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PRO LOW CARBON: CARBON ASSESSMENT METHODOLOGIES

A REPORT FOR WESTERN POWER DISTRIBUTION

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TABLE OF CONTENTS

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1. INTRODUCTION

1.1 BACKGROUND

FutureFlex is a participant-led trial of second-generation DSO services, deploying step change innovations for procurement, testing and delivery suitable for domestic scale assets. It is a joint project delivered by Western Power Distribution (WPD), Everoze and Smart Grid Consultancy (SGC), funded by the Network Innovation Allowance (NIA).

1.2 PRO LOW CARBON

Pro Low Carbon is an exploration of the carbon impact of DSO services. It aims to provide clarity on the carbon emissions associated with the procurement of DSO services from local flexibility technologies and lead to a better understanding of the environmental impact of ancillary electricity services at a local level. In alignment with the core principles of the FutureFlex project, Pro Low Carbon will approach this task in a way that is:

User-centric: Acting on the feedback that domestic energy users are concerned with the environmental impact of all aspects of their energy supply by creating an evidence-base on which carbon-reducing market and policy interventions can be founded.

Coordinated: Keeping Ofgem regularly updated on the progress of the workstream by offering them the opportunity to provide input and help shape the project, which they see as an important exercise that will provide them with part of the evidence they need to formulate regulatory interventions in flexibility markets.

Holistic: Recognising the advantages of low carbon technologies in flexibility service provision and creating a framework to consider more than just the technical characteristics of a technology in procurement processes.

1.2.1 Idea genesis

The idea for Pro Low Carbon emerged during the process of consolidating feedback from participants of the workshops that took place during the first phase of FutureFlex. Multiple individual pieces of feedback featured a common thread: a concern about the lack of attention paid to the carbon impact of flexibility services and a dissociation of flexibility service procurement from the net zero ambition of the wider energy sector.

More specifically, feedback from workshop participants expressed:

- Concern that the ***negative externality*** of carbon emissions is not priced into procurement mechanisms and that this disadvantages domestic flexibility technologies. The absence of this signal from service procurement means the value of providing such services is the same for all technologies, regardless of the negative effects of increased carbon emissions that are a consequence of procuring services from certain technologies. Including this signal was seen as an opportunity to boost the currently low value of service provision for low carbon technologies.
- Concern that there is little work being done to ***ready the domestic flexibility market to meet decarbonisation targets***. It was observed that meeting decarbonisation targets requires market intervention and that the current lack of understanding of the carbon impact of flexibility services and technology-neutral procurement approach evidences a lack of such market intervention. It was seen as a barrier to the roll out of domestic flexibility technologies that no actor was providing this stimulation, and that this was a role that the DSO could play an important part in.

1.2.2 Objective

The objective of Pro Low Carbon is *to explore and understand the carbon impact of procuring DSO services from local flexibility technologies*.

The most immediate outcome of achieving this objective will be to provide WPD with an understanding of the carbon impact of their procurement decisions for flexibility services. However, it is not just WPD that will benefit from this work. The findings will also be applicable to other DSOs and this applicability could extend to all those who procure ancillary electricity services, particularly if those services are provided by local scale technologies. The development of a precise method of accounting for carbon emissions from flexibility services will provide a template which could be built on and adapted for a range of uses.

This work will also form an evidence base to feed into research currently being undertaken by BEIS and Ofgem probing the treatment of carbon in flexibility markets. There are clear synergies between this research and Pro Low Carbon; BEIS's and Ofgem's stated goals include the adequate facilitation of low carbon flexibility through market arrangements, the robust monitoring and reporting on carbon intensity, and the integration of heat pumps, EVs and other new technologies into the low carbon flexibility marketplace. A solid understanding of the carbon impact of DSO service procurement backed up by quantified research will be a firm basis to help BEIS and Ofgem achieve these goals. And while the scope of Pro Low Carbon itself is not concerned with the market structure of flexibility markets or with the policy and regulations that shape them, the opportunities to build on the foundations laid here will be numerous. Follow on work, which is best done in a holistic manner at a national government level, could include:

- **Embedding carbon transparency into markets:** Make carbon emissions visible within markets, both externally and internally, ensuring that emissions are kept at front-of-mind during procurement and dispatch and also providing the correct information and signals to market participants.
- **Pricing carbon emissions into flexibility service procurement:** Probe mechanisms for the financial valuation of carbon impact with flexibility service markets. This would act to boost the value available to low carbon flexibility services and, at a local level, potentially increase the number of domestic homes participating in DSO flexibility service tenders.
- **Exploring who might pay the premium:** Investigate options for how the negative externality of carbon is paid for. There are numerous options that could be explored, including willing customers; direct contribution by local or national authorities; and direct action by DSOs themselves, linked to the RIIO-ED2 business plan.

