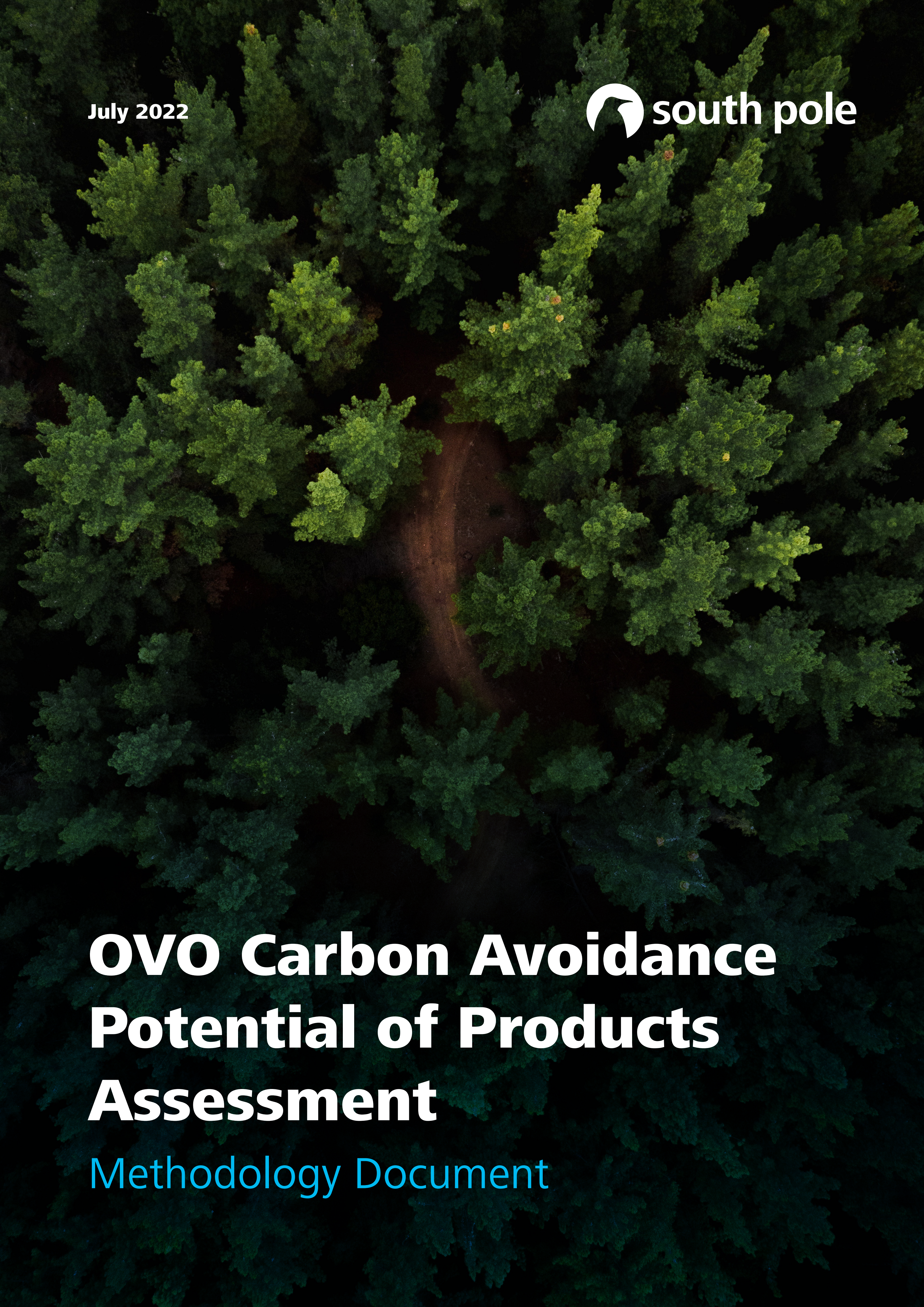
July 2022

south pole



# OVO Carbon Avoidance Potential of Products Assessment

## Methodology Document

# Acknowledgements

**Prepared for:**
**OVO Energy**

**Prepared by:**
**South Pole Carbon Asset Management Ltd. (South Pole)**
Technoparkstrasse 1 · 8005 Zurich · Switzerland
southpole.com

**Project Manager:**
Dr Tianzong Li, Consultant
t.li@southpole.com

**Project Leader:**
Rob Ellinson, Managing Consultant
r.ellinson@southpole.com

**Contact person:**
Roby Crean, Key Account Manager
r.crean@southpole.com

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# Executive summary

Average global temperatures have increased by 1.2 degrees Celsius since 1800. It's critical that we act now, together, to help mitigate and manage climate change. OVO is deeply committed to a sustainable, greener future through its sustainability strategy – Plan Zero. The Plan Zero strategy drives OVO to develop products and services that will help their customers decarbonise home energy use. It is these (scope 3) emissions from the sale of electricity and gas that contribute approximately 99.9% of OVOs GHG footprint.

Through Plan Zero, OVO has committed to:

- Reach net zero carbon by 2030 for OVO's scope 3 emissions (from the sale of electricity and gas), referred to as OVO's 2030 net zero target.

- Achieve an absolute reduction in emissions in line with a 1.5 degrees science-based target (SBT) by 2030. This target has been calculated by OVO together with The Carbon Trust.

To support these goals, OVO reviewed the products within their existing portfolio and currently in development to identify those with the greatest potential for enabling their customers to avoid carbon emissions (and thereby reduce OVO's scope 3 emissions from energy sold to customers).

The objective of this project was to establish a credible methodology for measuring the emissions avoided from OVO's portfolio of decarbonisation products and services (low carbon solutions), and use this to assess the potential of each solution to avoid carbon emissions.

By applying established frameworks and principles for carbon accounting, carbon avoidance factors were calculated for each of OVO's low carbon solutions through comparing the emissions from a business-as-usual scenario with OVO's low-carbon solution. The assessments were underpinned using assumptions based on secondary research from credible sources, OVO product teams, or OVO's proprietary primary data sources. The assessment was conducted from November 2021 to March 2022.

The avoided emissions for ten of OVO's low carbon solutions were successfully modelled, as well as establishing a set of credible methodologies that can be expanded alongside OVO's growing portfolio of decarbonisation products. These methodologies can be further enhanced as more comprehensive and higher quality data becomes available to fine-tune modelling assumptions.

The results of our assessment show that OVO has the potential to bring solutions to market that could drive down the carbon emissions from home energy use, and contribute towards slowing down climate change.

The outputs from this project could be used as a valuable input into OVO's commercial strategy and decision-making (for example in prioritising products to be developed or scaled up). Ultimately, the information on carbon emissions avoided could support further alignment between OVO's commercial and climate strategies.

Overall, it is our hope that this guidance will enable more businesses to assess the avoided carbon potential of low carbon products that can support aligning their business activities with their climate targets and ambition.

# 1 Project overview

## 1.1 Context

This report describes the methodologies, data, assumptions and calculations that were applied in order to determine the carbon avoidance potential of several of OVO Energy's (hereinafter: OVO) low carbon solutions. This project launched in November 2021 and concluded in March 2022.

OVO has sought to understand how best to reduce its scope 3 carbon emissions in line with net zero. Scope 3 emissions contribute to approximately 99.9% of OVOs GHG footprint, of which the primary emissions sources are from the sale of electricity and gas. As part of OVO's sustainability strategy – Plan Zero – OVO has committed to:

- Reach net zero carbon by 2030 for OVO's scope 3 emissions (from the sale of electricity and gas), referred to as OVO's 2030 net zero target.
- Achieve an absolute reduction in emissions in line with a 1.5 degrees science-based target by 2030. This target has been calculated by OVO together with The Carbon Trust.

The Plan Zero strategy drives OVO to develop products and services that will help their customers decarbonise home energy use.

## 1.2 Objectives

The objectives of this project were to:

1. establish a credible methodology for measuring the emissions avoided from OVO's portfolio of decarbonisation products and services (low carbon solutions); and
2. use the methodologies developed to assess the potential of each solution to avoid carbon emissions

OVO reviewed the products within their existing portfolio and currently in development to identify those with the greatest potential for enabling their customers to avoid carbon emissions (and thereby reduce OVO's scope 3 emissions from energy sold to customers). A combined total of ten products and services were selected as part of this study.

OVO worked with leading climate action expert South Pole to calculate the carbon avoidance potential of these low carbon products and services.

OVO intends to use the outputs from this project to inform its commercial strategy for developing, rolling out and marketing low carbon solutions. The analysis from this project can be used to build the business case for prioritising and scaling up solutions that will make the biggest difference to climate change.

## 1.3 Results summary

| Package | Product | Average annual carbon avoidance factor from product lifecycle | Average annual carbon avoidance factor from product use-phase only | Solution description |
|---|---|---|---|---|
| **EV leasing** | EV leasing via third party partnerships | 1,519.7 kg$CO_2$e/year/ EV leased | 1,636.3 kg$CO_2$e/year/ EV leased | This assessment covers the life cycle carbon avoidance potential of accessing electric car leasing deals via third party partnerships, instead of buying new internal combustion engine (ICE) vehicles. |
| **Air source heat pump** | Air source heat pump | Market-based: 1,619.1 kg$CO_2$e/year/ install<br><br>Location-based: 1,396.3 kg$CO_2$e/year/ install | Market-based: 1,719.5 kg$CO_2$e/year/ install<br><br>Location-based: 1,496.6 kg$CO_2$e/year/ install | This assessment covers the life cycle carbon avoidance potential of replacing an average gas boiler (efficiency=84%) with an air source heat pump (COP=3.0) to provide heat for spacing heating and hot water in an average-sized three-bedroom semi-detached house in the UK. |
| **Insulation** | Solid wall insulation | Market-based: 1,123.7 kg$CO_2$e/year/ household<br><br>Location-based: 1,162.1 kg$CO_2$e/year/ household | Market-based: 1,137.8 kg$CO_2$e/year/ household<br><br>Location-based: 1,176.3 kg$CO_2$e/year/ household | This assessment covers the life cycle carbon avoidance potential of insulating solid wall with 100mm carbon enhanced EPS insulation board for an average-sized three-bedroom semi-detached house (with 85 $m^2$ wall area). |
| **Insulation** | Cavity wall insulation | Market-based: 823.1 kg$CO_2$e/year/ household<br><br>Location-based: 851.0 kg $CO_2$e/year/ household | Market-based: 825.5 kg$CO_2$e/year/ household<br><br>Location-based: 853.4 kg $CO_2$e/year/ household | This assessment covers the life cycle carbon avoidance potential of insulating cavity wall with 100mm blowing wool insulation produced by Knauf Insulation for an average-sized three-bedroom semi-detached house (with 85 $m^2$ wall area). |
| **Smart thermostat** | Smart thermostat | Market-based: 292.9 kg$CO_2$e/year/ install<br><br>Location-based: 302.8 kg$CO_2$e/year/ install | Market-based:: 292.9 kg$CO_2$e/year/ install<br><br>Location-based: 302.8 kg$CO_2$e/year/ install | This assessment covers the life cycle carbon avoidance potential of replacing a dumb digital programmable thermostat with a Tado smart thermostat in an average home (in terms of energy consumption) in the UK. The smart thermostat can automatically optimise temperature in the home based on whether the space is occupied, windows and doors are opened, weather forecast and a pre-set user schedule. |

| Package | Product | Average annual carbon avoidance factor from product lifecycle | Average annual carbon avoidance factor from product use-phase only | Solution description |
|---|---|---|---|---|
| **Gas boiler replacement** | High efficiency gas boiler | Same as use phase only | Market-based: 288.9 kg$CO_2$e/year/ install<br><br>Location-based: 298.7 kg$CO_2$e/year/ install | This assessment covers the life cycle carbon avoidance potential of replacing an average gas boiler (efficiency=84%) with a high-efficiency boiler (efficiency=94%) to provide heat for spacing heating and hot water in an average-sized three-bedroom semi-detached house in the UK. |
| **Smart charging** | Smart electric vehicle charger | 85.5 kg$CO_2$e/year/unit installed | 86.5 kg$CO_2$e/year/unit installed | This assessment covers the life cycle carbon avoidance potential of using smart chargers optimised by the Kaluza Flex Platform to charge at times when the carbon intensity of the grid is low, instead of using a dumb three-pin charger. Kaluza Flex is a software platform that controls and optimises energy use by smart devices. In addition to the smart charging effect, it has been found that the smart charger may have a higher charging efficiency compared to that of a three-pin home EV charging cable. |
| **Smart meter** | Smart meter | Market-based: 66.1 kg$CO_2$e/year/ install<br><br>Location-based: 81.9 kg$CO_2$e/year/ install | Market-based: 66.2 kg$CO_2$e/year/ install<br><br>Location-based: 82.0 kg$CO_2$e/year/ install | This assessment covers the life cycle carbon avoidance potential of replacing a standard dual fuel electricity and gas meters with a digital readout smart meter for both electricity and gas. The smart meter could provide real-time feedback to the user on their household energy consumption and emissions can be avoided where the this feedback is adopted. Users are able to understand their energy consumption better. |
| **Insulation** | Roof insulation | Market-based: 65.6 kg$CO_2$e/year/ household<br><br>Location-based: 67.8 kg$CO_2$e/year/ household | Market-based: 66.9 kg$CO_2$e/year/ household<br><br>Location-based: 69.2 kg$CO_2$e/year/ household | This assessment covers the life cycle carbon avoidance potential of increasing roof insulation thickness from 120mm to 270mm for an average-sized three-bedroom semi-detached house (with 45 $m^2$ roof area), using glass mineral wool insulation produced by Knauf Insulation. |

**Table 1: Description and carbon avoidance factors for each of the ten assessments**

# 2 Approach

## 2.1 Overview of approach

Avoided carbon emissions describe the emissions that can be avoided or reduced through the use of a particular product or service when compared to another with the same function. The difference in the greenhouse gas (GHG) emissions between the two scenarios being compared is known as the carbon avoidance. These two scenarios are named:

- The **business-as-usual (BAU) baseline scenario** refers to the scenario where the established product or service is being used, e.g. driving an internal combustion engine (ICE) vehicle to work.
- The **low carbon solution (LCS) scenario** describes the scenario where a low carbon product or service is being used with the same function as the BAU scenario, e.g. driving an electric vehicle to work

The calculation approach applied throughout this document to calculate the carbon avoidance potential of the products is detailed in Annex 1. The carbon avoidance factors represent the avoided carbon for a one-year period using the 'location-based method'. The GHG emissions calculations include emissions from all lifecycle stages[1] of the products.

As there's no universal technique for calculating carbon avoidance, several frameworks[2] were selected to best guide the carbon emission avoidance potential of OVO's products.

1 The product life-cycle stages provides a framework for accounting the cradle to grave emissions of a product, meaning, all emissions that are released throughout all stages of a products life, including: Production, Transportation and installation, Use and End-of-life treatment. See section 2.5 for full description of the lifecycle stages.

2 Greenhouse Gas Protocol (GHGP), 2004: A Corporate Reporting And Accounting Standard.
Greenhouse Gas Protocol (GHGP), 2005: The GHG Protocol for Project Accounting.
Greenhouse Gas Protocol (GHGP), 2011: Product Life Cycle Accounting and Reporting Standard
Mission Innovation, 2020: The Avoided Emissions Framework.
World Resources Institute (WRI), 2019: Estimating And Reporting The Comparative Emissions Impacts Of Products.

