UNIVERSITY OF EXETER | CENTRE FOR ENERGY AND THE ENVIRONMENT

Producing a Carbon Footprint and Projecting Emissions for Treveth Holdings

CENTRE FOR ENERGY AND THE ENVIRONMENT

Contract Document 337

January 2024

UNIVERSITY OF EXETER | CENTRE FOR ENERGY AND THE ENVIRONMENT

Author(s):	D Lash
Report number:	Contract Document 337
Publication date:	17th January 2024
Revision number:	1.1

CENTRE FOR ENERGY AND THE ENVIRONMENT
University of Exeter
Hope Hall
Prince of Wales Road
Exeter, EX4 4PL
+44(0)1392 724159
www.exeter.ac.uk/cee

Cover image: Trevithick Farm, Newquay

Management Summary

Treveth are a Cornish company who work in partnership with Cornwall Council to deliver new homes and commercial development for the benefit of people who live and work in Cornwall. The Centre for Energy and the Environment at the University of Exeter was commissioned by Treveth to develop a framework quantifying their carbon footprint based on the most relevant standards, and then to implement that framework for an initial baseline year. This footprint would then be used in combination with known national policy, and planned measures and interventions by Treveth to project emissions to 2030 and to produce a high-level strategy identifying critical factors to its success.

The footprint produced here is based on referring to the main organisational carbon footprinting standards (BS EN ISO 14064-1, the Greenhouse Gas Protocol, and the Environmental Reporting Guidelines) and applying them to Treveth. The framework outlines definitions and principles, the setting of organisational and reporting boundaries and categories, reporting periods and calculation methods, as well as reporting values and target setting. A detailed description of scope and method for establishing carbon emissions using a data hierarchy approach for each sub-category within the inventory, as well as a method for mapping emissions to a custom-derived reporting categorisation.

Total net emissions for the 2022/23 period were 1,326 tCO_2e. Of these, 975 tCO_2e were associated with dwellings, 127 tCO_2e with non-domestic buildings and 224 tCO_2e from overheads/own operations. The largest sub-category was from construction of dwellings, at 863 tCO_2e. This was mainly driven by the spend in the period on consultants for planned new developments, and do not include the actual construction of those dwellings which will be accounted for in future years as they are completed. It is expected that when this happens, emissions here will increase. Most emissions are Scope 3 (87.7%) with Scope 1 representing 3.7% of the total, and Scope 2 accounting for 8.6%.

An exercise was undertaken to project emissions annually to the 2030/31 year based on best estimates for Treveth's activities over the period, combined with wider assumptions regarding technology and decarbonisation. Emissions are strongly influenced by the extent to which development – in particular residential – occurs in a given year. The modelling assumes each new dwelling results in 34.1 tCO_2e of upfront emissions, though this is mitigated to some extent by 23.8 tCO_2e of 'Module D' which are sequestered in building materials. Over the whole period considered cumulative emissions are approximately 58,000 tCO_2e, whilst offsets from 'Module D' are 26,000 tCO_2e (i.e., 45% of source emissions). Of the source emissions, construction of dwellings makes up 79.62% and operational energy a further 10.81%, which is almost all from electricity use and 1.13% from maintenance and refrigerant leaks. Emissions from non-domestic buildings make up only 5.01%, whilst own operations are a further 3.43%. This suggests that the main opportunities for reducing emissions over the period involve focussing on the design of the dwellings to both avoid emissions through site selection, design, material choice, and use of fuel in construction, as well as increasing the amount of 'Module D' offset by as much as possible.

Contents

1 Introduction

Treveth are a Cornish company who work in partnership with Cornwall Council to deliver new homes and commercial development for the benefit of people who live and work in Cornwall. The Centre for Energy and the Environment at the University of Exeter was commissioned by Treveth to develop a framework quantifying their carbon footprint based on the most relevant standards, and then to implement that framework for an initial baseline year. This footprint would then be used in combination with known national policy, and planned measures and interventions by Treveth to project emissions to 2030 and to produce a high-level strategy identifying critical factors to its success. This report describes those objectives in the following sections.

2 Reference Standards

There are two main standards in use that provide methods for quantifying organisational GHG emissions. The first of these is BS EN ISO 14064-1 [1] (referred to from here as ISO 14064) and the accompanying ISO/TR 14069 [2] which provides specific guidance on applying ISO 14064. The second is the Greenhouse Gas Protocol (referred to from here as the GHG Protocol) [3] which was revised in 2015, and has an accompanying documents [4] and [5] which provide more detail on quantifying emissions from supply chains. In addition, there is the UK's Environmental Reporting Guidelines (ERG) [6] (specifically Chapter 3), which is broadly based on 14064 and the GHG Protocol, but is a lot less detailed. Finally, PAS 2060 [7] enables organisations to demonstrate carbon neutrality. Within PAS 2060 (Annex C Table C.1) it lists ISO 14064, the GHG Protocol, and the ERG as the three standards that can be used by organisations to provide methods to quantify GHG emissions.

In general, there is significant overlap between ISO 14064 and the GHG Protocol. As will be discussed when considering emissions categories, ISO 14064 has slightly wider coverage, and in addition it has been revised more recently, and so this will be the initial standard referenced in developing a framework here. However, the specific category guidance for the GHG Protocol is newer and so a hybrid approach will be followed. It can be said that in meeting the ISO 14064 criteria, the GHG Protocol criteria and ERG will also be met.

3 General Approach

3.1 Definition of "Carbon Footprint"

A "carbon footprint" is taken here to be the net emissions of carbon dioxide equivalent by an organisation over a year (i.e., an annual GHG inventory), with the full boundaries of the organisation discussed in the sections below. The net emissions are established by calculating emissions from all sources (processes that release GHGs into the atmosphere), sinks (processes that remove GHGs from the atmosphere) and reservoirs (components other than the atmosphere that have the capacity to accumulate GHGs).

GHGs that contribute to anthropogenic climate change include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). These each have a different contributory impact to climate change for the same fixed mass. The total impact of all GHGs resulting from the activities of an organisation is measured by multiplying the mass of each gas emitted by its Global Warming Potential (GWP) to an equivalent mass of carbon dioxide termed "carbon dioxide equivalent" (measured in tCO_2e). Typically, GHG emission factors will already be based on carbon dioxide equivalents and so no additional calculations will be necessary. Section 5.2.2 of ISO 14064 states that direct emissions should be quantified separately for each GHG, however it is recommended

that for Treveth, the carbon footprint is reported as carbon dioxide equivalent only (i.e., in tCO2e) with no disaggregation into the separate GHGs.

3.2 Guiding Principles

As per Section 4 of ISO 14064 the footprint should be developed with the following principles:

- Relevance: GHG sources (and sinks and reservoirs) and methodologies should be appropriate to the needs of Treveth
- Completeness: All relevant GHG emissions and removals should be included
- Consistency: Meaningful comparison in GHG-related information should be enabled
- Accuracy: Bias and uncertainty should be reduced as much as is practicable
- Transparency: Information should be sufficiently disclosed.

3.3 Organisational Boundaries

Confirming the organisational boundary is an important step at the outset of the production of the footprint. This is covered in Section 5.1 and Annex A of ISO 14064 and in more detail and with examples in Chapter 3 of the GHG Protocol. The two standards align in their approach. It is stated that organisations can comprise one or more facilities, and that at each of these GHG emissions may be produced from one or more sources or sinks. A facility is defined as a single installation, set of installations or production processes (stationary or mobile), which can be defined within a single geographical boundary, organizational unit, or production process.

Facility-level emissions should then be consolidated by one of the following approaches:

- Control: The organisation accounts for all emissions over which it has either financial or operational control.
- Equity: The organisation accounts for its proportion of GHG emissions from respective facilities. This is more likely to be relevant for joint ventures (JVs) though in discussion with Treveth this was deemed to be not applicable.

The control approach is likely to be the most relevant approach for Treveth (the equity share approach is stated as being particularly useful for multinational companies with operations in a number of different jurisdictions). Under the control approach 100% of GHG emissions are accounted for operations over which it has control. Emissions from operations where the organisation owns an interest but has no control are not included. Control is defined in one of two ways, and a choice must be made between them:

- Financial control: An organisation has financial control over the operation if it has the ability to direct the financial and operating policies of the operation with a view to gaining economic benefits from its activities. For example, financial control usually exists if the company has the right to the majority of benefits of the operation, however these rights are conveyed. Similarly, a company is considered to financially control an operation if it retains the majority risks and rewards of ownership of the operation's assets.
- Operational control: An organisation has operational control over an operation if it, or one of its subsidiaries, has the full authority to introduce and implement its operating policies at the operational level.

It is stated in the GHG Protocol that in most cases, whether an operation is controlled by the company or not does not vary based on whether the financial control or operational control criterion is used (though the oil and gas sector is a notable exception). In practice for Treveth, using either approach is

likely to result in the same total emissions within the inventory. There may however be some differences in categorisation. For example, Annex F of the GHG Protocol outlines in detail how to account for emissions from leased assets. For each scenario emissions will fall within the footprint, though whether they are Scope 1/2 or Scope 3 (scopes will be discussed in the next section) will depend on the type of lease. There are two types of leases which are:

- Finance or Capital lease: This type of lease enables the lessee to operate an asset and also gives the lessee all the risks and rewards of owning the asset. Assets leased under a capital or finance lease are considered wholly owned assets in financial accounting and are recorded as such on the balance sheet. Under this lease the lessee is considered to have ownership and both financial and operational control of the leased asset. Conversely, the lessor does not have ownership or financial or operational control of these assets.
- Operating lease: This type of lease enables the lessee to operate an asset, like a building or vehicle, but does not give the lessee any of the risks or rewards of owning the asset. Any lease that is not a finance or capital lease is an operating lease. Under this lease the lessee is considered not to have ownership or financial control but to have operational control of the leased asset. Conversely, the lessor has ownership and financial control of these assets but not operational control.

The allocation of emissions depending on the lease type and whether the asset is being leased or let out using the Financial Control approach is shown in Table 1. If an Operational Control approach is used instead, then the values for the Operating lease column are swapped (i.e., Scope 1/2 becomes Scope 3 and vice-versa).

Table 1: Allocating emission from leased assets under using an organisation's Financial Control boundary for lessee and lessor scenarios (adapted from Annex F GHG Protocol)

Perspective	Finance/Capital Lease	Operating Lease
Treveth are the lessee e.g., tenant	Lessee does have ownership and financial control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are Scope 2.	Lessee does not have ownership or financial control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are Scope 3.
Treveth are the lessor e.g., landlord	Lessor does not have ownership or financial control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are Scope 3.	Lessor does have ownership and financial control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are Scope 2.

It is recommended that the footprints should be produced based on a Financial Control organisational boundary.

3.4 Reporting Boundaries

Organisations should establish reporting boundaries and sources and sinks of GHG emissions within each. These are separated into direct and indirect emissions with sub-categories as discussed in the next section. This results in Scopes 1, 2 and 3 emissions as follows and shown in Figure 1:

- Scope 1 (direct emissions): Activities owned or controlled by the organisation that release emissions straight into the atmosphere, e.g., combustion in owned boilers or vehicles.
- Scope 2 (energy indirect): Emissions released into the atmosphere associated with the consumption of purchased electricity, heat, steam, and cooling.

- Scope 3 (other indirect): Emissions that are a consequence of the organisation's actions, which occur at sources which are not in ownership or control of the organisation, e.g., business travel by means other than company vehicles, waste disposal, or purchased materials.