1.2.3 Approach

Understanding the carbon impact of flexibility services is not a simple task. The topic is broad and finding an answer which can be applied universally across the entire energy flexibility sector is not practical – it is instead necessary to focus on a particular segment of the market and develop understanding in this area. This is the opportunity that FutureFlex is providing – the opportunity to explore the carbon impact of procuring DSO services from local flexibility services.

The Pro Low Carbon approach has been shaped to fit this opportunity and requires close collaboration with WPD, as well as the support of an expert carbon accounting consultant. It has been split into several phases:

a. **Secure data:** Work with the WPD Flexible Power team to identify the technologies which are providing flexibility services within WPD's area and the characteristics of their utilisation. The use of real data from a currently procured service adds weight to the conclusions that will be drawn. The first step is to use this data to understand the current situation of flexibility service procurement within WPD's network area, the variety of service suppliers and how their assets are called on.
b. **Explore use cases:** Unlike traditional generation infrastructure, flexible technologies typically provide multiple services during their lifetime, often swapping between different operational modes during a day, and even providing two different services simultaneously. These technologies may be installed to fulfil a core purpose (for example home heating for a heat pump) which is supplemented by commercial flexibility services such as those procured by WPD. In this context carbon emissions must be attributed correctly. The data provided by WPD will be used to build up typical use cases of assets providing DSO services, including both current and future market technologies.
c. **Investigate methodologies:** With an understanding of what technologies provide flexibility services and how they are used, it is then possible to explore the range of carbon assessment methodologies. Several

standard methods exist, each aimed at different uses, from businesses, to consumer products and infrastructure. Common standards will be explored and their potential for application to flexibility service delivery will be critiqued. The complex use case of local flexibility technologies, which are expected to have both material embodied carbon emissions *and* material operational emissions, may warrant a completely novel approach to carbon assessment. This phase will investigate current methodologies, critique them, and provide recommendations for the carbon assessment methodology to be used in the following phase.

d. **Quantify the impact:** To generate a measurable response to the objective of Pro Low Carbon the recommended carbon assessment methodology will be applied to the flexibility technology use cases assembled from the data provided by WPD. This work will be supported by a carbon assessment specialist.
e. **Share findings:** Disseminate the findings of the work, focussing on conclusions and implications of the results to ensure clear communication of information that can be used to inform potential changes to the treatment of carbon in flexibility markets and provide the maximum potential for meaningful follow on work.

1.2.4 The structure of this report

This report comes under the ***investigate methodologies*** phase of Pro Low Carbon. It will explore and critique carbon assessment methodologies and form recommendations for defining a methodology to be carried forward into subsequent work that attempts to fairly take account of all aspects of the carbon impact of procuring DSO services from local flexibility technologies.

The report is structured as follows:

- **Introduction:** Setting out the context of the report
- **The range of methodologies:** Outlining the current range of carbon and environmental impact assessment methodologies
- **Critique methodologies and summarise findings:** Compare the identified methodologies against the aims of Pro Low Carbon and draw out findings for how an assessment methodology appropriate for exploring the carbon impact of flexibility services can be developed and put to use.

2. THE RANGE OF METHODOLOGIES

2.1 BACKGROUND

Numerous standards and guidelines have been developed to help tackle the problem of understanding carbon emissions and wider environmental impacts. There is a desire to understand the effects on the environment of many different types of entity: governments and shareholders desire to know the environmental impact of corporations; consumers are interested in the greenhouse gas (GHG) emissions associated with the products they buy; various stakeholders are concerned by the carbon emissions of large infrastructure projects or other developments. There are also standards that have been developed to help understand the environmental impact of cities, nation states, and policy interventions.

The three main forms of carbon assessment methodology can be loosely defined as product, corporate and project standards.

Product standards are commonly known as Life Cycle Assessments (LCAs). They attempt to track the life of a product from raw material extraction through to manufacturing, distribution, use, and disposal or recycling.

Corporate standards are designed to capture the greenhouse gas emissions of the activities of a business or organisation. The scope of this assessment can be focussed – targeted at just the operations directly under the control of the organisation – or more expansive, including emissions associated with purchased energy and other indirect emissions within the value chain.