## 2.2 Process for quantifying carbon avoidance potential

The following steps outline the process for quantifying the carbon avoidance potential of each solution:

| | Step | Description | Example from assessment of an air source heat pump (ASHP) replacing a gas boiler |
|---|---|---|---|
| Step 1 | **Understand the mechanism and identify solution** | High-level research and rough calculations were conducted to understand the carbon avoidance mechanisms (i.e. fuel switching, energy saving, awareness training etc.) and which life cycle stages had the most significant impact on the carbon avoidance factor for each low carbon solution. | For heating a home, switching fuel from gas (using a gas boiler) to electricity (using an ASHP) means fewer carbon emissions because gas is more carbon-intensive than electricity. In addition, the ASHP is typically more efficient than a gas boiler due to the different heating mechanisms. Therefore an ASHP is a possible solution for avoiding carbon emissions, and the mechanisms are fuel switching and increasing energy efficiency. |
| Step 2 | **Define scope** | System boundaries were defined for each low carbon solution, as well as the unit of analysis. | Defining the boundaries of the system involved clarifying precisely what the system was, e.g. the heat pump, cylinder and piping. It was then crucial to determine what was going to be analysed; in this example one air source heat pump to provide heat for an average-sized three-bedroom semi-detached house in the UK. |
| Step 3 | **Define BAU baseline** | The selected BAU baseline represents the most widely used alternative to achieving the same function without the low carbon solution in place. | Through consulting with OVO and analysing historic installations, it was understood that a gas boiler was the most common system that was being replaced by the ASHP. |
| Step 4 | **Collect data** | A data collection template was developed for each low carbon solution. | A combination of primary and secondary data was collected for each of the lifecycle stages, and assumptions were made to support modelling any carbon avoidance factors where data was not available. |
| Step 5 | **Modelling and calculation** | Modelling and carbon avoidance potential calculation was conducted after the data collection step. | The life cycle GHG emissions for both the BAU and LCS scenarios were calculated, and the carbon avoidance potential was calculated by comparing the lifecycle carbon footprint of the two systems. |

**Figure 1: Steps for quantifying carbon avoidance potential**

## 2.3 Scope and boundary setting

The scope and boundary setting for each assessment has followed the principles of relevance, accuracy, completeness, consistency and transparency, adopted from the GHG Protocol Corporate Standard[3].

For all of the assessments, the general list of emissions sources that have been included and excluded are outlined in Table 2. In cases where an emissions source has been excluded from a specific assessment, this has been explained in the relevant methodology section for that assessment (Sections 3 & 4).

| Inclusion | Exclusion |
|---|---|
| • Embodied emissions of products<br>• Transportation of products<br>• Energy consumed during installation<br>• Use stage energy consumption<br>• Service and maintenance<br>• Energy consumed during disassembly<br>• Waste disposal<br>• End-of-life treatment | • Packaging of products<br>• Disposal of packaging materials<br>• Capital goods related to storage of the products at any stage during distribution<br>• Embodied carbon of capital goods (infrastructure/vehicles) involved in the production and transportation of the product.<br>• Transport of people involved in delivery, maintenance, refurbishment and repair<br>• Software to run the product (if applicable) |

**Table 2: General inclusion and exclusion criteria for the assessments**

### 2.3.1 Rebound effects

Rebound effects can occur when carbon emissions increase due to unintended or ancillary use of the solution. These effects often relate to difficult to predict behavioural changes that are either a direct or longer-term effect of the newly introduced solution. For all assessments, rebound effects were not considered unless otherwise stated, and only the direct, intended avoided emissions associated with implementing the solution have been calculated.

## 2.4 Life cycle approach

We recommend a life cycle approach to align with the GHG Protocol Product standard lifecycle stages[4].

This provides a framework for accounting the cradle-to-grave emissions of a product, including:

- Production
- Transportation and installation
- Use
- End-of-life.

The life cycle stages are defined according to the follows:

**Production stage:** The production stage involves GHG emissions that are released before installation. This includes all of the emissions associated with the manufacturing of the product, often referred to as the embodied carbon of a product.

**Transportation and installation stage:** The transportation and installation stage includes GHG emissions that are released during the transportation and installation of the product before the use of the product.

**Use stage:** The use stage includes all of the direct emissions that are associated with the use of the product. This stage begins when the customer takes possession of the product and ends when the product is discarded for transport to a waste treatment location or has reached the end of its designed service life.

**End-of-life (EoL) stage:** The end-of-life stage begins when the used product is discarded by the consumer or has reached the end of its designed service life, and ends when the product is returned to nature or allocated to another product’s life cycle.

3 Greenhouse Gas Protocol (GHGP), 2004: A Corporate Reporting And Accounting Standard.

4 Greenhouse Gas Protocol (GHGP), 2011: Product Life Cycle Accounting and Reporting Standard

## 2.5 Attribution of carbon avoidance (acceptance of double-counting)

Currently, there is no consistent way to attribute avoided emissions entirely to a single entity. In this assessment, when OVO contributes to avoiding carbon together with another stakeholder, OVO and the other stakeholder are both entitled to claim the total carbon avoidance potential.

For example, in the smart charging scenario, both OVO and Indra (the smart charger manufacturer) can claim the entire carbon avoidance potential as they have both contributed towards implementing a scenario resulting in avoided carbon.

There is a risk of double-counting. However, there is no universal standard to regulate the attribution of carbon avoidance, and it is widely accepted that the 'accept double-counting' approach[5] is the most cost-efficient attribution approach in such cases.

## 2.6 Data quality

### 2.6.1 Types of data

A combination of different data types were used in this assessment to calculate the carbon avoidance potentials. The different types of data include:

1. Primary data: relates directly to the solution being assessed.
2. Secondary data: derives from other sources such as government reports, industry reports, academic publications and reputable media sources.
3. Proxy data: comes from similar processes or products. For example, the life cycle emissions of EPS insulation board were derived from a similar project's environmental product declarations (EPD).
4. Assumptions: are derived from a number of sources. For example, the roof area data of a typical UK three-bedroom semi-detached house is derived from the expertise and knowledge derived from historic installations.

### 2.6.2 Accuracy

The accuracy of product life cycle GHG accounting can range from a high-level screening study to a full in-depth analysis. In this project, a streamlined life-cycle GHG footprint analysis approach was adopted for both the BAU baseline and LCS scenarios.

Between South Pole and OVO, an appropriate level of accuracy for estimating the GHG emissions was determined based on the objectives of the use of the carbon avoidance factors outlined in Section 1.2.

The intent is for OVO to have a high-level understanding of the carbon avoidance potential of each low carbon solution product that OVO has introduced to the market.

OVO intends to use the outputs from this project to inform its commercial strategy for developing, rolling out and marketing low carbon solutions.

However, the results presented in this assessment should not form the basis of any organisational or product carbon footprint for the purposes of external reporting or any comparative assertion[6]. Further description of the applicability of the results and information outlined in this study can be found in Annex 2.

### 2.6.3 Assumptions

Where possible, primary or secondary/proxy data were used in the carbon avoidance calculation. In the absence of data, appropriate assumptions have been applied and aligned jointly with OVO internal subject matter experts based on literature research, industry experience and historic installations data.

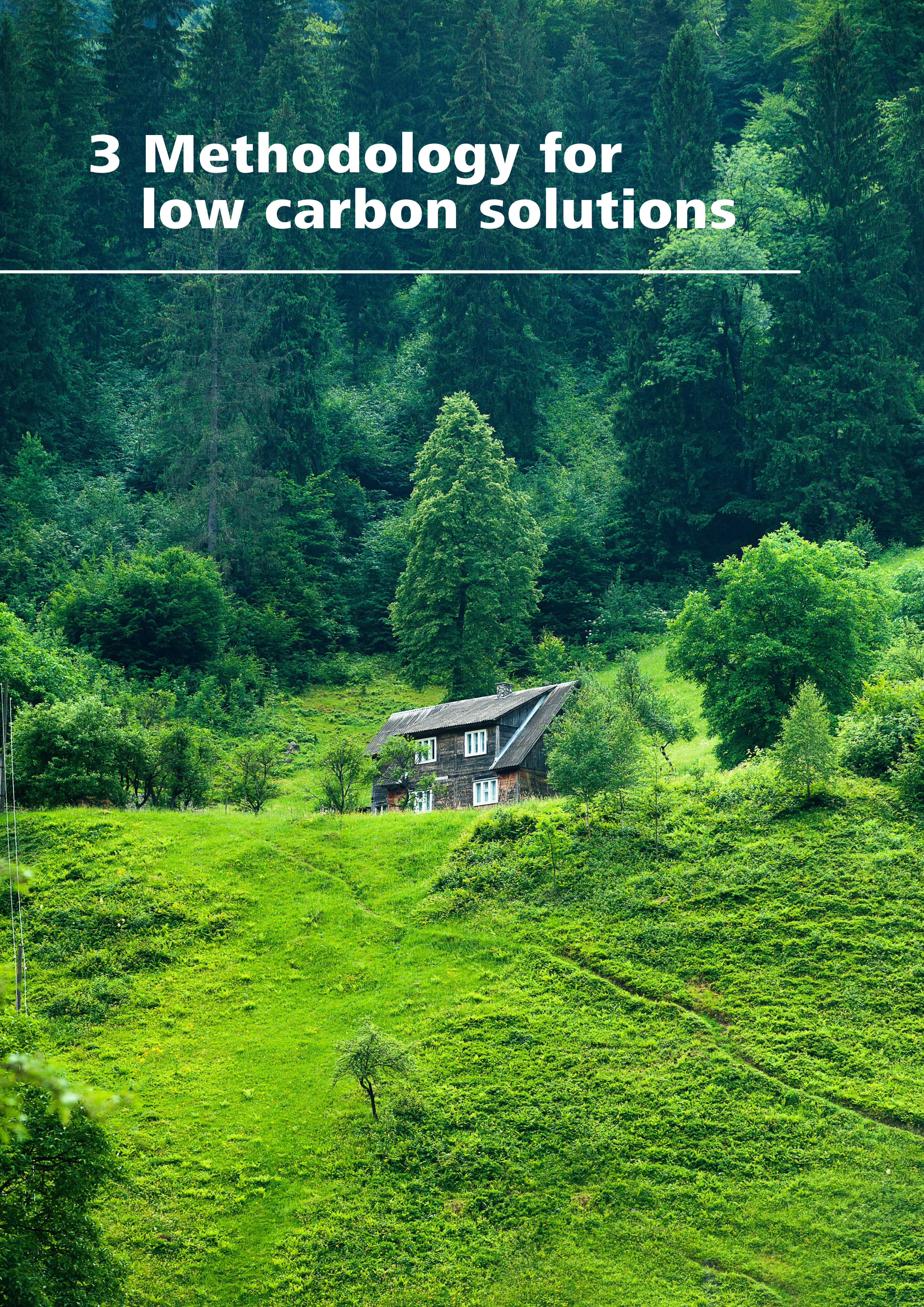
All of the approaches applied were considered to have achieved sufficient accuracy to enable the users to achieve the intended objectives outlined in Section 1.2.

As mentioned, the chosen level of accuracy of this assessment was deemed appropriate, based on the objectives of the study. There is inherent uncertainty associated with the carbon avoidance factors outlined within this study as a result of the data inputs and assumptions that have been applied. It has been recommended that future improvements to this methodology include a qualitative or quantitative uncertainty assessment.

5 Mission Innovation, 2020: The Avoided Emissions Framework.

6 According to ISO 14040, comparative assertion is an environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function.

# 3 Methodology for low carbon solutions



## 3.1 Electric vehicle leasing

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) |
|---|---|
| **Whole life cycle of product** | **1,519.7** |
| **Use phase only** | **1,636.3** |

### Solution description and scope

Leasing electric vehicles (EV) can encourage drivers to move away from buying new internal combustion engine vehicles (ICE). In the UK, the lifecycle GHG emissions of an EV are significantly less than for an ICE; this can be attributed to the fuel switching from fossil fuels to electricity, and the high renewable energy proportion in the electricity mix.

This assessment covers the life cycle carbon avoidance potential of EVs. The unit of analysis is one vehicle that will be used in the UK.

A description of the BAU baseline and LCS scenarios is included in the table below. It has been assumed that each customer who participates in an EV leasing plan would otherwise have been leasing/buying an ICE vehicle.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Internal combustion vehicle | Average sized internal combustion vehicle with an average fuel carbon intensity |
| **LCS scenario** | Electric vehicle | Average battery electric vehicle |

**Table 3: A description of the BAU baseline and LCS scenarios for the electric vehicle leasing carbon avoidance assessment**

### Carbon avoidance mechanism

Electric vehicles can deliver carbon avoidance potential through:

- Fuel switching from fossil fuels to electricity.
- A reduction in the service and maintenance requirements of EVs compared to ICEs (this is due to EVs having fewer mechanical components compared to a conventional ICE).

It is recognised that further carbon avoidance mechanisms could be enabled through smart charging and more efficient charging when switching to electric vehicle use. However, carbon avoidance from smart charging has not been included within the scope of this assessment. The carbon avoidance potential of smart charging has been assessed seperately in the Section 3.7 of this document.

## Methodology

### Production stage

For both the BAU and LCS, production-related emissions were derived from the International Council on Clean Transportation (ICCT), 2021[7] study that provides GHG emissions estimates for the production and recycling of the glider and powertrain of lower-medium cars in Europe.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product embodied carbon (includes the glider, powertrain and end-of-life emissions. The battery embodied carbon is not included for EV)** | 7,200 $kgCO_2e$ | 6,500 $kgCO_2e$ |
| **Battery embodied carbon (end-of-life not included)** | n/a | 2,700 $kgCO_2e$ |
| **Product life span** | 17 years[8] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Annual equivalent embodied carbon (excl. end-of-life of EV battery)** | 423.5 $kgCO_2e$/vehicle | 541.2 $kgCO_2e$/vehicle |

### Transportation and installation stage

For both BAU and LCS, the vehicles were delivered by driving the vehicle to the customers' location. Emissions were calculated as follows:

*Emissions from transportation ($kgCO_2e$) =*
*Average distance travelled for vehicle delivery (mile) * Average car emissions factor ($kgCO_2e$/mile)*

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Average distance travelled for vehicle delivery** | 100.00 miles[9] | |
| **Average car emissions factor ($kgCO_2e$/km)** | 0.35 $kgCO_2e$/mile[10] | 0.11 $kgCO_2e$/mile[11] |

7 International Council on Clean Transportation (ICCT), 2021: A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric. Assuming the EV is low to medium sized with a 45 kWh battery

8 MyEV.com, How Long Should An Electric Car's Battery Last?. (A life span of 17 years was selected for both scenarios. At the time of writing, there were no reliable studies that indicate different lifespans for the two scenarios.