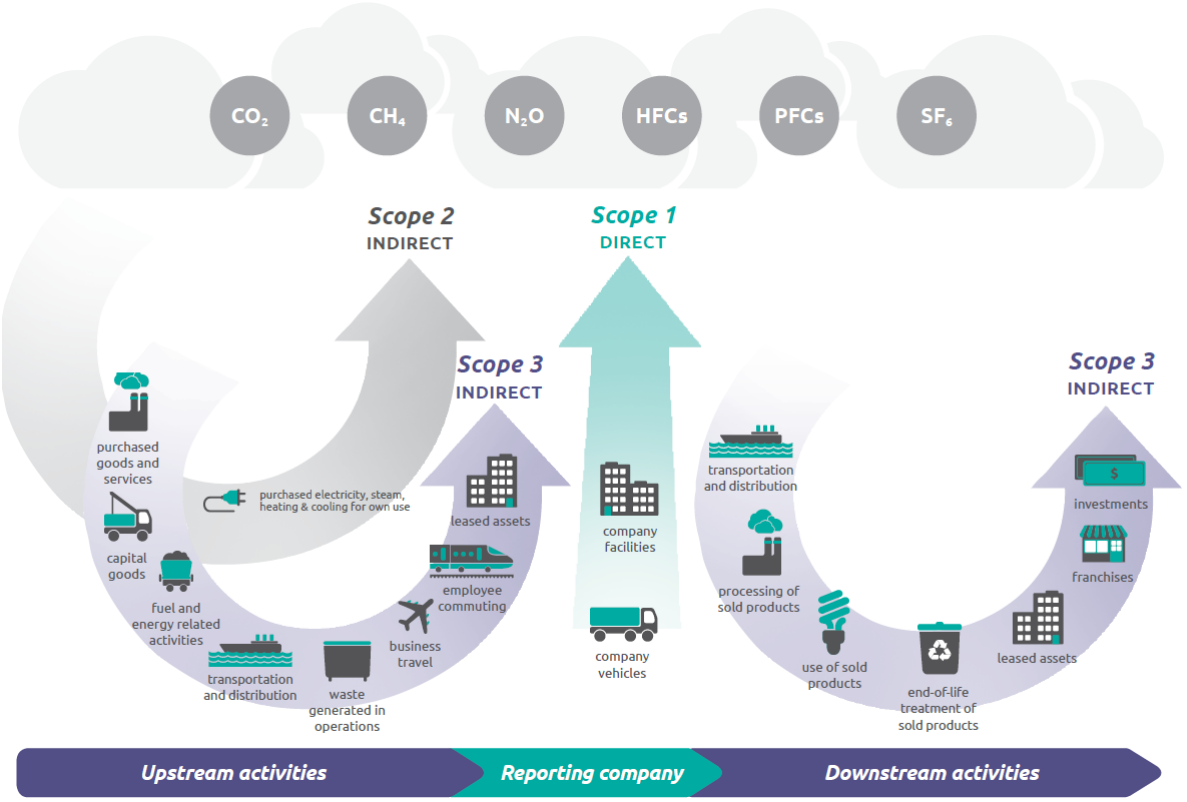


Figure 1: The relationship of direct and indirect emissions [Source: GHG Protocol]

Scope 3 emissions can occur upstream, downstream, or be designated as out of stream. This is helpful to avoid double-counting between organisations. The inclusion of indirect emissions (Scope 3) with discussion of this in Annex H of ISO 14064. Here it is stated that these criteria should be based on those stated in Section 3.2 of this report and that significance should be based on magnitude, level of influence, business risk or opportunity, sector-specific guidance, outsourcing and employee engagement. These should be assessed for significance with the help of external experts, sector-specific guidance, literature reviews or third-party databases. Often, a significance test will be clear but where it is not (for example where data is qualitative) then a "deeper analysis of the criteria may be helpful". An example is given where it is estimated that a source is estimated to be approximately 10% of an organisation's total indirect emissions but that relevant data would be very expensive to obtain, and the resulting accuracy would be poor. In all cases where sources of emissions are not included this should be stated in a transparent manner. The next section discusses categories in more detail.

3.5 Inventory Categories

Categories within each of the three scopes are provided by ISO 14064 and the GHG Protocol and their secondary documents respectively. These two standards were cross-referenced and in general they align, with some minor differences. These include slight category name differences, ISO 14064 having a "Client and Visitor" category and the GHG Protocol having a "Processing of Sold Products" category exclusively of one another. ISO 14064 does however have a catch-all "Other Indirect Emissions" category so in that sense is more comprehensive and has been chosen as the basis for selection of sub-categories here. A list of categories and whether they have been scoped in and out for the footprints for Treveth based on initial assessments and discussions is shown in Table 2. Specific explanation of

what is included within each of these together with data collection and calculation approaches is provided in Section 4.

Table 2: Inventory categories and their recommended inclusion or not within the footprints for Treveth

Scope	Upstream/ Downstream	No.	Category ISO 14064-1	Include/ Exclude
Scope 1: Direct GHG emissions and removals				
1	Direct	1	Direct emissions from stationary combustion	Include
		2	Direct emissions from mobile combustion	Include
		3	Direct process related emissions	Exclude
		4	Direct fugitive emissions	Include
		5	Direct emissions and removals from Land Use, Land Use Change and Forestry (LULUCF)	Include
Scope 2: Energy GHG indirect emissions				
2	Upstream	6	Indirect emissions from imported electricity consumed	Include
		7	Indirect emissions from consumed energy imported through a physical network	Include
Scope 3: Other indirect GHG emissions				
3	Upstream	8	Energy-related activities not included in direct emissions and energy indirect emissions	Include
		9	Purchased goods and services[1]	Include
		10	Capital equipment	Include
		11	Waste generated from organisational activities	Include
		12	Upstream transport and distribution	Include
		13	Business travel	Include
		14	Upstream leased assets	Include
		15	Investments	Exclude
	Downstream	16	Client and visitor transport	Exclude
		17	Downstream transport and distribution	Exclude
		18	Use stage of the product	Exclude
		19	End of life of the product	Include
		20	Downstream franchises	Exclude
		21	Downstream leased assets	Exclude
		22	Employee commuting	Include
	Varies	23	Other indirect emissions not included in the other 22 categories	Exclude

In addition to the above categories, there is value in reporting against categories that better align with the internal organisation of Treveth. For example, emissions from buildings may arise from stationary combustion (category 1 in Table 2), imported electricity (6), energy related activities (8), capital equipment (10) i.e., the construction of new buildings, and upstream leased assets (14) i.e., buildings that Treveth are tenants in. Reporting emissions under a "buildings" category with additional sub-categories as required, may be more informative. A secondary reporting category list can be produced by mapping all the categories (including splitting categories where necessary) into the new list. Following discussions with Treveth, a secondary category list has produced as follows:

[1] This category is called "Purchased products" in ISO 14064 but the equivalent GHG Protocol category "Purchased goods and services" is deemed more appropriate.

1. Domestic Buildings
    1.1 Construction
    1.2 Maintenance
    1.3 Operational Energy
    1.4 Refrigerants
    1.5 End of Life
2. Non-Domestic Buildings
    2.1 Construction
    2.2 Maintenance
    2.3 Operational Energy
    2.4 Refrigerants
    2.5 End of Life
3. Own Operations
    3.1 Own Premises
    3.2 Transport
    3.3 Procurement (general)
    3.4 Own Waste
    3.5 Work at Home energy use
4. Offsetting
    4.1 Exported renewable energy
    4.2 Land management

3.6 Reporting Periods

The carbon footprint should be undertaken for a period covering one year and should be updated on an annual basis. Typical periods used include the April to March financial year, the January to December calendar year, or other periods that are specific to the organisation in question. It has been agreed that Treveth should use the financial year reporting period (i.e., 6th April to 5th April). The baseline footprint produced here will be for the 2022/23 period.

The underlying data and emission factors used in the calculations should be based on the chosen reporting period. Where there is no data available covering the full reporting period, the following hierarchical approach should be taken:

1. If data is available for part of the period, then it should be used to provide an average value for that period of time and then multiplied up to estimate the total for a year. For example, if consumption data is only available for half of the year, then it should be doubled to estimate consumption for a full year. In the case of data that is sensitive to the time of year (for example gas consumption in buildings), then efforts should be made to normalise the consumption for the time of year (for example degree day data can be used in this case).
2. If partial data is not available, then data from the previous year's footprint should be used.
3. If no data from previous years are available, then estimates should be made using secondary sources of data e.g., benchmark data in the case of building energy consumption.

In all cases, if data is not available for a full year, then measures should be put in place to enable the data to be available for the next year's footprint. In addition, it should be clearly stated where estimates have been made in the absence of data being available.

3.7 Quantifying Emissions and Removals

Calculation methodologies should be selected to minimise uncertainty and yield accurate, consistent, and reproducible results. This should consider technical feasibility and cost of data gathering. Within each category, sources and sinks should be identified. Annex C of ISO 14064 provides detailed supplementary guidance on selecting data and developing models and methods for quantifying emissions and removals. It is stated that data that is typically uses includes:

- Activity data e.g., mass, volume, energy or monetary value
- Calorific values
- Emission factors, usually expressed as tCO_2e/quantity of activity data
- Composition data, usually expressed as carbon content, often used for higher accuracy and primary and site-specific emission factor calculations
- Oxidisation factors
- Conversion factors
- Emissions, usually on a mass basis per a reference period (e.g., hourly)
- Monetary values, usually amounts spent on certain products, materials or services

Some of the above are likely to be more relevant than others for the production of footprints for Treveth. In general, calculating emissions from an activity will depend on the data available from the organisation. As it is not practicable to directly measure the actual mass of GHGs emitted from an activity, the calculation will take the form of multiplying some input activity data with an emission factor.

The choice of activity data will depend on what is available, but in principle a data hierarchy approach should be taken that priorities primary data (i.e., that collected by the organisation) and site-specific data over secondary data and other estimates. For example, for emissions from vehicles, it would be preferable to use the actual amount of fuel used to the amount spent on fuel, which in turn would be more accurate than knowing the distance travelled. Where a mix of data is available within a category then the hierarchy approach should still be followed. For example, if fuel consumption data exists for some vehicles and mileage data exists for all vehicles, then the fuel consumption data should be used for those vehicles, and the mileage data for the remainder. In addition, steps should be put in place to capture fuel consumption data for all vehicles for the following year's inventory. Specific guidance on the expected hierarchy for each category identified in Section 3.5 is provided in Section 4.

Emission factors may come from a range of sources, however the most extensively used will be the UK GHG Conversion Factors for Company Reporting [8] (referred to from here as the "Government EFs"). These provide consistent emission factors to be used for a range of activities and are updated annually.

In all cases, as a minimum an aggregate value should be quantified for each category. However, there will be benefits to maintaining as fine a level of granularity as the source data enables within the calculations and reporting. For example, for buildings this would include calculating emissions on a per-building basis if metered data is available for each building, rather than just as the sum-total of all buildings within the estate. For reporting it may be preferable to only separate out the most significant sources within the category to avoid long unmanageable lists e.g., for large buildings, with smaller buildings or sites aggregated together. The full detail should however be retained within calculation tools or spreadsheets to enable onward analysis.

Any emissions offset using carbon credits should be separately reported and the guidance in Section 9 and Annex C of PAS 2060 should be used to ensure the integrity of those offsets.

It is stated in ISO 14064 that uncertainty in the outputs should be quantified and documented, and guidance for doing so is given in ISO/TR 14069. However, this approach relies on knowing in quantified terms the uncertainty associated with each part of the calculation (activity data and emission factors), and as this will not be known it is recommended that at this time, quantifying of uncertainty will not be possible and should not be pursued.

3.8 Intensity Ratios

The headline inventory should be reported in absolute terms as tCO_2e. In addition, normalising the emissions (either totals, sub-totals, or for individual categories) by some common variable to produce "intensity-based" emissions enables the result to be contextualised, and some comparison between different organisations to be made. Examples are provided in the GHG Protocol and the ERG Annex F. Variables that might be appropriate for Treveth include tCO_2e per:

- Number of employees i.e., per full time equivalent (FTE)
- Annual budget i.e., per £million
- Area of property estate (for buildings emissions only)

For Treveth, additional appropriate indicators could be produced based on the remapped categories as follows:

- Domestic Buildings: tCO_2e/dwelling.
- Non-Domestic Buildings: $kgCO_2e/m^2$
- Own Operations: tCO_2e/FTE

3.9 Target Setting

Chapter 11 of the GHG Protocol discusses target-setting. Treveth has projected to 2030 to align with Cornwall Council's aspirations to be Carbon Neutral by 2030 and then Net-Zero by 2045.

Carbon Neutral is taken to mean that the sum of GHGs emitted are balanced or 'offset', though there is not a requirement to reduce absolute emissions. Applicable offsets include carbon avoidance/reduction credits as well as removals. This target covers Scopes 1 and 2, with Scope 3 encouraged.

Net-Zero is taken to mean that GHG emissions are reduced in-line with the latest climate science (keeping within 1.5°C of global warming at a 50% probability) with offsetting only used for activities that are challenging to reduce. Only carbon removal credits are valid (not avoidance or reduction). This target covers Scopes 1, 2 and 3.

