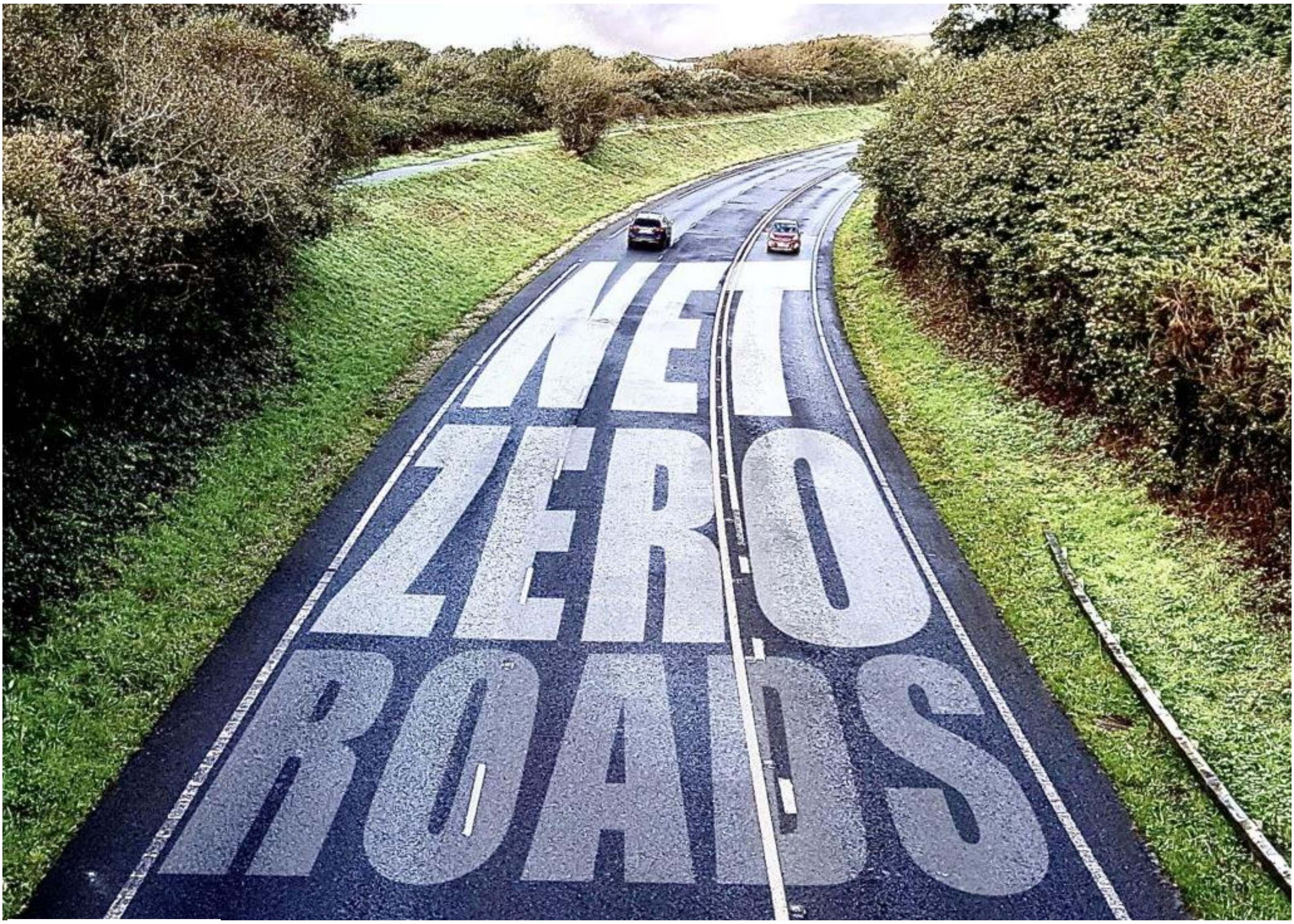
Wessex Live Labs 2

Carbon Baseline Report

November 2024



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1. Introduction

The Wessex Live Lab is a three-year project funded by the UK Department for Transport (DfT) as part of the wider Live Labs 2 programme for decarbonising local roads, run by the Association of Directors of Environment, Economy, Planning, & Transport (ADEPT). The project is a collaborative partnership between three local authorities - Cornwall Council (CC), Hampshire County Council (HCC), and Somerset Council (SC) - along with their contractors and project partner organisations. Sitting within the wider Corridor & Place-Based Decarbonisation Thematic Group alongside Devon County Council and Liverpool City Council, the Wessex Live Lab focuses on decarbonising highways maintenance activities across nine 'Net Zero Corridors' (**Figure 1**).

