Carbon Reporting Methodology

Open Networks
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DOCUMENT CONTROL

Authorities

Version	Issue Date	Authorisation	Comments
1	20/06/2022	Open Networks Workstream 1A	
1.1	26/10/2022		
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Related documents

1	Smart Systems and Flexibility Plan https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021
2	Open Networks PID 2022 ON22-PRJ 2022 Project Initiation Document (PID) (13 Jan 2022) Published
3	Agreed scope of P7 2022 https://www.energynetworks.org/industry-hub/resource-library/on22-ws1a-p7-carbon-reporting-scope-(25-mar-2022).pdf
4	Review of other carbon reporting methodologies 2022 https://www.energynetworks.org/industry-hub/resource-library/on22-ws1a-p7-report-on-existing-carbon-reporting-methodologies-(27-april-2022).pdf
5	Carbon Reporting Methodology 2022 https://www.energynetworks.org/assets/images/Resource library/2022/Dec/ON22-WS1A-P7 Carbon Reporting Methodology (26 Oct 2022).pdf

Change history

Version	Description
1.1	Updates made following consultation feedback. Expanded the discussion on choice of grid intensity factors and DTU/GTD methodology. Updated timeframes in recommendation on future work in relation to energy efficiency.
1.2	Improvements and review of future development areas.

Distribution

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Introduction

About ENA

Energy Networks Association (ENA) represents the owners and operators of licenses for the transmission and/or distribution of energy in the UK and Ireland. Our members control and maintain the critical national infrastructure that delivers these vital services into customers' homes and businesses.

ENA's overriding goals are to promote UK and Ireland energy networks ensuring our networks are the safest, most reliable, most efficient and sustainable in the world. We influence decision-makers on issues that are important to our members. These include:

- Regulation and the wider representation in UK, Ireland and the rest of Europe
- Cost-efficient engineering services and related businesses for the benefit of members
- Safety, health and environment across the gas and electricity industries
- The development and deployment of smart technology
- Innovation strategy, reporting and collaboration in GB

As the voice of the energy networks sector, ENA acts as a strategic focus and channel of communication for the industry. We promote interests and good standing of the industry and provide a forum of discussion among company members.

About Open Networks

Britain's energy landscape is changing, and new smart technologies are changing the way we interact with the energy system. Our Open Networks programme is transforming the way our energy networks operate. New smart technologies are challenging the traditional way we generate, consume and manage electricity, and the energy networks are making sure that these changes benefit everyone.

ENA's Open Networks programme is key to enabling the delivery of Net Zero by:

- opening local flexibility markets to demand response, renewable energy and new low-carbon technology and removing barriers to participation
- providing opportunities for these flexible resources to connect to our networks faster
- opening data to allow these flexible resources to identify the best locations to invest
- delivering efficiencies between the network companies to plan and operate secure efficient networks

We're helping transition to a smart, flexible system that connects large-scale energy generation right down to the solar panels and electric vehicles installed in homes, businesses and communities right across the country. This is often referred to as the smart grid.

The Open Networks programme has brought together the nine electricity grid operators in the UK and Ireland to work together to standardise customer experiences and align processes to make connecting to the networks as easy as possible and bring record amounts of renewable distributed energy resources, like wind and solar panels, to the local electricity grid.

The pace of change Open Networks is delivering is unprecedented in the industry, and to make sure the transformation of the networks becomes a reality, we have created six workstreams under Open Networks to progress the delivery of the smart grid.

2022 Open Networks programme Workstreams

- WS1A: Flexibility Services
- WS1B: Whole Electricity System Planning and T/D Data Exchange
- WS2: Customer Information Provision and Connections
- WS3: DSO Transition
- WS4: Whole Energy Systems
- WS5: Communications and Stakeholder Engagement

Our members and associates

Membership of Energy Networks Association is open to all owners and operators of energy networks in the UK.

- Companies which operate smaller networks or are licence holders in the islands around the UK and Ireland can be associates of ENA too. This gives them access to the expertise and knowledge available through ENA.
- Companies and organisations with an interest in the UK transmission and distribution market are now able to directly benefit from the work of ENA through associate status.

ENA members

ENA associates

- Chubu
- EEA
- Guernsey Electricity Ltd
- Heathrow Airport
- Jersey Electricity
- Manx Electricity Authority
- Network Rail
- TEPCO

Executive Summary

The Smart Systems and Flexibility Plan [1] sets out Ofgem and BEIS' approach to facilitating the transition to a smarter and more flexible energy system on a pathway to net zero greenhouse emissions by 2050. The plan sets out several actions for the Open Networks programme. Action 3.6 requires networks and system operators to have consistent methodologies for carbon reporting by 2023.