As part of target setting, progress should be reported on at least an annual basis (though tools developed may enable "live" data to be visualised) and including against intermediate targets if applicable.

4 Data Collection and Analytical Approach by Category

4.1 Scope 1: Direct Emissions

4.1.1 Direct emissions from stationary combustion

Description

Direct emissions arising from the combustion of fuels (for example, natural gas or oil) on-site in plant (for example boilers or generators) within the organisational boundaries of the reporting organisation. In practice, this is likely to be predominantly gas boilers in owned buildings.

Data Hierarchy and Calculation Approach

The aim should be to establish emissions at a building level of granularity. The following hierarchy should be followed for data collection (best to worst):

1. Quantity of Fuel: Amount of fuel obtained from metered or measured data e.g., kWh natural gas or litres of fuel.
2. Spend on Fuel: Amount spent per fuel which can then be converted to quantity of fuel using the gas and electricity prices in the non-domestic sector dataset [9] that is produced annually (for oil, the local price should be used).
3. Floor Area: The gross internal floor area of each building together with the building type (e.g., office). If this is not available then CIBSE TM46 [10] which provides average benchmark energy consumption values for different building types can be used to establish fuel consumption.

For the first two of these, if data is only available for part of the year then to extrapolate for a full year, degree day analysis as described in CIBSE TM41 [11] should be used so that the annual estimate is not biased by the period for which data is available.

In all the above, once the quantity of fuel used has been established in kWh, then this can be converted to GHG emissions using the Government EFs.

Allocations of emissions from boilers etc. has the potential to be allocated either here (direct emissions) or under “Upstream leased assets” (Section 4.3.7) depending on the type of lease as described in Section 3.3, though the data gathering and calculation method is the same.

Approach Taken for Footprint

Treveth own dwellings at Heathlands, The Coppers, and Tregover. These are rented out to tenants but are included as Scope 1 (and 2) emissions here. The EPC data for each property was used to estimate the annual kWh for each of space heating and hot water, and these were added to obtain total gas consumption. This was multiplied by the Government EFs.

Treveth own commercial premises at Bodmin, Falmouth, Helston, and Pool. These are rented out to tenants but are included as Scope 1 (and 2) emissions here. Annual energy consumption was established based on EPC data provided by Treveth as follows:

- In total there were 39 premises
- The floor area and main heating fuel type was provided for each building
- Where an EPC was available:
    - The headline emissions in kgCO2/m^2 were multiplied by floor area to obtain total building tCO_2.

    - The emission factors for gas and electricity used in the preparation of the EPC were combined with the CIBSE TM46 benchmarks for fossil fuel and electricity use to estimate the split of emissions for gas heated buildings (34% gas, 66% electricity).
    - This was used to obtain an estimate of annual kWh of gas (and electricity) where relevant.
- Where an EPC was not available, then the mean EPC rating from buildings within the same development where an EPC was available was applied, and the same process as above was followed.
- In all cases, the annual gas use was multiplied by the Government EFs.

Treveth do not own their own offices and so emissions from this were included in Section 4.3.7

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Operational Energy > *By Site*
- Non-Domestic Buildings > Operational Energy > *By Site*

4.1.2 Direct emissions from mobile combustion

Description

Direct emissions arising from fuel burnt in transport equipment within the organisational boundaries of the reporting organisation. In practice, this will be emissions from owned vehicles. Emissions from other transport will be accounted for within Scope 3 categories.

Data Hierarchy and Calculation Approach

The aim should be to establish emissions for each vehicle within the fleet, with reporting aggregated to sensible summary headings e.g., vehicle types, or departments. Where individual vehicle data is not available (e.g., a department only knows total fuel consumption for that department) then this would provide the same overall result but would offer less opportunity to identify potential improvements. The following hierarchy should be followed for data collection (best to worst):

1. Quantity of Fuel: Amount of each fuel (e.g., diesel or petrol) obtained from recorded data. This can then be multiplied by the fuel emission factors ($kgCO_2e$/litre) from the Government EFs.
2. Spend on Fuel: Amount spent per fuel which can then be converted to quantity of fuel using the weekly road fuel prices dataset [11] that is produced annually. This can then be multiplied by the fuel emission factors ($kgCO_2e$/litre) from the Government EFs.
3. Distance and vehicle emission factor: The annual distance travelled by each vehicle should be multiplied by the vehicle specific emission factor (gCO_2e/km) provided by the vehicle manufacturer. This is likely to under-estimate emissions, as these emission factors are typically more optimistic than those observed under real world conditions.
4. Distance and Mode: Where the above information is not available, then the annual distance travelled by each vehicle should be multiplied by the emission factors from the Government EFs which are available for a range of different vehicle types in $kgCO_2e$/km.
5. Where none of the above are available, then estimates of distance should be made and steps taken to better capture activity data (ideally quantity of fuel) for the forthcoming year of reporting.

Approach Taken for Footprint

For the 2022/23 period there were no owned vehicles and so no emissions from this category. In future years the maintenance team may be brought in-house which would mean emissions from this category would be included.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Own Operations > Transport > Own Vehicles

4.1.3 Direct process related emissions

This category has been taken to be out of scope as it is not relevant to the activities of Treveth.

4.1.4 Direct fugitive emissions

Description

These are direct uncontrolled emissions of GHG, with any process that directly utilises GHG being a potential source of emissions. In practice, this will mean emissions of refrigerants for space conditioning systems in buildings (e.g., cooling or heat pumps) and potentially vehicles owned by the organisation.

Data Hierarchy and Calculation Approach

The aim should be to calculate emissions at a building resolution. Emissions from vehicle cooling systems are likely to be very small. The following hierarchy should be followed for data collection (best to worst):

1. Amount and type of refrigerant: The mass (kg) of refrigerant (by type) available from each system within a building. It is noted that systems above 12 kW are required under the Energy Performance of Buildings Directive to undertake regular air conditioning inspections. This can then be multiplied by the emission factor for the relevant GHG ($kgCO_2e/kg$) from the Government EFs.
2. Equipment list: Where the above is not available, then an asset list should be produced outlining each relevant unit within a building including the refrigerant type and charge mass (kg). Annex C of the ERG provides a method for converting this to total mass leakage during installation, operation, and disposal years which can then be multiplied by the emission factor for the relevant GHG ($kgCO_2e/kg$) from the Government EFs.
3. Where neither of the above is available then this category should be excluded, and steps taken to capture the relevant data for the forthcoming year.

Approach Taken for Footprint

For the 2022/23 period there were none of these systems present and so there were no emissions from this category. This situation would change as heat pumps are installed in buildings.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Refrigerants > *By Site*
- Non-Domestic Buildings > Refrigerants > *By Site*

4.1.5 Direct emissions and removals from Land Use, Land Use Change and Forestry (LULUCF)

This category has been taken to be out of scope this year though it may be included in future years. The areas of land in question are small and even notwithstanding the challenges in verifying the use of land as a carbon sink, the overall impact from this category is likely to be minimal.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Offsetting > Land Management

4.2 Scope 2: Energy Indirect Emissions

4.2.1 Indirect emissions from imported electricity consumed

Description

These are indirect emissions associated with the import of electricity by the organisation. It excludes upstream emissions associated with the production of fuels feeding power stations, embodied emission associated with the production of generation plant, and the transmission and distribution network (these are captured within Scope 3). In practice, this will be electricity consumption from buildings, and increasingly vehicles.

Data Hierarchy and Calculation Approach

The aim should be to establish emissions at the same level of resolution as direct emissions of buildings and vehicles described earlier. As such, the same data hierarchy and calculation methods described in Sections 4.1.1 and 4.1.2 should be followed for buildings and vehicles respectively regarding activity data and emission factors when using a "location-based" approach to imported electricity as discussed in Annex E of ISO 14064. This approach uses grid-averaged emission factors and are available within the Government EFs. If time-specific emission factors are available and can be used in conjunction with corresponding electricity consumption data, then this may be used instead of average grid emission factors.

An alternative approach regarding emission factors is to use a "market-based" approach. This allows the organisation to use an emission factor provided by the electricity supplier provided that the energy contract (e.g., a Power Purchase Agreement [PPA] or Renewable Energy Guarantee of Origin [REGO]):

- Conveys the information associated with the unit of electricity delivered together with the characteristics of the generator
- Is ensured with a unique claim
- Is tracked and redeemed, retired, or cancelled by or on behalf of the reporting entity
- Is as close as possible to the period to which the contractual instrument is applied and comprises a corresponding timespan

The ERG recommended that if the market-based approach is used, then in addition that these results are presented alongside the location-based approach.

Where the organisation generates renewable energy (for example from photovoltaic panels on the roof of a building), then of the generated electricity a portion will be self-consumed (and so will be reflected in a reduced demand for imported electricity), and the remainder will be exported. Annex G of the ERG states that this component can be used to reduce the net tCO_2e figure, and that in addition the total offset arising from exported generated electricity must not be greater than gross Scope 2 emissions. In this case, to account for the offset within the inventory metered data from an export meter would be required. The ERG also state that organisations can also report on the amount of consumed generated renewable energy, though this is not a requirement.

To summarise, it is proposed that:

- Scope 2 emissions arising from imported electricity for buildings and vehicles should be calculated using the aforementioned activity data and location-based emission factors e.g., from the Government EFs.
- If the organisation generates renewable electricity and there is metered export kWh data available, then this should me multiplied by the location-based grid average Scope 2 "electricity generation" emission factor from the Government EFs, and this value reported as an offset (negative value) at the end of the inventory in Section 4.4. This offset can be used to demonstrate an overall reduction in emissions from the gross total to result in a net total and cannot be greater than the total gross Scope 2 emissions.
- Where the organisation has a contract with a supplier to provide low carbon electricity e.g., via a PPA, then the emission factor from that supplier can be used to calculate the equivalent offset compared to the location-based approach and reported as an offset to enable a net emissions to be calculated as described above. It is important that any renewable energy used within the supply contract can be demonstrated to be additional.
- There is no need to establish or report emissions that are avoided via the self-consumption of renewable electricity.
- Upstream emissions arising from electricity consumption are captured within Scope 3 of the footprint.

Allocations of emissions from electricity consumption has the potential to be allocated either here (Scope 2 indirect emissions) or under "Upstream leased assets" (Section 4.3.7) depending on the type of lease as described in Section 3.3, though the data gathering and calculation method is the same.

Approach Taken for Footprint

For dwellings, the same buildings identified in Section 4.1.1 were searched by postcode in the Government's electricity statistics[2] to obtain the median electricity consumption per meter in that postcode. This was applied to all dwellings where data was available. Where it was not, then the average value from all relevant meters (104 in total) was used instead. The annual electricity consumption was multiplied by the Government EFs.

For non-domestic buildings, the same process as described in Section 4.1.1 was followed.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Operational Energy > *By Site*
- Non-Domestic Buildings > Operational Energy > *By Site*
- Own Operations > Transport > Own Vehicles
- Own Operations > Transport > Leased Vehicles

4.2.2 Indirect emissions from consumed energy imported through a physical network

Description

These are indirect emissions associated with the import of energy by the organisation, for example district heating.

[2] https://www.gov.uk/government/statistics/postcode-level-electricity-statistics-2020-experimental

Data Hierarchy and Calculation Approach

The approach would depend on the type and extent of the energy network, but in principle establishing energy use from buildings would be undertaken as described in Section 4.1.1 (Direct emissions from stationary combustion), with GHG emissions being calculated by multiplying the energy use by an emission factor specific to the energy network.

Approach Taken for Footprint

For the 2022/23 period there were no relevant district energy schemes and so there were no emissions from this category. In future years this may change.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Operational Energy > *By Site*
- Non-Domestic Buildings > Operational Energy > *By Site*

4.3 Scope 3: Other Indirect Emissions

4.3.1 Energy-related activities not included in direct emissions and energy indirect emissions

Description

These are indirect emissions from upstream activities associated with fuel and electricity consumption by the reporting organisation. Examples include the extraction, production, transport, and distribution of fuel and energy. In practice, this will be an additional well to tank (WTT) uplift on all fuel use from stationary and mobile construction (Sections 4.1.1 and 4.1.2), imported electricity (Section 4.2.1), business travel (Section 4.3.6), upstream leased assets (Section 4.3.7), and employee commuting (Section 4.3.15).

