Report on existing carbon reporting methodologies

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Related documents

Reference 1	WS1A P7 Carbon Reporting Scope
Reference 2	ON22-PRJ 2022 Project Initiation Document (PID)

Distribution

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Introduction to ENA

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.

2021 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

Cadent – Your Gas Network
electricity north west – Bringing energy to your door
ESB NETWORKS
gtc
nationalgrid
nationalgridESO
Northern Gas Networks
Northern Ireland Electricity Networks
NORTHERN POWERGRID
Scottish & Southern Electricity Networks
SGN – Your gas. Our network.
SP ENERGY NETWORKS
UK Power Networks – Delivering your electricity
WALES&WEST UTILITIES
WESTERN POWER DISTRIBUTION – Serving the Midlands, South West and Wales

ENA associates

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

Executive Summary

The product 7 team was formed to develop a methodology for DSOs to calculate and report the carbon impact of flexibility service actions. This is a new area of work for the Open Networks programme, 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.

The product team reviewed and summarised seven different carbon reporting methodologies as given below that are prominent in the UK (which may also be applicable in other jurisdictions), drawing primarily on published materials.

- ESO Carbon Intensity for GB electricity system
- EU ETS monitoring and reporting
- The GHG Protocol for corporate GHG inventories
- The Green Book and supplementary guidance
- IPCC Guidelines for national GHG inventories
- PAS 2080 for Carbon Management in Infrastructure
- Pro Low Carbon innovation project from WPD

The report does not conclude on which approach should be adopted but seeks to inform the potential options for consideration by the team in the next stage of the project.

The team discussed their similarities and differences and relevance to DNO reporting by investigating the purpose of the report, the reporting boundary, their approach to calculation, emission factors used, and what emissions sources were included.

The team broadly categorised the approaches by their reporting purpose - GHG inventories, life-cycle assessments, and grid intensity approaches. GHG inventories as adopted by national and corporate inventories tend to have standardised and narrower reporting boundaries (focus on direct impacts) than life-cycle assessments such as PAS 2080.

Grid intensity reports as produced by the ESO also has a narrow reporting boundary and caters for use by consumers for carbon footprinting. WPD's Pro Low Carbon project was the only methodology specifically designed for DSO flexibility services, recommending inclusion of direct and indirect carbon impacts in a relatively standardised way.

Generally, the wider the reporting boundary the more complex and divergent the calculation may become particularly as they demand more data which may not be readily available.

The calculation approaches were broadly similar, by multiplying an activity data by an emissions factor and expressed in terms of CO2 equivalent. There was a range of emissions factors used from fuel emissions factors, grid intensity factors, and embodied carbon factors from several different sources.

In the next stage of the team's work, the team will design an appropriate methodology for DNO reporting drawing on the approaches reviewed in this report.

Report Introduction

The product 7 team was formed to develop a methodology for DSOs to calculate and report the carbon impact of flexibility service actions. The scope of the group is detailed in the WS1A P7 Carbon Reporting Scope document [1]. This report is the second deliverable from the product team as set out in the Project Initiation Document [2].

This is a new area of work for the Open Networks programme, 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 reviews and summarises existing carbon reporting methodologies prominent in the UK (but may also be applicable in other jurisdictions) and considers their applicability for DSO flexibility services. The report does not conclude on which approach should be adopted but seeks to inform the potential options for consideration by the team in the next stage of the project.

Methodology of review

The following seven methodologies were reviewed and their summary included in the Appendix.

- ESO Carbon Intensity for GB electricity system
- EU ETS monitoring and reporting
- The GHG Protocol for corporate GHG inventories
- The Green Book and supplementary guidance
- IPCC Guidelines for national GHG inventories
- PAS 2080 for Carbon Management in Infrastructure
- Pro Low Carbon innovation project from WPD

The product team used public and freely available materials to undertake this review for the exception of PAS 2080 which relied primarily on within-team expertise. The team also drew on the study conducted under the Pro Low Carbon project by WPD to help complete the summary, as the project performed a similar review of methodologies as included in their published reports. Additional methodologies, although omitted in this report, has been considered by the team as part of review of the Pro Low Carbon project report[1].

Comparison between carbon reporting methodologies

Purpose of each report

Each carbon reporting programme has developed guidelines and methodologies to meet their specific purpose. This can be broadly categorised into three main types as given below.