In 2022, the product 7 (P7) team was formed to deliver this objective. In 2023, the Carbon Reporting Technical Working Group (TWG) reviewed and updated the methodology.

This report contains the methodology that all Distribution Network Operators (DNOs) has adopted for consistent reporting. Additional notes are provided to explain the rationale and limitations of the methodology and recommendations to Open Networks as areas for further work.

This report was initially published as part of the summer 2022 consultation and was revised based on industry feedback in late 2022 [5]. This updated version includes changes made in 2023 following a review from the TWG, which includes:

- Clarifying the guidance where details are missing or unclear;
- Review of 2022 recommended development areas; and
- Producing an excel tool to help users implement and adapt the calculation.

The use of flexibility services can increase or reduce carbon emissions. These impacts have been categorised into direct, consequential, and indirect impacts. Direct impacts can include emissions from burning fuel in the case of a generator when dispatched, consequential impacts can include displacing another generator as a result of changing the energy balance, and indirect impacts can include emissions embedded in the materials used by the flexible asset. There are also counterfactual carbon impacts, such as network reinforcement or using a backup generator, from which flexibility services impacts could be evaluated.

The methodology contained in this document specifies the calculation of direct and consequential impacts, whilst indirect impacts could be added at a future date. The P7 team came to this conclusion after consideration of the policy drivers to ensure that the approach is comparable with the Electricity System Operator (ESO) and is consistent between DNO reports. Counterfactual carbon impact calculations and optioneering is beyond the scope of P7 [3].

Methodologies are standardised depending on whether the resource is generation, storage (export), or demand/storage (import). But within these broad groupings there are sub categorisations such as the type of generation, which determines the conversion factors used, such as fuel emission factors or generator efficiencies. These factors generally come from standard industry accepted sources.

The format of presenting the impacts is also specified in the methodology for inclusion in each DNO' Distribution Flexibility Services Procurement Report, as required under the distribution licence.

Introduction to carbon reporting

The P7 team was formed to develop a methodology for DNOs to calculate and report the carbon impact of flexibility service actions. In 2023, the Carbon Reporting Technical Working Group (TWG) reviewed and updated the methodology.

The scope of P7 was detailed in the Open Networks 2022 Programme Initiation Document [2] and subsequently in the approved P7 scope [3]. In developing this methodology, the product team also conducted a review of other carbon accounting methodologies [4].

This was a new area of work for the Open Networks programme in 2022, based on action 3.6 in the Smart Systems and Flexibility Plan, to develop common methodologies for carbon reporting and monitoring of flexibility markets by 2023 as part of Licence Condition 31E reporting.

This report contains the methodology that all DNOS have adopted for consistent reporting including updates in 2023. Additional notes have been provided to explain the rationale and limitations of the methodology and recommendations to Open Networks as areas for further work.

This report was initially published as part of the summer 2022 consultation and was revised based on industry feedback [5]. This report reflects changes made in 2023 following a review from the TWG.

Updates in 2023

This section explains the changes that have been made to the methodology in 2023, which broadly includes:

- Clarifying the guidance where details are missing or unclear based on feedback from TWG members following implementation in 2022.
- Investigation of other areas identified in 2022 as areas for future development including grid intensity factors and use of asset-specific data.
- Producing an excel tool to help users implement the calculation for their own purposes.

Clarifying the guidance

The following table lists the change or clarification made (or recommended where there is dependency on further engagement with Ofgem).

Change	Rationale
LC31 technology types - adding more granularity to technology categorisation in the Distribution Flexibility Services Procurement Report appendices template. Pending engagement with Ofgem.	Currently LC31 technology categories are based on energy source but not the conversion technology. This results in different technologies placed into the same category. This additional field adds transparency and better aligns with the carbon impact calculation.
Storage treated like demand - clarification that storage technologies that deliver flexibility through its imports should be calculated differently to storage technologies that deliver flexibility through their exports. Whether this is categorised as	An EV that shifts load to another period is behaving as demand. The storage calculation (for an increase in exports) considers the charge-discharge cycle which isn't relevant here. If it is unknown whether the storage is providing flexibility through its imports or its exports