The diversity of these corridors - in terms of geographical characteristics, contracting models, and proximity to material resources - reflects the variety of approaches to highways maintenance across the three Local Authorities, allowing findings at corridor level to be scaled up to network level and *vice versa*. The total combined length of the three authority's networks is approximately 22,800km, representing 6% of Britain's local highway network. As Cornwall, Hampshire, and Somerset are all large, predominantly rural counties, maintenance activities on their highway networks are likely to reflect those in other Local Authorities with similar characteristics.

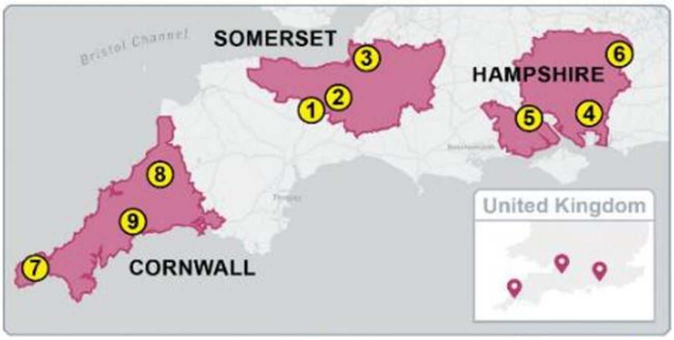

Figure 1. Location of the three Local Authorities and the nine 'Net Zero Corridors'.

The first phase of the project in Year 1 focused on creating a full-service carbon baseline for each Local Authority (LA), which quantified the CO_2e[1] emissions attributable the whole of the Highways maintenance service over a single year under 'business-as-usual' (BAU) conditions. This included the LA themselves; their Tier 1 contractor (Cormac for Cornwall, and Milestone Infrastructure for Hampshire and Somerset); and, where applicable, their main Tier 2 subcontractor (OCL Regeneration for Hampshire, and Wainwright for Somerset). The second phase of the project in Year 2 draws the focus down to corridor level, starting with the creation of a carbon baseline for each corridor, which will include a carbon profile for every cyclical, reactive, and planned Highways maintenance activity occurring on a given corridor.

This report illustrates our carbon baselining journey to date, including an exploration of our methodology, results & key findings from the three full-service baselines, as well as a case study of our first corridor baseline: the A30 Hook-Surrey corridor in Hampshire (see corridor 6 in **Figure 1.**). Caveats and limitations of our approach are also discussed, along with key challenges, opportunities, lessons, learned, and a summary of our next steps. To ensure that the process remains as meaningful as possible to the Highways sector as a whole, carbon baselining and accounting is viewed as a dynamic exercise, and therefore all data presented in this report remains subject to change based on new data and knowledge which may become available during the course of the project.

[1] Carbon dioxide equivalent (CO_2e) is a measure of the total amount of greenhouse gases (CO_2, CH_4, N_2O, F-gases, and SF_6) emitted by a given item or process, weighted by their global warming potential relative to one unit of CO_2. The term 'carbon emissions' is colloquially used to refer to CO_2e.

2. Delivery of Strategic Outline Business Case (SOBC) commitments

2.1. Completion of full-service carbon baselines

"During mobilisation we will identify the current carbon baseline... for the complete year before the start of work on the Corridors and include all works that will be in scope of our Live Labs project."

Net Zero Corridors Outline Business Case, Page 44

A full-service carbon baseline has been identified for each of three local authorities for the complete baseline year. Carbon baselining was carried out by Colas, with strategic support and resource development by the Future Highways Research Group (FHRG / Proving Services). As set out in the SOBC, this has been calculated in accordance with the FHRG CCAS guidance, and includes emissions created by construction, routine maintenance, reactive maintenance, cyclical maintenance, winter maintenance, operations, and disposal.