- **Carbon inventories** – standardised methodologies to calculate the carbon impact attributable to a reporting entity such as a country, company, or installation within specified boundaries to comply with legal, regulatory, or voluntary requirements such as the EU ETS or corporate GHG inventories.

[1] Pro Low Carbon: Carbon assessment methodologies - https://www.westernpower.co.uk/downloads/149422

- **Life cycle assessments (LCA)** – a framework methodology to calculate the life cycle environmental impact of an activity or project, compared to a baseline, affording a greater degree of flexibility to define the scope of the report such as under PAS 2080 for infrastructure projects or evaluating policy interventions using supplementary guidelines for The Green Book.
- **Grid intensity** – methodologies to calculate the carbon intensity of the electricity grid, such as the ESO's carbon intensity report, can be used by electricity consumers such as individuals and organisations to calculate their carbon footprint.

Table 1: Existing methodologies by report purpose categorisation

	Carbon inventory	Life cycle assessments (LCA)	Grid intensity
ESO Carbon Intensity for GB electricity system			✓
EU ETS monitoring and reporting	✓		
The GHG Protocol for corporate GHG inventories	✓		
The Green Book and supplementary guidance		✓	
IPCC Guidelines for national GHG inventories	✓		
PAS 2080 for Carbon Management in Infrastructure		✓	
Pro Low Carbon innovation project from WPD		✓	

A standardised carbon inventory with narrowly set boundaries are simpler to implement and compare between DNO reports, whilst a LCA is inherently more complex with wider boundaries and baselines which increases the scope for divergence on assumptions and calculations. Even where the framework of a LCA is standardised such as under PAS 2080, the lack of standard datasets increases calculation complexity and divergence.

The LCA is however more suitable for inclusion in options appraisals and could therefore be more useful as an input to the Common Evaluation Methodology (CEM) and whole-systems CBA which are both evaluation tools and methodologies developed through Open Networks. Note that the product 7 team will not develop methodologies for comparing carbon impact of different options as agreed in the product team scope [2].

Under the RIIO-2 framework, the ESO are required to report on the carbon intensity of their actions which is currently using the grid intensity forecasting methodology[2]. Actions taken through the Balancing Mechanism is presented as the change in average grid intensity, and hence reflects the impact it has on electricity consumer's carbon footprint.

[2] The Electricity System Operator Reporting and Incentives Arrangements: Guidance Document

Reporting boundary

Carbon inventories require clearly specified boundaries of what is included and excluded from the accounts. This can be broadly defined at the programme-level for consistency, but the reporting entity needs to specify exact boundaries, such as what is under the company's operational control for corporate GHG accounting. Alternatively, the guidelines can accept user defined boundaries based on what is considered by the user as a significant source of carbon emissions.

The boundary can be defined based on the type of carbon impact it includes or excludes:

- **Direct impact** – the carbon impact that can be directly attributed to the activity such as the combustion of fuel or reduction in process emissions. This can be considered Scope 1 emissions under the GHG Protocol, and Scope 2 for electricity consumption, or operational impacts under Pro Low Carbon.
- **Consequential impact** – the carbon impact that occurs because of the activity such as the change in grid intensity due to the consequential change in the supply-demand balance by dispatching flexibility services. This is included in the operational impacts under Pro Low Carbon or can be Scope 3 under the GHG Protocol.
- **Upstream indirect impact** – the carbon impact of previous activities such as materials extraction and transportation. Known as Scope 3 under the GHG Protocol or non-operational impacts under Pro Low Carbon.
- **Downstream indirect impact** – the carbon impact of subsequent activities such as end-of-life emissions. Known as Scope 3 under the GHG Protocol or non-operational impacts under Pro Low Carbon.
- **Baseline/counterfactual impacts** – the carbon impact of the counterfactual(s) which is required under options appraisals and LCA to understand the relative carbon impacts.

The Pro Low Carbon project, which is a WPD flexibility services innovation project, recommended inclusion of direct, consequential and indirect carbon impacts for a more complete representation of carbon impact. Whereas the ESO carbon intensity and EU ETS reporting boundaries only captures direct impacts.

Corporate GHG inventories require reporting on direct and electricity consumption impacts, with optional disclosure on upstream and downstream impacts. LCA approaches would include all impacts whilst an options appraisal will require the counterfactual impacts from which to compare.