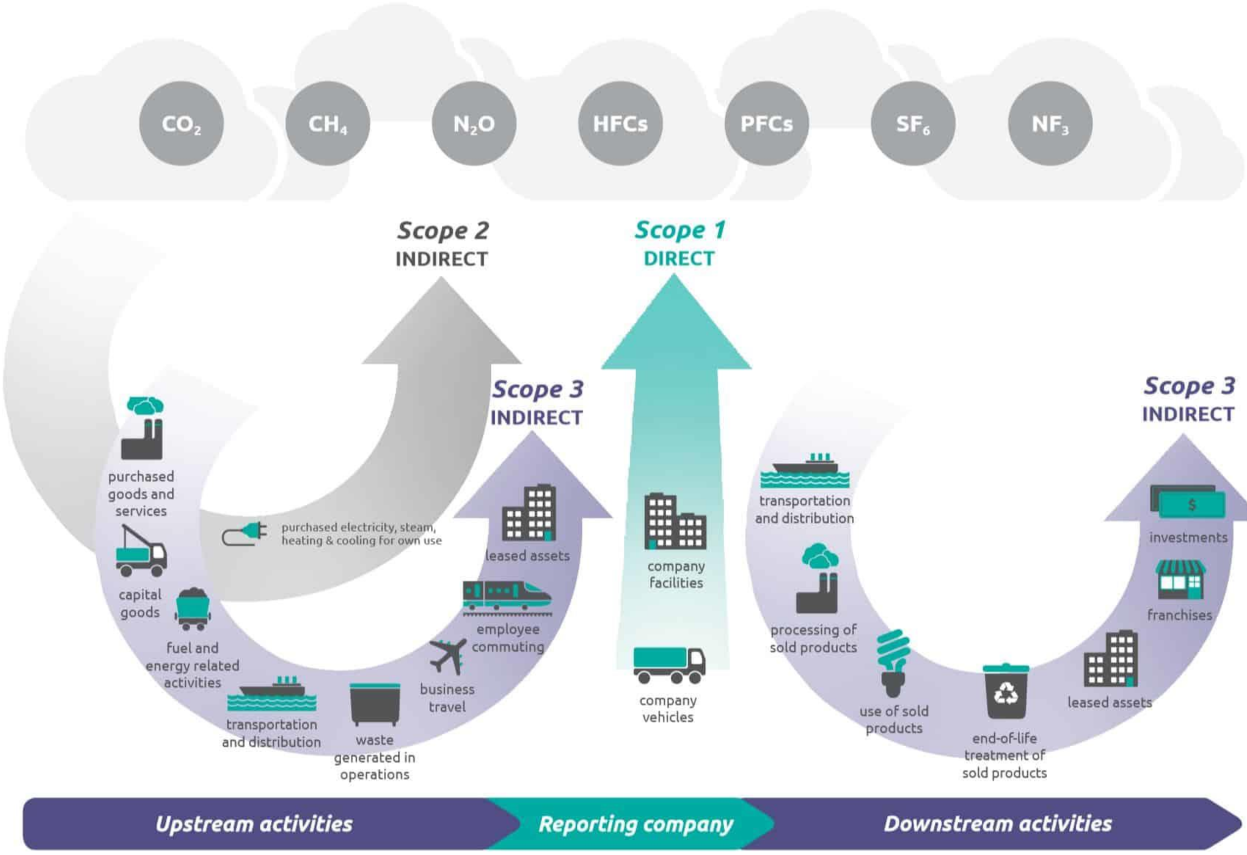
Project standards fill the gap between corporations and products. They can deal with projects, initiatives and assets such as power stations and climate mitigation projects. These methodologies typically focus on the impacts of the operational phase of a project, but in some cases can also include the impacts associated with the construction or creation of a scheme.

Several concepts that are important to understand for the discussion of carbon assessment methodologies are described in the following sections.

2.1.1 Scope 1, 2 and 3 emissions

The Greenhouse Gas Protocol groups emissions into three categories or 'scopes'. This concept is most useful when discussing corporate standards for GHG emissions as it is designed to categorise the activities of business and organisations.

Scope 1	Direct emissions from owned or controlled sources	▪ Fuel combustion ▪ Company vehicle emissions ▪ Fugitive emissions
Scope 2	Indirect emissions from the generation of purchased energy	▪ Generation of purchased electricity, heat and steam
Scope 3	All other indirect emissions occurring in the upstream and downstream value chain	▪ Purchased goods and services ▪ Travel ▪ Waste disposal ▪ Distribution ▪ Use of sold products ▪ Investments



THE DIFFERENT SCOPES OF CORPORATE GREENHOUSE GAS EMISSIONS. *GREENHOUSE GAS PROTOCOL, TECHNICAL GUIDANCE FOR CALCULATING SCOPE 3 EMISSIONS, 2013.*