Data Hierarchy and Calculation Approach

The data collection will be exactly the same as for emissions from direct combustion from stationary and mobile equipment and imported electricity, but rather than using the emission factor in those sections, the emission factor for WTT as stated in the Government EFs should be used instead. In practice, this will uplift the total emissions arising from a building or vehicle. For fuel combustion (e.g. natural gas or oil), there is a single WTT factor associated with that fuel. For electricity, the upstream emissions include WTT emissions associated with combustion at the generation plant (e.g., remote power stations), the transmission and distribution (T&D) network, and then WTT emissions on the T&D network. It would be reasonable to sum these three emission factors to get a single additional "WTT" emission factor for imported electricity consumption. This electricity total WTT emission factor should be applied only to any imported electricity (i.e., not to onsite generated and exported electricity).

Approach Taken for Footprint

These were calculated automatically in the spreadsheet created for the analysis by establishing these emissions in parallel to the main emission source, as described above.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Operational Energy > *By Site*
- Non-Domestic Buildings > Operational Energy > *By Site*
- Own Operations > Own Premises

- Own Operations > Transport > Own Vehicles
- Own Operations > Transport > Leased Vehicles
- Own Operations > Transport > Business Travel
- Own Operations > Transport > Commuting

4.3.2 Purchased products and services

Description

These are emissions associated with the consumption of goods and services by the reporting organisation that are not otherwise included elsewhere in the inventory. For example, capital equipment, business travel, or electricity consumption are all examples of goods and services that are consumed, but they are already accounted for within specific sub-categories in the inventory that have been created within the standards to improve transparency and consistency. These scope of these emissions are "cradle to gate" i.e., all emissions that occur up to the point of sale by a producer e.g., raw material extraction, transport to a manufacturing facility, processing etc., but not including onward transport to the customer (the reporting organisation here), which is covered in Section 4.3.5 "upstream transport and distribution". In practice, this category will rely heavily on engagement with both procurement departments, and supply chain partners.

Data Hierarchy and Calculation Approach

The ultimate goal to aim for would be to have specific quantified emissions for each good or service purchased by the organisation. In practice, this will not at this moment be achievable, and there will need to be a balance found between having sufficient granularity and accuracy of outputs against the time and effort required to calculate emissions from supply chains. Reporting may be by supplier and/or sector.

An initial scoping exercise based on the "spend-based" calculation method (see point 4 in the list below) should be adopted to establish significance within the procurement activities of the organisation. The GHG Protocol contains examples where capturing 80% of spend using more detailed calculation approaches and then extrapolating for the remaining 20% may be appropriate.

The GHG Protocol supply chain guidance documents discuss four calculation methods, of which only first and last are likely to be practicable for Treveth. The following hierarchy should be followed for data collection (best to worst):

1. Supplier-specific method: This involves obtaining product level data directly from the supplier, and three methods ranked best to worst are described here:
    a. The emissions from the product will have been calculated by the supplier ideally following the BS EN ISO 14067 standard [12] of Environmental Product Declarations (EPDs) [13]. The product emission factors used should be "cradle to gate" and not full lifecycle. These standards would provide the assurance that a fair and recognised approach has been adopted.
    b. If a supplier has undertaken product calculations but has not followed these standards then it may still be possible to use their data though this should be done with caution and in discussion with the supplier to understand the calculations.
    c. If this is not available, then the supplier may have produced their own emissions intensity value (e.g., $kgCO_2e$/£ spent) based on their own specific data, which could then be used with the value of the contract to estimate emissions.
2. Hybrid method: This approach effectively relies on gathering all the relevant data from a supplier (for example Scope 1 and 2 emissions, plus data such as mass of upstream materials)

to enable the reporting organisation to then calculate the emissions. This option is discounted here as likely to be too resource-intensive to be applicable in most/all cases for Treveth.

3. Average-data method: This method involves gathering quantified activity data (other than cost) such as mass of product, number of., hours spent etc. which can then be used with secondary data e.g., published databases, government statistics, literature studies, and industry associations. The GHG Protocol provides examples of databases [14], some of which are commercial. Adopting this method would rely on both capturing activity data using quantities other than contract value, and collectively deciding on the appropriate database for each product and applying it. As the former is not routinely undertaken and certainly not holistically across all categories of procurement, this option is discounted at this moment.
4. Spend-based method: This method involves assigning a sector (e.g., using the Standard Industry Classification [SIC] codes) to each item of spend, and then multiplying the value with a sector-specific emission factor. It may be more time-efficient to aggregate spend items by supplier and then rank suppliers by total spend. It is likely that a pareto principle will apply meaning that manual allocation of sector can be applied to the highest spend suppliers and then for the "tail" an average can be applied based on the top suppliers. This is the approach outlined in the ERG and Annex E, though the emission factors there are very out-dated. The most recent and applicable emission factors to be used are from the UK's carbon footprint dataset [15] in the "SIC multipliers" sheet. Whilst this method is effective at being able to relatively quickly calculate emissions arising from anywhere in the economy, it is important to recognise it is not likely to be accurate and cannot distinguish emissions between spend within a category or between suppliers, and is only really useful as an initial rough "snapshot" rather than as a tool that can identify specific opportunities or track changes over time (as the only two factors in the calculation are amount spent and the emission factor).

In all cases, it is important to avoid the potential for double counting by excluding calculation of emissions that are already accounted for elsewhere. For example, in the case of adopting a spend-based analysis, the amount spent on suppliers of energy and business travel should not be included here as they will be included elsewhere in the inventory.

Approach Taken for Footprint

Data was provided by Treveth for four accounts as follows:

- Development: For use on the construction of new development and assigned to capital equipment (Section 4.3.3).
- Commercial: For maintenance of the commercial estate.
- Tranche A: For maintenance of dwellings.
- Holdings: Procurement for general operations and overheads.

Spend from each of these accounts was allocated to one of the 97 sector categories from the UK Carbon Footprint. Any spend that was being included using a more specific method (e.g. energy use), or that was outside of the scope of the footprint, was excluded from the calculations. The spend in each sector was multiplied by the emission factor given in the UK Carbon Footprint. As this was from 2019, the emission factors were scaled down to account for inflation. The resultant emission factors are still likely to be slightly high, as the carbon intensity of the supply chain is likely to have decreased over the period (for example, due to a decarbonising electricity grid).

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Maintenance > *By category title*
- Non-Domestic Buildings > Maintenance > *By category title*
- Own Operations > Procurement (general) > *By category title*

4.3.3 Capital equipment

Description

These are emissions associated with the purchase of capital goods. There is the potential for overlap in the categorisation of either purchased goods/products, and capital goods and so it is important that they are only accounted for in one place. The GHG Protocol states that *"Capital goods are final products that have an extended life and are used by the company to manufacture a product; provide a service; or sell, store, and deliver merchandise. In financial accounting, capital goods are treated as fixed assets or as plant, property, and equipment (PP&E). Examples of capital goods include equipment, machinery, buildings, facilities, and vehicles"*. Whilst purchased products are sometimes referred to as "consumables" and are used over a short period of time (e.g., days or usually less than a year), capital goods are used for much longer periods (e.g., 5 to 50 years). Whether a good is classified as a "purchased product" or "capital good", the reporting should make clear which category it is being accounted for in.

In practice for Treveth this is likely to include:

- The construction of new buildings: Emissions should be reported on a per building basis.
- Major refurbishment of existing buildings, including replacement of major plant: Emissions should be reported on a per building basis for refurbishment, whilst major plant can be aggregated.
- New vehicles: Emissions can be reported as aggregated values with descriptions e.g., 20 new cars for Division X etc.

Data Hierarchy and Calculation Approach

Emissions can be calculated in the same way as for purchased products and services (Section 4.3.2). For the "supplier-specific method", for buildings and general plant there is guidance and standards available from LETI [16] and CIBSE [17] respectively that can help with quantifying cradle-to-gate emissions from projects. As with the purchased products and services section, the "supplier-specific method" and "spend-based method" are likely to be the only two relevant calculation methods.

There is some disagreement between ISO 14064 and the GHG Protocol on handling amortisation of emissions. This is where emissions can be divided by the time period of the capital good, for example if a vehicle is expected to be amortised over 10 years in the organisation's accounts, then the cradle-to-gate emissions can be divided by 10 and added in each of the next 10 years of the inventory. Whilst ISO 14064 states that this is an allowable approach, the more recent guidance from the GHG Protocol states that in accounting for emissions from capital goods *"…companies should not depreciate, discount, or amortize the emissions from the production of capital goods over time. Instead companies should account for the total cradle-to-gate emissions of purchased capital goods in the year of acquisition, the same way the company accounts for emissions from other purchased products in category 1. If major capital purchases occur only once every few years, Scope 3 emissions from capital goods may fluctuate significantly from year to year. Companies should provide appropriate context in the public report (e.g., by highlighting exceptional or nonrecurring capital investments)"*. This guidance should be followed here.

Approach Taken for Footprint

The same approach as for Section 4.3.2 was taken, with spend from the 'Development' category assigned to capital equipment. In future years, emissions associated with the construction of new development will be added to this category.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Construction > *By Site*
- Non-Domestic Buildings > Construction > *By Site*

4.3.4 Waste generated from organisational activities

Description

Waste can impact on organisational GHG emissions in several ways, including:

- The use of recycled materials in the products the organisation purchases. These are already accounted for in Sections 4.3.2 and 4.3.3).
- The transport and subsequent processing of waste generated by the organisation. This is what is covered within this section. Technically, the transport of waste from the organisation to the waste treatment facility would constitute "upstream transport and distribution", however as the Government EFs combine the transport and waste processing impact, they are assumed to be included within this section.
- The onward disposal of waste from products sold by the organisation. This is not applicable to Treveth.

For waste generated by the organisation that is recycled, this has two potential GHG reducing benefits, firstly the reuse of material can lower embodied emissions from purchased products (this is accounted for in the purchase of those products), and secondly by avoiding sending that waste to be processed (e.g., preventing material from entering landfill sites). The second of these can be optionally reported as "avoided emissions", however as the supporting data is likely to be hard to obtain and the overall impact for Treveth minimal, it is recommended that this is not reported.

Data Hierarchy and Calculation Approach

The aim should be to obtain data at building resolution (i.e., waste produced at each site), however this may not be possible and given the predicted low overall impact from this section, a single aggregated value may be acceptable. The following hierarchy should be followed for data collection (best to worst):

1. Site data: Where the specific mass of data is available then this should be used. If this is available at building/site resolution then this should be used, or if not then aggregated. Where mass is broken down by waste stream (e.g., paper, plastics, electrical equipment etc.), then this should be used. Otherwise, the generic "commercial and industrial waste" category should be assumed. The mass of each waste stream (or total) should be allocated a waste processing method (e.g., landfill, energy from waste, open-loop recycling etc.). If this is not known, then an assumption should be made based on knowledge of waste contracts within the organisation. The derived annual mass of waste (tonnes) can then be multiplied by the corresponding emission factor from the Government EFs. It should be noted that these factors include an allowance for typical transport distances to a waste processing site and for the processing itself. As the benefit of recycling and energy recovery from waste are accounted for in the supply of recycled material and energy, for most EFs that values are low as they only include the transport component. The notable exception to this is any organic waste (and the generic "commercial and industrial waste" category) sent to landfill.

2. Benchmark data: Where specific site data is not available, then benchmark data waste generation data [18] may be applicable, for example as shown in Table 3. This can be multiplied by the number of staff (FTE) and then applied with the Government EFs.
3. Spend data: Alternatively, if the value of the waste contract is known (£) then this can be multiplied by the "Waste collection, treatment and disposal services; materials recovery services" category from the SIC sectors as described in Section 4.3.2.