A suitable reporting boundary for flexibility services should be specified in accordance with the purpose of the report as discussed in the earlier section.

Calculation approach

The calculation of carbon impact is broadly similar across the methodologies considered, which involve multiplying activity data by an emissions factor and is given in terms of CO2 equivalent using the IPCC's Global Warming Potential for different GHGs involved.

There were two noteworthy observations on the approach to calculations which may warrant further exploration.

- **Methodology hierarchy** - under the IPCC and EU ETS guidelines, three tiers are defined, each tier corresponding to the level of complexity of the calculation increasing with the significance or uncertainty of the emissions source. The first and second tiers uses default and national emission factors respectively whilst the third tier uses installation specific calculations such as direct measurements of

GHG. Even in LCA approaches, one of the initial steps of the calculation is to identify the most significant emission sources on which to focus the assessment.

- **The party responsible for the calculation** - the EU ETS monitoring and reporting requirements stipulate that the calculation of emissions is carried out by each installation which is then verified by a third party, whilst the monitoring plan itself needs to be approved by an authority. This differs to a centrally administered calculation such as the ESO grid intensity methodology and the Pro Low Carbon approach.

Emission factors

Emission factors converts an activity such as consumption of energy or combustion of fuel into a carbon emission value. These are normally given in terms of kg or tonne of CO2 equivalent per unit of fuel or energy. The following table summarises the three main types of emission factors that is more relevant to flexibility services and the main source of data as used in the methodologies considered.

Some of the methodologies have accuracy as a key principle, and therefore advocate use of bespoke, site-specific factors over default factors where they can provide more accurate results.

Conversion factor type	Data source
Fuel emission factors – for combustion of fuels	• BEIS' UK Conversion factors for GHG reporting - used by EU ETS, Pro Low Carbon, and in the Green Book supplementary guidance (via data tables). • IPCC international default values are used for lowest tier calculations under the EU ETS. • National GHG reporting under the NIR uses a range of sources including from the EU ETS and the 2004 Carbon Factors Review.
Life cycle emission factors – for the embodied and end of life emissions	• Ecoinvent data was used by the Pro Low Carbon project via the Carbon Trust (requires data licence). • Circular Ecology's Inventory of Carbon & Energy (ICE) V3.0 (embodied carbon only) * • Certified product Environmental Product Declarations (EPDs) *
Grid intensity factors – for grid electricity	• Pro Low Carbon uses the marginal grid intensity based on independent factors not available in public domain. • DUKES CO2 emissions from electricity supplied for different fuel types used for ESO Carbon Intensity calculations. • Data tables in The Green Book supplementary guidance provides marginal and average electricity emissions factors. • BEIS's UK Conversion factors for GHG reporting

* Not specified within methodology but was identified from in-team expertise as standard sources

Emission sources included

The methodologies that necessarily captures significant volumes of emissions/sinks such as the EU ETS, national GHG inventories, and ESO carbon intensity focuses on the major emission sources such as large generators, interconnector imports, and other energy intensive industries. Arguably some of these large-scale emission sources are less likely to be providing DSO flexibility services due the voltage level concerned.

Corporate GHG accounting and LCA allows the reporting entity to select what emissions sources to include, whilst Pro Low Carbon models the most common flexibility services technologies - batteries, demand-side response, diesel, and gas generation. Note that the type of technologies that are providing flexibility services and the configuration of those technologies, such as a combination of technologies behind the customer meter, are likely to be diverse and may present challenges in specifying standard emission factors.

The product team were also interested in the treatment of energy efficiency under the methodologies considered. Only The Green Book supplementary guidance provided explanations on how to calculate the energy savings. Whilst the SECR guidance for corporate GHG inventories does recommend a narrative explanation on energy efficiency actions taken. Note that measures of carbon intensity as compared between previous years can also offer some indication of energy efficiency.

Whilst not considered in this report, the International Performance Measurement and Verification Protocol (IPMVP)[3] is a widely adopted methodology for measurement and verification of energy efficiency projects albeit not extending into standardised quantification of carbon impact.

Conclusion

The product team reviewed and summarised seven different carbon reporting methodologies that are prominent in the UK drawing primarily on published materials. The team then discussed their similarities and differences and relevance to DNO reporting by investigating the purpose of the report, the reporting boundary, their approach to calculation, emission factors used, and what emissions sources were included.