9 Based on historical sales data, the average vehicle transportation distance from the vehicle depot to the customer's home was 100 miles. An average distance of 100 miles was used in this calculation for both scenarios

10 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average car-fuel unknown" (Emissions factor includes the well-to-tank (WTT) emissions)

11 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average car-Battery Electric Vehicle" (Emissions factor includes the well-to-tank (WTT) emissions)

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation and installation stage (total)** | 34.85 $kgCO_2e$/vehicle | 11.11 $kgCO_2e$/vehicle |
| **Annual equivalent GHG emissions from transportation and installation stage** | 2.05 $kgCO_2e$/vehicle | 0.65 $kgCO_2e$/vehicle |

## Use stage

The use stage emissions were calculated using the following equation for both scenarios:

*Use stage emissions ($kgCO_2e$) =*
*Emissions from the vehicle use ($kgCO_2e$) + Emissions from the vehicle maintenance ($kgCO_2e$)*

Where:
*Annual emissions from the vehicle use ($kgCO_2e$) =*
*Average annual passenger car mileage (mile) * distance based emissions factor for travel ($kgCO_2e$/mile)*

*Annual emissions from the vehicle maintenance (kgCO2e) =*
*Average annual passenger car mileage (km) * distance based emissions factor for maintenance ($kgCO_2e$/km)*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Average annual passenger car mileage** | 6,800 miles (10,948km)[12] | |
| **Distance-based emissions factor for travel** | 0.35 $kgCO_2e$/mile[13] | 0.11 $kgCO_2e$/mile[14] |
| **Distance-based emissions factor for maintenance[15]** | 0.006 $kgCO_2e$/km | 0.004 $kgCO_2e$/km |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Annual emissions from the vehicle use** | 2,369.87 $kgCO_2e$ | 755.41$kgCO_2e$ |
| **Annual emissions from the vehicle maintenance** | 65.66 $kgCO_2e$ | 65.66 $kgCO_2e$ |
| **Annual emissions from use stage** | 2,435.5 $kgCO_2e$ | 799.19 $kgCO_2e$ |
| **Annual carbon avoidance from use stage** | 1,636.34 $kgCO_2e$/vehicle | |

12 UK Department for Transport (UK DfT), 2021, National Travel Survey

13 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average car-fuel unknown" (Emissions factor includes the well-to-tank (WTT) emissions)

14 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average car-Battery Electric Vehicle" (Emissions factor includes the well-to-tank (WTT) emissions)

15 International Council on Clean Transportation (ICCT), 2021: A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric, (The maintenance GHG emission factor has been calculated by averaging the diesel and gasoline maintenance EFs)

## End-of-life (EoL) stage

For both scenarios, the end-of-life recycling of the powertrain and glider are included in the figures provided in the production stage. For this study, It has been assumed that the life span for the EV and ICE will be the same (17 years)[16].

Given that this excludes the battery end-of-life treatment for the LCS estimate, this has been calculated using the following equation:

*Battery end-of-life emissions (kg$CO_2$e) = Battery weight (kg) * End-of-life GHG emission factor (kg$CO_2$e/kg)*

*Where:*
*Battery weight (kg) = Battery capacity (kWh)/Battery energy density (kWh/kg)*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Battery capacity** | n/a | 45 kWh[17] |
| **Battery energy intensity** | n/a | 0.13 kWh/kg[18] |
| **End-of-life GHG emission factor** | n/a | 21.29 kg$CO_2$e/tonne[19] |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Battery weight** | n/a | 346.15 kg |
| **Battery end-of-life emissions** | n/a | 7.37 kg$CO_2$e/vehicle |
| **Annual equivalent GHG emissions from EV batter end-of-life stage** | n/a | 0.43 kg$CO_2$e/vehicle |

16 At the time of writing, there were no reliable studies that indicate different lifespans for the two scenarios.

17 International Council on Clean Transportation (ICCT), 2021: A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric. (The maintenance GHG emission factor has been calculated by averaging the diesel and gasoline maintenance EFs)

18 International Council on Clean Transportation (ICCT), 2021, Battery Electric Tractor-Trailers In The European Union: A Vehicle Technology Analysis

19 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Electrical items-Batteries-Open-loop recycle".

## 3.2 Air source heat pump

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Whole life cycle of product** | **1,619.1** | **1,396.3** |
| **Use phase only** | **1,719.5** | **1,496.6** |

### Solution description and scope

An air source heat pump (ASHP) captures heat from outside and moves it into the house.

It uses electricity to transfer heat instead of directly combusting natural gas to generate heat via boilers, which is the most common heat source for UK households. Carbon emissions are avoided through the electrification of the household heating system. As a result of decarbonising the UK grid, from 2021 electricity (from the UK grid) has had a lower carbon intensity compared to natural gas combustion.

This assessment covers the life cycle carbon avoidance potential of replacing a gas boiler with an air source heat pump. This includes replacing the water cylinder and main unit itself, however, it excludes any other ancillary parts (e.g. pipes, valves etc.). These ancillary components were excluded from the assessment on the basis that the requirement to replace them varies from installation to installation, and there is no typical case.

The potential cooling function of using an ASHP was not taken into account given the current cooling demand for domestic buildings is low in the UK, according to a study conducted by BEIS[20].

The unit of analysis is one air source heat pump to provide heat for an average-sized three-bedroom semi-detached house in the UK.

A description of the BAU baseline and LCS scenarios is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Gas boiler | A well-insulated average-sized three-bedroom semi-detached house in the UK, with an average gas boiler to provide heat for spacing heating and hot water. |
| **LCS scenario** | Air source heat pump | A well-insulated average-sized three-bedroom semi-detached house in the UK, using an ASHP (powered by electricity) to provide space heating and hot water. |

**Table 4: A description of the BAU baseline and LCS scenarios for the air source heat pump carbon avoidance assessment**

20 Department for Business, Energy & Industrial Strategy (BEIS), 2021, Cooling in the UK

For both BAU and LCS scenarios, it has been assumed that the house has a cavity wall type, and that the house is well insulated. This is defined as the house having a 270mm glass wool (λ 0.040 – 0.046 W/mK) roof insulation and 100mm blowing wool cavity wall insulation. This was based on the Energy Savings Trust guidelines for roof and wall insulation.

Based on South Pole's understanding of OVO's ASHP installations, they are only installed in houses that have been fully insulated. Therefore, for this assessment, it is assumed that the average UK household gas consumption of 13,047 kWh is for a three-bedroom semi-detached house with 120 mm roof insulation and no wall insulation. The energy savings (kWh) associated with insulating the house (from the roof and cavity wall insulation assessments within this document) have been deducted from this average UK household consumption figure (derived from BEIS) for both the BAU and LCS, to reflect the energy demand for a fully insulated house.

### Carbon avoidance mechanism

ASHP can deliver carbon avoidance potential through:

- Reducing energy usage for space heating and hot water through the increased coefficient of performance (COP) of the ASHP at space and water heating in comparison to the gas boiler.
- Switching fuels from natural gas to electricity. Electricity from the UK grid has a lower carbon intensity.

### Methodology

#### Production stage

To evaluate and compare the life cycle carbon avoidance of substituting the gas boiler with an ASHP, with the exception of changing the heating system, all other physical characteristics of the house were considered to be the same.

Therefore, only the difference in the production stage of the different heating systems has been taken into consideration in this assessment.

For both the BAU and LCS, the GHG emissions associated with the production stage were derived from the literature.

For an average gas boiler, the embodied carbon value of 330 $kgCO_2e$ was used, and for the ASHP the embodied carbon value of 1,563 $kgCO_2e$ was used[21].

#### Transportation and installation stage

For both the BAU and LCS, activity data and secondary emissions factors were applied to calculate the emissions from the transportation and installation stage (where applicable) by applying the equation below:

*Transportation and installation stage emissions =*
*emissions from transportation ($kgCO_2e$) + emissions from installation ($kgCO_2e$)*

Where:
*Emissions from transportation ($kgCO_2e$) =*
*Average distance travelled by the engineer from the depot to customer home (km) * GHG emission factor of vehicle type ($kgCO_2e/km$)*

In both scenarios, it was assumed that the engineer would be travelling with the products. It was determined that only small electric tools and hand tools such as an impact driver (18-24v), crimp gun and SDS drill would be used at the installation stage. On this basis, as no heavy equipment would be required, these emissions were considered negligible and excluded from the scope of this assessment.

21 Stephen Finnegan et al. 2018, The embodied CO2e of sustainable energy technologies used in buildings: A review article.

It has been assumed that all three vehicles used in the ASHP installation would be required to travel for the same distance of 300 km per installation. This was based on a typical installation of an ASHP by an OVO engineer.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Average distance travelled by the engineer from the depot to customer home** | 300 km[22] | |
| **GHG emission factor of vehicle type** | 0.30 $kgCO_2e/km$[23] | 1.20 $kgCO_2e/km$[24] |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 90.04 $kgCO_2e$ | 359.23 $kgCO_2e$ |
| **Emissions from installation** | 0 | 0 |
| **Carbon avoidance (from transportation and installation stage)** | -269.19 | |

## Use stage

The use stage emissions were calculated using the following equation:

*BAU average annual use stage emissions ($kgCO_2e$) =*
*(UK average annual household gas consumption for space heating and hot water (kWh)-energy saving from insulating the roof (kWh) – energy saving from insulating the cavity wall (kWh)) * gas GHG emission factor ($kgCO_2e/kWh$)*

Where:
*UK average annual household gas consumption for space heating and hot water (kWh) =*
*UK average annual household gas consumption (kWh) * Gas consumption that used for spacing heating and hot water (%)*

*LCS average annual use stage emissions ($kgCO_2e$) =*
*(UK average annual household gas consumption for space heating and hot water (kWh) – energy saving from insulating the roof(kWh)-energy saving from insulating the cavity wall (kWh)) * Efficiency improvement factor from the ASHP (%) * electricity GHG emission factor ($kgCO_2e/kWh$)*

Where:
*Efficiency improvement factor (%) = Energy efficiency of average gas boiler (%)/COP of ASHP (converted in %)*

22 Based on historical sales data, the average vehicle transportation distance from the vehicle depot to the customer's home was 300 km. This distance was applied in both scenarios.

23 For a gas boiler installation, it was determined that one average-sized diesel van would be used to conduct the delivery and installation, resulting in an emissions intensity of 0.3 $kgCO_2e/km$. Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average Vans (up to 3.5 tonnes)-diesel" (Factor includes WTT emissions)

24 For the AHSP installation, one small van, one medium van and one rigid HGV are required for transporting materials, equipment and labour from the depot to the customer, resulting in an aggregated emissions intensity of 1.2 $kgCO_2e/km$. Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average Vans (up to 3.5 tonnes)-diesel" & "Rigid HGV (>3.5-7.5 tonnes)-Average laden" (Factor includes WTT emissions)

The OVO 2020-2030 emissions factors ($kgCO_2e$) for electricity and gas were applied to convert the gas consumption data (kWh) to GHG emissions ($kgCO_2e$). The results were reported using both the market- and location-based methods.

For both scenarios there are no planned replacement of parts, and only visual inspections are required as part of the annual maintenance and servicing. It has been assumed that a negligible amount of energy will be consumed during the service and maintenance and therefore have been excluded from the use-stage calculation.

### Data input

| Data field | BAU & LCS input values |
|---|---|
| UK average annual household gas consumption | 13,407 kWh[25] |
| Gas consumption that used for spacing heating and hot water | 97.62%[26] |
| Energy saving from insulating the roof | 322.58 kWh[27] |
| Energy saving from insulating the cavity wall | 3,948.49 kWh[28] |
| Efficiency of average gas boiler | 84%[29] |
| Coefficient of performance (COP) of ASHP | 3.0 (300%)[30] |
| Gas GHG emission factor | The OVO 2020-2030 emissions factors ($kgCO_2e/kWh$) were applied |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| UK average annual household gas consumption for space heating and hot water (kWh) | 13,087.9 kWh | |
| Efficiency improvement factor from the ASHP | n/a | 0.28 |
| Average annual carbon avoidance from use stage (location-based) | 1719.49 $kgCO_2e$ | |
| Average annual carbon avoidance from use stage (location-based) | 1496.63 $kgCO_2e$ | |

25 Department for Business, Energy & Industrial Strategy, 2021, Energy Consumption in the UK (ECUK): Final Energy Consumption Tables, " temperature corrected – average consumption of a UK household".

26 UK, Department for Business, Energy & Industrial Strategy, 2021, Energy Consumption in the UK (ECUK): End Use Tables (97.62% has been calculated as the average percentage of gas consumption that has been used in space heating and hot water. )

27 The energy-saving value from insulating the roof was derived from the roof insulation carbon avoidance assessments included within this study. For more information, please refer to section 3.9. roof insulation methodology.

28 The energy-saving value from insulating the cavity wall was derived from the cavity wall insulation carbon avoidance assessments included within this study. For more information, please refer to section 3.4. Cavity wall insulation methodology.

29 The average gas boiler efficiency was taken as the average from OVO's historic installation records.

30 Amir A Safa et al. 2015, Comparative thermal performances of a ground source heat pump and a variable capacity air source heat pump systems for sustainable houses

## End-of-life (EoL) stage

For both BAU and LCS scenarios, the end-of-life treatment has been assumed as open-loop recycling; the total emissions from this stage were calculated based on a weight-based approach. The emissions of the EoL stage were calculated as follows:

*EoL emissions (kg$CO_2$e) = Product weight (kg) * GHG emission factor for EoL stage(kg$CO_2$e/kg)*

The GHG emission factor that was applied for the end-of-life treatment was 21.29 kg$CO_2$e/tonne[31]

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product weight** | 58.5 kg[32] | 211 kg[33] |
| **GHG emission factor for EoL stage** | 21.29 kg$CO_2$e/tonne[34] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from EoL stage** | 1.2457 kg$CO_2$e | 4.4930 kg$CO_2$e |
| **Carbon avoidance (from EoL stage)** | -3.247 kg$CO_2$e | |

31 Department for Business, Energy & Industrial Strategy, 2021 (BEIS), 2021 for "Waste disposal-Electrical items-WEEE-small"

32 Number based on Worcester Bosch 32 CDI, data was provided by OVO product team

33 Number based on Daikin HT unit (146kg) +Joule 300L cylinder (65kg), data was provided by OVO product team

34 Department for Business, Energy & Industrial Strategy (BEIS), 2021, "WEEE-large open-loop recycle"

## 3.3 Solid wall insulation

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | Market-based method | Location-based method |
| Whole life cycle of product | 1,123.7 | 1,162.1 |
| Use phase only | 1,137.8 | 1,176.3 |

### Solution description and scope

In a typical uninsulated household, approximately 33% of space heating is lost through the walls[35]. Insulating the walls is considered an effective way to reduce space heating energy consumption and thus reduce GHG emissions and energy bills.

This assessment covers the life cycle carbon avoidance potential of insulating the solid walls with 100mm graphite expanding polystyrene (EPS) insulation boards[36] in an average-sized three-bedroom semi-detached house in the UK. It has been assumed that a three-bedroom semi-detached house is the most representative house type in the UK[37].

All other physical characteristics of the house remained the same when comparing the BAU and the LCS scenarios.

The unit of analysis is one average-sized three-bedroom semi-detached house with a wall area of 85 $m^2$ using only gas for space heating. It has been assumed that the average wall area for a three-bedroom semi-detached house is 85$m^2$. This was based on OVO's historic installation data for a three-bedroom semi-detached house.

After an initial assessment conducted by South Pole, the impact from ancillary materials and processes such as mechanical fixings, the basecoat, primer and render finishes etc., were considered to have a negligible contribution to estimated emissions. Therefore, those processes were excluded from this assessment.

A description of the BAU baseline and LCS scenarios is included in the table below:

| Scenario | Product/service | Description |
|---|---|---|
| BAU baseline scenario | Uninsulated solid wall | An average-sized three-bedroom semi-detached house in the UK with no existing solid wall insulation. |
| LCS scenario | Insulated solid wall with 100mm insulation | An average-sized three-bedroom semi-detached house in the UK with 100mm graphite EPS boards. EPS 80 graphite has been used as a proxy product in this assessment. This was considered the most commonly installed insulation material and brand. |

Table 5: A description of the BAU baseline and LCS scenarios for the solid wall insulation carbon avoidance assessment

35 Energy Saving Trust (EST, Cavity-wall insulation.
36 Determined with OVO as the most representative product type for a solid wall insulation.
37 Department for Levelling Up, Housing and Communities (DLUHC), 2021, English Housing Survey data on stock profile

### Carbon avoidance mechanism

Insulating the solid wall can deliver carbon avoidance potential through:

- Reducing heat loss from the wall and thus a reduction in household gas consumption required for space heating

### Methodology

#### Production stage

For both the BAU and LCS, product volumes ($m^3$) and primary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below:

*Emissions from production stage ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor ($kgCO_2e/m^3$)*

The product volume is calculated by multiplying the wall area (85 $m^2$) with the insulation thickness.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ [38] |
| **GHG emission factor** | 44.61 $kgCO_2e/m^3$ [34] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from production stage** | 0 | 379.19 $kgCO_2e$ |
| **Carbon avoidance (from production stage)** | -379.19 $kgCO_2e$ | |

#### Transportation and installation stage

For both BAU and LCS, activity data and secondary emissions factors were applied to calculate the emissions from the transportation and installation stage using the following equations:

*Transportation and installation stage emissions =*
*emissions from transportation ($kgCO_2e$) + emissions from installation($kgCO_2e$)*

Where:
*Emissions from transportation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for transportation ($kgCO_2e/m^3$)*

*Emissions from installation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for installation ($kgCO_2e/m^3$)*

38 The product volume is calculated by multiplying the wall area (85 $m^2$) with the insulation thickness. For LCS the thickness of insulation is 100mm. The insulation thickness is a value that varies from installation to installation and 100mm was considered as a suitable representative thickness during discussions with the OVO installations team.