Demand or Storage under LC31 is pending engagement with Ofgem.	then assume the more conservative assumption as per the next clarification.
Assumptions under limited data - where data is missing the DNO should use conservative assumptions that biases overestimating the impacts to encourage more information to be provided.	This general principle should guide assumptions where information is unavailable.
Treatment of multi-technology solutions – clarification that the calculation can be disaggregated based on the known contribution of each technology before being aggregated. How this is categorised in LC31 is pending engagement with Ofgem.	Calculation reflects the contribution of each technology type. In practice, DNOs may not know this contribution and in which case should use the technology type that results in the highest carbon impact as per previous clarification.
Report more granular carbon impact data – add an additional column in the Distribution Flexibility Services Procurement Report appendices template to show the carbon impact per dispatch. Pending engagement with Ofgem.	Will add greater transparency in the dataset. TWG expects this will be relatively simple to implement as carbon calculations are already calculated by dispatch.
Missing conversion factors – where there is no appropriate conversion factor available for a given solution, the DNO should attempt to source a factor and share with other DNOs via the ENA central governance (not yet set-up) for review and inclusion in standard guidance.	The central governance arrangement is pending discussion and agreement with the ENA and so the specific process cannot be specified, however the intention is to keep the standard guidance and dataset under regular review and to incorporate new information when it is required and becomes available.
Baseline for carbon calculation – DNOs should use energy delivered calculated under the contract as the energy delivered in the carbon calculations.	It would add additional complexity to have a different baseline in the carbon calculation to the commercial baseline as it duplicates the settlement calculations and energy delivered datasets.
Incorporate methodology for demand-turn-up and generation-turn-down – the DTU/GTD methodology has been moved into the main part of the report to make it more visible.	TWG received feedback that it was not clear that the DTU/GTD was included in the methodology, even though it was but was in the supporting notes section.
Standard caveat wording – standard wording to be included in the Distribution Flexibility Services Procurement Report to summarise the carbon calculation methodology, assumptions, and limitations.	Informs readers of the Distribution Flexibility Services Procurement Report of the high-level methodology used to produce the report and where to find more information..

Review of future development areas

The following table lists areas of further development, identified in 2022, that was reviewed in 2023 and the outcome of that review. The TWG gathered views from industry via a focus group held on 02 July 2023 on the key areas and checked with the Department for Energy Security and Net Zero to ensure continued policy alignment. Further discussion is included in the Supporting Notes section.

Development area	Decision and rationale
Incorporating asset-specific information into the calculation – asset specific information where available should be shared with the ENA governance (not yet set-up) for review, consultation, and adoption. DNOs should avoid adopting this information unilaterally except where no alternative standard information is available and only temporarily until ENA governance can provide guidance.	Whilst there is potential for increased accuracy in using asset specific data there are two major pitfalls. Firstly, validating that information would be particularly difficult for DNOs, and secondly, it could lead to divergences between DNO reporting. The future central governance body would be the best conduit for dissemination of new data and information. Feedback during the focus group agreed with this approach.
Time-series grid intensity factors – DNOs should continue to use a static marginal grid intensity factor to evaluate the impact on the grid from a change in demand/generation. In most cases DNOs should use a short-run marginal grid intensity factor approximated from gas generation representing the temporary impact. Where the flexibility intervention results in sustained and long-term (years) change to demand/supply then DNOs can use the Green Book long-run marginal grid intensity factor. This may apply to interventions such as energy efficiency or long-term scheduled flexibility services contracts.	There is limited benefit to adopting a time-series factor at present, but when conditions change in future this can be reviewed by ENA governance. There are three key reasons: • A marginal grid-intensity factor is most appropriate for evaluating a change than the average. The marginal grid-intensity does not vary much over time as it is currently driven by gas. • The implementation cost of moving from a static factor to a time-series factor is relatively high. • There are subscription-based datasets of time-series marginal grid-intensity available, but these are not openly accessible and therefore not ideal for transparency and replicability. Feedback from EV aggregator stakeholders at the focus group wanted to use the methodology to incentivise load shifting. However, incentivising a desired policy outcome is not the purpose of DNO carbon reporting. Nevertheless, the TWG intends to make available an excel tool to help users recreate/adapt the calculation based on their use case. The TWG also identified that the current Green Book marginal grid intensity factor is a long-run factor and does not reflect short-run impacts. Currently the Green Book marginal grid intensity factor used is 278gCO2e/kWh whilst the derived short-run factor is around 520 gCO2e/kWh.

Assumptions on consequential DSR/storage behaviour -	Due to the above decision to continue with a static grid intensity factor these assumptions are not required. However, focus group comments aligned with the TWG view that there are many variables that can determine storage and DSR behaviour and would require either further sub-categorisation or generalised assumptions based on a model DSR/storage.

Methodology

DNOs will perform the calculation by technology category without input from providers, except to confirm the technology category where required.

The calculation includes direct (such as fuel combustion) and consequential carbon impacts (such as battery charging) but excludes indirect impacts (such as embedded emissions in the materials).