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[3] IPMVP - https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

The team also reviewed how different technology types were treated in the methodologies. Pro Low Carbon modelled the main types for DSO flexibility services including residential level assets whilst the EU ETS captures large generation and other energy intensive industries. The corporate GHG inventory and life-cycle assessments allows the person reporting discretion in selecting the source of emissions.

In the next stage of the team's work, the team will design an appropriate methodology for DNO reporting drawing on the approaches reviewed in this report. Some of the key questions the team will consider in subsequent work include:

- Purpose - how will the DNO report be used and by whom?
- Boundary - where should the reporting boundary be set?
- Calculation - what is the right level of complexity of calculation?
- Data - is data available to support the approach?
- Technologies - how can the range of different flexible solutions be accommodated?

Appendix

The review of existing methodologies used available published documentation such as guidance and report submissions. The links are provided as reference to allow the reader to study the material in more detail.

ESO Carbon Intensity of GB electricity system

Category	Grid carbon intensity
Purpose	The Carbon Intensity dashboard, app, and API forecast is **designed to enable consumers or smart devices to optimise their behaviour to minimise their carbon footprint**. It provides GB and 14 regional grid carbon intensity forecasts up to 48 hours ahead. The dashboard also provides real-time intensity for every 30-minute period, historic weekly intensity since 2009, and the change in intensity following ESO actions in the Balancing Mechanism updated every hour.
Produced by	ESO, WWF, Environmental Defence Fund Europe and the University of Oxford department of Computer Science.
Boundary	• Electricity **generation from all large, metered power stations, interconnector imports, transmission, and distribution losses** (to convert to consumption point). • **Excludes upstream emissions** and indirect land use change impacts. • **Excludes emissions from unmetered and embedded generators** not visible to ESO (but includes estimate for embedded wind and solar)
GHGs	**CO2 only**
Calculation	• Generation dispatch is forecasted using historic data and forecasted demand, wind, and solar generation • Carbon intensity is the sum for all generation – carbon intensity (by fuel type) * output, divided by national demand. Then converted to consumption by adjusting for transmission losses. • Interconnector intensity uses imported generation mix * carbon intensity (by fuel type) • Effect of balancing actions is the difference between the carbon intensity of all the generators in the BM before and after balancing actions have been applied.
Reporting	Data and **forecasts** published on dashboard, app, and API, ESO data portal. This methodology is currently used to publish the carbon intensity of ESO actions as required under RIIO-2 framework.
Emission factors	• Carbon intensity, by fuel type, based on output-weighted average efficiency of generation in GB and DUKES CO2 emission factors (2017, which was derived from total CO2 emissions per electricity supplied by fuel type) • Interconnector carbon intensity factors (GridCarbon 2017 -> generation sources from Staffell, Ian 2017)

Activity data	Generation output uses ELEXON BMRS data, Interconnector generation mix from ENTSOE Transparency Platform
Technologies	Large generation (biomass, coal, gas, hydro, nuclear, oil, other, solar, wind) and interconnector imports. Not considered energy efficiency (impact of will be embedded in demand and demand forecasts)
Links	• ESO carbon intensity methodologies – https://carbonintensity.org.uk/ • ESO carbon intensity dashboard – https://dashboard.nationalgrideso.com/

EU ETS monitoring and reporting

Category	Carbon market compliance
Purpose	The EU Emission Trading Scheme (ETS) is a policy instrument to cut GHG emissions within the EU, through a cap-and-trade market mechanism (cap on total GHG emission by sector, reducing over time, each year parties must surrender allowances either allocated or purchased to cover their reportable emissions). The UK ETS replaced the UK's participation in the EU ETS in January 2021. The Monitoring and Reporting Regulation (MMR) and guidance sets out the rules relating to the compliance cycle.
Produced by	European Commission
Boundary	Applies to energy intensive industries, power generation, and aviation. Direct emissions only. Operators need to define the monitoring boundaries for each installation.
GHGs	CO2, N2O, PFCs (also expressed as CO2 equivalent using GWP)
Calculation	• Monitoring requirements increase based on size of emissions through tiers (like IPCC guidelines). Can be measured (GHG concentration and volumetric flow) or calculated. Calculation method can use emission factors or carbon mass balance. • Calculation for combustion emission = Activity Data (=Fuel Quantity * Net Calorific Value) * Emission Factor * Oxidation Factor (account for incomplete reaction). Calculation for process emission = Activity Data * Emission Factor * Conversion Factor
Reporting	Annual monitoring, reporting and verification as part of compliance cycle. Annual emissions report (AER) must be verified by accredited verifier before compliance checks by the Competent Authority. The Competent Authority also must approve monitoring plan before implementation. Templates available.
Emission factors	Lowest tiers usually apply an internationally applicable default value (such as IPCC standard factors). Second tier uses national factors (used for national GHG inventory). The highest tier usually requires the factor to be determined from laboratory analysis.
Activity data	Depending on tier as discussed above.
Technologies	Applies to energy intensive industries, power generation, and aviation. Eligible hospitals and small emitters can opt out.