39 Innovation and Chemical Industries in Sweden (IKEM)-Environmental Product Declaration (EPD): EPS 80 graphite insulation (A1-A3 stages)

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ |
| **GHG emission factor for transportation** | 0.23 $kgCO_2e/m^3$ [40] | |
| **GHG emission factor for installation** | 0.51 $kgCO_2e/m^3$ [41] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 0 | 1.97 $kgCO_2e$ |
| **Emissions from installation** | 0 | 4.33 $kgCO_2e$ |
| **Emissions from transportation and installation stage** | 0 | 6.30 $kgCO_2e$ |
| **Carbon avoidance (from transportation and installation stage)** | -6.30 $kgCO_2e$ | |

## Use stage

The carbon avoidance from this stage is calculated by:

*Annual carbon avoidance from use stage ($kgCO_2e$) = Annual energy saving (kWh) * gas carbon intensity ($kgCO_2e$/kWh)*

Where:
*Annual energy saving (kWh) =*
*Annual energy bill saving as a result of insulating the solid wall (£)/Energy unit price (£/kWh)*

The OVO 2020-2030 proprietary emissions factors ($kgCO_2e$) for gas were applied to convert the gas consumption data (kWh) to GHG emissions ($kgCO_2e$). The results were reported using both the market- and location-based methods.

### Data input

| Data field | Input value |
|---|---|
| **Annual bill saving as a result of insulating the solid wall** | £255[42] |
| **Energy unit price** | 0.0465 £/kWh[43] |
| **Gas GHG emission factor** | The OVO 2020-2030 emissions factors ($kgCO_2e$/kWh) were applied |
| **Product life span** | 60 years |

40 Innovation and Chemical Industries in Sweden (IKEM)-Environmental Product Declaration (EPD): EPS 80 graphiteinsulation (A4 stages)
41 Innovation and Chemical Industries in Sweden (IKEM)-Environmental Product Declaration (EPD): EPS 80 graphiteinsulation (A5 stages)
42 Energy Saving Trust (EST), Insulating solid wall.
43 Energy Saving Trust (EST), Our data

### Calculations

| Data field | LCS input value |
|---|---|
| **Annual energy saving** | 5,483.87 kWh |
| **Average annual carbon avoidance from use stage (market-based)** | 1,137.8 $kgCO_2e$ |
| **Average annual carbon avoidance from use stage (location-based)** | 1176.29 $kgCO_2e$ |

## End-of-life (EoL) stage

For both the BAU and LCS, activity data and secondary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below:

*Emission from EoL stage ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor ($kgCO_2e/m^3$)*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ |
| **GHG emission factor for transportation** | 54.46 $kgCO_2e/m^3$ [44] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emission from EoL stage** | 0 | 462.94 $kgCO_2e$ |
| **Carbon avoidance (from end-of-life stage)** | -462.94 $kgCO_2e$ | |

44 Innovation and Chemical Industries in Sweden (IKEM)-Environmental Product Declaration (EPD): EPS 80 graphiteinsulation (C1-C4 stages)

## 3.4 Cavity wall insulation

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Whole life cycle of product** | 823.1 | 851.0 |
| **Use phase only** | 825.5 | 853.4 |

### Solution description and scope

Insulating a cavity wall is also considered to be an effective way to reduce the loss of heated air through the walls, and therefore reduce space heating energy consumption, GHG emissions and energy bills.

This assessment covers the life cycle carbon avoidance potential of insulating the cavity walls with 100mm blowing wool insulation in an average-sized three-bedroom semi-detached house in the UK[45]. It has been assumed that the semi-detached house is the most representative house type in the UK[46]. All other physical characteristics of the house remained the same when comparing the BAU and the LCS scenarios.

The unit of analysis is one average-sized three-bedroom semi-detached house with a wall area of 85 m2 using only gas for space heating. It has been assumed that the average wall area for a three-bedroom semi-detached house is 85 m2. This was based on OVO's historic installation data for a three-bedroom semi-detached house.

After an initial assessment conducted by South Pole, the impact from ancillary materials and processes such as mechanical fixings, the basecoat, primer and render finishes etc., were considered to have a negligible contribution to the results. Therefore, those processes were excluded from this assessment.

A description of the BAU baseline and LCS scenarios is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Uninsulated cavity wall | An average-sized three-bedroom semi-detached house in the UK with no existing cavity wall insulation. |
| **LCS scenario** | Insulated cavity wall with 100mm insulation | An average-sized three-bedroom semi-detached house in the UK with 100mm blowing wool cavity wall insulation. Blowing wool insulation ($\lambda$ 0.040 – 0.045 W/mK) produced by Knauf has been used as a proxy product in this assessment. This was considered the most commonly installed insulation material and brand. |

**Table 6: A description of the BAU baseline and LCS scenarios for the cavity wall insulation carbon avoidance assessment**

45 Determined with OVO as the most representative product type for a cavity wall insulation.
46 Department for Levelling Up, Housing and Communities (DLUHC), 2021, English Housing Survey data on stock profile

## Carbon avoidance mechanism

Insulating the cavity wall can deliver carbon avoidance potential through:

- Reducing heat loss from the wall and thus a reduction in the household gas consumption required for space heating

## Methodology

### Production stage

For both the BAU and LCS, product volumes ($m^3$) and primary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below:

*Emissions from production stage ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor ($kgCO_2e/m^3$)*

The product volume ($m^3$) is calculated by multiplying the wall area (85 $m^2$) with the insulation thickness.

For the BAU and LCS scenarios, the insulation thicknesses were 0 mm and 100 mm, respectively.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ [47] |
| **GHG emission factor** | 13.10 $kgCO_2e/m^3$ [48] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from production stage** | 0 | 111.35 $kgCO_2e$ |
| **Carbon avoidance (from production stage)** | -111.35 $kgCO_2e$ | |

### Transportation and installation stage

For both BAU and LCS, activity data and secondary emissions factors were applied to calculate the emissions from the transportation and installation stage using the following equations:

*Transportation and installation stage emissions =*
*emissions from transportation ($kgCO_2e$) + emissions from installation($kgCO_2e$)*

Where:
*Emissions from transportation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for transportation ($kgCO_2e/m^3$)*

*Emissions from installation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for installation ($kgCO_2e/m^3$)*

38 The product volume is calculated by multiplying the wall area (85 $m^2$) with the insulation thickness. For LCS the thickness of insulation is 100mm.
39 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Blowing wool insulation (λ= 0.040 – 0.045 W/mK, A1-A3 stages)

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ |
| **GHG emission factor for transportation** | 0.23 $kgCO_2e/m^3$ [49] | |
| **GHG emission factor for installation** | 0.65 $kgCO_2e/m^3$ [50] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 0 | 1.94 $kgCO_2e$ |
| **Emissions from installation** | 0 | 5.48 $kgCO_2e$ |
| **Emissions from transportation and installation stage** | 0 | 7.42 $kgCO_2e$ |
| **Carbon avoidance (from transportation and installation stage)** | -7.42 $kgCO_2e$ | |

## Use stage

The carbon avoidance from this stage is calculated by:

*Average annual carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * gas carbon intensity ($kgCO_2e$/kWh)*

Where:
*Annual energy saving (kWh) = Annual bill saving as a result of insulating the cavity wall (£)/Energy unit price (£/kWh)*

The average estimated UK energy bill saving was £185, and the gas unit price was 0.0465 £/kWh[51]

The OVO 2020-2030 proprietary emissions factors ($kgCO_2e$) for gas were applied to convert the gas consumption data (kWh) to GHG emissions ($kgCO_2e$). The results were reported using both the market- and location-based methods.

**Data input**

| Data field | Input value |
|---|---|
| **Annual bill saving as a result of insulating the cavity wall** | £185[52] |
| **Energy unit price** | 0.0465 £/kWh[53] |
| **Gas GHG emission factor** | The OVO 2020-2030 emissions factors ($kgCO_2e$/kWh) were applied |

49 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Blowing wool insulation (Ð= 0.040 – 0.045 W/mK, A4 stage))
50 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Blowing wool insulation (Ð= 0.040 – 0.045 W/mK, A5 stage))
51 Energy Saving Trust-Our data
52 Energy Saving Trust (EST), Insulating cavity wall
53 Energy Saving Trust (EST), Our data

### Calculations

| Data field | LCS input value |
|---|---|
| **Annual energy saving** | 3,978.49 kWh |
| **Average annual carbon avoidance from use stage (market-based)** | 825.46 $kgCO_2e$ |
| **Average annual carbon avoidance from use stage (location-based)** | 853.39 $kgCO_2e$ |

## End-of-life (EoL) stage

For both the BAU and LCS, activity data and secondary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below.

*EoL emissions ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for EoL stage($kgCO_2e/m^3$)*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 0 | 8.5 $m^3$ |
| **GHG emission factor** | 0.2142 $kgCO_2e/m^3$ [54] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from production stage** | 0 | 1.82 $kgCO_2e$ |
| **Carbon avoidance (from production stage)** | -1.82 $kgCO_2e$ | |

54 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Blowing wool insulation (Ð= 0.040 – 0.045 W/mK, C2-C4 stages), (GHG emission factors of 0.14 $kgCO_2e/m^3$ and 0.07 $kgCO_2e/m^3$ were applied for the end-of-life transportation and treatment stages respectively)


## 3.5 Smart thermostat

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Whole life cycle of product** | **292.9** | **302.8** |
| **Use phase only** | **292.9** | **302.8** |

### Solution description and scope

Installing a smart thermostat has the potential to avoid carbon emissions by reducing the overall energy consumption for space heating. This is achieved through automatically controlling room temperature based on various parameters that include whether the space is occupied, the windows and doors are opened, weather forecast and pre-set user schedules.

This assessment covers the life cycle carbon avoidance potential of smart thermostats[55]. To evaluate and compare the impact of installing a smart thermostat on energy saving, for this assessment all other physical characteristics of the household in both BAU and LCS scenarios are assumed to be the same; only the impacts of installing and using the smart thermostat are being assessed.

The unit of analysis is one residential household with average UK gas consumption for one year. The average UK household gas consumption was derived from BEIS and is for an unspecified house size

A description of the BAU baseline and LCS scenarios is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Dumb digital programmable thermostat | An average UK house with one manual digital temperature programmable thermostat |
| **LCS scenario** | Smart thermostat | An average UK house using one Tado smart thermostat with automatic temperature control. |

**Table 7: A description of the BAU baseline and LCS scenarios for the smart thermostat carbon avoidance assessment**

### Carbon avoidance mechanism

Smart thermostats can deliver carbon avoidance potential through:

- Reducing natural gas consumption for space heating through automatically optimising temperature based on whether the space is occupied, the windows and doors are opened, the weather forecast and pre-set user schedules.

55 The Tado smart thermostat has been selected as a representative product for this assessment.

## Methodology

### Production stage

No GHG emissions calculations were conducted for the production stage on the basis that the products weigh the same and the avoided emissions would equal 0 through applying the calculation methodology outlined below:

*Embodied emissions (kg$CO_2$e) = Product weight (kg) * GHG emission factor (kg$CO_2$e/kg)*

The product weight for both cases was 0.132 kg.[56]

### Transportation and installation stage

The transport-related emissions were calculated using the following equation:

*Emissions from transportation (kg$CO_2$e) =*
*Product weight (kg) * distance travelled * Average van unknown fuel GHG emission factor (kg$CO_2$e/kg.km)*

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Distance travelled** | 0[57] | 30 miles (48.28km) [58] |
| **Average van unknown fuel GHG emission factor** | n/a | 0.00076 kg$CO_2$e/kg.km[59] |
| **Energy consumed during the installation process** | 0 [60] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 0 | 755.41 kg$CO_2$e |
| **Emissions from installation** | 0 | 0 |
| **Carbon avoidance (from transportation and installation stage)** | -0.048 kg$CO_2$e | |

55 Product weights were provided by OVO, from products weighed in the OVO lab

56 For the BAU scenario, it was determined that the emissions would be equal to zero. It is assumed that the BAU scenario thermostat was installed at the time of boiler installation and therefore no transportation emissions were calculated. This was considered the most representative case when discussing with the OVO installation team.

57 For the LCS scenario, the thermostat is posted from the depot to the customer household and a distance of 30 miles (48.28 km) was assumed (based on the typical transportation distance for an OVO engineer delivering a EV smart charger).

58 Department for Business, Energy & Industrial Strategy (BEIS), 2021, "Van-Average-Fuel unknown (up to 3.5 tonnes)" (well-to-tank (WTT) emissions have been included).

59 Department for Business, Energy & Industrial Strategy (BEIS), 2021, "Van-Average-Fuel unknown (up to 3.5 tonnes)" (well-to-tank (WTT) emissions have been included).

60 In both scenarios, it is assumed that no energy was consumed during the installation. This assumption was based on discussions with the OVO product team and learning that only light hand tools, if any, would be required for their installation.

## Use stage

The use stage emissions were calculated using the following equation:

*Annual BAU use stage emissions (kg$CO_2$e) =*
*UK average annual household gas consumption for space heating (kWh) * Natural gas GHG emission factor (kg$CO_2$e/kWh)*

*Annual LCS use stage emissions (kg$CO_2$e) =*
*UK average annual household gas consumption for space heating (kWh) *(One space heating requirement reduction enabled by smart thermostat (%)) * Natural gas GHG emission factor (kg$CO_2$e/kWh)*

The OVO 2020-2030 emissions factors (kgCO2e/kWh) were applied to convert the energy consumption data to GHG emissions. The results were reported using both the market- and location-based methods.

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **UK average annual household gas consumption (kWh)** | 13,407 kWh[61] | |
| **Gas consumption that used for spacing heating** | 75.20%[62] | |
| **Space heating requirement reduction enabled by smart thermostat** | n/a | 14% [63] |
| **Gas GHG emission factor** | The OVO 2020-2030 emissions factors (kg$CO_2$e/kWh) were applied | |
| **Product life span** | 15 years | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **UK average annual household gas consumption for space heating** | 10,082 kWh | 8,670.52 kWh |
| **Average annual carbon avoidance from use stage (location-based)** | 292.86 kg$CO_2$e | |
| **Average annual carbon avoidance from use stage (location-based)** | 302.76 kg$CO_2$e | |

## End-of-life (EoL) stage

For both BAU and LCS scenarios, the end-of-life treatment has been assumed as open-loop recycling; there is no data to support this, but it is assumed that owners are more environmentally conscious and more likely to recycle/refurbish their goods. No GHG emissions calculations were conducted for the end-of-life stage on the basis that the products weigh the same and the carbon avoidance would equal 0 through applying the calculation methodology outlined below:

*EoL emissions (kg$CO_2$e) = Product weight (kg) * GHG emission factor for open loop recycling (kg$CO_2$e/kg)*

61 Department for Business, Energy & Industrial Strategy (BEIS), 2021, Energy Consumption in the UK (ECUK): Final Energy Consumption Tables,"temperature corrected – average consumption of a UK household".