The general formula varies by generation, storage (export), and demand / storage (imports). In the formulae:

- kWh is the energy delivered (as opposed to requested) measured at the site of the resource;
- η is the energy conversion efficiency of the generator *g* or storage *s;*
- EF is the fuel emission factor;
- GI is the grid intensity factor at import *i*, export *e*, or at turndown *td;* and
- Payback% is the consequential increase in load or generation following a turn-down or turn-up event respectively.

Solution	Export increase / import decrease	Export decrease / import increase
Generation	• combustion of fuel (direct) = **+kWh/η_g x EF** • displace grid generation (consequential) = **-kWh x GI**	• reduced combustion of fuel (direct) = **-kWh/η_g x EF** • replaced by more grid generation (consequential) = +**kWh x GI**
Storage (export)	• input energy (consequential) = +**kWh/η_s x GI$_i$** (if from grid), or **+(kWh/η_s)/η_g x EF** (if from generator) • displace grid generation (consequential) = **-kWh x GI$_e$**	• replaced by more grid generation (consequential) = +**kWh x GI** • displace grid generation (consequential) = • -kWh x GI

Demand or Storage (import)	• reduced grid imports (direct) = **-kWh x GI_{td}** • increased grid imports (consequential) = +**kWh x payback% x GI_i**	• increased grid imports (direct) = +**kWh x GI** • reduced grid imports (consequential) = +**kWh x payback% x GI**

Notes

Generation

- When a generator is instructed to export it burns more fuel and displaces the marginal grid generation.
- When a generator is instructed to reduce exports, it burns less fuel with the reduction replaced by an increase from the marginal grid generation. For a renewable generator assume a zero EF.
- If the generator is displacing imports, the carbon impact is the same as the equivalent amount exported directly to the grid.
- For bioenergy, report on both inclusive and exclusive of biogenic CO_2 released during burning of biomass and biofuels by using the relevant emission factors.

Storage (export)

- When storage is instructed to increase exports, it displaces the marginal grid generation. The source of that energy and the efficiency of energy conversion is also counted.
- When storage is instructed to reduce exports, the calculation assumes a temporal shifting of that export.
- If storage input energy is physically supplied from a renewable generator assume zero carbon, this does not apply to non-physical supplies of low carbon electricity, which should assume grid intensity.
- If storage discharge is displacing imports, the carbon impact is the same as the equivalent amount exported directly to the grid.
- Where DNOs are unsure whether storage is providing export increase or import reduction, use the storage calculation. This ensures carbon impacts are not underestimated and incentivises additional information to be provided.

Demand / storage (import)

- When demand or storage is instructed to reduce imports the reduction in energy is replaced by the marginal grid generation. There is a consequential rebound in load known as payback.
- When demand or storage is instructed to increase imports the increase in energy is supplied by the marginal grid generation. There is a consequential reduction in load, an equivalent to “payback”.
- If demand is shifted, such as deferred EV charging, then payback% is 100%. Otherwise, assume an associated payback as a percentage of the turn-down energy of 21%. Where DNOs are unsure, assume

load shifting. This ensures carbon impacts are not underestimated and incentivises additional information to be provided. For import increase the payback% assumption is 100%.

- Where DNOs are unsure whether storage is providing export increase or import reduction, use the storage calculation. This ensures carbon impacts are not underestimated and incentivises additional information to be provided.

Conversion factors

DNOs should use the conversion factor sources presented in the following table.

The data source used for grid intensity is a static value, all grid intensity factors is therefore equal (except for short-run and long-run factors). In the case of storage, $GI_i = GI_e$ and in the case of demand, $GI_{td} = GI_i$. The different notations in the formula allows for inclusion of time series grid intensity factors in future. See Supporting Notes for further discussion on use of grid intensity factors.

Factor type	Source	Notes
Fuel emission factors	• BEIS/Defra[1]	CO_2e, Gross CV. Updated annually.
Efficiency	• BEIS Electricity Generation Costs 2020[2] – [A] • Coal – DUKES[3] – [B] • BEIS Storage Costs and Assumptions 2018[4] – [C]	The DUKES report is updated annually, however the others are one-off reports.
Grid intensity	• Short-run: Fuel emission factors and efficiency as per above sources.	• Short-run: EF of natural gas divided by efficiency of an OCGT e.g. based on 2022 EF, 183gCO2e/kWh / 35% = 523gCO2e/kWh.