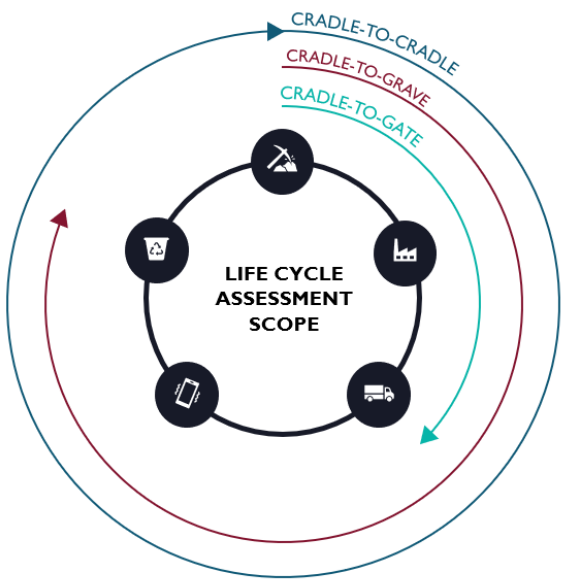
2.1.2 Stages of a product life cycle

Product life cycle assessments are often described as taking a cradle-to-grave perspective: accounting for every step in a product's life from inception (the cradle) to disposal (the grave). The journey of a product between these two extremes can be broken down into several steps.

1. **Raw material extraction**
2. **Manufacturing and processing**
3. **Distribution**
4. **Use**
5. **Disposal**

Cradle-to-grave is the most commonly used concept for product lifecycle assessments. However, there are alternatives:

- **Cradle-to-gate:** The cradle to gate approach only follows a product's life until it leaves the factory. It sets the boundaries of the study from the material extraction to the point at which the product is ready for transportation, excluding any environmental impacts of the transportation, use and disposal of the product.
- **Cradle-to-cradle:** This approach extends the cradle-to-grave approach to include all activities necessary to recycle the product such that it is ready to be reused into another product. It is the most comprehensive of all assessments but is generally only applicable to certain products.



2.1.3 Environmental impact

Some assessment methodologies are designed to calculate impacts on multiple aspects of the environment. These impacts are not just limited to greenhouse gasses and climate change but also include land use, water use, resource depletion, pollution, biodiversity and more.

However, the scope of this work is concerned only with greenhouse gas emissions; other impacts will not be considered. When discussing climate change impacts, greenhouse gasses are generally converted into units of carbon dioxide equivalent (CO_2e) so that the cumulative impact can be presented as single metric. This approach will be mirrored in Pro Low Carbon – in this report the terms greenhouse gas, carbon dioxide equivalent and more simply carbon are all used to mean carbon dioxide equivalent. All refer to the greenhouse gas emissions associated with the procurement of DSO services from local flexibility services.

2.2 METHODOLOGIES

The methodologies reviewed in this section have been selected to represent a range of well-developed and widely-used techniques. The selection is not meant be exhaustive – there are many more methodologies for assessing carbon emissions in existence than could be adequately described in this report.

Assessing the procurement of DSO services from local flexibility technologies is a challenge that touches on multiple established sectors, including the electricity supply industry, the provision of services by businesses and the manufacture of consumer products. The methodologies reviewed here have been chosen because they each represent a different aspect of this challenge.

2.2.1 EU ETS emissions calculation methodology

A policy instrument founded on accurate emissions reporting: The EU Emissions Trading Scheme (ETS) is a policy instrument that places a cap on emissions from certain sectors and establishes a trading scheme through which permits for emissions can be exchanged. The ETS is not in itself a carbon assessment methodology, but instead a scheme designed to cut GHG emissions from industry. But to measure emissions and determine if permits have been exceeded a greenhouse gas accounting framework is needed – this section deals with the emissions assessment methodology that sits underneath the EU ETS.

Applying a narrow scope and range of impacts: The framework for assessment of emissions is based on the activities of participants and the emissions sources associated with them. The impacts considered are fairly narrow in scope and this scheme is focused only on the direct emissions of industry. But by virtue of the fact that it applies to the majority of all heavy industry within the EU (over 11,000 installations and 45% of the EU's total GHG emissions) it can claim to account for a large proportion of the upstream emissions of all installations.

