nationalgridESO

Carbon Intensity
Balancing Actions

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Issue: April 2021

Introduction

The carbon intensity of balancing actions measures the difference between the carbon intensity of the combined Final Physical Notice (FPN) of machines in the Balancing Mechanism (BM) and the equivalent profile with balancing actions applied.

This report details the methodology behind the calculating the carbon intensity estimates. For more information about the Carbon Intensity visit here [1].

What is and is not included

The metric looks specifically at dispatchable machines in the BM. It uses the Bid Offer Acceptance (BOA) data to track balancing actions and contrast it with the unit's submitted FPN. Solar data is also considered, data is collected from Sheffield Solar found here.

This metric does not include the balancing actions of interconnectors or small BMUs. Interconnectors are connected to two energy systems and therefore NGESO is not wholly responsible for control actions. Interconnectors also do not receive instructions via BOAs.

It is important to note that the NGESO control room does not make dispatch decisions on the carbon intensity of BMUs. The remit is to balance the system and maintain system security in the most economically way possible.

Methodology

The methodology behind the carbon intensity of balancing actions is relatively straightforward. Each Balancing Mechanism Unit (BMU) belongs to a fuel type category and each fuel type has an associated carbon emissions factor, with the unit gCO_2/kWh.

BMUs submit a FPN, which is a plan of their committed schedule (barring faults). The FPN details if a unit is planning on ramping up/down or staying at a fixed level.

BOAs are balancing actions made against the submitted FPNs. Bids reduce the energy supplied by a BMU when compared to the energy that would have been supplied had it followed the FPN schedule. Offers are the reverse, offers increase the energy supplied by a BMU.

As the carbon emission factors of all BMUs are known, it is possible to make a comparison between the carbon intensity had all BMUs followed their FPNs and the carbon intensity with all BOAs applied.

For example, if wind is curtailed due to a constraint on the network the control room will instruct the wind BMU down with a bid and may compensate by instructing a gas plant up with an offer. This will result in the carbon intensity of the BOA profile being higher than that of the FPN profile.

It is important to note that this metric is not a measure of emissions but instead tracks the difference of carbon intensity. The 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, where $P_{g,t}$ is either the FPN level or BOA level. This is then divided by national demand D_t to give the carbon intensity for GB:

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

Table 1 shows the peer-reviewed carbon intensity factors of GB fuel types used in this methodology. Carbon intensity factors are based on the output-weight average efficiency of generation in GB and DUKES CO_2 emission factors for fuels [4].

On average, the difference between the two profiles will not vary by a great deal. The number of BOAs and the volume of energy instructed will be small in comparison to the levels of national demand and generation.

This rule of thumb may not apply when the national carbon intensity is approaching low levels, considered below 150 gCO_2/kWh. Carbon intensity is lowest when there are high levels of nuclear, wind and solar generation. Under these conditions, the control room may need to instruct bids to renewable sources for network constraints and stability concerns. Conventional fossil types (gas/coal) may be required to balance the system. This situation is shown below in figure 1.

Figure 1: Graph of the carbon intensity of balancing actions under high renewable generation conditions.

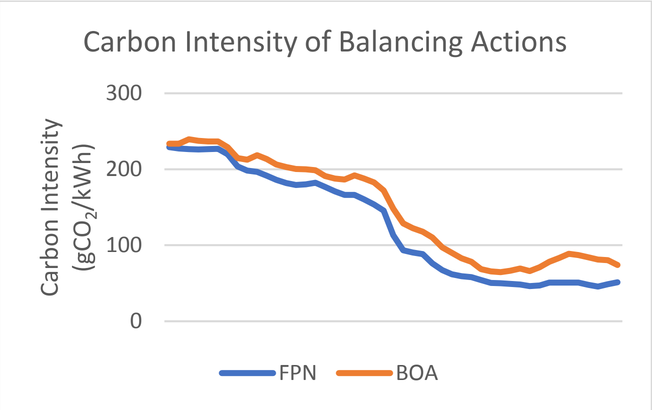

Table 2: Carbon intensity factors for each fuel type and interconnector import [2][3].

Fuel Type	Carbon Intensity gCO_2/kWh
Biomass[i]	120
Coal	937
Gas (Combined Cycle)	394
Gas (Open Cycle)	651
Hydro	0
Nuclear	0
Oil	935
Other	300
Solar	0
Wind	0
Pumped Storage	0

References

[1] Carbon Intensity API (2017): www.carbonintensity.org.uk
[2] GridCarbon (2017): www.gridcarbon.uk
[3] Staffell, Iain (2017) “Measuring the progress and impacts of decarbonising British electricity”. In Energy Policy 102, pp. 463-475, DOI: 10.1016/j.enpol.2016.12.037
[4] DUKES (2017): www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

Glossary of Terms

FPN – Final Physical Notice
BM – Balancing Mechanism
BMU – Balancing Mechanism Unit
BOA – Bid Offer Acceptance
NGESO – National Grid Electricity System Operator