Table 3: Breakdown of office waste per FTE to use if site specific data is not available (Source: Cundalls)

Waste Stream	Split	Mass (kg)
White paper	20%	40
Cardboard	14%	28
Newspaper and Magazines	13%	26
Other Paper	13%	26
Food	21%	42
Building (services and other)	4%	8
Plastic cups	1%	2
Cans	3%	6
Glass	3%	6
Office Equipment	2%	4
Other Plastic	6%	12
TOTAL	100%	200

Approach Taken for Footprint

No site-specific data was available, so the benchmark office waste production values from Table 3 were applied to the relevant emission factors and these were multiplied by the total number of FTE. It was assumed that all waste was recycled except for food waste which was assumed to be landfilled. This is a worst-case assumption and actual emissions would be lower if that food waste were for example taken to an energy from waste facility.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Own Operations > Own Waste > n/a

4.3.5 Upstream transport and distribution

Description

This category includes transportation and distribution (both transport and logistics including warehousing) of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers (i.e., those with which the organisation has a direct purchase order) and its own operations, and transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics. The transport within the supply chains between tier 1 and 2 suppliers should be included within the "purchased goods and services" section i.e., that section reports "cradle-to-gate" emissions (where gate is the factory gate of a

supplier), and this section should report on the transport of those goods from the factory gate to the organisation.

Data Hierarchy and Calculation Approach

For Treveth this is likely to be relevant for the construction of new buildings. Here, the hierarchy of information should be as follows:

- Actual fuel consumption associated with delivery of materials.
- Distances, mass, and mode associated with delivery of materials.

Approach Taken for Footprint

There were no relevant emissions in this category for this year. For future years, this information may come from the embodied carbon analysis which includes separated calculations for transport of materials.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > Construction > *By Site*
- Non-Domestic Buildings > Construction > *By Site*

4.3.6 Business travel

Description

This section includes emissions from business travel in vehicles owned or operated by third parties and also includes emissions associated with hotel stays on business trips. The aim should be to report emissions by mode of transport and for hotel stays as follows.

- Cars – hire cars
- Cars – "grey fleet" (employee-owned vehicles other than employee commuting)
- Taxis
- Air travel
- Rail travel
- Bus and coach travel
- Hotel stays

Emissions associated with travel in vehicles owned or leased by the organisation, or from commuting, are covered in other sections.

Data Hierarchy and Calculation Approach

The aim should be to establish emissions for each mode. The following hierarchy should be followed for data collection (best to worst):

1. Fuel-based method: Where fuel usage is known (e.g., from fuel cards used in hire cars or the grey fleet), these should be used with the Government EFs ("average car unknown fuel" emission factor, unless better records are available within the organisation) as described in Section 4.1.2). In some cases, mileage claims will be available in which case the distance can be used directly, or converted from spend to distance using the claim rate (e.g. 45p/mile). The amount of fuel used will not be obtainable for other modes e.g., public transport.
2. Activity-based method: For vehicles, the distance and mode for each vehicle type can be multiplied by the applicable emission factor ($kgCO_2e$/passenger.km) from the Government EFs.

For hotel stays, the number of nights can be multiplied by the $kgCO_2e$/room per night emission factor from the Government EFs.

3. Spend-based method: Where specific data is not known, then spend data can be multiplied by the applicable emission factor from the relevant SIC sector as described in Section 4.3.2.

Approach Taken for Footprint

Data was available from expense claims separated based on their description into grey fleet, trains, parking (assume zero emissions), taxis, and flights. For grey fleet expenses, the spend was converted to mileage based on 45 p/mile and this was combined with the Government's EF for an 'average car with unknown fuel' to estimate emissions. For all other modes, the spend was directly multiplied by the EF from the UK's Carbon Footprint for the appropriate sector.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Own Operations > Transport > Business Travel

4.3.7 Upstream leased assets

Description

This includes emissions associated with any leased assets, typically buildings, vehicles, and equipment. Classification of these emissions is dependent on the type of lease. A "finance lease" is a long-term lease (usually over 3 years) after which the reporting organisation pays a nominal rent or can sell or scrap the equipment and although during the course of the lease the reporting organisation does not own the equipment, it is responsible for maintaining and insuring it. Under this situation, emissions should be reported under the "Capital equipment" section. With operating leases and contract hire, the leasing company takes the asset back at the end of the lease and is responsible for maintenance and insurance, and the reporting organisation does not show the asset on its balance sheet. Where Treveth lease assets under an operating lease or contract hire, their emissions should be reported in this section. The main focus is on emissions associated with assets that consume energy. Whilst allowances for embodied, maintenance and end of life emissions can also be made, these are likely to be hard to gather data for and so can be included (whilst ISO 14064 does discuss them, the GHG Protocol does not include them).

Data Hierarchy and Calculation Approach

The required emissions from buildings are those from stationary combustion (Section 4.1.1), fugitive emissions (Section 4.1.4), and imported electricity (Section 4.2.1) sections. For vehicles, emissions are from the mobile combustion (Section 4.1.2) and imported electricity sections. For equipment, emissions are from the stationary combustion and imported electricity sections. Guidance for data requirements and calculation methods are given in those sections.

An alternative calculation approach, if specific asset energy data is not possible, is to establish the total Scopes 1 and 2 emissions from the lessor and then allocate a proportion of these to the lessor (e.g., if the lessee leases out 10% by area of its building to the lessor, then 10% of its Scope 1 and 2 emissions would be allocated to the lessor). This approach is not expected to be viable here. It is not stated in either ISO 14064 or the GHG Protocol that WTT emissions need to be added to these emissions.

It is important to avoid double counting, for example from "purchased products and services" e.g., adding on emissions associated with paying rent on a building in addition to also counting emissions from direct metering of the same premises.

Approach Taken for Footprint

For the 2022/23 period, this category included office space at Pydar House which is occupied by Treveth under an Operating Lease. Sub-metered energy data either for the space rented or for the buildings was not available. The energy bill for each of gas and electricity paid to the landlord (on the basis of proportional square meterage of the total building occupied) was converted to kWh consumption using generic gas and electricity prices from BEIS for the period. In addition, water bill data was also available, though it was not straightforward to obtain a unit rate for water use. Initial estimates suggested that emissions from this are likely to be de minimis.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Own Operations > Own Premises > n/a
- Own Operations > Transport > Leased Vehicles

4.3.8 Investments

This category has been taken to be out of scope.

4.3.9 Client and visitor transport

This category has been taken to be out of scope as it is likely to be very small and not practicable to monitor or calculate in a meaningful way.

4.3.10 Downstream transport and distribution

This category has been taken to be out of scope as it is not relevant to the activities of Treveth.

4.3.11 Use stage of the product

This category has been taken to be out of scope as it is not relevant to the activities of Treveth.

4.3.12 End of life of the product

Description

The product here is taken to be the buildings that are leased out i.e., dwelling and non-domestic buildings. Emissions from waste are based on the generation of waste from demolition. The government emission factors include a notional allowance for transport of waste to a waste processing site. Emissions from the processing are not included for any method aside from landfill, and there the only significant emissions are where organic matter decomposes in landfill.

Data Hierarchy and Calculation Approach

The calculation would require the quantification of mass by waste stream, and waste processing method. These can then be applied to the corresponding emission factor.

Approach Taken for Footprint

For the 2022/23 period, 7 units were partially demolished at the Maudlin Farm site in Liskeard. Waste quantities were available by waste stream expressed as number of skips (20 m skip, which was taken to be a 20 m^3 skip filled totally to a limit of 12 tonnes, as a worst-case assumption). It was assumed that the demolition waste was generally landfilled, whilst it was assumed that any timber was taken to an energy from waste facility. There was no demolition of non-domestic buildings.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Domestic Buildings > End of Life > *By Site*
- Non-Domestic Buildings > End of Life > *By Site*

4.3.13 Downstream franchises

This category has been taken to be out of scope as it is not relevant to the activities of Treveth.

4.3.14 Downstream leased assets

This category has been taken to be out of scope as it is not relevant to the activities of Treveth. Any buildings that are owned by Treveth but leased to others (downstream) would be accounted for in sections 4.1.1 and 4.2.1 as under financial control reporting and an operating lease, these would be Scopes 1 and 2 respectively.

4.3.15 Employee commuting

Description

This includes transport of employees between their homes and workplaces. In the case of Treveth this would cover transport from the home to the office, with any transport during working hours captured within other sections. This can cover a range of modes but in practice will be mainly driving (either single driver or car sharing) as well as potentially public transport modes and walking/cycling. Also included in this section for Treveth is "home working" i.e., emissions arising from energy used to heat homes and operate work equipment whilst staff are home working.

Data Hierarchy and Calculation Approach

There are different ways that the data can be reported, for example by site, mode, department etc. and there is potential for a standardised approach to be taken for Treveth. In the first instance, the lack of specific data is likely to limit any usefulness of more granular categorisation. This is an issue that could be revisited as data quality improves.

The following hierarchy should be followed for data collection (best to worst):

1. Fuel-based method: Where fuel consumption from commuting it known it should be used in the calculations, however this is expected to be generally not applicable.
2. Distance-based method: Organisation-specific data is gathered to establish total distance for each travel mode. This would need to be captured from an organisation travel survey that should be updated on an annual basis. It should establish for each employee the one-way distance from home to the place of work and the annual distance by number of days worked per year commuted by each mode, and assuming a two-way journey each day. This data can then be multiplied by the appropriate modal emission factor ($kgCO_2e$/passenger.km) from the Government EFs. For car sharing it should be assumed that the emission factor for a car ("average car with unknown fuel") is divided by two (assuming typically car-sharing involves two people sharing a journey) and for walking and cycling the emission factor will be zero. In the case of a travel survey 100% coverage of staff will not be possible, and so the results of the survey should be extrapolated to cover all staff.
3. Average-based method: This method can be used when organisation-specific data (i.e., from a staff commuting survey) is not available. Here, details on distance and mode can be estimated from the National Travel Survey [19], and in particular Tables NTS0303(average distance travelled by mode) and NTS0412 (commuter trips by employment status and main mode). This can be combined with staff numbers, number of days worker per year, and the Government EFs to calculate commuting emissions.

To calculate emissions from homeworking, the total number of hours worked at home need to be established e.g., from records or based on proportion of contracted hours worked at home. These can be multiplied by the "Homeworking (office equipment + heating)" emission factor (kgCO_2e per FTE working hour) from the Government EFs. The results can be broken down into sub-categories (e.g., departments) if required, or otherwise aggregated as a single organisational total.

Approach Taken for Footprint

Treveth undertook an internal survey of staff travel. This established for each member of staff what proportion of time they worked (either full time, or a fraction thereof), the number of days per week travelled to the office typically, distance from home to office, main mode of commute transport, additional mode of transport and frequency, and whether the member of staff lift shares. Additional assumptions were made that there are 220 days in a full working year, that there are 8 hours in a working day, for frequency of additional transport "occasional" was taken to mean once a month and "very occasional" once a quarter, and the lift sharing would halve the emissions from a journey. Emissions from commuting were calculated by establishing the total annual distance travelled by each mode and multiplying this by the appropriate emission factor. Emissions from home working were calculated by establishing the total number of hours worked at home (where number of days at home was derived from 5 minus typical days commuted to the office) by the government emission factor for homeworking (heating and equipment).

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Own Operations > Transport > Commuting

4.3.16 Other indirect emissions not included elsewhere

No other sources of emissions have been identified.

4.4 Offset Carbon

Description

This includes any GHG offsets, for example purchased voluntary offsets, or exported renewable energy.

Data Hierarchy and Calculation Approach

Offset emissions from purchased voluntary offsets will be available directly from the purchase of those credits. Offsets from exported generated electricity can be established as described in Section 4.2.1.

Approach Taken for Footprint

There was no offset carbon in this year.

Alternative Categorisation and Mapping

For the alternative categories, emissions from this category should be allocated to:

- Offsetting > Exported Renewable Energy
- Offsetting > Purchased voluntary offsets

5 Results

The split of emissions by Scope and alternative Category are shown in Figure 2. The results of the calculations for the ISO 14064-1 are shown in Figure 3 and Figure 4. The results for the alternative

categories are shown in Figure 5 and Figure 6. Total net emissions for the 2022/23 period were 1,326 tCO_2e. Of these, 975 tCO_2e were associated with dwellings, 127 tCO_2e with non-domestic buildings and 224 tCO_2e from overheads/own operations. The largest sub-category was from construction of dwellings, at 863 tCO_2e. This was mainly driven by the spend in the period on consultants for planned new developments, and do not include the actual construction of those dwellings which will be accounted for in future years as they are completed. It is expected that when this happens, emissions here will increase. Most emissions are Scope 3 (88%) with Scope 1 representing 4% of the total, and Scope 2 accounting for 9%.