No changes were made to this scope: whilst the decision was made to exclude street lighting because it was not part of any LA's primary Highways Maintenance contract, the inclusion of street lighting was never mentioned in the SOBC. Carbon emissions from general road users were explicitly excluded, as the SOBC stated that "tailpipe emissions of vehicles using the corridor will be outside the scope of this project."

2.2. Corridor baselining

"During mobilisation, a Year 1 carbon baseline will be identified for each corridor in the trials... As the corridors will each include a planned maintenance scheme over the three years, we will ensure a baseline for this activity is captured to enable like-for-like comparison."

Net Zero Corridors Outline Business Case, Pages 42-44

The calculation of carbon baselines for the corridors actually began in Year 2, due to the prioritisation of the full-service baselines in Year 1, which took longer to complete than anticipated in the SOBC. At the time of writing this report, only the A30 Hook-Surrey corridor in Hampshire has been completed, and the carbon baselining process is underway for the A391 St. Austell NEDR in Cornwall and the A38 Taunton-Devon corridor in Somerset (see corridors 9 and 1 in **Figure 1.**). Whilst most of the corridors include multiple planned maintenance schemes, no major schemes have yet been planned for the Green Pastures corridor in Cornwall. The B2150 Denmead-Droxford corridor in Hampshire is being extended along the A32 to include a planned scheme in West Meon, whilst the A38 Taunton-Devon corridor has been extended along the A38 Chelston link road to include planned works on the Chelston interchange.

2.3. Dual approach to carbon reporting

"We will take the dual approach of considering both individual elements (carbon components) and the whole system to drive carbon emissions down and out of the maintenance lifecycle."

Net Zero Corridors Outline Business Case, Page 7

In order to determine which elements of the carbon baseline to prioritise for decarbonisation, we have identified 'carbon hotspots' at the level of individual carbon components within both the full-service and corridor baselines. These are categorised into broader categories (materials, transportation, waste, etc.) to indicate the spread of carbon emissions across the maintenance lifecycle. We are also reporting carbon emissions at activity level on the corridors, and at inventory level within the full-service baseline, to identify where these carbon hotspots sit within the wider Highways maintenance system. Whilst no changes have been made to this commitment, we have yet to determine how the full maintenance lifecycle carbon emissions will be considered over the whole lifespan of the asset.

2.4. Data from Confirm

"We will be supported with data export and import for the Carbon Analyser by the software providers Brightly. This will align data held within the Confirm software system with the FHRG calculator."

Net Zero Corridors Outline Business Case, Page 42

Data exports from the Confirm software system have been provided for the Hampshire and Somerset corridors by the Confirm teams at Brightly, Hampshire County Council, and Somerset Council. It was originally anticipated that these data exports could be imported directly into Carbon Analyser to automatically create activity-level carbon profiles for the corridors. However, the data from Confirm were not suitably formatted nor entered by users in sufficient levels of detail to be imported into Carbon Analyser without intensive pre-processing. Consequently, data from the Confirm outputs have been processed in MS Excel and manually entered into Carbon Analyser for the A30 Hook-Surrey and A38 Taunton-Devon corridors. As Cornwall Council do not use Confirm, data for the reactive works on the A391 St. Austell NEDR were obtained from the defect reporting system RMS.

3. Methodology

The carbon baselining process was carried out in accordance with the Carbon Calculation and Accounting Standard (CCAS) carbon reporting guidance for local highways authorities, developed by the Future Highways Research Group (FHRG). All carbon calculations and accounting were carried out by the project Carbon Analyst using the FHRG Carbon Analyser tool.

3.1. Full-service carbon baselines

A full-service carbon baseline was carried out for each of the three Local Authorities using a top-down carbon accounting approach, whereby resources were assigned at the local authority level to four inventories: Premises & Sites, Staff & Contractors, Vehicles & Plant, and Products & Services (**Figure 2.**). The financial year April 2022 – March 2023 was selected as the baseline year, being the year for which the most recent and complete datasets were available, as well as avoiding any potentially anomalous influence of the COVID-19 lockdowns on the highways maintenance service.