Description	The EU ETS is a system that caps overall GHG emissions of participants. It was established as a policy instrument to act on the emission reducing targets established by the 1997 Kyoto Protocol within the EU. As a system designed to regulate and gradually reduce GHG emissions from large industrial facilities, it is focussed on the operational emissions of heavy industry, although since its introduction in 2005 it has gradually expanded to cover a greater range of industries and emissions.
Scope	The scheme requires reporting on the direct (Scope 1) emissions of participants. Emissions that would fall under Scope 2 and Scope 3 are not accounted for within the ETS.
Environmental impacts	Only some greenhouse gasses are considered. The current form of the scheme accounts for carbon dioxide emissions, nitrous oxide and perfluorocarbons. There is no consideration of environmental impacts to water, land or anything else outside of the three gases mentioned.
Application	The scheme is effectively a methodology for projects. In this case the projects included are large ones; the ETS applies to power stations and combustion plants over 20MW in capacity, oil refineries, coke ovens, iron and steel plants, and production facilities for

	cement clinker, glass, lime, bricks, ceramics, ammonia, pulp and paper and board. It also covers the aviation industry, CO_2 capture and storage and nitric, adipic and glyoxylic acid production. Certain small installations can be excluded from the requirement to participate in the ETS.
Calculation approach	Several different methodologies exist for the monitoring and reporting of methodologies under the ETS. The main distinction is between calculation-based and measurement-based approaches. ▪ Calculation-based methodologies are built upon an understanding of the emissions sources arising from activities, termed sources streams. Factors are applied to each activity to convert to emissions in units of carbon equivalent ▪ Measurement-based methodologies require acquire measurement of gasses emitted. Emissions are calculated based on the flow of a gas stream and the GHG concentration of this gas. Although there are options for how monitoring is undertaken, each option is stringently defined; for example, there is no allowance to select only certain greenhouse gasses.
Developed by	The European Commission

2.2.2 GHG Protocol Corporate Standard

Setting international standards for GHG assessment: The GHG Protocol is a set of standards, guidance, tools, and training for measuring and managing GHG emissions. It encompasses a range of different frameworks which are applied internationally to measure emissions for corporations, products, projects, organisations and policy actions.

A standard for corporate GHG assessment: The GHG Corporate Accounting & Reporting Standard is designed for companies and other organisations. It underlines the UK Government's Streamlined Energy and Carbon Reporting (SECR) framework through which listed companies must report their GHG emissions.

Description	The GHG Protocol Corporate Accounting and Reporting Standard was first published in 2001. It is designed to standardise the task of corporate GHG reporting – establishing an accurate and fair assessment methodology that was simple, consistent, transparent and allowed compassion of results between sectors and countries.
Scope	The GHG Protocol divides emissions into the three now commonly understood categories: Scope 1, 2 and 3, as described in section 2.1.1. Complying with the Corporate Standard involves addressing Scope 1 and 2 emissions, while inclusion of Scope 3 emissions is encouraged but voluntary.
Environmental impacts	As the name suggests, GHG Protocol standards are focused on greenhouse gas emissions. The Corporate Standard covers the accounting and reporting of seven greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride). Other environmental impacts are not considered.
Application	The standard was designed for use by businesses but can also be made use of by other organisations with operations that give rise to GHG emissions such as government agencies, NGOs and educational establishments. Putting the standard into practice involves setting organisational and operational boundaries, tracking emissions over time, and reporting in line with requirements. Additional guidance is provided within the standard on the methodology of identifying and calculating emissions, supplemented by various calculation tools to aid accurate reporting. The GHG Protocol is widely recognised, and this standard forms the basis of many mandatory and voluntary corporate emissions reporting and management schemes such as the UK's SECR framework.

Calculation approach	Following definition of the inventory boundary (considering the organisations which will be included and the scope of emissions to be covered) the GHG Protocol Corporate Standard follows a well-defined 5 step process to calculate emissions: 1. Identify emission sources and categorise into scope 1, 2 and 3; 2. Select calculation approach, which can be direct measurement, calculated according to a chemical mass balance analysis approach, or as is most common, calculated by applying emissions factors to each known source; 3. Collect data on the activities of the organisation and select the emissions factors to be used. The standard does not dictate which factors should be used but does provide an extensive database to aid selection of the most appropriate values; 4. Calculate emissions through use of one of the recommended tools made available by the GHG Protocol or through independent means; 5. Collate data from all facilities and consolidate the results. Because it aims to simplify and improve the consistency of GHG reporting, the scheme itself is well defined but does offer some flexibility in terms of calculation approach and activities to be included.
Developed By	World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD)

2.2.3 ISO 14040

A standard framework for LCAs: The international standard ISO 14040 is a long-standing framework for Life Cycle Assessments. It forms the basis for many modern LCA applications including many of the software packages developed to quickly conduct LCAs of consumer products. ISO 14040 is part of a family of standards that define the principles and guidelines for an assessment. It can be interpreted as desired for the need at hand but does not provide a rigid methodology to follow that is applicable to all products, processes or activities.