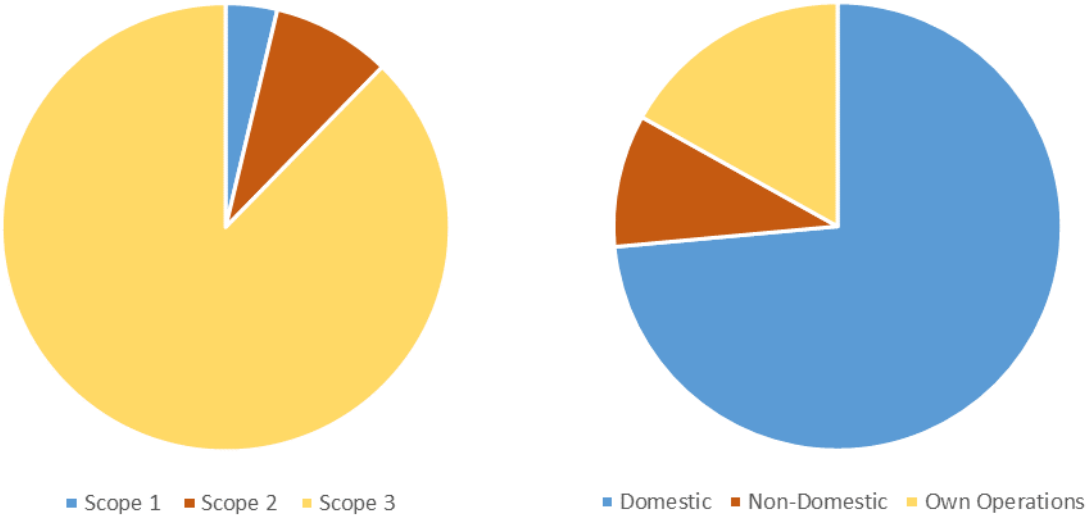
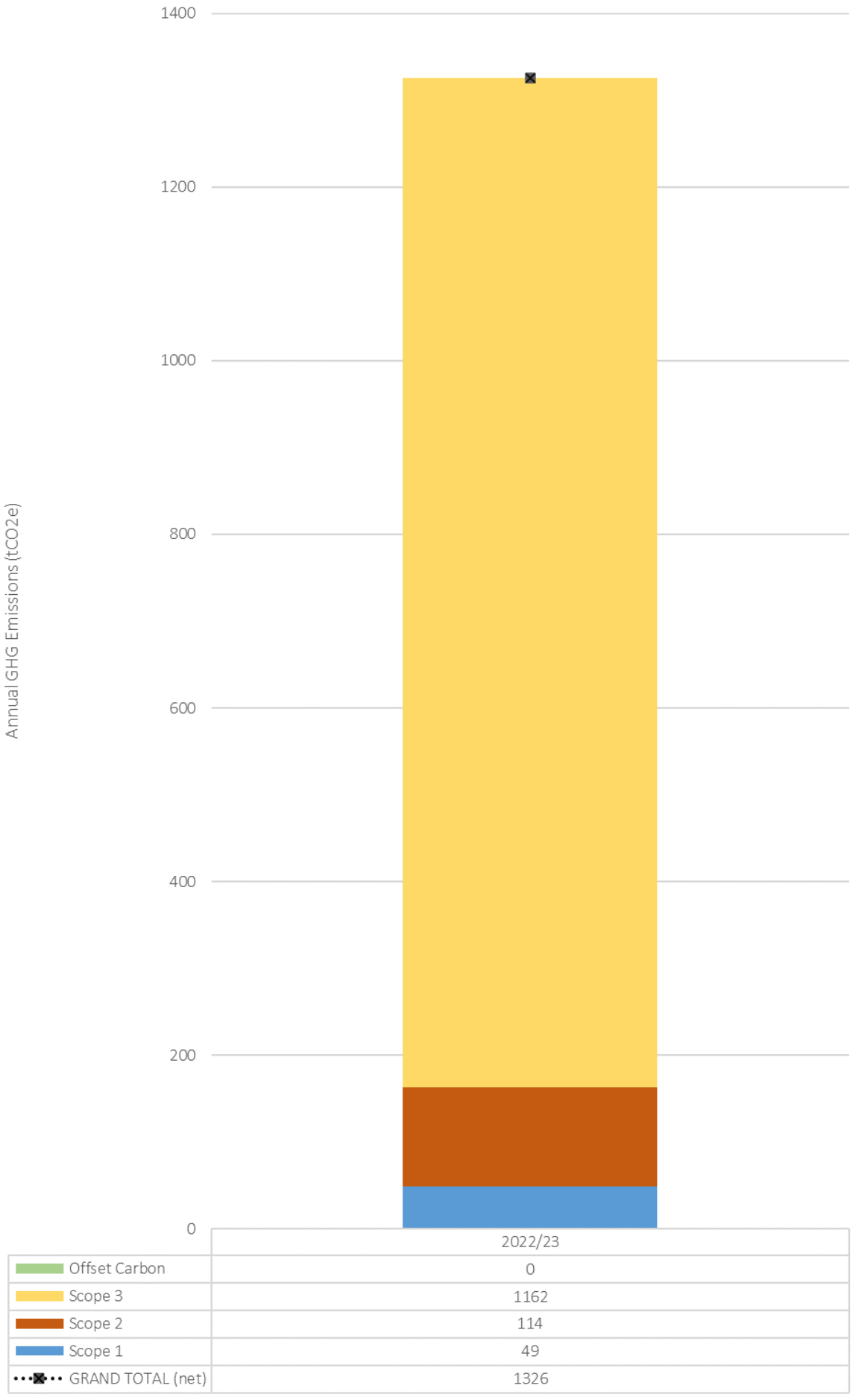
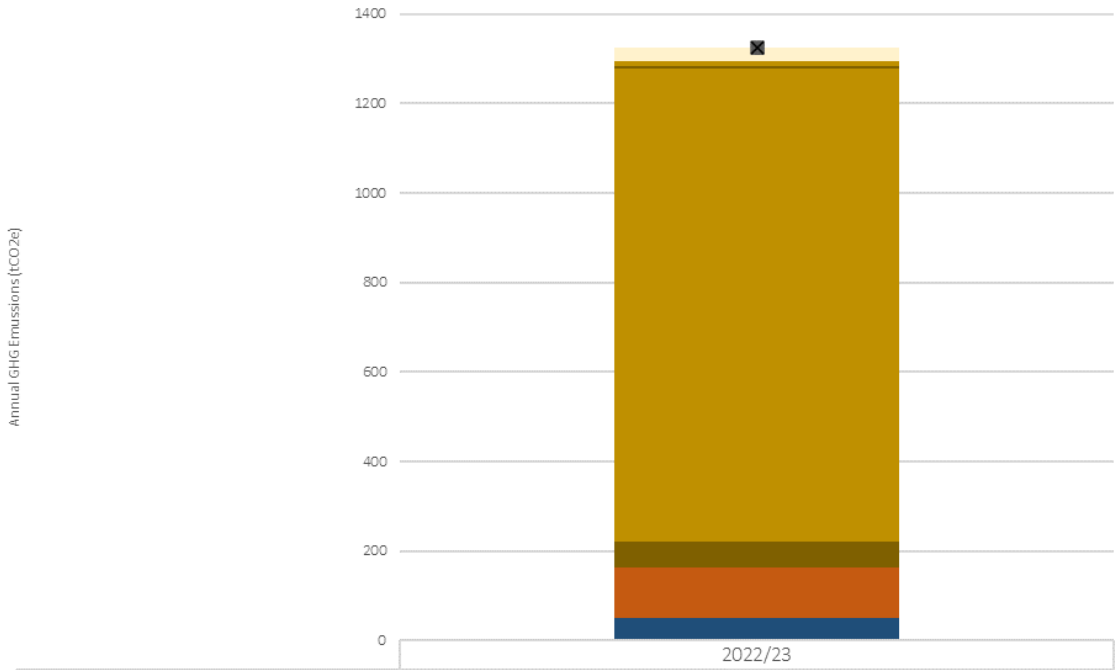


Figure 2: Split of emissions by scope (left) and alternative category (right)



	2022/23
Offset Carbon	0
Scope 3	1162
Scope 2	114
Scope 1	49
GRAND TOTAL (net)	1326

Figure 3: Breakdown of emissions by Scope 1, 2 and 3 from ISO 14064-1



	2022/23
Offset Carbon	0
Other indirect emissions not included in the other 22 categories	0
Employee commuting	32
Downstream leased assets	0
Downstream franchises	0
End of life of the product	0
Use stage of the product	0
Downstream transport and distribution	0
Client and visitor transport	0
Investments	0
Upstream leased assets	10
Business travel	6
Upstream transport and distribuUpstream transport and distribution tion	0
Waste generated from organisational activities	1
Capital equipment	0
Purchased products	1055
Energy-related activities not included in direct emissions and energy indirect emissions	58
Indirect emissions from consumed energy imported through a physical network	0
Indirect emissions from imported electricity consumed	114
Direct emissions and removals from Land Use, Land Use Change and Forestry (LULUCF)	0
Direct fugitive emissions	0
Direct process related emissions	0
Direct emissions from mobile combustion	0
Direct emissions from stationary combustion	49
GRAND TOTAL (net)	1326