	Premises & Sites	Staff & Contractors	Vehicles & Plant	Purchased Products & Services
What data was collected?	• Electricity usage • Gas usage • Water usage	• No. of home working & commuting days • Commuting mode, distance, & fuel type • Annual business miles	• Vehicle & plant functions and fuel types • Vehicle mileages • Plant fuel consumption	• Purchased materials & goods • Waste management services • 3rd-party transportation • Other 3rd-party services
How was the data collected?	• Meter readings supplied for each depot / site	• Staff commute survey • Business mileage claims obtained from HR	• Fleet list provided with fuel types / VRNs and mileages. • Bulk fuel consumption (plant & some vehicles).	• List of products & services purchased • Names of suppliers • Quantities in physical units or £
From whom was the data collected?	• Local Authorities • Tier 1 contractors	• Local Authorities • Tier 1 contractors	• Local Authorities • Tier 1 contractors • Tier 2 subcontractors	• Local Authorities • Tier 1 contractors • Tier 2 subcontractors

Figure 2. Data collection methods for each of the four carbon inventories.

A data collection proforma template produced by the FHRG was sent to each LA and their Tier 1 contractors (Cormac for Cornwall Council; Milestone Infrastructure for Hampshire County Council and Somerset Council), as well as Wainwright, Milestone's Tier 2 subcontractor for Somerset. The majority of the data provided for the carbon baselines in Hampshire and Somerset was either entered directly into this template or provided in a similar format. In contrast, the data for Cornwall primarily came from an existing carbon baseline for 2022-23 which was calculated by Cormac and audited by a third party.

The functions and organisational units included within the scope of the baseline were based upon the teams responsible for highways maintenance activities in each LA. Street lighting was explicitly excluded at the beginning of the carbon baselining process, as each LA contracted out street lighting maintenance separately to the main Highways contract.

Where possible and appropriate, the FHRG-recommended carbon factors were selected in Carbon Analyser, unless sufficient detail was provided to select a more specific carbon factor. Outputs from Carbon Analyser can be found in **Appendix A.** which has been provided alongside this report.

3.1.1. Premises & Sites

Electricity, gas, and water consumption figures were obtained for each of the contractors' highways depots in each LA. Where meter readings or bills were not available for the full baseline year, any available data were extrapolated to twelve months. For the Council headquarters in Hampshire

(Trafalgar House) and Somerset (County Hall), data were not available for the full baseline year, so the monthly averages from Jan 2021-Nov 2022 and Jul 2022-Jul 2023 were used for Hampshire and Somerset respectively. Water consumption for Trafalgar House and County Hall was estimated based on the number of staff and the per-capita water consumption in the depots. The share of emissions allocated to the Highways service for each LA headquarters was calculated based on the percentage of desks allocated to Highways staff. The Highways service share was 100% for each of the depots, split between the LA and the Tier 1 contractor based on the quantity billed to each organisation.

In Cornwall, the 'dual reporting' method was used for Scope 2 emissions from electricity consumption, as Cormac purchased renewable energy under a Renewable Energy Guarantee of Origin (REGO) tariff with a maximum kWh limit. Under the 'market-based' method, an emissions factor of zero was applied to all electricity consumption covered by the REGO tariff, whilst the emissions factor quoted by the supplier was applied to any electricity consumption exceeding the maximum threshold. Under the 'location-based' method, the BEIS emissions factor for UK National Grid electricity was applied to all electricity consumption. These two values were reported alongside one another, as advised under the Greenhouse Gas Protocol (2015). In addition to Cormac's highways depots and the head office in Scorrier, the Castle An Dinas quarry & asphalt plant and two aggregate recycling sites were also included. Heating oil consumption was also recorded for the quarry and two of the depots. The share of emissions allocated to Cornwall Council's Highways service was 100% for all sites except the quarry, for which energy consumption was allocated based on the proportion of asphalt sales dedicated to the Cornwall Highways contract.

3.1.2. Staff & Contractors

To collect data on the commuting and home working patterns of staff & contractors, a survey was produced and sent out to the relevant teams in each LA. This was initially trialled as a MS Word document with Somerset Council, then developed into a MS Forms survey[2] for Cornwall Council/Cormac and Hampshire County Council. A separate MS Forms survey was sent to Milestone employees on the Hampshire and Somerset highways contracts.