Description	ISO 14040 was first developed in 1996 and was updated in 2006. ISO 14040 forms the basis for a family of international standards that include ISO 14044, ISO 14047 and ISO 14071. Together, they set out the principles, framework, requirements, guidelines, and examples of applying a systematic approach to evaluate the environmental impact of a product, process, or activity. In other words, to carry out an LCA.
Scope	Defining the scope and purpose of the LCA is a key part of the process. LCA studies can be bounded by different stages of the life of the product, process or activity being evaluated. Common models include cradle-to-gate, cradle-to-grave and cradle-to-cradle are applied depending on the purpose of the evaluation. ISO 14040 provides a framework to perform an LCA but does not dictate the scope of the assessment.
Environmental impacts	A full scope LCA covers all environmental impacts. Impact categories are often weighted by their relative, subjective importance so that environmental impact can be compared numerically across different products.
Application	The ISO 14040 family of standards are designed for a wide application across a range of products, both manufactured and consumed. The framework is designed to address environmental impacts throughout a product's lifecycle in order to allow improvement of the environmental performance of products and better decision making based on defensible understanding of environmental impacts.
Calculation approach	ISO 14040 divides the LCA process into four steps: 1. The goal and scope of the study are defined, guiding the process of the assessment and setting its bounds. 2. A life cycle inventory (LCI) is carried out, covering all the energy, water and material inputs to a given process and all the pollution, emission and waste outputs from that same process.

	3. The environmental impact of these inputs and outputs are quantified and the results weighted and combined into a score for ease of comparison. 4. Ways to reduce the impacts are identified. LCAs can be product specific, based on detailed description of specific processes (bottom up) or can be calculated according to macro-economic data for whole product classes (top down). Despite standardisation, undertaking LCA remains a subjective activity both in terms of the complexity of the assessment, the input data used and the weighting of environmental impacts.
Developed by	The International Organization for Standardization (ISO)

2.2.4 ISO 14067

An LCA approach to Carbon Footprinting: The ISO 14067 standard has been developed to specifically focus on the greenhouse gas emissions of products. It is consistent with the general ISO 14040 framework, but more prescriptive on the treatment of GHGs and their conversion to units of carbon dioxide equivalent.

Description	ISO 14067 was developed subsequently to the ISO 14040 family of standards to focus the process of carrying out a life cycle assessment on the single impact category of climate change.
Scope	The standard is designed to assess the global warming potential of products, which is expressed as a carbon dioxide equivalent footprint. It aims to standardise both the quantification and reporting of greenhouse gas emissions.
Environmental impacts	ISO 14067 relates entirely to climate change potential as a result of greenhouse gas emissions.
Application	Taking a more targeted approach than ISO14040, ISO 14067 provides clear criteria for the calculation of the carbon footprint of a product, forgoing other environmental impacts such as those relating to land and water use. The standard is designed to give organisations of all kind the means to calculate the carbon footprint of their products and provide a better understanding of ways in which they can reduce it.
Calculation approach	ISO 14067 introduces the concept of gate-to-gate and partial life cycle assessment of products. While it ultimately derives the carbon footprint of a product, the 'product' functional unit can also be a service. Production of a carbon footprint is the first step, to be followed by the identification of a reduction and offsetting strategy for the emissions identified. The standard is considered to be broadly consistent with PAS 2050 discussed in Section 2.2.5, however it has a differing approach on some issues such as carbon storage and delayed emissions. There is only limited flexibility in the method if followed directly.
Developed by	The International Organization for Standardization.

2.2.5 PAS 2050

A life cycle assessment focussed on GHG emissions: The PAS 2050 standard is a framework for LCAs of products and services. It is based on ISO 14040 but is more specific, focussing its attention on greenhouse gas emissions and providing useful guidance on the setting of objectives and understanding of the boundaries of the assessment, particularly in the setting of rules and recommendations for different sectors.

The basis for the GHG Protocol Product Standard: PAS 2050 is the foundation for the GHG Protocol Product Standard – an internationally recognised and well-used framework for life cycle assessment and reporting. PAS 2050 can be thought of as the actual methodology for performing the LCA. The GHG Protocol standard then incorporates this methodology (with some minor variations) and builds it into a standard method for public reporting of the environmental impacts of products and services.