[1] Conversion factors for company reporting - https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
[2] Electricity generation costs 2020 - https://www.gov.uk/government/publications/beis-electricity-generation-costs-2020
[3] DUKES - https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes
[4] Storage cost and assumptions 2018 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/910261/storage-costs-technical-assumptions-2018.pdf

	• Long-run: Green Book data tables[5]	• Long-run: Average of consumption long-run marginal factors, use most recently updated value rather than forecasts (2021 at time of writing). Irregularly updated. • Note, long-run refers to interventions that results in sustained change in demand/generation over years. Short-run refers to interventions that result in temporary change in demand/generation.
Payback%	For demand-turn-down: Low Carbon London report[6] For demand-turn-up: TWG view	Demand-turn-down: From a one-off innovation trial. Assume 21% for reduction services, based on the average of trial events. Assume 100% for load shifting solutions. Demand-turn-up: Assume 100%

Technology categorisation

The technology categorisations are given in the following table, which maps LC31 technology categories by the relevant technology categories required for selecting the appropriate conversion factor. This is advisory rather than prescribed to allow for some flexibility where the mapping is incomplete.

The LC31 technology categories may be subject to change pending engagement with Ofgem to add additional granularity.

LC31 Technology Categorisation	Emissions Factor (and Grid intensity factor)	Efficiency	Demand payback
Advanced Fuel (produced via gasification or pyrolysis of biofuel or waste)		Advanced Conversion Technologies [A]	
Biofuel - Biogas from anaerobic digestion (excluding landfill & sewage)		Anaerobic digestion (AD) [A]	
Biofuel - Landfill gas	Biogas - Landfill gas		
Biofuel - Other	Biogas - Biogas	Energy from Waste (EfW) [A]	
Biofuel - Sewage gas	Biogas - Biogas		

[5] Green Book - https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[6] Low Carbon London - LCL-Learning-Report-A7-Distributed-Generation-and-Demand-Side-Response-services-for-smart-Distribution-Networks.pdf (ukpowernetworks.co.uk)

Biomass	Biomass - wood logs, wood chips, wood pellets, grass/straw	Biomass – dedicated [A]	
Demand	Grid intensity		Payback (21%), shifting (100%)
Fossil - Brown coal/lignite			
Fossil - Coal gas			
Fossil - Gas	Gaseous fuels - natural gas	OCGT, CCGT, Recip [A]	
Fossil - Hard coal	Solid fuels - Coal (electricity generation)	Coal [B]	
Fossil - Oil	Liquid fuel - Diesel (average biofuel blend)	Diesel [A]	
Fossil - Oil shale			
Fossil - Other	Other factors available		
Fossil - Peat			
Geothermal			
Hydrogen			
Nuclear			
Solar			
Stored Energy (all stored energy irrespective of the original energy source)	Grid intensity	Pumped hydro, CAES, thermal energy storage, Lithium Ion, Zonc, Flow, Sodium Sulphur [C]	
Waste Water (flowing water or head of water)			
Wind			
Other			

Report format

DNOs should include the following paragraph in their Distribution Flexibility Services Procurement Report should to summarise the methodology to readers and references this methodology document.

> The carbon impact calculation presented in this report follows the standard ENA methodology. The calculation varies depending on whether the flexibility asset is generation, storage (export), or demand / storage (import). The impacts include direct impacts (such as burning fuel) and consequential impacts (such as demand payback) but not indirect impacts (such as embodied carbon). The conversion factors used are generally industry standard which include grid-intensity, plant efficiencies, fuel emission factors, and payback assumptions. Asset specific factors are not used to maintain consistency between DNO reports which means that the methodology reports an approximation of carbon impacts. The detailed methodology is available on the ENA website at [*insert link to the latest methodology*].

A table in the following format should be included in the Distribution Flexibility Services Procurement Report showing energy (requested and delivered) and carbon impact (broken into direct and consequential). An accompanying narrative should explain what the data shows and use of charts to present the information is encouraged.

Energy delivered can differ to energy requested due to under or over delivery. Over-delivery is capped at 150% (captures over-delivery but excludes scenarios where over delivery may not be a consequence of the dispatch). Delivered energy is used to calculate carbon impacts.

Subject to agreement with Ofgem to update the data template, the carbon impact per dispatch should be added as another column in the template. In addition, technology sub categorisations based on Embedded Capacity Register / G99 should also be added to reflect different solutions within each LC31 category, for example if demand is shifted or reduced or the different types of Stored Energy.

For bioenergy, add an additional column to “Direct carbon impact”. In the first of these columns, report on the carbon impact exclusive of biogenic CO_2 using the default emission factors, and in the second column report on the biogenic CO_2 using the “outside of scope” emission factors, from the BEIS/Defra conversion factors (full set). The former calculation nets off the CO_2 released at combustion with the CO_2 absorbed during the growth phase of the bioenergy, whilst the latter calculation reports the CO_2 released at combustion. This is in line with the GHG Protocol guidance for corporate accounting.

