

Carbon Intensity

National Grid | Carbon Intensity Forecast Methodology

Issue number: November 2017

Forecast Methodology

National Grid, in partnership with Environmental Defense Fund Europe and WWF, has developed a Carbon Intensity forecast for the GB electricity system, with weather data provided by the Met Office.

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 CO₂ emissions related to electricity generation only. The forecast includes CO₂ 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 CO₂ emissions related to electricity generation that are included in the forecast. This work does not consider the CO₂ emissions of unmetered and embedded generators for which National Grid does not have visibility of.

Methodology

The Carbon Intensity forecast is particularly sensitive to short-term forecast errors in demand, wind and solar generation, as this impacts the amount of dispatchable generation that is required to meet demand. The forecast also makes use of

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



historic generation data to make predictions about future generation, which invariably changes according to system conditions. 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 CO₂ emissions by fuel type. With these limitations in mind, the Carbon Intensity forecast should only be used as an indicative trend of carbon intensity over the next two days, and not a perfect forecast.

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

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

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 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 CO₂ emission factors for fuels [3].

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

	gCO ₂ /kWh
Fuel Type	Carbon Intensity
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
Other	300
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 gCO₂/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.

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.

An index for carbon intensity has been developed to illustrate times when the carbon intensity of GB system is high/low. Table 2 shows the preliminary numerical bands for the Carbon Intensity Index.

Table 2: Preliminary bands for the Carbon Intensity Index and numerical ranges for the years 2017-2019.

	gCO ₂ /kWh		
	Carbon Intensity		
Index	2017	2018	2019
Very High	400+	360+	320+
High	300-399	270-359	240-319
Moderate	200-299	180-269	160-239
Low	100-199	90-179	80-159
Very Low	0-99	0-89	0-79

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 CO₂ 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:

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References

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