Description	PAS 2050 is a publicly available specification encouraging a standardised approach to LCAs of greenhouse gas emissions for products and services. First released in 2008, it was revised in 2011. It aims to assess the carbon footprint of a given activity or entity and is closely tied to the GHG Protocol Product Standard, which is based on PAS 2050 but also includes requirements for public reporting.
Scope	The PAS 2050 methodology recommends different scopes of assessment for different forms of goods and services. For consumer products this is a cradle-to-grave assessment; however, the standard gives licence to users to define the scope of the process themselves. In cases such as products sold to businesses, the scope may end at the sale and transport of the product.
Environmental impacts	PAS 2050 builds on the ISO 14040 family of standards but is focussed only on greenhouse gas emissions. It includes consideration of carbon dioxide, methane, nitrous oxide, hydrofluoro-carbons, perfluorocarbons and sulfur hexafluoride emissions.
Application	The standard is designed to apply to all goods and services and be used by manufacturers, retailers, traders, business to business and business to consumer services. It is designed to aid the internal assessment of product life cycle GHG emissions, to allow evaluating improvements to manufacturing and production, and for benchmarking and the support of corporate sustainability goals.
Calculation approach	There are five basic steps within the PAS 2050 LCA approach: 1. Build a process map of the product's life cycle, to include all material energy and waste flows from raw material extraction to disposal; 2. Confirm the boundaries of the assessment – a high-level footprint assessment can be carried out here to aid prioritisation of the effort; 3. Collect data on material volumes, activities, and emissions factors. PAS 2050 does not dictate which emissions factors should be used but provides sector and country-specific recommendations; 4. Calculate the footprint by applying emissions factors to activity data; 5. As an optional final step uncertainty analysis can be performed to better understand and then improve the accuracy of the assessment. The method is adaptable to different system boundaries and includes an allowance for considerable flexibility in the selection of emissions factors and collection of activity data.
Developed by	The British Standards Institute (BSI) sponsored by the Carbon Trust and Defra.

3. CRITIQUE OF METHODOLOGIES

3.1 COMPARISON

	EU ETS emissions calculation methodology	GHG Protocol Corporate Standard	ISO 14040	ISO 14067	PAS 2050
Type of assessment	Designed for large infrastructure projects	Applicable to companies and other organisations, not products or processes	A general framework for LCA	An LCA guideline for evaluating the carbon footprint of products	An LCA guideline for evaluating the carbon footprint of products
Scope boundary	Only direct Scope 1 emissions are accounted for	Reporting of Scope 1 and 2 emissions is mandatory while inclusion of Scope 3 is voluntary	As a framework all possible scopes of LCA are catered for	Includes provision for cradle-to-grave, cradle-to-gate, gate-to-gate and partial LCAs	The standard offers the option for cradle-to-grave or cradle-to-gate assessments
Impacts included	Only climate change impacts are covered (in the form of GHGs) but the gasses included are limited – some GHGs are missing	GHG emissions are the sole impact included, and seven primary GHGs are included in the calculations	All impact categories are included in the framework and can be chosen as desired. This allows all GHGs to be considered	The focus is on climate change emissions in the form of GHGs. All GHG emissions are included	All GHG emissions are included
Application	Due to the focus on Scope 1 emissions the scheme is not suitable for technologies which do not directly emit GHGs	As a corporate standard the application is limited to corporations and organisational activities	If appropriately bounded,an ISO 14040 based approach can suit a wide range of applications	Designed for products but generally applicable to a wide range of applications	Designed for products but generally applicable to a wide range of applications
Calculation approach	The scheme is relatively inflexible as it underpins the EU's main policy instrument for capping GHG emissions. Within the scheme itself there is little scope to bend the rules	The standard aims to simplify and improve the consistency of corporate GHG reporting. It is high-level and still retains some allowance for accommodating different uses.	As a general framework ISO 14040 does not specify the level of detail required. It could be applied in a highly detailed or a light-touch manner	ISO 14067 aims to standardise the quantification process of GHG emission for products. If directly applied, the standard has only limited flexibility in complexity and method	While aiming to provide uniform specifications for GHG emissions of goods and services, PAS 2050 allows addition of bespoke industry or product specific requirements

3.2 FINDINGS

Pro Low Carbon requires an environmental impact assessment methodology that can help improve understanding of *the carbon impact of procuring DSO services from local flexibility technologies.* Expressed in another way, it could be said that the project aims to provide clarity on how the award of DSO service contracts to certain technologies contributes to the greenhouse gas emissions of procuring those services.

The establishment of a suitable methodology to assess the carbon emissions of different technologies providing DSO services is the first step towards achieving this goal. The methodology needs to align with this goal; it needs to consider the right environmental impacts; its scope and boundaries need to be appropriate; it needs to be relatively simple to maximise future use; and it needs to be inclusive of the technologies that provide DSO services now and in the future.

These are the factors which must be considered in order to critique the methodologies outlined in Section 2 and form recommendations for a methodology to adopt or construct.

► What are we assessing?

The objective of Pro Low Carbon involves a product (the flexibility technology, be it domestic battery, diesel genset, or anything in between) providing a certain function (providing the flexibility service). We are not looking to assess every aspect of the usage of a product – we are only interested in the contribution that arises from the provision of the DSO service. This could include both the emissions arising from actively providing the service during operations as well as the embodied and end of life emissions, where these can be attributed to the provision of the flexibility service.