62 UK, Department for Business, Energy & Industrial Strategy, 2021, Energy Consumption in the UK (ECUK): End Use Tables

63 Fraunhofer Institute For Building Physics Ibp, 2013, Simulation Study On The Energy Saving Potential Of A Heating Control System Featuring Presence Detection And Weather Forecasting, it has been found that Tado smart thermostat could save 14-26% heating energy requirements through intelligent control of the heat source. For conservative reason, 14% energy saving has been taken into this assessment

## 3.6 Gas boiler

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Use phase only** | **288.9** | **298.7** |

### Solution description and scope

Heating and hot water account for more than half of the energy consumption of an average household in the UK[64]. As a result, upgrading the boiler to a higher-efficiency model can significantly reduce carbon emissions through increased fuel efficiency.

This assessment covers the life cycle carbon avoidance potential of replacing an average-efficiency gas boiler with a more fuel-efficient one.

The unit of analysis is defined as one UK home with average dual-fuel (electricity and gas) consumption in the UK.

A description of the BAU baseline and LCS scenarios for electric vehicle charging is included in the table below:

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Average-efficiency gas boiler heating an average UK dual-fuel household | A gas boiler with an average coefficient of performance (COP) as defined by OVO boiler installation records of 0.84 |
| **LCS scenario** | High-efficiency gas boiler heating an average UK dual-fuel household | A gas boiler with an A++ SEDBUK Rating that has a COP of 0.94 |

**Table 8: A description of the BAU baseline and LCS scenarios for the gas boiler carbon avoidance assessment**

### Carbon avoidance mechanism

Higher efficiency gas boilers can deliver carbon avoidance through:

- Reducing gas consumption by increasing fuel efficiency.

### Methodology

It was established with OVO that in almost all cases, like-for-like replacements of the gas boilers take place. Therefore, the production, transportation and installation and end-of-life stage calculations of the BAU and LCS scenarios have the same value, and there are 0 $kgCO_2e$ of avoided emissions for these stages. **Therefore, only avoided emissions associated with the use stage have been assessed.**

To evaluate and compare the impacts of upgrading the gas boiler, all physical characteristics of the household in both BAU and LCS scenarios were assumed to be the same.

64 Energy Saving Trust (EST), 2021. Heating your home.

### Production stage

No GHG emissions calculations were conducted for the production stage on the basis that the products weigh the same, and the avoided emissions would equal 0 through applying the calculation methodology outlined below:

*Embodied emissions ($kgCO_2e$) = Product weight (kg) * GHG emission factor ($kgCO_2e/kg$)*

The gross product weight of both scenarios was considered to be similar, based on historical installation records.

### Transportation and installation stage

No GHG emissions calculations were conducted for the transportation and installation stage on the basis that the average installation distance between the depot and customer home would be the same, and the avoided emissions would equal 0 through applying the calculation methodology outlined below:

*Emissions from transportation ($kgCO_2e$) =*
*Average distance travelled for vehicle delivery (km) * Average car emissions factor ($kgCO_2e/km$)*

Based on historical sales data, the average installation transportation distance from the vehicle depot to the customer's home was 300 km for both scenarios.

### Use stage

The use-stage emissions were calculated using the following equation:

*BAU use stage emissions ($kgCO_2e$) =*
*UK average annual household gas consumption for space heating and hot water (kWh) * gas GHG emission factor ($kgCO_2e/kWh$)*

Where:
*UK average annual household gas consumption for space heating and hot water (kWh) = UK average annual household gas consumption (kWh) * Gas consumption that used for spacing heating and hot water (%)*

*LCS use stage emissions ($kgCO_2e$) = UK average annual household gas consumption for space heating and hot water (kWh) * Efficiency improvement factor from the high-efficiency gas boiler (%) * Natural gas GHG emission factor ($kgCO_2e/kWh$)*

Where:
*Efficiency improvement factor (%) = COP of average-efficiency gas boiler/COP of high-efficiency gas boiler*

The OVO 2020-2030 emissions factors ($kgCO_2e$) for electricity and gas were applied to convert the gas consumption data (kWh) to GHG emissions ($kgCO_2e$). The results were reported using both the market- and location-based methods.

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **UK average annual household gas consumption (kWh)** | 13,407 kWh[65] | |
| **Gas consumption that used for spacing heating and hot water** | 97.62%[66] | |
| **Efficiency of average gas boiler** | 84%[67] | 94%[68] |
| **Gas GHG emission factor** | The OVO 2020-2030 emissions factors ($kgCO_2e/kWh$) were applied | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **UK average annual household gas consumption for space heating and hot water (kWh)** | 13,087.9 kWh | |
| **Efficiency improvement factor** | n/a | 0.89 |
| **Average annual carbon avoidance from use stage (market-based)** | 288.88 $kgCO_2e$ | |
| **Average annual carbon avoidance from use stage (location-based)** | 298.66 $kgCO_2e$ | |

## End-of-life (EoL) stage

No GHG emissions calculations were conducted for the end-of-life stage on the basis that the products weigh the same and the avoided emissions would equal 0 through applying the calculation methodology outlined below:

*EoL emissions ($kgCO_2e$) = Product weight (kg) * GHG emission factor ($kgCO_2e/kg$)*

65 Department for Business, Energy & Industrial Strategy (BEIS), 2021, Energy Consumption in the UK (ECUK): Final Energy Consumption Tables,"temperature corrected – average consumption of a UK household".

66 UK, Department for Business, Energy & Industrial Strategy, 2021, Energy Consumption in the UK (ECUK): End Use Tables, (97.62% has been calculated based on data from this source as the average percentage of gas consumption that has been used in space heating and hot water.)

67 The average gas boiler efficiency was taken as the average of historic installation records resulted in 84%.

68 The average efficiency of A++ boilers was taken as the average of historic installation records resulted in 94%.


## 3.7 Smart charging

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year/unit installed)* |
|---|---|
| Whole life cycle of product | 85.5 |
| Use phase only | 86.5 |

### Solution description and scope

Smart electric vehicle (EV) charging[69] is a low-carbon alternative to charging a vehicle with a dumb three-pin charger. This has been shown to reduce greenhouse gas (GHG) emissions.

This assessment covers the life cycle carbon avoidance potential of using a smart charger. The representative product for a smart charger will be an Indra smart charger optimised by the Kaluza Flex Platform. The Kaluza Flex platform is software that controls and optimises smart devices to charge at times when the carbon intensity of the grid is low.

The unit of analysis for this assessment is defined as one EV charger to charge EVs or plug-in hybrid vehicles.

A description of the BAU baseline and LCS scenarios for electric vehicle charging is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| BAU baseline scenario | Dumb three-pin electric vehicle home charger. | 5m UK home electric vehicle charging cable[70] |
| LCS scenario | Smart electric vehicle charger. | Indra smart electric vehicle charger optimised by the Kaluza Flex platform to charge at times when the carbon intensity of the grid is low. |

Table 9: A description of the BAU baseline and LCS scenarios for the electric vehicle smart charging carbon avoidance assessment

### Carbon avoidance mechanism

Smart charging can deliver carbon avoidance potential through:

- Increased charging efficiency[71] compared to the traditional three-pin dumb charger
- The time-shift feature enabled by the Kaluza Flex Platform: the Kaluza Flex Platform installed on the smart charger will automatically forecast the carbon intensity on the grid in real-time and only charge the vehicle when the electricity is greener (i.e. when there is a higher proportion of renewable energy contributing to electricity generation on the UK grid).

69 Smart charging involves charging an electric vehicle (EV) at times when demand for electricity is lower, for example at night, or when there is lots of renewable energy on the grid. A dumb charger is a charger that charges the vehicle using electricity at the time it is plugged in and switched on.

70 This was determined as an appropriate baseline as it was considered less likely that owners would be purchasing a smart charger to replace their existing one if they already owned one. This product was considered as a representative product for a standard three-pin electric vehicle home charger (Rolec-EVPP0200-10Amp-2.2kW-3Pin UK-5 meter dumb charger).

71 The efficiency of an EV charger depends on the efficiency of various internal components when converting electrical power from the AC supply to the DC main lithium ion EV battery. Electricity consumption is higher in lower efficiency chargers due to losses during this process.

## Methodology

### Production stage

#### Calculation methodology

For both the BAU and LCS, activity data and secondary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below.

*Emissions from production stage (kg$CO_2$e) = Product weight (kg) * GHG emission factor (kg$CO_2$e/kg)*

#### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product weight** | 2.4 kg[72] | 3.5 kg[73] |
| **GHG emission factor** | 5.65 kg$CO_2$e/kg[74] | |

#### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from production stage** | 13.56 kg | 19.77 kg |
| **Carbon avoidance (from production stage)** | -6.21 kg$CO_2$e/kg | |

### Transportation and installation stage

For both BAU and LCS, activity data and associated GHG emissions factors were applied to calculate the emissions from the transportation and installation stage (if applicable) by applying the equation below:

*Transportation and installation stage emissions =*
*emissions from transportation (kg$CO_2$e) + emissions from installation(kg$CO_2$e)*

Where:
*Emissions from transportation (kg$CO_2$e) =*
*Average distance travelled by the engineer from pick up point to customer home (mile) * Emissions intensity of vehicle type (kg$CO_2$e/mile)*

*Emissions from installation (kg$CO_2$e) =*
*energy consumption from installation (kWh) * Emissions intensity of energy (kg$CO_2$e/kWh)*

72 Rolec-EVPP0200-10 Amp – 2.2 kW-3 Pin UK – 5 Meter dumb charger
73 Product weight and lifespan of 10 years provided by the product manufacturer
74 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Electrical items-small:.

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Average distance travelled by the engineer from pick up point to customer home** | 0[75] | 30 miles[76] |
| **Energy consumption from installation** | 0[77] | |
| **GHG emission factor** | n/a | 0.11 $kgCO_2e$/mile[78] |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 0 | 3.33 $kgCO_2e$ |
| **Emissions from installation** | 0 | |
| **Carbon avoidance (from transportation and installation stage)** | -3.33 $kgCO_2e$ | |

## Use stage

The use stage emissions for both BAU and LCS scenarios were calculated by applying the formula below:

*Use stage emissions ($kgCO_2e$) =*
*Annual energy consumption of UK EV charger users (kWh) * emissions factor of the energy consumed during high/low carbon intensity periods ($kgCO_2e$/kWh)*

For the LCS scenario, the average energy consumption of UK EV charger users (1,740 kWh/year) has been provided from modelled data provided by Kaluza, who have analysed data on the energy use of EV chargers connected to their platform. For the BAU baseline scenario, the annual energy demand was calculated from the annual energy demand of the LCS scenario by applying the following formula:

*Annual energy demand (BAU) = Annual energy demand (LCS) * charging efficiency (LCS)/charging efficiency (BAU)*

75 It has been assumed that the portable dumb charger was provided as an accessory when purchasing the EV. Therefore, the transportation distance of the dumb charger was zero.

76 Data provided by the OVO installations team indicated that the average transportation distance from the depot to the customer household would be 30 miles

77 In both scenarios, it is assumed that no energy is consumed during the installation. This assumption was based on discussions with the OVO product team and learning that only light hand tools, if any, would be required for their installation

78 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average Vans (up to 3.5 tonnes)-battery electric vehicle". (OVO has an electric van fleet, any smart charger installed by OVO will be using the electric vans for delivery. Emissions factor includes the well-to-tank emissions from transportation of 0.0229 kgCO2e/mile)

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Charging efficiency** | 85%[79] | 95%[80] |
| **Annual energy demand** | 1,944.7 kWh | 1,740 kWh[81] |
| **Emissions factor of the energy consumed during high/low carbon intensity periods[83]** | High carbon intensity: 0.3032 $kgCO_2e/kWh$ | Low carbon intensity 0.2892 $kgCO_2e/kWh$ |
| **Energy for service and maintenance** | 0 [83] | |
| **Product lifespan** | 10 years | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from use stage (per year)** | 589.6 $kgCO_2e$ | 503.14 $kgCO_2e$ |
| **Emissions from service and maintenance** | 0 | |
| **Annual carbon avoidance (from use stage)** | 86.47 $kgCO_2e$ | |

## End-of-life (EoL) stage

For both BAU and LCS scenarios, the end-of-life treatment has been assumed as open-loop recycling[84]; the total emissions from this stage were calculated based on a weight-based approach. The emissions of the EoL stage were calculated as follows:

*EoL emissions ($kgCO_2e$) = Product weight (kg) * GHG emission factor ($kgCO_2e/kg$)*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product weight** | 2.4 kg | 3.5 kg |
| **GHG emission factor** | 21.29 $kgCO_2e$/tonne [85] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from end-of-life stage** | 0.05 $kgCO_2e$ | 0.07 $kgCO_2e$ |
| **Carbon avoidance (from end-of-life stage)** | -0.02 $kgCO_2e$ | |

79 According to the literature, the charging efficiency of a traditional three-pin charger ranges from 74-85% (when charging a Nissan Leaf). A conservative approach has been taken and 85% charging efficiency has been assumed as the charging efficiency for the conventional three-pin charger (BAU baseline scenario). Andreas Kieldsen et al., 2016. Efficiency Test Method for Electric Vehicle Chargers. In Proceedings of EVS29 – International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium

80 The charging efficiency of smart chargers has been assumed to be 95% which was derived from Kaluza during their study of the avoided carbon associated with the Flex Platform.

81 For the LCS scenario, the average energy consumption of UK EV charger users (1,740 kWh/year) has been measured by Kaluza.

82 This dataset provides BAU carbon intensity (no smart control enabled, in $kgCO_2e/kWh$) and low-carbon intensity($kgCO_2e/kWh$) emissions factors as a result of enabling smart control for the UK grid. Emissions factors were derived from South Pole analysis that combined the National Grid fuel mixes during high/low carbon intensity periods with OVO's internal analysis of the lifecycle emissions intensities of different fuel types.

83 It has been assumed that no service/repair/maintenance will be required for the BAU and LCS scenarios.

84 Open-loop recycling is any recycling process where the recycled materials are converted into both new raw materials and waste products. Typically, materials recycled through open-loop recycling go on to be used for purposes different from their former, pre-recycled purpose.

85 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Electrical items-small".


## 3.8 Smart meter

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Whole life cycle of product** | **66.1** | **81.9** |
| **Use phase only** | **66.2** | **82.0** |

### Solution description and scope

Installing smart meters can avoid carbon emissions by reducing the overall household energy consumption. Users receive real-time information such as daily energy consumption and spend. They can use this information to optimise their energy use strategy and reduce their energy bills with the information provided by smart meters.

This assessment covers the life cycle carbon avoidance potential of a household that has installed a smart meter.

In addition to the carbon avoidance achievable from reducing energy use, due to behaviour change, smart meters are also an important enabler in digitalising the electricity grid, to make it smart and more flexible. The potential for carbon emissions avoidance and reduction enabled by a smarter electricity grid has been researched and analysed elsewhere, and are out of scope of this assessment. Nonetheless, it is important to recognise that the carbon avoidance potential of smart meters extends beyond the mechanism described above.

The unit of analysis is a residential household with average dual-fuel (electricity and gas) consumption in the UK.