Provide the dispatch intensity metric (total carbon impact divided by the total energy delivered).

LC31 Technology Category	Requested energy (MWh)	Delivered energy (MWh)	Direct carbon impact (kgCO2e)	Consequential carbon impact (kgCO2e)
Fossil – Gas				
Demand				
Stored Energy				
…				
…Total				

Supporting Notes

This section provides commentary on the considerations and rationale in the development of the methodology.

Purpose of report

The purpose of the report is to make carbon impacts of flexibility services actions transparent and consistent between DNOs. It sets the foundation and will inform future developments and interventions that may be required to ensure flexibility markets are consistent with net zero.

The methodology in this report covers **outturn** carbon impacts from flexibility services actions. It does not include **counterfactual** impacts (such as network reinforcement or displacing mobile generators), or even **relative** impacts (the difference between outturn and counterfactual impacts) which would be required to evaluate between different interventions. Counterfactual calculations are out of scope of P7. The calculations specified in this methodology however could form part of that evaluation, such as under the Common Evaluation Methodology developed in P1.

As will be discussed later, the outturn carbon impact calculation in this methodology does not include all impacts, omitting indirect impacts. Users should therefore be mindful of this limitation when interpreting the values and comparing between technologies.

Accordingly, the proposed reporting format only covers outturn carbon impacts. DNOs can include relative impacts optionally with appropriate narrative explanations to allow the user to understand what assumptions have been used. The calculation of counterfactual and relative impacts has not been standardised.

Comparable with ESO

The scope of P7 is DNO reporting. However, in accordance with the policy objective the team sought to ensure that the methodology was comparable with the ESO approach. This was achieved by adopting a narrow reporting boundary and presenting direct and consequential impacts separately in the report. However, differences in approach remain as it was necessary and desirable for this DNO methodology.

The ESO approach calculates direct emissions from large transmission connected assets in the Balancing Mechanism, presents impacts in terms of the change in grid intensity, publishes information on a half-hourly basis, and uses CO_2 emissions factors (excludes other greenhouse gases).

For DNO reporting, which is on an annual submission cycle, it was necessary to include methodologies for smaller distributed energy resources. The product team decided that for storage and demand, the inclusion of consequential impacts of charging and load payback respectively would be more reflective of impacts than just considering impacts at dispatch. The team also decided that CO_2e emissions factors should be used to capture all greenhouse gases. Currently most DNOs do not calculate and report on grid intensity of their networks which makes reporting the impact in terms of a change in grid intensity more difficult as a starting position, but this could be explored in future work.

Methodology scope boundary

The team’s review of other carbon accounting methodologies [4] identified two main types of reporting methodologies being inventory or life-cycle assessments. Carbon inventories tend to have a narrow reporting boundary which records emissions directly attributable to the reporting entity, whilst life-cycle assessments include all emissions with respect to a project or activity.

The following table show different sources of carbon impact from flexibility services and how they have been categorised into direct, indirect, and consequential impacts. Direct impact is dispatch (and standby where applicable) whilst consequential impacts are considered as second-order effects such as displacing other grid generation or demand payback. The indirect effects relate to embodied and end-of-life emissions.

Stage in flexibility life-cycle >	Investment decision	Procurement	Pre-dispatch	Dispatch	Post-dispatch	Decommission
Counterfactual emissions	Emissions from network solution	Alternative DERs contracted	Alternative DERs contracted	Alternative DERs dispatched	Alternative DERs dispatched	Network solution or alternative DER end-of-life emissions
Attribution to DSO flexibility service (first order effects)	Emissions from flexibility services	Embedded emissions from contracted DERs Indirect	Standby emissions – e.g. part loaded DER if required on hot-standby	Dispatch emissions - e.g. fuel combustion, reduced electricity consumption. Direct		End-of-life emissions from contracted DER Indirect
Consequential	Emissions from higher network losses due to higher grid utilisation	Change in wider market e.g. wholesale, balancing.	• BESS pre-charging. • Change in wider market e.g. wholesale, balancing.	• Ramp-up/down emissions. • Change in wider market e.g. wholesale, balancing.	• Energy efficiency rebound effect. • DSR payback.	Change in wider market e.g. wholesale, balancing. Consequential

Out of P7 scope

Out of P7 scope

The team decided to include direct and some consequential impacts (storage import, demand payback, and grid generation displacement) in the calculation but not indirect impacts for the following reasons.