Corporate emissions assessments are not likely to be suitable if embodied and end of life emissions need to be considered. Project level assessments could be appropriate but also rarely deal with the early life (embodied) or disposal related impacts. Product LCAs offer a framework within which full lifecycle emissions can be included, although a bespoke method will be needed to deal with the complicated operational emissions impact in the case of deferred electricity consumption.

A product LCA approach looks to be best suited to this goal of this work. Special attention will need to be paid to the operational stage of the life cycle, which for some technologies will include significant emissions and require careful consideration to be assessed in an appropriate manner.

► How do we bound the scope?

To truly understand the impact of procuring flexibility services from different technologies it is necessary to consider every stage of the lifecycle (cradle-to-grave), as every stage will have its impact. This is particularly the case with flexibility services, where the provision of the service itself may not necessarily be the most emissions-intensive part of the product's life.

It may be that this work shows that certain stages of the life cycle are negligible in comparison to others and can be ignored without harming the accuracy of the assessment. But this is a conclusion that can only be reached when every aspect of the life cycle has been thoroughly considered.

The methodology needs to be flexible to accommodate different scopes of assessment. The base assumption will be that every life cycle stage from cradle to grave is considered, but to be applicable to all possible use cases it is important to be able to exclude certain stages if the emissions of these stages are not attributable to the provision of flexibility services.

► Which environmental impacts will be included?

This work sits within the context of the energy industry, historically one of the largest emitters of greenhouse gas emissions. Despite the changing face of electricity demand and supply, this work will still be dealing with technologies that burn hydrocarbons and directly emit greenhouse gasses. This is not to say that flexibility technologies do not have other environmental impacts, but for the purposes of this study the question is framed around carbon emissions, or more accurately, carbon dioxide equivalent emissions.

This assessment will include greenhouse gas emissions that can be converted into units of CO_2e. The methodology used will have to be amenable to this; including a framework for the inclusion of all potential GHG emissions from the assets studied and not mandating that other environmental impacts be included.

► What will the methodology be applied to?

Pro Low Carbon is focussed on local flexibility technologies. But even within this category there are a wide range of different asset types, and it will be necessary to include the full spectrum to understand the range of impacts that arise from different technologies and generate meaningful findings that can inform policy and regulatory change. Flexible power services are currently provided by technologies including demand response, biogas, diesel generators, gas generators and portfolios of domestic batteries.

The methodology chosen needs to be applicable to the full range of technologies that currently provide services through Flexible Power as well as to those technologies which do not currently provide services but which are likely to in the future. This means it needs to be general, adaptable, and equally applicable to both large and small sized assets.

► How detailed is the calculation?

The objective of Pro Low Carbon is to explore the carbon impact of local flexibility services. But the project needs to do this in a way that is pragmatic; ensuring that this significant and weighty question is answered in a way that produces meaningful and insightful results. Consideration must also be given to the fact that this is not where this challenge ends – there will many opportunities to build on the results of Pro Low Carbon in the future. In order to maximise its impact the carbon assessment methodology used should be one that is easly applicable in the future, to national flexibility services, procurement mechanisms and more. This leans the requirements towards a methodology that is flexible and relatively simple, such that it can be applied to a large range of different assets in an automated manner based on easily obtainable data inputs.

The methodology needs to be flexible to accommodate different scopes of assessment and be simple enough that it can be carried out quickly and repeatedly. The base assumption will be that every life cycle stage from cradle to grave will be considered, but for future applicability it is important to be able to exclude certain stages if they do not contribute significantly to the overall impact.

3.3 NEXT STEPS

The next stage of Pro Low Carbon will determine how to quantify the GHG emissions of procuring DSO services from local flexibility technologies. This report has set out the framework for how this can be done. In particular, the methodology needs:

- To be based on an LCA framework
- To be capable of including enviornmental impacts from all stages of the technology life cycle
- To include all major greenhouse gas emissions that can be converted to CO_2e
- To be applicable to the technologies currently providing DSO services and to those that will do in the future
- To be flexible to accommodate different levels of detail in the assessment

To develop the final method of assessment all of these requirements will be taken into account. However, the manner in which these needs are accommodated within this work will be shaped by the complexity of the task at hand. Going forward, it will be necessary to consider:

- How to efficiently quantify carbon emissions with one method that can be applied to a wide range of different technologies;
- How to account, within one framework, for the emissions associated from operational behaviours that vary from demand reduction to burning fuels;
- How to best allocate embodied emissions for technologies that provide multiple services and for which DSO service provision is not the primary role.