Information provided in the survey included:

- Name / Staff ID (where required, for ease of following up on responses, this was visible only to the LA enabler, who anonymised the data before sharing with the Carbon Analyst).
- Department / Organisational unit
- Home town and assigned work location
- Annual number of days working from home
- Annual number of days commuting to work
- Vehicle ownership (personal, employer-owned, or lift share), plus reg. no. if employer-owned
- Primary commuting mode
- Miles travelled per day to and from work
- Vehicle size class and fuel type, if applicable
- Primary mode of business travel
- Annual business mileage

[2] For MS Forms survey template, see https://forms.office.com/Pages/ShareFormPage.aspx?id=k-ALvq2iTEST2VYm6Dvu_P5hg-8-KYZFg5MruKdL06RUQUZCTkJFUExXNEdFOVc4SVRWQkhQVUlDMC4u&sharetoken=tOf9riFf5bqjjNhNlmNG

Business mileage claims were obtained from the HR department for Cornwall (aggregated by fuel type) and Somerset (assigned to individuals). These were cross-referenced against the survey responses and assigned to individuals where possible. For Hampshire, only business mileage estimates provided by survey respondents were available. Any residual business mileage claims which could not be assigned to an individual survey respondent were transferred to the 'Travel' inventory under Products & Services.

For staff who used an employer-owned vehicle for commuting and/or business travel, this was recorded as a zero value in Staff & Contractors to avoid double counting, as all LA and contractor vehicles were recorded under Vehicles & Plant. Home working days and any travel in a private vehicle or public transport was still recorded for these individuals.

As it was infeasible to obtain a 100% response rate on the surveys (**Figure 3.**), the automatic Extrapolation function in Carbon Analyser was used to approximate the emissions from commuting and home working for the remaining employees who did not respond, based on the average responses for each commuting mode and fuel type.

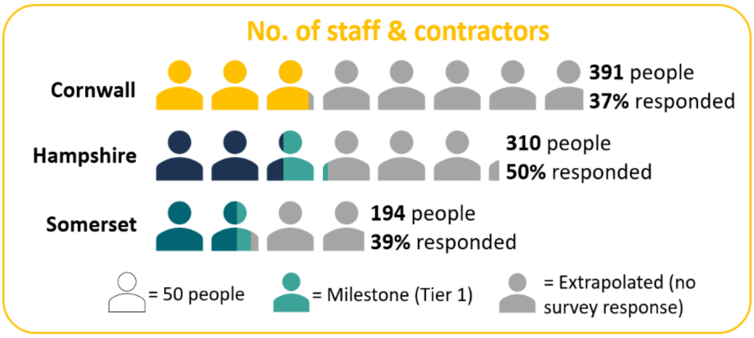

Figure 3. Survey response rates and total staff numbers for each Local Authority.

3.1.3. Vehicles & Plant

Each LA and their Tier 1 contractor was requested to provide the following data on the vehicles allocated to the Highways service, including operational and pool vehicles:

- Registration number
- Vehicle type (car, van, HGV, plant, etc.)[3]
- Fuel type[3]
- Function (e.g. Highways Safety Inspections)
- Gross vehicle weight and/or engine size[3]
- Depot at which the vehicle is based
- Fuel consumption for the baseline year
- If fuel consumption unavailable, mileage for the baseline year.

Where available, fuel consumption (in litres, or kWh for electric vehicles) was used as the unit of measure for carbon calculation. Otherwise, the mileage was used, with the carbon factor selected on the basis of vehicle size (engine size for cars, or gross vehicle weight for vans and HGVs), in accordance with the vehicle size categories specified by DESNZ & DEFRA.[4] Inspection vehicle mileages for Somerset Council were provided separately by the Inspection Manager. Where no records of vehicle mileages were available for the baseline year, this was inferred from the difference in odometer readings between the closest MOTs to the start and end of the baseline year.[5] For plant items, the bulk fuel consumption for all plant using each fuel type was provided by the contractor.

[3] Where this was unavailable, this was determined by searching the registration number database at https://vehicleenquiry.service.gov.uk/.
[4] See https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
[5] See https://motorscan.co.uk/ for odometer readings for a given registration number at each MOT.