A description of the BAU baseline and LCS scenarios is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Conventional dual fuel meters | An average UK house with standard dual fuel electricity and gas meters that do not include analysis. |
| **LCS scenario** | Smart meters | An average UK house using one digital readout smart meter for electricity and gas. |

**Table 10: A description of the BAU baseline and LCS scenarios for the smart meter carbon avoidance assessment**

### Carbon avoidance mechanism

Smart thermostats can deliver carbon avoidance potential through:

- Reducing natural gas and electricity consumption through providing real-time feedback to the user on their household energy consumption.

## Methodology

### Production stage

For both the BAU and LCS, the product weight and secondary emissions factors were applied to calculate the embodied emissions of the production stage by applying the formula below.

*Emissions from production stage ($kgCO_2e$) = Product weight (kg) * GHG emission factor ($kgCO_2e/kg$)*

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| Product weight[86] | 2.77 kg | 2.95 kg |
| GHG emission factor | 5.65 $kgCO_2e/kg$ [87] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| Emissions from production stage | 15.64 $kgCO_2e$ | 16.66 $kgCO_2e$ |
| Carbon avoidance (from production stage) | -1.02 $kgCO_2e$ | |

### Transportation and installation stage

The transport-related emissions were calculated using the following equation:

*Emissions from transportation ($kgCO_2e$) = Distance travelled from product depot to customer home (miles) * Emissions intensity of vehicle type – Diesel van (up to 3.5 tonnes) emissions intensity ($kgCO_2e/mile$)*

In both scenarios, it is assumed that no energy was consumed during the installation. This assumption was based on discussions with the OVO product team and learning that only light hand tools, if any, would be required for their installation.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| Distance travelled from product depot to customer home | 30 miles [88] | |
| Distance based emissions factor for travel | 0.48 kg $CO_2e/mile$ [89] | |
| Energy consumption from the installation stage | 0 [90] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| Emissions from transportation | 14.49 $kgCO_2e$ | 14.49 $kgCO_2e$ |
| Emissions from installation | 0 | |
| Carbon avoidance (from transportation and installation stage) | 0 $kgCO_2e$ | |

88 It has been assumed that both for BAU and LCS scenarios, the products were delivered by an average diesel van for 30 miles, this value was derived from historic installation data.

89 In both cases the products are installed by OVO. Given that Diesel vans are used in 78% of the installations a 3.5 tonne Diesel van was used in the calculation for both scenarios. Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Average Vans (up to 3.5 tonnes)-diesel" (Factor includes WTT emissions)

90 In both scenarios, it is assumed that no energy was consumed during the installation. This assumption was based on discussions with the OVO product team and learning that only light hand tools, if any, would be required for their installation.

## Use stage

The use-stage emissions were calculated using the following equation:

*BAU use stage emissions (kg$CO_2$e) = UK average annual household gas consumption (kWh) * Natural gas GHG emission factor (kg$CO_2$e/kWh) + UK average annual household electricity consumption (kWh) * electricity GHG emission factor (kg$CO_2$e/kWh)*

*LCS use stage emissions (kg$CO_2$e) = UK average annual household gas consumption (kWh) * (1-average gas demand reduction as a result of using smart meter (%)) * Natural gas GHG emission factor (kg$CO_2$e/kWh) + UK average annual household electricity consumption (kWh) * (one average electricity demand reduction as a result of using smart meter (%)) * electricity GHG emission factor (kg$CO_2$e/kWh)*

The OVO 2020-2030 emissions factors (kg$CO_2$e) for electricity and gas were applied to convert the energy consumption data to GHG emissions. The results were reported using both the market- and location-based method.

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| UK average annual household gas consumption | 13,407 kWh [92] | |
| UK average annual household electricity consumption | 3,954 kWh [93] | |
| Average gas demand reduction as a result of using smart meter | n/a | 2.2% [94] |
| Average electricity demand reduction as a result of using smart meter | n/a | 3% [95] |
| Natural gas and electricity GHG emission factor | The OVO 2020-2030 emissions factors (kg$CO_2$e/kWh) were applied | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| UK average annual household gas demand | 13,407 kWh | 13,112 kWh |
| UK average annual household electricity demand | 3,954 kWh | 3,835 kWh |
| Average annual carbon avoidance from use stage (market-based) | 66.19 kg$CO_2$e | |
| Average annual carbon avoidance from use stage (location-based) | 81.98 kg$CO_2$e | |

## End-of-life (EoL) stage

For both BAU and LCS scenarios, the end-of-life treatment has been assumed as open-loop recycling; there is no data to support this, but it is assumed that owners are more environmentally conscious and more likely to recycle/refurbish their goods.

The total emissions from this stage were calculated based on a weight-based approach. The emissions of the EoL stage were calculated as follows:

*EoL emissions (kg$CO_2$e) = Product weight (kg) * GHG emission factor for EoL stage (kg$CO_2$e/kg)*

93 Department for Business, Energy & Industrial Strategy (BEIS), 2021, Energy Consumption in the UK (ECUK): Final Energy Consumption Tables,"temperature corrected – average consumption of a UK household".

94 Department for Business, Energy & Industrial Strategy (BEIS), Based on the available evidence, the BEIS has assumed that gross average reduction in demand per household will be: 2.2% for gas.

95 Reduction number for gas consumption reduction is derived from the UK Department for Business, Energy & Industrial Strategy (BEIS), Based on the available evidence, the BEIS has assumed that gross average reduction in demand per household will be: 3% for electricity.

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product weight** | 2.77 kg | 2.95 kg |
| **GHG emission factor for EoL stage** | 21.29 $kgCO_2e/kg$ [96] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emission from EoL stage** | 15.64 $kgCO_2e$ | 16.66 $kgCO_2e$ |
| **Carbon avoidance (from end-of-life stage)** | -1.02 $kgCO_2e$ | |

93 Department for Business, Energy and Industrial Strategy (BEIS), 2021. Greenhouse gas reporting conversion factors, "Electrical items-small".

## 3.9 Roof insulation

### Results overview

| | Carbon avoidance factor ($kgCO_2e$/year) | |
|---|---|---|
| | **Market-based method** | **Location-based method** |
| **Whole life cycle of product** | 65.6 | 67.8 |
| **Use phase only** | 66.9 | 69.2 |

### Solution description and scope

Topping up roof insulation is considered as an effective way to reduce the loss of heated air through the roof and therefore reduce space heating energy consumption, GHG emissions and energy bills[97].

This assessment covers the life cycle carbon avoidance potential of increasing the thickness of roof insulation from 120mm to 270mm in an average-sized three-bedroom semi-detached house in the UK[98]. The semi-detached house is considered to be the most representative house type in the UK. In this assessment, all other physical characteristics of the house remained the same when comparing the BAU and the LCS scenarios.

The unit of analysis is one average-sized, three-bedroom semi-detached house with a roof area of 45 $m^2$ using gas heating as the sole heating source. It has been assumed that the average roof area for a three-bedroom semi-detached house is 45$m^2$, which was based on OVO's historic installation data for a three-bedroom semi-detached house.

A description of the BAU baseline and LCS scenarios is included in the table below.

| Scenario | Product/service | Description |
|---|---|---|
| **BAU baseline scenario** | Roof with 120mm insulation | An average-sized three-bedroom semi-detached house in the UK with 120 mm glass mineral wool roof insulation. OVO's historic installations experience revealed that beyond the 1960s it was rare for a household to have no insulation and that top-ups were the most common type of installation. |
| **LCS scenario** | Top up the roof insulation from 120mm to 270mm (150 mm top up thickness) | Increasing the roof insulation from 120 mm to 270 mm with glass wool for an average-sized three-bedroom semi-detached house in the UK. (it is estimated that 6.75$m^3$ of insulation material will be added to the BAU scenarios). It has been assumed that glass mineral wool insulation (λ 0.040 – 0.046 W/mK) produced by Knauf has been used for both the BAU and LCS scenarios. This was considered as the most commonly-used mineral wool installed by OVO. |

**Table 11: A description of the BAU baseline and LCS scenarios for the roof insulation carbon avoidance assessment**

97 Energy Saving Trust (EST), Roof and loft insulation

98 Department for Levelling Up, Housing and Communities (DLUHC), 2021, English Housing Survey data on stock profile

## Carbon avoidance mechanism

Increasing the thickness of roof insulation can deliver carbon avoidance potential by:

- Reducing natural gas consumption used for space heating by reducing heat loss through the roof.

## Methodology

### Production stage

For both the BAU and LCS, product volumes ($m^3$) and primary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below:

*Emissions from production stage ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor ($kgCO_2e/m^3$)*

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 5.4 $m^3$ [99] | 12.15 $m^3$ [100] |
| **GHG emission factor** | 9.42 $kgCO_2e/m^3$ [101] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from production stage** | 50.87 $kgCO_2e$ | 114.45 $kgCO_2e$ |
| **Carbon avoidance (from production stage)** | -63.59 $kgCO_2e$ | |

### Transportation and installation stage

For both BAU and LCS, activity data and secondary emissions factors were applied to calculate the emissions from the transportation and installation stage using the following equation:

*Transportation and installation stage emissions=*
*emissions from transportation ($kgCO_2e$) + emissions from installation($kgCO_2e$)*

Where:
*Emissions from transportation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for transportation($kgCO_2e/m^3$)*
*Emissions from installation ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor for installation ($kgCO_2e/m^3$)*

99 The product volume is calculated by multiplying the roof area (45 m2) with the insulation thickness of 120mm, it was assumed that the existing property already has 120mm of existing roof insulation installed.

100 Energy Saving Trust (EST), Roof and Loft Insulation,

101 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Glass mineral wool insulation (λ 0.040 – 0.046 W/mK, A1-A3 stages)

**Data input**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 5.4 $m^3$ | 12.15 $m^3$ |
| **GHG emission factor for transportation** | 0.15 $kgCO_2e/m^3$ [102] | |
| **GHG emission factor for installation** | 0.3 $kgCO_2e/m^3$ [103] | |

**Calculations**

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from transportation** | 0.82 $kgCO_2e$ | 1.85 $kgCO_2e$ |
| **Emissions from installation** | 1.61 $kgCO_2e$ | 3.62 $kgCO_2e$ |
| **Emissions from transportation and installation stage (total)** | 2.43 $kgCO_2e$ | 5.47 $kgCO_2e$ |
| **Carbon avoidance (from transportation and installation stage)** | -3.04 $kgCO_2e$ | |

## Use stage

The avoided emissions from this stage is calculated by:

*Annual carbon avoidance from use stage ($kgCO_2e$) =*
*Annual energy saving (kWh) * gas GHG emission factor ($kgCO_2e/kWh$)*

Where:
*Annual energy saving (kWh) = Annual energy bill saving from roof insulation (£)/Energy unit price (£/kWh)*

This method has been applied where the EST data has been used as the input and there is no further information on the inputs for the BAU and LCS values, only the calculated difference between the two is provided.

The OVO 2020-2030 proprietary emissions factors ($kgCO_2e$) for gas were applied to convert the gas consumption data (kWh) to GHG emissions ($kgCO_2e$). The results were reported using both the market- and location-based methods.

**Data input**

| Data field | Input value |
|---|---|
| **Annual energy bill saving from roof insulation** | £15[104] |
| **Energy unit price** | 0.0465 £/kWh[105] |
| **Gas GHG emission factor** | The OVO 2020-2030 emissions factors ($kgCO_2e/kWh$) were applied |
| **Product lifespan** | 50 years |

102 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Glass mineral wool insulation (λ 0.040 – 0.046 W/mK, A4 stage)
103 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Glass mineral wool insulation (λ 0.040 – 0.046 W/mK, A4 stage)
104 Number derived from Energy Saving Trust (EST), by topping up the roof insulation from 120mm to 270 mm, it could save £15 on the annual bill for a typical semi-detached house.
105 Energy Saving Trust (EST), Our data

### Calculations

| Data field | LCS input value |
|---|---|
| **Annual energy saving** | 322.58 kWh |
| **Average annual carbon avoidance from use stage (market-based)** | 66.93 $kgCO_2e$ |
| **Average annual carbon avoidance from use stage (location-based)** | 69.19 $kgCO_2e$ |

## End-of-life (EoL) stage

For both the BAU and LCS, activity data and secondary emissions factors were applied to calculate the embodied emissions of the production stage by applying the equation below:

*EoL emissions ($kgCO_2e$) = Product volume ($m^3$) * GHG emission factor ($kgCO_2e/m^3$) for end-of-life treatment*

### Data input

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Product volume** | 5.4 $m^3$ | 12.15 $m^3$ |
| **GHG emission factor for end-of-life treatment** | 0.1428 kg CO2e/$m^3$ [106] | |

### Calculations

| Data field | BAU input value | LCS input value |
|---|---|---|
| **Emissions from end-of-life treatment** | 0.77 $kgCO_2e$ | 11.74 $kgCO_2e$ |
| **Carbon avoidance (from end-of-life stage)** | -0.96 $kgCO_2e$ | |

106 Knauf Insulation, 2020, Environmental Product Declaration (EPD): Glass mineral wool insulation (λ 0.040 – 0.046 W/mK, C2 stages), (The GHG emission factors of 0.0946 kgCO2e/m3 and 0.0482 kgCO2e/m3 were applied for the EoL transportation and disposal stages respectively (C2 and C4 stages)).

# 4 Methodology for low carbon behaviour changes (OVO Greenlight)

## Overview

The OVO Greenlight product offers customers information about their energy consumption and carbon footprint, and provides insights/advice to help reduce them.

The product provides these insights in two primary ways:

- It helps customers understand where the most energy is used at home (for customers with half-hourly smart meter readings, it gives a detailed breakdown of where they use their energy in the home).
- It provides simple tips to save energy at home.

A selection of energy savings tips (listed below) were assessed individually for their maximum carbon avoidance potential[107]:

| OVO Greenlight energy saving tips | Total estimated carbon avoidance potential ($kgCO_2e$/year) | | Description |
|---|---|---|---|
| | Market-based method | Location-based method | |
| Switch off lights | 2.9 | 14.7 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to switch lights off when not in use. |
| Use eco mode on appliances | 14.0 | 70.0 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to use the eco-mode on their dishwashers, tumble dryers and washing machines. |
| Switch off rather than standby | 8.4 | 41.9 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to switch off their household devices and appliances instead of putting them on standby mode. |
| Use appliances at different times | 0.0 | 97.1 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to use appliances and devices when the carbon intensity is relatively lower on the grid (off-peak hours). |
| Turning the thermostat down by 1 degree | 267.7 | 276.8 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to reduce the room temperature on thermostat by 1-degree Celsius |
| Shorter showers | 200.8 | 207.6 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to reduce their shower time to four minutes.[108] |
| Draught proofing | 133.9 | 138.4 | This assessment covers the carbon avoidance potential of prompting customers on the OVO Greenlight platform to block or seal any gaps that lead to unwanted draughts in the house to increase the airtightness of the properties, thus reducing energy consumption. |

**Table 12: List of Greenlight energy savings tips selected to be assessed for their carbon avoidance potential**

107 Given the level of uncertainty associated with which and how many tips a customer engaging with OVO Greenlight will adopt, the results of the carbon avoidance potential assessment for OVO Greenlight are only reported at the 'tip' level and have not been summed to provide an overall avoidance factor for Greenlight.

108 At the time of writing, South Pole was unable to gather information from the EST on the scenario that shorter showers were being compared in order to produce an energy saving.

The methodologies in Section 4 differ from the lifecycle approach taken in Section 3, and only assess the carbon avoidance associated with changes in behaviour in relation to energy consumption.

The methodologies largely rely on energy savings data modelled by the Energy Saving Trust (EST). EST is a reliable and independent source of data that provides up-to-date estimates of cost savings. We've chosen to calculate carbon savings based on EST cost savings because (a) it is more readily available and broadly applicable for UK average households than alternative sources of secondary data on energy consumption for the devices we examining; and (b) calculating from EST cost savings enables us to apply OVO's emissions factors so that the carbon savings calculated are specific to OVO customers.