Figure 4: Breakdown of emissions by detailed sub-category from ISO 14064-1

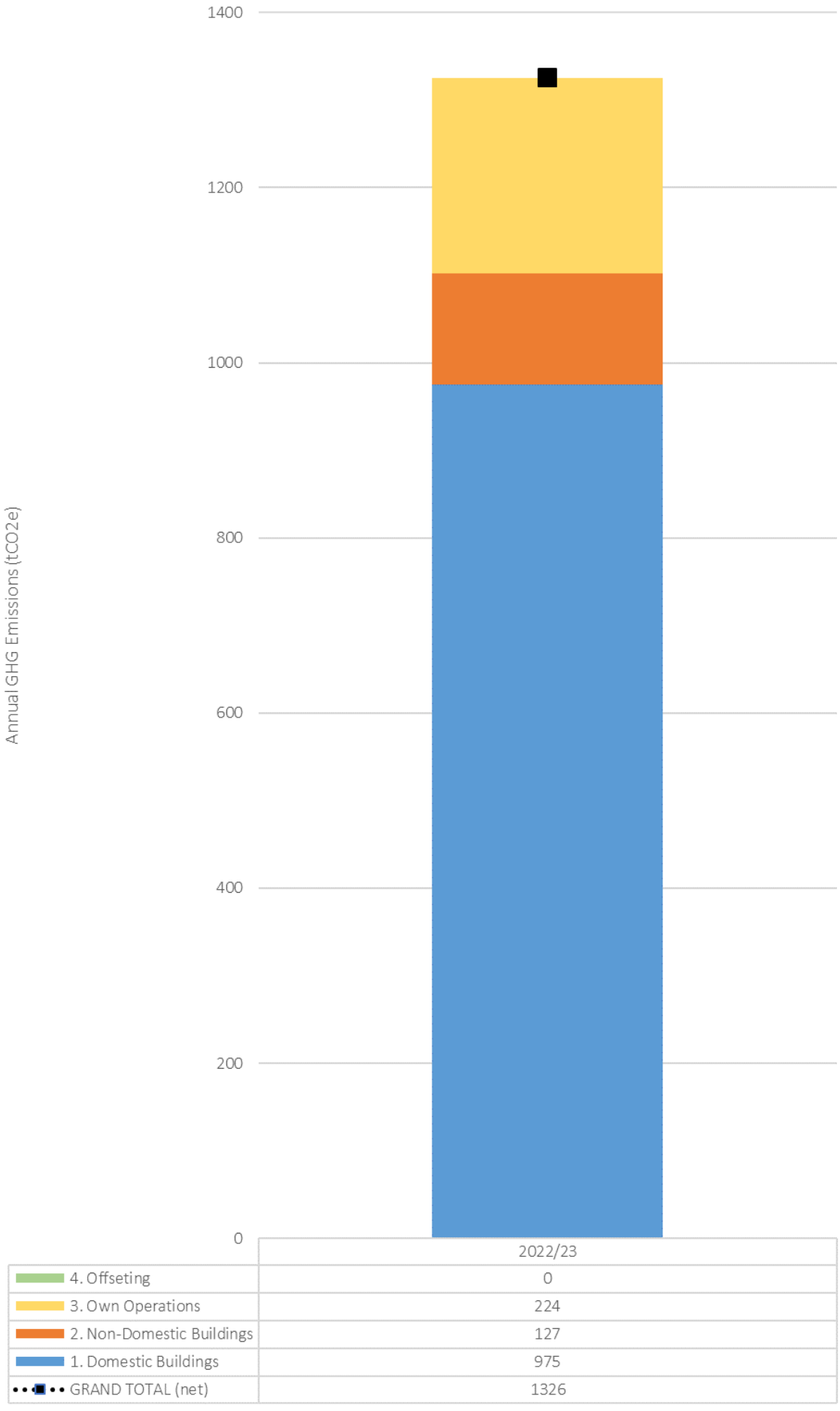
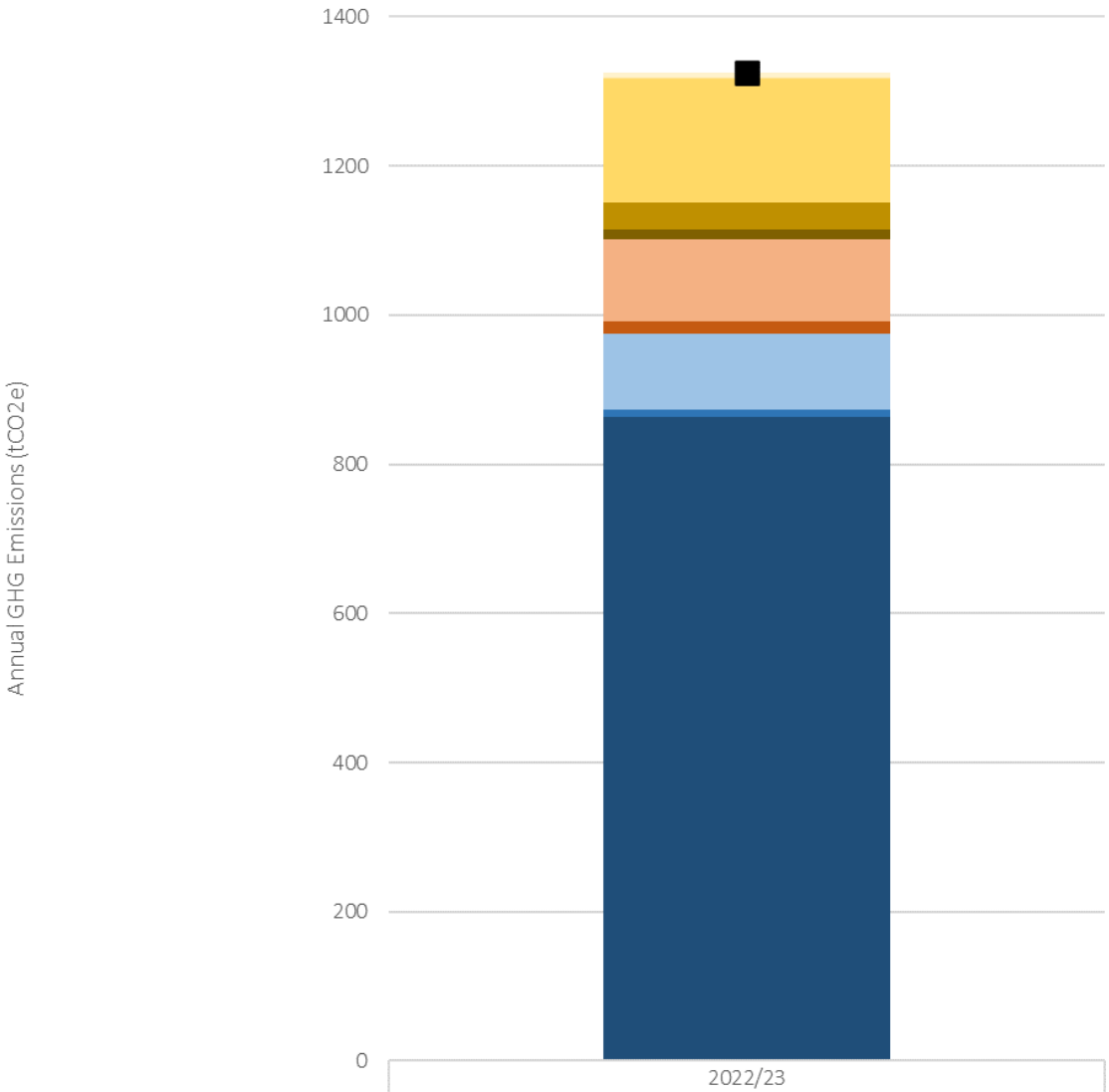


Figure 5: Breakdown of emissions by headline alternative categories



	2022/23
4.4 Module D' construction offsets	0
4.3 Purchased voluntary offsets	0
4.2 Land management	0
4.1 Exported renewable energy	0
3.5 Work at Home energy use	8
3.4 Own Waste	1
3.3 Procurement (general)	166
3.2 Transport	37
3.1 Own Premises	13
2.5 End of Life	0
2.4 Refrigerants	0
2.3 Operational Energy	110
2.2 Maintenance	17
2.1 Construction	0
1.5 End of Life	0
1.4 Refrigerants	0
1.3 Operational Energy	102
1.2 Maintenance	9
1.1 Construction	863
GRAND TOTAL (net)	1326

Figure 6: Breakdown of emissions by detailed alternative categories

6 Projected Emissions

6.1 Approach

An exercise was undertaken to project emissions annually to the 2030/31 year based on best estimates for Treveth's activities over the period, combined with wider assumptions regarding technology and decarbonisation. The following sections outline the assumptions made within each alternative category.

6.1.1 Domestic Buildings

Treveth's development pipeline was provided which sees 1,088 dwellings completed up to the 2027/28 year. No further dwellings were assumed to be completed beyond this for modelling purposes, though it is likely that Treveth will continue to construct homes to the end of the period and beyond.

A lifecycle analysis was undertaken for a standard design of a dwelling by a consultant to Treveth. This estimated that emissions from the product stage (modules A1 to A3) were 28.0 tCO_2e, transport to site (A4) were 0.5 tCO_2e, and site operations (A5) 5.6 tCO_2e. Estimates for the use phase (Module B) and end of life stage (Module C) were also provided, but these were not used as an alternative method was used for operational energy use, maintenance and demolition. Module D emissions (beyond lifecycle stage) were estimated at -23.8 tCO_2e per dwelling due to the proportion of timber used within the buildings, and these were used within the offsetting section. The emissions from all Module A sections were applied to the completion projections to estimate total emissions for each year.

The emissions in 2022/23 included dwelling construction emissions from bought goods and services from the 'Development' budget account. The same amount of spend was assumed through the period, but the emission factors were adjusted with all emissions from goods adjusted based on the UK's projected change in emissions [20] from the Industry sector (indexed to 2022), with emissions from services adjusted to the Buildings sector (indexed to 2022).

Emissions from maintenance were estimated based on the same method used for the 2022/23 period, but with emission factors adjusted by the projected changes to national Industry and Buildings emissions as described in the previous paragraph. The resultant maintenance emissions per dwelling were multiplied by the number of homes in Treveth's portfolio accounting for any new completions.

Operational emissions were comprised of the existing dwellings (with gas boilers) and any new dwellings which were all heated with ASHPs. Operational energy use for a new dwelling was based on a sample EPC for a property in Trefula Road, Redruth which had total electricity use of 4,753 kWh. Electricity emission factors were assumed to reduce due to a decarbonising grid as published in the Government Green Book [21] (Well to Tank emissions were held constant). Emissions from refrigerant leakage were estimated based on each ASHP having 1.35 kg of R32 refrigerant and an assumed annual leakage rate of 6% (from Annex C of [6]).

6.1.2 Non-Domestic Buildings

A small amount of known development is projected over the period, with Dundance Lane and Normandy Way assumed to be completed in 2023/24, and Lucknow Road in 2024/25. Emissions from construction were based on an assumed 600 $kgCO_2e/m^2$ (Modules A1 to A5) which is a C rating from the LETI design guide. This benchmark was applied to the floor areas of the developments.

Maintenance was estimated in the same way as for the 2022/23 year and adjusted in the same way as described in the Domestic Buildings section. Operational emissions were assumed to be based on the same amount of energy consumption, with the three new developments assumed to use energy at the

same rate as the existing development. It was assumed that there were no refrigerants, and that there was no disposal and therefore end of life emissions over the period.

6.1.3 Own Operations

Treveth's occupation of a small part of Pydar House in Truro was assumed to stay the same over the period (which represents a very small proportion of overall emissions). Regarding transport, the main source of emissions was from commuting. The number of staff was assumed to increase from current levels to about 50 by 2025/26, and then held at this level. The commuting patterns (mode, distance, frequency) were kept the same, though an adjustment was made for cars to account for the increasing penetration of electric vehicles into the overall fleet mix. Emissions from all other transport (grey fleet, public transport) were kept constant as these were a very small proportion of overall emissions. Emissions from spend on goods and services (the 'Holdings' account) were projected based on an assumed same level of spend, with emission factors adjusted by the projected national Industry and Buildings sector emissions as described in the Domestic Buildings section.

6.1.4 Offsetting

Sequestered carbon from all 'Module D' emissions from the standard design of a Treveth dwelling were multiplied by the completion trajectories to establish offset emissions for a given year. These were reported separately and the resultant net emissions as distinct from the total gross emissions. Within the period to 2030/31 there are no demolitions and so this Module D carbon would still be removed from the atmosphere. Planned demolition would not be for decades later, at which point it may be possible that the release of the carbon to the atmosphere will be prevented due to technological improvements (though this cannot be guaranteed).

No other offsetting was assumed in the modelled scenario.

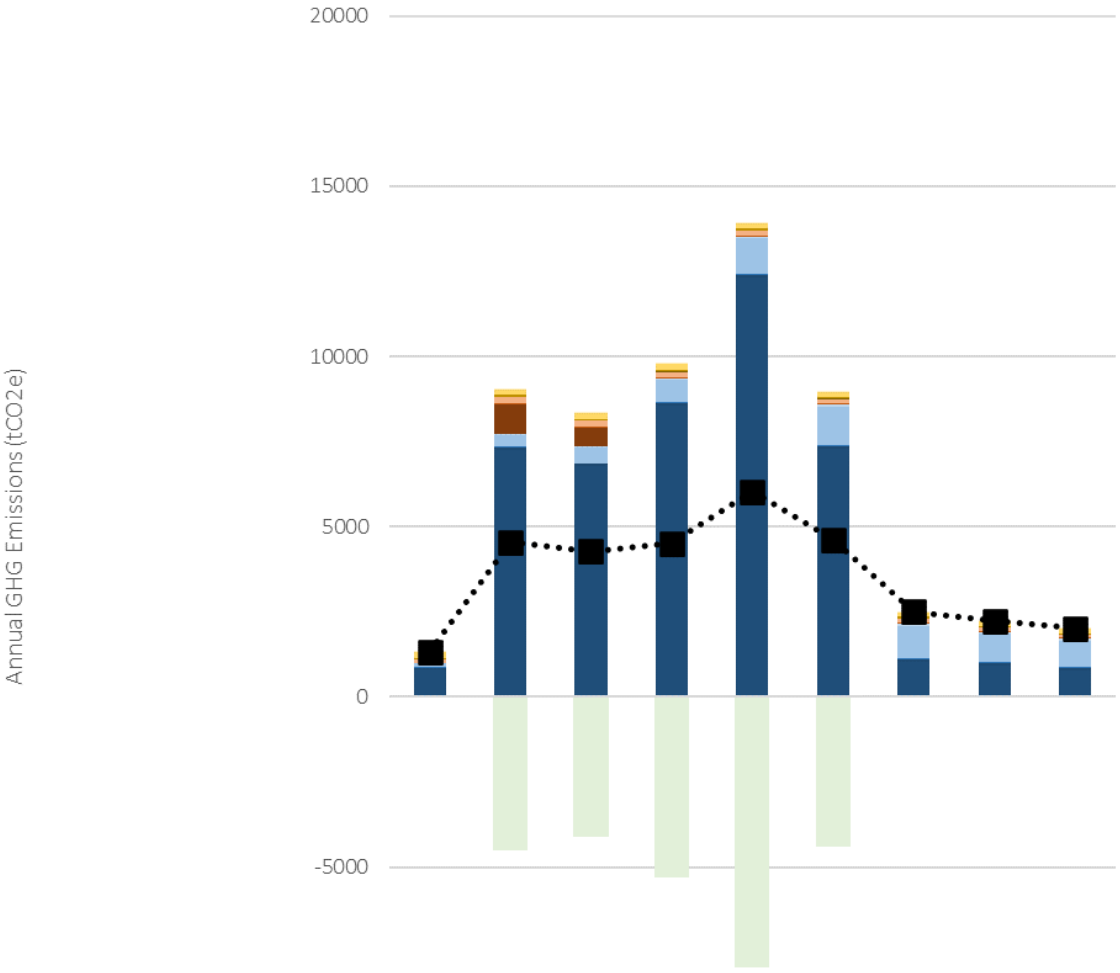
6.2 Results and Discussion

Projected emissions by alternative category are shown in Figure 7. Emissions are lowest in the previously measured 2022/23 year. After this, for a period of 5 years the construction of new dwellings results in significantly higher emissions. This is mitigated to some extent (though not fully) by the offset 'Module D' emissions associated with each dwelling. The final three years of the period do not assume any construction and so emissions return to lower levels. These are higher than the 2022/23 emissions as there are more dwellings and so operational emissions are higher, though there has also been some reduction due to decarbonisation of electricity supply, increased use of electric vehicles, and assumed carbon intensity of purchased goods and services.