3.1.4. Products & Services

This inventory included any Scope 3 products and services purchased by the LA, their Tier 1 contractor, and/or (where applicable) their main Tier 2 subcontractor. For Somerset Council, values provided by the Tier 2 subcontractor Wainwright were removed from Milestone's submission to avoid double counting. The data submitted for each LA is presented in **Table 1.** below:

Item	Cornwall	Hampshire	Somerset
Materials	• Material type • Product • Quantity (units) • Tonnage • BEIS carbon factor	• Material type • Supplier • Quantity (units)	• Material type • Supplier • Quantity (units)
Services	• ONS industry type • Net value (£) • ONS carbon intensity per £[6]	• Service • Network or office-based • Provider • No. of person-days	N/A, as main subcontracted service was captured by Wainwright data
3rd-party transport & plant	Included in the above.	• Supplier • Activity type • Fuel spend (£) • Vehicle & fuel type (HCC) • Mileage (HCC)	• Supplier • Activity type • Fuel spend (£) • Vehicle & fuel type • Mileage
Waste management	• Waste type • Tonnage • BEIS carbon factor	• Waste type • Tonnage • Provider • Disposal method	• Waste type • Tonnage • Provider • Disposal method
Business travel	Any mileage claims not attributable to specific Staff & Contractors.	Mileages extrapolated from survey responses.	Any mileage claims not attributable to specific Staff & Contractors.

Table 1. Data provided for the Products & Services inventory by each local authority and their contractors/subcontractors.

Where fuel consumption data were provided in £ spend, this was converted to litres by calculating the average price of diesel in the UK over the financial year 2022-23 (£1.8106 per litre). For efficiency, items of the same type from different suppliers were aggregated into a single item. As no carbon factor was available for warm mix asphalt, this was assumed to be 10% lower than the FHRG-recommended carbon factor for hot mix asphalt ([ICE] Asphalt, General, 4.5% binder content {2023}) based on supplier estimates.

[6] See https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsintensitybyeconomicsectorunitedkingdom

3.2. Corridor carbon baselines

A carbon baseline is being calculated for each of the nine corridors, starting with the A30 Hook-Surrey corridor in Hampshire; the A391 St. Austell North-East Distributor Road (NEDR) in Cornwall; and the A38 Taunton-Devon corridor in Somerset. At the time of writing, only the A30 Hook-Surrey corridor has been completed, so only the results of this scheme baseline will be presented in this report. For the Carbon Analyser outputs for this scheme, see **Appendix B.** which is provided alongside this report.

Each corridor baseline will be broken down into the three main categories of Highways maintenance (cyclical, reactive, and planned works). These categories will in turn be broken down into activity types for cyclical and reactive maintenance, and individual schemes for planned maintenance. To provide a representative baseline for the decarbonised experiments on the corridors whilst also aligning with the full-service baseline, 2022-23 is considered to be the baseline year for cyclical and reactive works (as it is assumed that the scale and frequency of these works will have remained relatively constant over the past three years), whilst the current financial year (2024-25 for the first three corridor baselines) is considered to be the baseline year for planned works.

The methodology below is considered to be a 'deep dive' approach. Due to the time and effort required to carry out a 'deep dive' corridor baseline, it is anticipated that at least two corridor baselines within each LA will be 'deep dives', whilst the remaining corridors may be approximated by extrapolating from the existing corridor baseline data where appropriate.

3.2.1. Cyclical works

The carbon footprint of cyclical maintenance activities was calculated in the Functions & Activities module of Carbon Analyser. This included activities such as the cleansing of signs, bollards, and drainage assets; verge cutting and other vegetation maintenance; and routine inspections of the carriageway, footways, and structural assets. Details of the number, area, or length of assets visited were provided in an Excel spreadsheet, along with the frequency at which these activities were carried out. The distance travelled was assumed to be in an average diesel van (unless otherwise specified, e.g., where a gully tanker was used for drainage cleaning) from the contractor or subcontractor's depot to the furthest point along the corridor where a given asset was present. Emissions from the decomposition of grass cuttings left on the verge or in urban greenspaces were calculated using the carbon and density factors provided by the Greenprint (South Gloucestershire and West Sussex) Live Lab.