All of the energy savings data inputs provided by the Energy Saving Trust have been modelled for a typical three-bedroom, gas-heated home. This data source does not state the type of house this is for.

## 4.1 Switching off lights when not in use

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **1. Switching off lights when not in use** | **2.9** | **14.7** |

### Solution description and scope

Prompting customers to switch lights off when not in use can avoid carbon emissions by reducing the overall household energy consumption.

This assessment covers the carbon avoidance associated with reducing energy consumption when switching off lights when not in use.

### Carbon avoidance mechanism

Switching off lights when not in use can deliver carbon avoidance potential through:

- Reducing electricity consumption

### Methodology

The carbon avoidance from this stage is calculated by:

*Annual Carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * electricity carbon intensity ($kgCO_2e$/kWh)*

Where:
*Annual energy saving (kWh) = Annual energy bill saving switching off lights (£)/Energy unit price (£/kWh)*

The estimated energy savings (£) from the EST are calculated using standard rates rather than Economy 7 rates, and does not include the standing charge[109]. This aligns with the EST's method for calculating avoided carbon.

### Data input

| Data field | Input value |
|---|---|
| **Annual estimated energy bill saving (£/year)** | £14.00 [110] |
| **Electricity (standard rate) (£/kWh)** | 0.2006 [111] |
| **Total annual energy saving (kWh/year)** | 69.79 [112] |
| **Electricity emissions factors ($kgCO_2e$/kWh)** | OVO 2020-2030 electricity market-based emissions factors |

**Table 13: Data input and conversion factors for carbon avoidance calculation**

109 Economy 7 rates have a day rate and night rate, whereas there is only one standard rate over the course of the day
110 Energy Saving Trust (EST), 2022: Quick tips to save energy at home.
111 Energy Saving Trust (EST), 2022: Our data
112 Calculated using the data inputs in this table

## 4.2 Switching off appliances and devices rather than leaving them on standby

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **3. Switching off appliances and devices rather than leave them on standby** | **8.4** | **41.9** |

### Solution description and scope

Prompting customers to switch off appliances and devices rather than leaving them on standby can avoid carbon emissions by reducing the overall household energy consumption.

This assessment covers the carbon avoidance associated only with switching off appliances and devices rather than leaving them on standby.

### Carbon avoidance mechanism

Switching off lights when not in use can deliver carbon avoidance potential through:

- Reducing electricity consumption

### Methodology

The carbon avoidance from this stage is calculated by:

*Annual carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * electricity carbon intensity ($kgCO_2e$/kWh)*

Where:

*Annual energy saving (kWh) = Annual energy bill saving (£)/Energy unit price (£/kWh)*

The estimated energy savings (£) from the EST are calculated using standard rates rather than Economy 7 rates, and does not include the standing charge.[113] This aligns with the ESTs method for calculating avoided carbon.

### Data input

| Data field | Input value |
|---|---|
| **Annual estimated energy bill saving (£/year)** | £40.00 [114] |
| **Electricity (standard rate) (£/kWh)** | 0.2006 [115] |
| **Total annual energy saving (kWh/year)** | 199.4 [116] |
| **Electricity emissions factors ($kgCO_2e$/kWh)** | OVO 2020 electricity market-based emissions factor |

**Table 14: Data input and conversion factors for carbon avoidance calculation**

113 Economy 7 rates have a day rate and night rate, whereas there is only one standard rate over the course of the day

114 Energy Saving Trust (EST), 2022: Quick tips to save energy at home.

115 Energy Saving Trust (EST), 2022: Our data

116 Calculated using the data inputs in this table

## 4.3 Using or charging appliances and devices during low carbon intensity hours

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **4. Using or charging appliances and devices during low carbon intensity hours** | **0.0** | **97.1** |

### Solution description and scope

The carbon emissions intensity of the electricity on the UK grid fluctuates. The grid carbon intensity fluctuations are a function of the changes in the electricity generation fuel mixes that occur throughout the day. Typically, there is a lower carbon-intensity fuel mix when demand is lower; when there is less need for fossil fuel generation demand can be met with greener generation. Prompting customers to use appliances and devices during these low demand periods can avoid carbon emissions.

This assessment covers the carbon avoidance associated with using a mobile phone, laptop charger, washing machine, tumble dryer and dishwasher during low carbon intensity periods.

### Carbon avoidance mechanism

Using or charging appliances and devices during low carbon intensity hours can deliver carbon avoidance potential through:

- Consuming electricity that has been generated with lower carbon intensity fuels from the UK grid

### Methodology

**Description of avoidance mechanism**

The carbon avoidance potential for these appliances was calculated using the following equation:

*Carbon avoidance factor ($kgCO_2e$) = Emissions from device/appliance use during high carbon intensive period ($kgCO_2$) – Emissions from device/appliance use during low carbon intensive period ($kgCO_2$)*

Where:

(i) *Appliance/device annual consumption (kWh) * high carbon intensity emissions factor ($kgCO_2e$/kWh) = Emissions from device/appliance use during high carbon intensive times ($kgCO_2e$)*

(ii) *Appliance/device annual consumption (kWh) * low carbon intensity emissions factor ($kgCO_2e$/kWh) = Emissions from device/appliance use during low carbon intensive period ($kgCO_2e$)*

The carbon avoidance factor is the sum of all the devices/appliances selected for this assessment which includes mobile phone, laptop, washing machine, tumble dryer and dishwasher, and it is assumed that these devices represent a typical UK household.

## Data input

| Data field | Total annual electricity consumption (kWh/year) |
|---|---|
| **Mobile phone charge** | 7.3 [117] |
| **Laptop charge** | 52.0 [118] |
| **Washing machine** | 252.0 |
| **Tumble dryer** | 205.0 |
| **Dishwasher** | 233.0 |
| **High carbon intensity[119]** | 0.3032 kg$CO_2$e/kWh |
| **Low carbon intensity** | 0.2892 kg$CO_2$e/kWh |

**Table 15: Data input and conversion factors for carbon avoidance calculation**

117 Calculated assuming that typical phone power use is six Watts, three hours per day, 365 days per year.

118 BEIS, 2021: ECUK 2021: Electrical products data tables.

110 This dataset provides BAU carbon intensity (no smart control enabled, in kg$CO_2$e/kWh) and low-carbon intensity(kg CO2e/kWh) emissions factors as a result of enabling smart control for the UK grid. Emissions factors were derived from South Pole analysis that combined the National Grid fuel mixes during high/low carbon intensity periods with OVO's internal analysis of the lifecycle emissions intensities of different fuel types.

## 4.4 Turning the thermostat down by one degree

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **5. Turning the thermostat down by one degree** | **267.7** | **276.8** |

### Solution description and scope

Reducing a thermostat's display temperature by one degree can result in a 10% reduction to the energy bill as a result of lower gas use[120]. Prompting customers to turn the thermostat down by one degree can avoid carbon emissions by reducing the overall household gas consumption.

This assessment covers the carbon avoidance associated only with turning down the thermostat by one degree.

### Carbon avoidance mechanism

Turning down the thermostat temperature deliver carbon avoidance potential through:

- Reducing household gas consumption

### Methodology

The carbon avoidance from this stage is calculated by:

*Annual carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * electricity carbon intensity ($kgCO_2e$/kWh)*

Where:
*Annual energy saving (kWh) = Annual energy bill saving (£)/Energy unit price (£/kWh)*

It is assumed that all of the estimated energy savings (£) are from gas heating and the standing charge has not been factored into the energy conversion. This aligns with EST's method for calculating avoided carbon.

At the time of writing, South Pole was unable to gather information from the EST on which temperature reduction this was between, but it is assumed that it is between 20-19 degrees[121].

### Data input

| Data field | Input value |
|---|---|
| **Annual estimated energy bill saving (£/year)** | £60.00 [122] |
| **Gas (standard rate) (£/kWh)** | 0.0465 [123] |
| **Total annual energy saving (kWh/year)** | 1,290.32 [124] |
| **Electricity emissions factors ($kgCO_2e$/kWh)** | OVO 2020 electricity market-based emissions factor |

**Table 16: Data input and conversion factors for carbon avoidance calculation**

120 Energy Saving Trust (EST), 2022: Heating controls
121 Energy Saving Trust (EST), 2022: Heating controls
122 Energy Saving Trust (EST), 2022: Quick tips to save energy at home
123 Energy Saving Trust (EST), 2022: Our data
124 Calculated using the data inputs in this table

## 4.5 Taking shorter (four-minute) showers

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **6. Taking shorter (four-minute) showers** | **200.8** | **207.6** |

### Solution description and scope

Showers require energy to supply, heat and treat the water that is used. Prompting customers to take four-minute showers can avoid carbon emissions by reducing the overall household water heating and supply consumption.

This assessment covers the carbon avoidance associated with taking shorter (four-minute) showers.

### Carbon avoidance mechanism

Taking four-minute showers can deliver carbon avoidance potential through:

- Reducing household gas consumption

### Methodology

The carbon avoidance from this stage is calculated by:

*Annual carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * gas carbon intensity ($kgCO_2e$/kWh)*

Where:

*Annual energy saving (kWh) = Annual energy bill saving (£)/Energy unit price (£/kWh)*

It is assumed that all of the estimated energy savings (£) are from water heating from gas and the standing charge has not been factored into the energy conversion. It is assumed that all energy savings are from gas (and not water or electricity). This assumption is based on the 2013 Energy Saving Trust study[125] that indicated that less than 50% of the population have a water meter and electric shower.

At the time of writing, South Pole was unable to gather information from the EST on the scenario that shorter showers were being compared in order to produce an energy saving.

### Data input

| Data field | Input value |
|---|---|
| **Annual estimated energy bill saving (£/year)** | £60.00 [126] |
| **Gas (standard rate) (£/kWh)** | 0.0465 [127] |
| **Total annual energy saving (kWh/year)** | 1,290.32 [128] |
| **Electricity emissions factors ($kgCO_2e$/kWh)** | OVO 2020 electricity market-based emissions factor |

**Table 17: Data input and conversion factors for carbon avoidance calculation**

125 Energy Saving Trust (EST), 2013: At home with water

126 Energy Saving Trust (EST), 2022: Quick tips to save energy at home

127 Energy Saving Trust (EST), 2022: Our data

128 Calculated using the data inputs in this table

## 4.6 Blocking any gaps that lead to unwanted draughts

### Results overview

| | Total estimated carbon avoidance potential ($kgCO_2e$/year) | |
|---|---|---|
| **Intervention** | **Market-based method** | **Location-based method** |
| **7. Blocking any gaps that lead to unwanted draughts** | **133.9** | **138.4** |

### Solution description and scope

Draughts occur where there are unwanted gaps in the construction of the house that lead to the outside of the house. These draughts can reduce the temperature of the house through the loss of heated air through these gaps, and therefore increase the energy demand required for space heating. Prompting customers to block any unwanted draughts can avoid carbon emissions by reducing the overall household energy consumption.

This assessment covers the carbon avoidance associated with blocking any unwanted draughts in the house.

### Carbon avoidance mechanism

Blocking any gas that lead to unwanted draughts can deliver carbon avoidance potential through:

- Reducing household gas consumption

### Methodology

The carbon avoidance from this stage is calculated by:

*Annual carbon avoidance ($kgCO_2e$) = Annual energy saving (kWh) * gas carbon intensity ($kgCO_2e$/kWh)*

Where:
*Annual energy saving (kWh) = Annual energy bill saving (£)/Energy unit price (£/kWh)*

It is assumed that all of the estimated energy savings (£) are from gas heating and the standing charge has not been factored into the energy conversion. This aligns with EST's method for calculating avoided carbon.

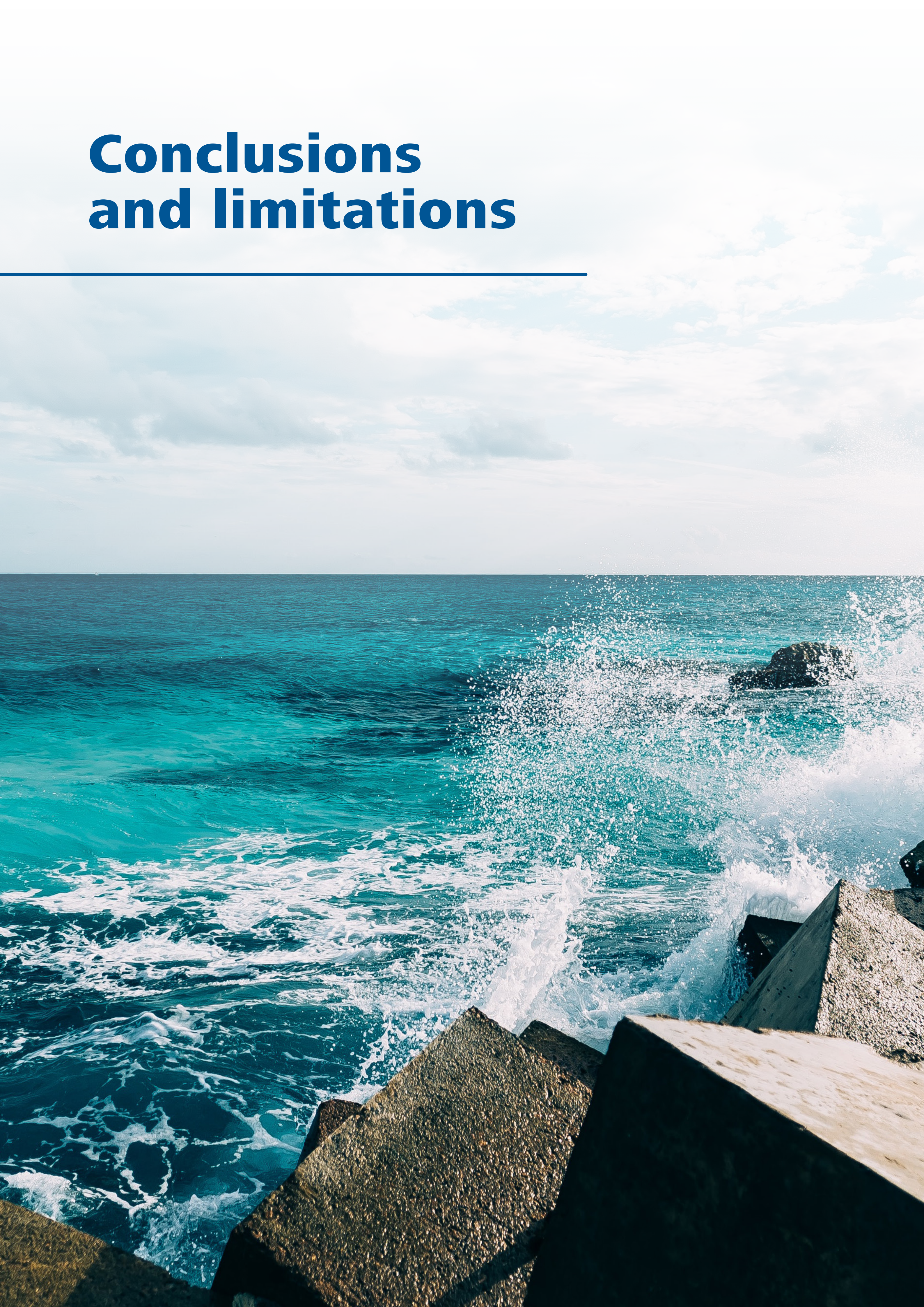
### Data input

| Data field | Input value |
|---|---|
| **Annual estimated energy bill saving (£/year)** | £30.00 [129] |
| **Gas (standard rate) (£/kWh)** | 0.0465 [130] |
| **Total annual energy saving (kWh/year)** | 645.16 [131] |
| **Electricity emissions factors ($kgCO_2e$/kWh)** | OVO 2020 electricity market-based emissions factor |

**Table 18: Data input and conversion factors for carbon avoidance calculation**

129 Energy Saving Trust (EST), 2022: Quick tips to save energy at home
130 Energy Saving Trust (EST), 2022: Our data
131 Calculated using the data inputs in this table

# Conclusions and limitations



The Low Carbon Solutions Carbon Avoidance Potential Assessment project has successfully established methodologies for eight solutions in OVO's portfolio of decarbonisation products and services. The results of our assessment show that OVO has the potential to bring solutions to market that could drive down the carbon emissions from home energy use, and contribute towards slowing down climate change.