Projected emissions by EN 14064-1 category are shown Figure 8. The same pattern can clearly be seen, with almost all emissions over the period being Scope 3.

Cumulative emissions over the 2022/23 to 2030/21 period are shown in Figure 9. Total emissions are approximately 58,000 tCO_2e, whilst offsets (from 'Module D') are 26,000 tCO_2e (i.e., 45% of source emissions). Of the source emissions, construction of dwellings makes up 79.62% and operational energy a further 10.81%, which is almost all from electricity use and 1.13% from maintenance and refrigerant leaks. Emissions from non-domestic buildings make up only 5.01%, whilst own operations are a further 3.43%.

This suggests that the main opportunities for reducing emissions over the period involve focussing on the design of the dwellings to both avoid emissions through site selection, design, material choice, and use of fuel in construction, as well as increasing the amount of 'Module D' offset by as much as possible.



	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
4.4 Module D' construction offsets	0	-4487	-4075	-5276	-7899	-4362	0	0	0
4.3 Purchased voluntary offsets	0	0	0	0	0	0	0	0	0
4.2 Land management	0	0	0	0	0	0	0	0	0
4.1 Exported renewable energy	0	0	0	0	0	0	0	0	0
3.5 Work at Home energy use	8	10	12	13	13	13	12	12	11
3.4 Own Waste	1	1	1	1	1	1	1	1	1
3.3 Procurement (general)	166	170	166	161	152	145	138	131	122
3.2 Transport	37	47	53	56	53	50	47	43	38
3.1 Own Premises	13	13	12	12	12	11	11	10	10
2.5 End of Life	0	1	0	0	0	0	0	0	0
2.4 Refrigerants	0	0	0	0	0	0	0	0	0
2.3 Operational Energy	110	172	161	152	156	142	119	101	94
2.2 Maintenance	17	29	38	32	31	30	28	27	25
2.1 Construction	0	894	557	0	0	0	0	0	0
1.5 End of Life	0	0	0	0	0	0	0	0	0
1.4 Refrigerants	0	10	20	32	50	59	59	59	59
1.3 Operational Energy	102	350	476	677	1034	1118	945	816	767
1.2 Maintenance	9	11	21	30	45	51	49	47	44
1.1 Construction	863	7336	6837	8615	12382	7352	1093	985	839
GRAND TOTAL (net)	1326	4556	4278	4505	6030	4611	2502	2232	2012

Figure 7: Projected emissions by detailed alternative categories

	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Offset Carbon	0	-4487	-4075	-5276	-7899	-4362	0	0	0
Other indirect emissions not included in the other 22 categories	0	0	0	0	0	0	0	0	0
Employee commuting	32	42	48	51	49	46	43	40	37
Downstream leased assets	0	0	0	0	0	0	0	0	0
Downstream franchises	0	0	0	0	0	0	0	0	0
End of life of the product	0	0	0	0	0	0	0	0	0
Use stage of the product	0	0	0	0	0	0	0	0	0
Downstream transport and distribution	0	0	0	0	0	0	0	0	0
Client and visitor transport	0	0	0	0	0	0	0	0	0
Investments	0	0	0	0	0	0	0	0	0
Upstream leased assets	10	10	9	9	9	9	8	8	8
Business travel	6	6	7	7	7	7	6	6	5
Upstream transport and distribuUpstream transport and distribution tion	0	97	88	114	171	95	0	0	0
Waste generated from organisational activities	1	2	1	1	1	1	1	1	1
Capital equipment	0	6136	5317	6164	9227	5095	0	0	0
Purchased products	1055	2207	2212	2560	3212	2388	1308	1189	1030
Energy-related activities not included in direct emissions and energy indirect emissions	58	135	200	273	381	441	442	443	444
Indirect emissions from consumed energy imported through a physical network	0	0	0	0	0	0	0	0	0
Indirect emissions from imported electricity consumed	114	348	400	520	773	782	584	435	377
Direct emissions and removals from Land Use, Land Use Change and Forestry (LULUCF)	0	0	0	0	0	0	0	0	0
Direct fugitive emissions	0	10	20	32	50	59	59	59	59
Direct process related emissions	0	0	0	0	0	0	0	0	0
Direct emissions from mobile combustion	0	0	0	0	0	0	0	0	0
Direct emissions from stationary combustion	49	49	49	49	49	49	49	49	49
GRAND TOTAL (net)	1326	4556	4278	4505	6030	4611	2502	2232	2012

Figure 8: Projected emissions by detailed sub-category from ISO 14064-1

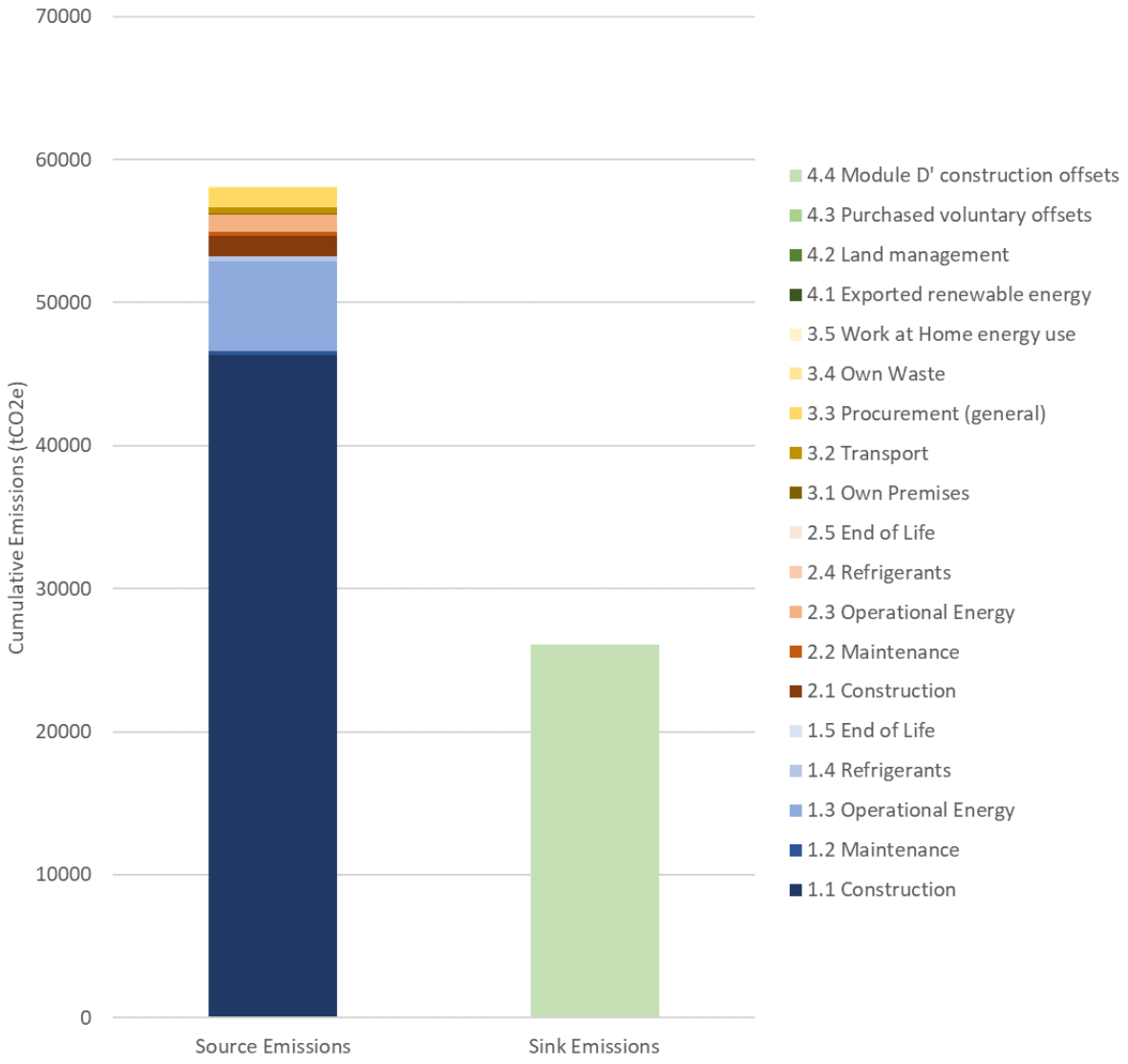


Figure 9: Cumulative emissions 2022/23 to 2030/31 by detailed alternative category for Sources and Sinks

References

[1] British Standards Institute, BS EN ISO 14064-1: Greenhouse Gases - Part 1: Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals, 2019.

[2] ISO-International Organization for Standardization, ISO/TR 14069:2013. Greenhouse gases-Quantification and reporting of greenhouse gas emissions for organizations. Guidance for the application of ISO 14064-1., 2013. (2013).

[3] World Business Council for Sustainable Development (WBCSD), World Resources Institute (WRI), A Corporate Accounting and Reporting Standard, Greenh. Gas Protoc. (2004) 1–116. https://doi.org/10.1196/annals.1439.003.

[4] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), Corporate Value Chain (Scope 3) Accounting and Reporting Standard: Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, 2011.

[5] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), Technical Guidance for Calculating Scope 3 Emissions: Supplement to the Corporate Value Chain (Scope 3) Accounting & Reporting Standard, 2013.

[6] H. Government, Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance, 2019.

[7] British Standards Institute, PAS 2060:2010 - Specification for the demonstration of carbon neutrality, (2014).

[8] HM Government, GHG Conversion Factors for Company Reporting, (2022).

[9] BEIS, Gas and electricity prices in the non-domestic sector, (n.d.). https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector.

[10] CIBSE, TM46 Energy benchmarks, 2008.

[11] CIBSE, TM41 Degree days: Theory and application, (2006).

[12] BS EN ISO 14067 : 2018 BSI Standards Publication Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quanti f ication, (2018).

[13] EN ISO 14025, Environmental labels and declarations - Type III environmental declarations - Principles and procedures, Eur. Stand. 2006 (2006) 25.

[14] GHG Protocol: Life Cycle Databases, (n.d.). https://ghgprotocol.org/life-cycle-databases.

[15] UK Government, UK and England's carbon footprint to 2019, (n.d.). https://www.gov.uk/government/statistics/uks-carbon-footprint.

[16] LETI Embodied Carbon Primer: Supplementary guidance to the Climate Emergency Design Guide, 2020.

[17] L. Hamot, C. Baganal George, CIBSE TM65: Embodied carbon in building services : a calculation methodology, 2021.

[18] Cundall, Information Paper 6: CO2e emissions due to office waste, 2013.

[19] Department for Transport, National Travel Survey, (n.d.). https://www.gov.uk/government/collections/national-travel-survey-statistics.

[20] Climate Change Committee, 2023 Progress Report to Parliament, 2023.

[21] DESNZ, Valuation of energy use and greenhouse gas (GHG) emissions: Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government, 2023.