- this keeps the report comparable with ESO direct-only reporting;
- direct emissions data sources are standard and readily available which ensures consistency;
- conversely, indirect emissions data sources and assumptions are less standard and less available, reducing consistency and subject to higher uncertainty;
- for storage and demand, it was considered more reflective of impacts to include the carbon impacts of input energy and payback respectively;
- the Pro Low Carbon project calculated that indirect impacts were a relatively small contributor to overall carbon impacts; and
- this was achievable within this year's Open Networks timetable.

The team recognises however that it would be desirable to include indirect impacts into the methodology as part of future work from 2024 onwards to capture the full carbon impact.

The inclusion of the displacement of grid generation is the approach taken for quantification of Scope 2 emissions for company reporting as defined under the GHG Protocol where electricity used, and hence not used, is at the grid intensity of grid generation to supply the load. Increases in grid exports is treated in the same way as reduction in grid imports as it has the same impact on the system. This will also enable calculation of carbon differentials for storage solutions using time-series grid intensities.

The P7 team also discussed whether grid generation displacement would apply to constraint management, which is the main application for DNO flexibility services. Load exceeding network limits, allowed to materialise and managed using flexibility services, would not be allowed to be supplied from beyond the constrained network as this would breach secure network limits. However, since the constraint is generally an N-1 constraint any excess load would still be physically supplied from outside the constrained network and it was therefore considered appropriate to include this component. This may not apply when the network is islanded. Networks that are not intact have not been considered in this methodology.

Consistent approach

The calculations are performed by DNOs using standard assumptions by technology to ensure consistency. The team recognises that not including asset specific information could reduce accuracy but decided that the first iteration should start on a consistent basis as a foundation for future improvements.

In other carbon accounting methodologies reviewed such as under the Emissions Trading Scheme, the calculation is performed by the owner/operator of the asset with independent verification. The team recommended in 2022 to consider developing a framework for incorporating provider information, such as plant specific efficiencies, where it can improve accuracy.

The TWG in 2023 reviewed treatment of asset specific data and concluded that that unilateral use by DNOs should be avoided but should be shared with the future ENA governance to review and disseminate.

Data sources

The conversion factors adopted have used industry accepted sources. The only exception is the assumption on payback for demand which comes from a previous innovation trial based on a small number of activations.

Static plant efficiency factors has the limitation that it does not change based on plant loading.

Grid intensity factors

There were three sources of grid intensity factors identified:

- BEIS/Defra's average grid intensity factors;
- Green Book data table average and marginal grid intensity factors; and
- ESO's time-series average grid intensity factors.

Data is also available from subscription-based providers such as WattTime and Electricitymaps. However, these are not openly available and is therefore not ideal for transparency and replicability.

A marginal grid intensity factor is considered more appropriate when evaluating the impact of a change whilst an average is generally used for carbon foot printing. A reduction in demand results in an increase in the marginal supply and not the average supply. This means that the Green Book factor was considered most appropriate.

However, the Green Book factor is a long-run factor which represents long-term changes in supply to long-term changes in demand which may be appropriate for long-term scheduled services but not for the more common dispatchable services. A short-run factor should be used which the TWG recommended should be derived from the emissions factor and efficiency from a gas generator[7].

Network losses are included in the calculation which, in the case of ESO and Green Book data tables, is included in the grid intensity factor.

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[7] Assumption that gas is the marginal generator the mahority of the time was confirmed by the Pro Low Carbon study https://www.westernpower.co.uk/downloads-view/206428

The ESO time-series grid intensity factor is derived from CO_2 emissions and does not include all Greenhouse Gasses (GHG) unlike the other two sources. At time of writing there are no plans from the ESO to report on marginal grid intensity or to change the components of GHG.

The benefit of a time-series factor is it can reflect different grid intensity periods across a day and so better reflects impacts from resources that shift load/exports. The rationale for having a static factor in the 2022 methodology was because there was no marginal grid intensity time-series data available and that it was better to overestimate carbon impact than underestimate to encourage more information to be provided by stakeholders.

The TWG reviewed this in 2023 and concluded that there was limited benefit to adopting a time-series factor at present, but this should be reviewed again when conditions change in future. There are three key reasons:

- A marginal grid-intensity factor is most appropriate for evaluating a change than the average. The marginal grid-intensity does not vary much over time as it is currently driven by gas.
- The implementation cost of moving from a static factor to a time-series factor is relatively high.
- There are subscription-based datasets of time-series marginal grid-intensity available, but these are not openly accessible and therefore not ideal for transparency and replicability.

At the focus group held in 2023, input from EV aggregator stakeholders indicated that they wanted to use this methodology to incentivise load shifting. However, incentivising a desired policy outcome is not the purpose of DNO carbon reporting. Nevertheless, the TWG intend to make available an excel tool to help users recreate/adapt the calculation based on their use case.