3.2.2. Reactive works

The carbon footprint of reactive maintenance activities was calculated in the Functions & Activities module of Carbon Analyser. This included activities such as pothole repairs and patching; ironwork reinstatements; repairs and/or replacement of kerbs, signage, bollards, and other assets; emergency drainage works; reactive vegetation clearance; and any other works which did not fall under the cyclical or planned categories of maintenance.

For Cornwall, data on the defect type, dimensions, repair material, and depot from which the team travelled were provided as a data export from the works management system RMS. For Hampshire and Somerset, a schedule of rates was provided for each activity on the corridors as an output from the works management system Confirm. Where data on material quantities or dimensions were unavailable, an average was taken of the existing data for the same or similar defect types. Missing values for plant fuel consumption were estimated based on market research into the average fuel consumption of specific plant items, as well as data from the CEDR and Liverpool Live Labs. Where the vehicle type and transport distances for travel and transportation were not specified, vehicles were assumed to be an average diesel van or HGV depending on the activity, travelling from the closest of the contractor's depots to the centre of the corridor (if a contractor vehicle) or from the main supplier of a given material to the contractor's depot (if a supplier vehicle).

Certain activities were downscaled from full-service level to corridor level where no information was available from Confirm. For example, emissions from winter maintenance (carriageway gritting) on the corridors were estimated by calculating the length of a given corridor as a percentage of each LA's priority gritting network, then applying this percentage as an adjustment multiplier to the distance driven by the gritters and the quantity of gritting salt purchased at full-service level.

Where specific material products were used, a product-specific carbon factor or third-party-verified Environmental Product Declaration (EPD) was sought from the manufacturer. In cases where this was unavailable, the carbon factor for a similar product was used as a proxy.

3.2.3. Planned works

The carbon footprint of planned maintenance schemes was calculated in the Projects & Configurations module of Carbon Analyser. Currently details on planned works have only been provided for the A30 Hook-Surrey corridor in Hampshire, so this section will focus solely on that corridor.

A bill of quantities (BoQ) was provided by the Project Enabler for two resurfacing schemes – Scheme HR764 on the carriageway south of Haywards Cottage, and Scheme HR749 from Odiham Road to Bracknell Lane in Hartley Wintney. The material quantities required for Scheme HR739 at the junction with Old School Lane/A287 in front of The Hogget pub were estimated based on the planned area and depth of the works, as no BoQ has yet been produced for this scheme, which is due to take place in March 2025. The quantity of asphalt and a list of the plant items used was also provided for three patching schemes, which in this report are coded as Scheme 2 (Newham Road to Station Road roundabout), Scheme 6 (Elvetham Lane), and Scheme 7 (Star Hill). For Schemes 6 and 7, a carbon factor for the specific hot rolled asphalt (HRA) product used was obtained from the supplier; for Scheme 2, the supplier was not known, so the general National Highways carbon factor for HRA was selected from the NICS carbon factor database in Carbon Analyser.

The quantity of fuel consumed by all plant items was estimated based on market research into the average fuel consumption of specific plant items, as well as data from the CEDR and Liverpool Live Labs on the fuel consumption and duration of usage for plant items used for patching and resurfacing. Details on the transportation of materials to site, and the quantity and destination of waste bituminous planings removed from site, were provided by the Project Enabler for HCC. For Scheme HR764, the carbon impacts of setting up and monitoring a diversion route were also quantified by calculating the total distance driven in a traffic management vehicle from the depot to the end of the diversion and back. As tailpipe emissions from other road users were explicitly excluded from the scope of this project, these were not factored into the emissions associated with traffic management.

4. Results & Key Findings

4.1. Full-service carbon baselines

Overall, all three local authorities had a similar pattern of CO_2e emissions across the four carbon inventories at full-service level in 2022-23, with the majority of emissions (62%-94%) coming from Products & Services, followed by a notably smaller proportion (3%-27%) from Vehicles & Plant (**Figure 4**.). At the disaggregated item level, asphalt was the most significant carbon hotspot across all three local authorities, accounting for approx. 16%-34% of total emissions for each authority.