Links	• Monitoring and Reporting Regulations and guidance documents – https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/monitoring-reporting-and-verification-eu-ets-emissions_en • UK ETS guidance – https://www.gov.uk/government/publications/participating-in-the-uk-ets/participating-in-the-uk-ets#permitting-monitoring-reporting-and-verification

The GHG Protocol

Category	Corporate GHG Inventory
Purpose	The GHG Protocol – A Corporate Accounting and Reporting Standard is a guidance for companies to quantify and report on GHG emissions using standardised approaches and principles. Other methodologies exist such as ISO 14064 but is similar to GHG Protocol. Large UK companies (using >40kWh energy, Large defined in Companies Act 2006) need to report their emissions publicly via the **Streamlined Energy and Carbon Reporting (SECR)** regulations.
Produced by	World Resource Institute (WRI) and World Business Council for Sustainable Development (WBCSD). Specific guidance for completing the SECR is available from BEIS which draws on the GHG Protocol methodology.
Boundary	• **Emissions are categorised into scopes**. Scope 1 – direct emissions from sources owned or controlled, Scope 2 **–** indirect emissions from electricity purchased for consumption, Scope 3 – other indirect emissions consequential of company activities but from sources not owned or controlled. Scope 3 reporting is voluntary, guidance under **GHG Protocol Corporate Value Chain Standard.** • **Define operational and control boundaries** – financial control boundary (ability to direct financial and operational policies of operations to gain economic benefits from its activities), **operational control boundary** (full authority to introduce and implement operating policies), and **equity share boundary**.
GHGs	**Seven GHG covered by Kyoto Protocol** – CO2, CH4, N2O, HFC, PFC, SF6, NF3. Other environmental impacts not considered. Report in **CO2 equivalent** based on IPCC's GWP.
Calculation	Identify emission sources (focus on most important sources), categorise their scope, select measurement approach (direct measurement, calculated via chemical mass balance or emissions factors), collect activity data, select emission factors, calculate using tools (**GHG emissions = activity data x emission conversion factor**), collate from all facilities.
Reporting	Under SECR, reported via Directors Report (large companies), Annual Report (quoted companies), Energy and Carbon Report (LLP). Use of **intensity ratio** (environmental impact per activity or financial metric) to aid comparison. The GHG Protocol methodology is also used by **Science Based Targets**.
Emission factors	Standard does not dictate which factors are used but provides database to aid selection. SECR guidance requires use of **UK emission factors** updated annually but some organisations can use site specific emission factors if more accurate.

Activity data	Scope 1 – purchased quantity of commercial fuels, mass balance, or direct measurement through monitoring, Scope 2 – metered electricity consumption, Scope 3 – calculated from activity data such as fuel use or passenger miles.
Technologies	Main emission sources in boundary. Under SECR, companies need to provide narrative on energy efficiency actions taken and if possible provide energy savings but no calculation guidance given. Use of intensity ratios can show efficiencies over time.
Links	• GHG Protocol – https://ghgprotocol.org/corporate-standard • SECR – https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance • Conversion factors 2021 – https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