The outputs from this project could be used as a valuable input into OVO's commercial strategy and decision-making (for example in prioritising products to be developed or scaled up). Ultimately, the information on carbon emissions avoided could support further alignment between OVO's commercial and climate strategies.

In addition, the development of the methodologies themselves provides a valuable case study on how to apply relevant carbon accounting frameworks to calculate the avoided emissions of low carbon solutions or products. This is a topic where, historically, literature has been sparse in the public domain.

South Pole acknowledges that our approaches can be enhanced over time and the reported carbon avoidance factors are limited by existing published data and underlying assumptions. However, we recognise the importance of learning about and refining these emerging techniques by putting theory into practice, as has been achieved through this project.

In the interim, South Pole welcomes users' feedback on improvements, and which would be a valuable input into future updates of this document.

In order for the reported carbon avoidance factors to maintain relevance, it is crucial for all aspects of the assessment to be updated at least annually. This includes the scope and boundaries of the BAU and LCS, underlying assumptions, data input and conversion factors.

Overall, it is our hope that this guidance will enable more businesses to assess the avoided carbon potential of low carbon products that can support aligning their business activities with their climate targets and ambition.

We fully expect that the methodologies and intensities within this document will continue to evolve as more comprehensive and better quality data become available. We anticipate the following refinements:

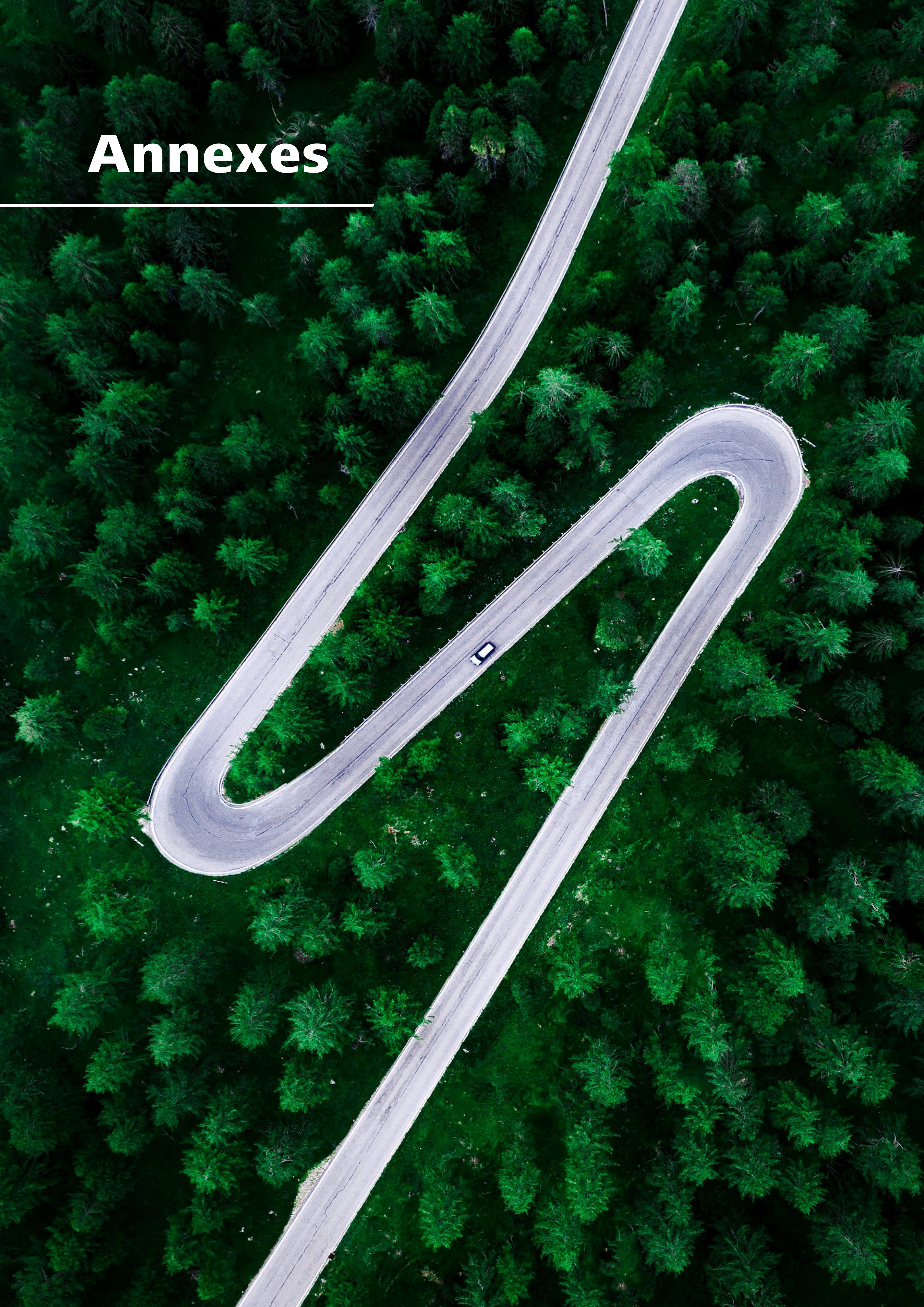
- **Uncertainty assessment:** There is a margin of error in the results of this analysis due to the inevitable uncertainty of the data inputs and modelling assumptions. This analysis (or future analyses) could be enhanced by conducting a qualitative description of the uncertainty relating to the assessment and what are the key parameters affecting the uncertainty. This would support OVO in determining appropriate uses for the results of the analysis.

- **Enhance transparency:** The transparency can be enhanced through further understanding secondary data sources, particularly data inputs sourced from the Energy Saving Trust (EST). EST was selected as a reputable, independent third-party source of data. Nevertheless, it would be beneficial to understand the parameters behind the data, which were not published alongside the data points.

- **Enhance primary data:** Secondary and proxy data were used due to a lack of primary data. This was appropriate for this high-level screening assessment, however, should the results of this assessment be required to be more specific in future iterations i.e. for the lifecycle assessment of a specific product, then greater levels of primary data should be used.

This document has been developed with the assistance of South Pole. South Pole, recognised by the World Economic Forum as a Social Enterprise, has been at the forefront of decarbonisation since 2006. With its global Climate Solutions platform, South Pole develops and implements comprehensive strategies that turn climate action into long-term business opportunities for companies, governments and organisations around the world. South Pole is also a leading project developer, and has provided nearly 1,000 projects in over 50 countries with climate finance to reduce over a gigaton of CO2 emissions, and to provide social benefits to less privileged communities who are particularly vulnerable to climate change. The company also supports airlines and other organisations in the aviation space to comply with CORSIA – the international aviation scheme for reducing and offsetting carbon emissions. For more information, visit www.southpole.com.

# Annexes



# Annex I
## Calculation approach

The carbon avoidance potential is estimated through a comparison of the greenhouse gas (GHG) emissions from a business as usual (BAU) baseline scenario with those from a low carbon solution (LCS) enabled scenario to demonstrate the benefit of the LCS to reduce overall system-level GHG emissions. This will involve the calculation of the following:

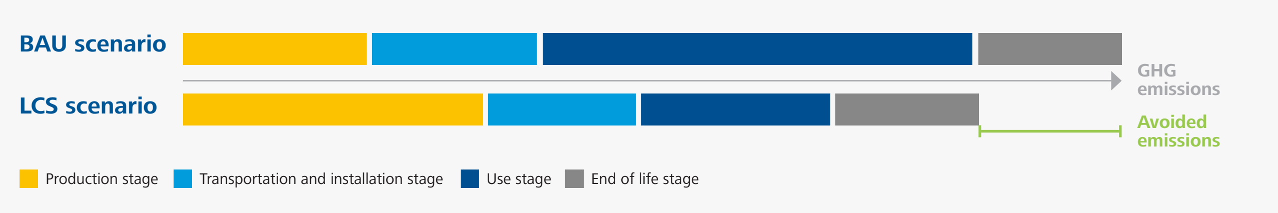
- BAU system emissions: the total lifecycle emissions from the BAU baseline, without the introduction of the LCS solution
- LCS system emissions: the total life cycle emissions from the LCS system
- Carbon avoidance (avoided emissions) : the difference between the total life cycle GHG emissions of the BAU system and LCS system that provides an equivalent function
- Carbon avoidance factor per sale/install: total avoided emissions of each sale or installed of LCS products.

The avoided emissions and carbon avoidance factor per sale can also be expressed in equations as follow:

*Carbon avoidance = (Life-cycle emissions of the BAU system) – (Life-cycle emissions of the LCS system)*

*Annual carbon avoidance = (Life cycle carbon avoidance)/(Product life-span)*

*Annual carbon avoidance factor = (Annual Avoided emissions) /(units of sale/installation)*[132]




For a small number of assessments for the use-stage where the EST data has been used as the input, the following equation has been used:

*Carbon avoidance ($kgCO_2e$) = energy saving (£) * energy carbon intensity (kWh/£)*

For each assessment the **solution description**, **unit of analysis and carbon avoidance mechanism** are outlined.

- The solution description and scope clearly define the boundary of what is included and excluded from each assessment, where completeness was the key principle that was followed. In cases where emissions sources were determined to be negligible, they were excluded from the assessment and the justification was disclosed.

- The unit of analysis describes the scenario that is being assessed and the lifecycle emissions will be calculated. For example, one EV charger to provide electricity for EVs or plug-in hybrid vehicles for one year is the unit of analysis for the smart charging assessment. It specifies the product, scenario and time period and is applicable to both BAU baseline and LCS scenarios.

This is due to the fact that when using this source, there is no available information on the BAU and LCS, only the difference between two.

Unless otherwise specified, the carbon avoidance factors outlined in this document are for a one-year period.

132 Completeness: Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.

# Annex II

## Applicability of the information and results in this document

The results in this document are only for referencing purposes and they are limited by:

The scope and boundaries defined within this assessment

- The secondary and proxy data used: the purpose of the assessment is to provide a high-level estimation of the carbon avoidance potential of a range of low carbon interventions promoted/will be promoted by OVO. South Pole could only estimate the most representative scenarios based on publicly available sources. Due to the ambiguity of the detailed product type and processes, secondary and proxy data are widely applied in this assessment.
- Underlying assumptions made where data is not available, specifically, for the carbon avoidance assessment of insulation, air source heat pump, and gas boiler, it has been assumed that the property is a three-bedroom, semi-detached house in the UK, with no wall insulation; 120mm of glass wool roof insulation; and gas as the only energy source for space heating and hot water. The wall area is 85 $m^2$, and the roof area is 45 $m^2$; the property would consume 13,407 kWh of natural gas and 3,954 kWh of electricity as of the year 2021.
- The exclusion criteria are defined in Section 2.3.
- The assumptions are defined within Section 3.

The information within this document should be used:

- as a referencing methodology for measuring the emissions avoided from OVO’s portfolio of decarbonisation products and services (low carbon solutions)
- as a referencing methodology for assessing the potential of each solution to avoid carbon emissions

The information within this document should NOT be used:

- as evidence for any comparative assertion
- as evidence for any in-depth product level GHG accounting
- as the evidence for any carbon credit project
- for any comparative study that involves any specific product
- as the evidence for any absolute description in marketing

To illustrate these points, the results within this document can be used to make statements such as:

“Replacing your gas boiler with an air source heat pump could potentially help you to save up to xxx $kgCO_2e$."

However, the information and results within this document should not be used to make **direct claims relating to specific products** or **absolute descriptions** for example:

“A [Brand name] air source heat pump will save you xx $kgCO_2e$ when replacing it with [Brand name] gas boiler."

# Annex III
## Glossary

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| **BAU baseline** | The business as usual (BAU) baseline, without the introduction of the low carbon solution. |
| **Carbon Avoidance** | Reductions in emissions caused indirectly by a product. This is where a product provides the same or similar function as existing products in the marketplace, but with significantly less GHG emissions. |
| **Carbon Avoidance Factor** | Carbon avoidance per unit of implementation (sale or installation). |
| **$CO_2$ equivalent ($CO_2e$)** | The universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate releasing (or avoiding releasing) different greenhouse gases against a common basis. |
| **COP** | Coefficient of performance (COP) is a measurement of the energy efficiency of a heat pump's heating performance. |
| **Emissions** | The release of GHG into the atmosphere. |
| **Embodied carbon** | All of the greenhouse gases emitted in producing the products. It is estimated from the energy used to extract and transport raw materials as well as emissions from manufacturing processes. |
| **Energy Saving Trust (EST)** | Energy Saving Trust is an independent organisation – working to address the climate emergency. |
| **EPD** | An EPD (environmental product declaration) is a document which may be used in different countries to quantifiably demonstrate the environmental performance of a product. |
| **EPS** | Expanded polystyrene |
| **Greenhouse gases (GHG)** | For the purposes of this document, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide ($CO_2$); methane ($CH_4$); nitrous oxide ($N_2O$); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride ($SF_6$) |
| **IPCC** | The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. |
| **LCS Scenario** | Low carbon solution (LCS) scenario, which enables the avoided emissions due to introducing product or service with low carbon enabling effects. |
| **Life cycle** | Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to end-of-life. |
| **Location-based method** | A location-based method reflects the average emissions intensity of grids on which energy consumption occurs (using mostly grid-average emission factor data). |
| **Market-based method** | A market-based method reflects emissions from electricity that companies have purposefully chosen. |
| **Mission Innovation** | Mission Innovation is a global initiative to accelerate public and private clean energy innovation to address climate change, make clean energy affordable to consumers, and create green jobs and commercial opportunities. |

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| **Net Zero** | Net zero means that the total greenhouse gas (GHG) emissions of a company would be equal to or less than the emissions that the company removed from the environment. |
| **Primary data** | Data from specific processes in the studied product's life cycle. |
| **Proxy data** | Data from a similar activity that is used as a stand-in for the given activity. Proxy data can be extrapolated, scaled up, or customised to represent the given activity. |
| **Science-based targets (SBT)** | Targets adopted by companies are considered science-based if they are in line with what the latest climate science says is necessary to limit warming to 1.5°C. |
| **Scope 1** | A reporting organisation's direct GHG emissions. |
| **Scope 2** | A reporting organisation's emissions associated with the generation of electricity, heating / cooling, or steam purchased for own consumption. |
| **Scope 3** | A company's scope 3 inventory includes the upstream and downstream emissions of the reporting company. |
| **Secondary data** | Process data that are not from specific processes in the studied product's life cycle. |
| **Unit of analysis (UoA)** | The basis on which the inventory results are calculated; the unit of analysis is defined as the quantity and quality of the solution |
| **WBCSD** | World Business Council for Sustainable Development is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future. |
| **WRI** | World Resources Institute is a global research organisation that works with governments, businesses, multilateral institutions and civil society groups to develop practical solutions that improve people's lives and ensure nature can thrive. |
| **λ value** | The λ value, also portrayed as K-value measures a product's thermal conductivity in units of W/m·K. |

south pole

Technoparkstrasse 1 · 8005 Zurich · Switzerland
info@southpole.com · southpole.com