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Carbon Intensity

National Grid | Carbon Intensity Forecast Methodology

Issue number: September 2017

Methodology

National Grid, in partnership with Environmental Defense Fund, WWF, and the Met Office, have developed a Carbon Intensity Forecast for the GB electricity system.

Introduction

National Grid's Carbon Intensity API (Application Programming Interface) provides an indicative trend of carbon intensity of the electricity system in Great Britain (GB) up to 48 hours ahead of real-time. It provides programmatic and timely access to both forecast and estimated outturn carbon intensity data. This report details the methodology behind the carbon intensity forecast and the Carbon Intensity Index. For more information about the Carbon Intensity API see here.

What's included in the forecast

The carbon intensity forecast includes CO_2 emissions related to electricity generation only. The forecast includes CO_2 emissions from all large metered power stations, interconnector imports, transmission and distribution losses, and accounts for national electricity demand, embedded wind and solar generation. This approach considers the carbon intensity of electricity consumed in GB.

While we recognise upstream emissions and indirect land use change impacts and other GHG emissions are important, it is only the CO_2 emissions related to electricity generation that are included in the forecast. This work does not consider the CO_2 emissions of unmetered and embedded generators for which National Grid does not have visibility of.

Methodology

Estimated carbon intensity data is provided at the end of each half hour settlement period*.

"National Grid are now forecasting carbon intensity for the GB electricity system"

Forecast carbon intensity is provided 48 hours ahead of real-time for each half hour settlement period and uses National Grid's latest forecasts for national demand, wind and solar generation.

The carbon intensity forecast therefore includes uncertainty from demand, wind and solar, as well as the uncertainty in the estimated CO_2 emissions of each fuel type. It is therefore important to note that these forecasts are likely to be less accurate than forecasts such as electricity demand, since it includes the confluence of uncertainties from demand, wind, solar, and CO_2 emissions by fuel type.

The GB carbon intensity C_t at time t is found by weighting the carbon intensity c_g for fuel type g by the generation $P_{g,t}$ of that fuel type. This is then

* A period of 30 minutes beginning on the hour or the half hour between 1 and 48.

divided by national demand D_t, to give the carbon intensity for GB:

$$C_t = \frac{\sum_{g=1}^{G} P_{g,t} \times c_g}{D_t} \quad (1)$$

The carbon intensity is then corrected to account for transmission and distribution losses to give the carbon intensity of electricity consumed [2].

Table 1 shows the peer-reviewed carbon intensity factors of GB fuel types used in this methodology [1][2]. Carbon intensity factors are based on the output-weighted average efficiency of generation in GB and DUKES CO_2 emission factors for fuels [3].

Table 1: Carbon intensity factors for each fuel type and interconnector import [1][2].

Fuel Type	Carbon Intensity (gCO_2/kWh)
Biomass†	120
Coal	937
Dutch Imports‡	474
French Imports‡	53
Gas (Combined Cycle)	394
Gas (Open Cycle)	651
Hydro	0
Irish Imports‡	458
Nuclear	0
Oil	935
Pumped Storage	0
Solar	0
Wind	0

The estimated carbon intensity uses metered data for each fuel type, which is also available from ELEXON via the Balancing Mechanism Reporting Service, and includes fuel types such as metered wind, nuclear, combined cycle gas turbines, coal etc. [4]. Estimated data is used for embedded wind and solar generation§. Weather data, such wind speeds and solar radiation, are procured separately by National Grid and so are not publically available.

† Using 'consumption-based' accounting, the carbon intensity attributable to biomass electricity is reported to be 120 ± 120 gCO_2/kWh [2]. The large uncertainty relates to the complex nature of biomass supply chains and the difficulty in quantifying non-biogenic emissions.

‡ The carbon intensity of interconnector imports is calculated using monthly ENTSO-E generation data and annual EuroStat data [2].

§ A large number of wind and solar farms are unmetered and embedded into the distribution networks, so near-real time estimates and forecast data are used to calculate carbon intensity.

Table 2 shows the Carbon Intensity Index within each of the five numerical ranges. A rolling-window linear regression for each fuel type is performed and used with forecast demand, wind and solar data to estimate forecast carbon intensity.

Table 2: Bands for the Carbon Intensity Index with numerical ranges for the years 2017-2019.

	Carbon Intensity (gCO_2/kWh)		
Index	**2017**	**2018**	**2019**
Very High	400+	350+	350+
High	300-399	300-399	250-349
Moderate	150-299	150-299	150-249
Low	50-149	50-149	50-149
Very Low	0-49	0-49	0-49

Limitations

There are a number of limitations with the approach outlined above. Firstly, this approach does not use Physical Notifications (PNs) of Balancing Mechanism (BM) units in the forecasts. This is to ensure that the commercial sensitivities surrounding the balancing market are maintained. This means that only past generation data can be used to calculate the forecast, limiting the available data for analysis and the potential forecast accuracy.

Finally, this work does not consider the CO_2 emissions of embedded generators that National Grid does not have visibility of or have access to operational metered data. Future work will look at estimating the contributions of these embedded generators to GB carbon intensity.

Contact:

We are always trying to advance the accuracy of the forecasts. If you have any suggestions, comments or queries please contact:
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References

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