The Green Book and supplementary guidance

Category	Policy/programme assessments
Purpose	The Green Book is used to appraise policies, programmes, and projects. Additional guidance is available to support quantification and valuation of energy use and GHG emissions for options appraisals to build business cases and impact assessments.
Produced by	The Green Book is issued by HM Treasury. The supplementary energy and emissions guidance is prepared by BEIS.
Boundary	Guidance given on assessing direct impact and indirect impact through planning, land use change, construction, or new products. Guidance only applicable for marginal changes and not wider changes to the market (as it will change values in data tables)
GHGs	Seven GHGs – CO2, CH4, N2O, HFC, PFC, SF6, NF3 – reported as CO2 equivalent using GWP. GHG emission factors in data tables incorporate CO2, CH4 and N2O. Can also consider additional wider impacts such as air quality and energy security.
Calculation	• Guidance is accompanied by excel-based calculation toolkit and data tables for latest assumptions. • Analytical process: identify key drivers of emissions impacted by policy/project; identify energy and emission counterfactual; identify policy interactions; quantify changes in fuel use, emissions (energy change x fuel-specific emission factor, use marginal emissions factor for changes in direct fuel use and average emission factors for footprinting), and other impacts (e.g. air quality); value these changes (split into emission traded/non-traded sectors); calculate cost-effectiveness. • Energy efficiency should be net of direct and indirect rebound effects (where available funds are spent on more energy). • Embedded emissions to be considered if appropriate, proportionate, and practical e.g., results in large change in imported emissions

Reporting	Report using template, providing further information e.g., on counterfactual and time profile of emissions, impact by group (households, suppliers). Include impact on UK territorial GHG emissions by sector to understand impact on UK Carbon Budgets. If policy includes material non-CO2 impacts, should provide impact on each gas separately.
Emission factors	• Provided in data tables – marginal and average grid intensity (given in emissions per unit of electricity consumed) and fuel emission factors. Factors mostly from Defra, and DfT for petrol, diesel gas and oil. • Bespoke emissions factors should be used where available instead of supplementary guidance emission factors
Activity data	Estimated change in energy use or supply
Technologies	Range of fuel emission factors provided. Guidance includes discussion on energy efficiency calculation incorporating rebound effects.
Links	• Green Book and supplementary guidance – https://www.gov.uk/government/collections/the-green-book-and-accompanying-guidance-and-documents • Data tables - https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

IPCC Guidelines for national GHG inventory

Category	National GHG inventory
Purpose	Guidelines used by countries that report to the **UN Framework Convention on Climate Change (UNFCCC)** to ensure reported GHG emissions is complete and comparable. The UK's annual **National Inventory Report (NIR)** meets its commitments as a Party under the UNFCCC, tracks progress against commitments under Kyoto Protocol (including UK's contribution to EU target), and against UK Carbon Budgets.
Produced by	The Intergovernmental Panel on Climate Change (IPCC) maintains the guidelines. The NIR is compiled by a consortium led by Ricardo on behalf of BEIS.
Boundary	All emission source and removal by sinks **since 1990** (excludes historic emissions), within defined **geographical territorial boundary, at point of release** (excludes emissions from imported goods and international air travel), includes adjustment for trades through the EU ETS.
GHGs	Seven direct GHGs under Kyoto Protocol – (CO2, CH4, N2O, HFC, PFC, SF6, NF3) and four indirect GHGs (NO, CO, NMVOC, SO2). Each gas is given a **Global Warming Potential (GWP)** expressed relative to CO2 equivalent.
Calculation	**Approach varies by significance of source and availability of data**, the more significant or uncertain the higher the "tier". Tier 1 is simplest using activity statistics and default emission factors. Tier 2 uses more country specific data. Tier 3 uses plant specific data. The **UK NIR mostly uses Tier2/3 methods**. Calculation of direct GHG for sources including power stations = **Emissions Factor (EF) x Activity Data (AD)**

Reporting	UK's annual NIR includes Common Reporting Format (CRF) tables. Each year the inventory is extended to cover another year and allows updates for new emission sources, revised estimates, and data revisions.
Emission factors	Emission factors in 2021 NIR is based on **UK specific data**. Predominately derived from EU ETS data (2005 onwards), refiner sector reporting (UK Petroleum Industry Association, 2020) and from the 2004 Carbon Factors Review (Baggott et al., 2004), with some solid fuel factors derived from UK research (Fynes and Sage, 1994); non-CO2 emission factors are predominately IPCC defaults (IPCC, 2006).
Activity data	DUKES for statistics on liquid, solid and gaseous fuels. EU ETS for emissions from installations. UK Petroleum Industry Association for refinery emissions, UK Iron and Steel Industry Annual Statistics for energy production/consumption in Iron and Steel industry.
Technologies	Covers all main categories of source/sinks of emissions including energy industries, industrial processes, agriculture and forestry, and waste. Energy efficiency not considered explicitly.
Links	• NIR 2021 – https://unfccc.int/ghg-inventories-annex-i-parties/2021 • Emissions factors, UK NAEI ("Energy background data") – https://naei.beis.gov.uk/ • IPCC 2006 – https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html • IPCC 2019 Refinement – https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

