the value currently used to calculate carbon paybacks, suggesting that current estimates are valid and wind farms really do reduce CO₂ emissions.

Further Work

Models of the GHG emissions during start-up and shut-down need to be developed to further refine the results. The analysis will then be extended to consider data over a longer time period, to identify whether there is a relationship between the increase in wind capacity and the GHG emissions savings.

Images courtesy of www.sixdegrees.org.au and [Leaflet at commons.wikimedia.org](http://commons.wikimedia.org)

References: 1. Advertising Standards Authority, "ASA Adjudication on RWE npower plc", 10th October 2007, from http://www.asa.org.uk/Rulings/Adjudications/2007/10/RWE-npower-plc/TF_ADJ_43298.aspx
 2. Hawkes, A.D., "Estimating marginal CO₂ emissions rates for national electricity systems", *Energy Policy*, vol. 38, pp 5977-5987, 2010
 3. Elxon, "Elxon Portal – BMRA Data Archive", Retrieved February 2013 from www.elxonportal.co.uk/bmradataarchive, 2013