Energy efficiency

The carbon impact of energy efficiency is expected to be similar to demand-side-response but with additional complexities. These complexities may relate more to the calculation of the energy saved than to the conversion of energy into a carbon impact, which would also use grid intensity factors. DNOs have limited experience of deploying energy efficiency programmes and therefore the P7 team have decided that this should be reviewed in future work as DNOs start developing such programmes.

Forecasting

Whilst it is possible to forecast the flexible capacity and potentially energy that may be required based on projected load growth, establishing what technologies will be providing the energy can be highly uncertain where contracts have yet to be awarded and the dispatch merit order unknown. The team had therefore recommended inclusion as part of future work to review. In 2023, the TWG believes the same issues remain as regarding ability to forecast particularly as procurement of flexibility starts to move closer to real time.

Flexible connection and DTU/GTD

There are two applications where this reporting methodology applies:

- Demand Turn Up (DTU) or Generation Turn Down (GTD) flexibility services can be used to manage constrained networks due to high volumes of generation. As a flexibility service, DTU/GTD is within scope of the LC31E reports.
- Flexible connections enable customers to connect to constrained part of network quickly and cheaply but with access restrictions when the constraint occurs – this may involve curtailing customer exports.

Generally, these are generation or storage assets, and curtailment is a reduction in export. Restrictions on import is less prevalent and so has not been considered further here. Flexible connections is not a flexibility service and therefore does not need to be included in the LC31E reports.

Outturn carbon impacts of DTU/GTD flexibility services is expected to be similar to curtailment actions as direction of service is the same. However, there could be differences due to commercial frameworks or method of dispatch. One main difference is flexible connections are designed to allow more renewable generators to connect than would have been possible otherwise in constrained areas of network. This is a counterfactual carbon impact which is not within scope of this reporting methodology but were it to be considered could outweigh the impacts of curtailment actions.

Accuracy of methodology

The carbon reporting methodology is based on generalised assumptions and conversion factors for a type of technology rather than using asset specific assumptions. This maintains consistency in DNO reports but means that the results can only be treated as an approximation.

Further work

Implementation

This methodology was issued for consultation in the summer of 2022 and has been revised based on feedback received. The P7 team recommended that P7 should reconvene to make updates, corrections, and issue clarifications as DNOs start implementing the methodology ahead of April 2023. Following implementation the TWG captured and incorporated improvements to the report in 2023.

Potential future work

The P7 team highlighted in 2022 the following areas that should be considered as part of future work. The table has been updated by the TWG in 2023.

Priority	Activity	Delivery year
1	Review stakeholder feedback post Distribution Flexibility Services Procurement Report publication	2023 – review complete
2	Review of technology categorisations to follow market and technology developments	2023 – review complete
3	Work with providers to incorporate asset specific information or calculations to increase accuracy	2023 – review complete
4	Evaluate source and use of granular grid intensity time series data to improve accuracy, and hence suitable assumptions on timing of storage charging and demand payback	2023 – review complete
5	Review other applications of flexibility for inclusion in the methodology	2023 – review complete

7	Sensitivity analysis in reporting	2023 – review complete
8	Review whether accurate forecasting of carbon impacts is possible	2023 – review complete
9	Enduring governance on carbon reporting methodology, including a repository for data and assumptions	2023 – pending ENA governance arrangement
10	Inclusion of indirect carbon impacts for more complete impact	Where considered appropriate and progressed through ENA governance
11	Investigate treatment of energy efficiency impacts as DNOs implement programmes	Timescales linked to introduction of energy efficiency by DNOs

Glossary

Conversion factors	used in this report as a general term to describe factors that are used in the calculations which can include fuel emission factors, grid intensity factors, and plant efficiency assumptions.
DSR	Demand side response
Grid intensity	refers to the carbon intensity of electricity that is imported from the grid in kgCO2e/kWh taking into account the carbon emissions from grid generation, interconnector imports, and potentially network losses.
Payback	otherwise known as rebound or bounce back, refers to when demand side response load increases after a turn-down event as the site recovers to pre-event conditions, for instance an increase in cooling load in a building having warmed up during the turn-down event. This could also refer to a similar rebound effect following realisation of economic benefits as a result of an energy efficiency saving measure.
Reporting Boundary	defines the scope of the calculation. This can include direct impacts (such as combustion of fuel to generate electricity), consequential impacts (such as the carbon emissions from grid generation to produce and transport electricity imported by a battery), or indirect impacts (such as embedded and end of life emissions attributed to the assets). We also describe narrow or wide boundaries to refer to the extent to which the calculation focuses on direct or whole-life emissions respectively.

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