PAS 2080

Category	Standard for infrastructure projects
Purpose	Common framework to help companies reduce volume of carbon used throughout a project, encouraging collaborative working through the supply chain for more effective **whole life cycle carbon** use. Was developed as a result of the 2013 Treasury Infrastructure Carbon Review to create a new specification for carbon reduction. Voluntary standard.
Produced by	Mott MacDonald and Arup with British Standards Institute
Boundary	Whole-lifecycle carbon management
GHGs	All, normalised to CO2e
Calculation	• Project level carbon accounting • Should include Whole Life Carbon Emissions of the infrastructure development project • Calculation methodology is not prescribed, although compliant tools exist • Carbon calculations should be done iteratively throughout a project lifecycle with the goal of taking project level action to reduce carbon emissions • Estimation at the design stages, moving to 'as built' emissions as the construction stage
Reporting	Reporting should be undertaken by all value chain members in a project lifecycle at key gateways where carbon emissions can be influenced

Emission factors	None – emissions factors are not specified within framework
Activity data	At discretion of person performing the calculation
Technologies	Emissions sources are reported in line with BS EN 15978:2011 (cradle to grave emissions).
Links	https://www.bsigroup.com/en-GB/our-services/product-certification/product-certification-schemes/pas-2080-carbon-management-in-infrastructure-verification/

Pro Low Carbon

Category	DSO flexibility services innovation project
Purpose	Pro Low Carbon (PLC) was part of a Western Power Distribution (WPD) **innovation project**, Future Flex, which investigated how to increase uptake of domestic flexibility. PLC reviewed methodologies and developed a **DSO specific methodology** for calculating the carbon impact of procuring flexibility services for different flexible technologies. To date these recommendations have not been adopted.
Produced by	PLC was a one-off study conducted by Everoze for WPD
Boundary	Categorises carbon impact into **non-operational** and **operational**. Non-operational impact attributed proportion of **embodied and end-of-life** emissions. Operational impact includes source impact and **offset in marginal grid impacts**.
GHGs	Includes all GHGs in CO2 equivalent (using GWP) for both operation and non-operational impacts.
Calculation	• Operational impact = carbon impact of energy generated/imported minus carbon impact of energy offset (grid intensity) • Non-operational impact = Non-operational emissions * % attributed (if investment in asset can be attributed to DSO services, and split based on percentage of DSO services to 10% internal rate of return) • Methodology retains some flexibility based on the technology and how emissions can be attributed to flexibility services
Reporting	Does not specify format or frequency of reporting.
Emission factors	• Carbon intensity of fuel emissions from UK Government GHG Conversion Factors for Company Reporting, 2020 • Marginal carbon intensity of grid offset uses independent dataset • Non-operational impact – Carbon Trust life cycle data using data from Ecoinvent through licence
Activity data	Source emissions forecasted via modelling scenarios, whilst non-operational attribution assumes DSO service revenue of £6k/MW/yr against different technology capital and operational cost.

Technologies	Project calculated intensities for batteries (domestic and large scale), DSR (commercial temp-controlled storage, domestic heat pump, EV charger), Diesel, Gas (natural, landfill). Energy efficiency was not considered.
Links	• Pro Low Carbon: Carbon impact of DSO flexibility services – https://www.westernpower.co.uk/downloads-view/206428 • Pro Low Carbon: Carbon assessment methodologies - https://www.westernpower.co.uk/downloads/149422

Glossary

ESO	Electricity System Operator
EU ETS	European Union Emissions Trading System
DNO	Distribution Network Operator
DSO	Distribution System Operator
DUKES	Digest of UK Energy Statistics
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
NIR	National Inventory Report
SECR	Streamlined Energy and Carbon Reporting
UNFCCC	United Nations Framework Convention on Climate Change
WPD	Western Power Distribution

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