However, Cornwall had notably higher emissions from Premises & Sites (1,354.7 tonnes CO_2e) and lower emissions from Products & Services (9,621.3 tonnes CO_2e) than the other two local authorities, as a large proportion of their asphalt was manufactured in-house at Cormac's Castle An Dinas quarry & asphalt plant, rather than being purchased from a third-party supplier. Emissions from Vehicles & Plant were also higher in Cornwall, as the total number of vehicles was much larger (over 600, compared to approximately 130-180 for Hampshire and Somerset).

The difference in the total quantity of CO_2e emissions reflects the difference in the length of the Highways network managed by each LA. Somerset, with the smallest network of approx. 6,600km, had the smallest carbon footprint at 12,457.5 tonnes CO_2e; conversely, Hampshire had both the largest network at 8,701km of carriageway, and the largest carbon footprint at 22,415.5 tonnes CO_2e. Normalised to the length of the Highways network in each LA, this equates to an average of approximately 2.1 tCO_2e/km for Cornwall; 2.6 tCO_2e/km for Hampshire; and 1.9 tCO_2e/km for Somerset.

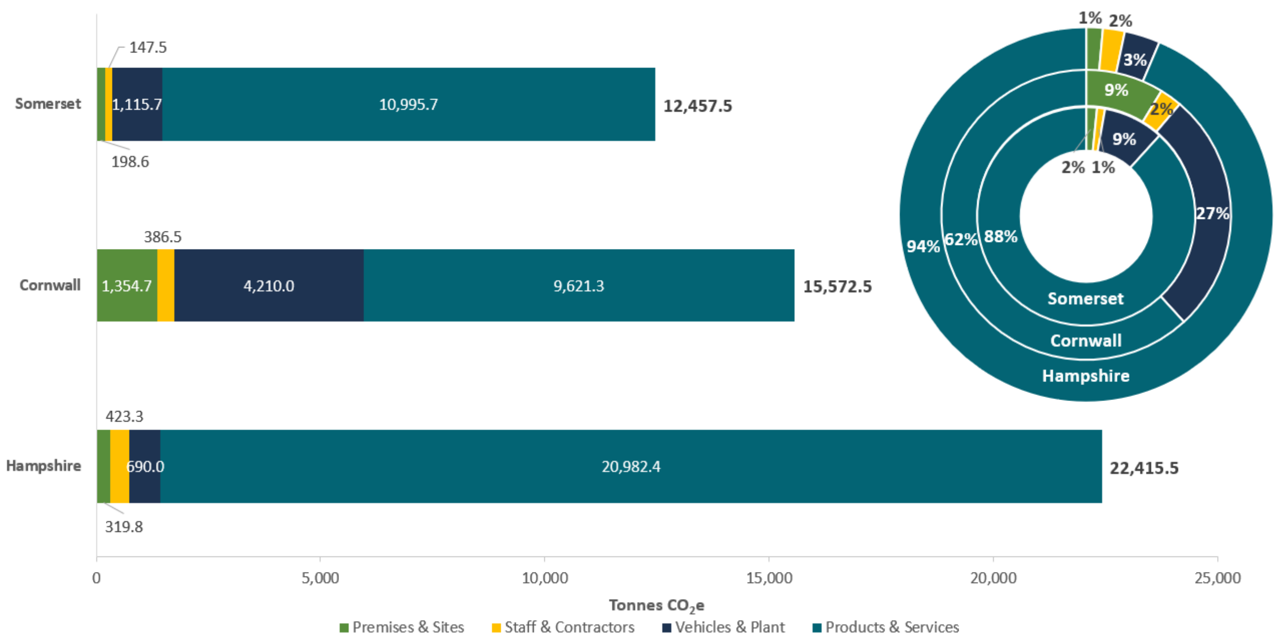

Figure 4. Comparison between the full-service carbon baselines for the each of the three local authorities, broken down by CCAS carbon inventory module.

4.1.1. Cornwall

In total, Cornwall Council's highway maintenance service emitted around 15,572.5 – 16,105.2 tonnes CO_2e (**Figure 5.**) – roughly equal to 9,505-9,830 one-way flights from London to New York.[7] Products & Services accounted for a significant 60-62% of total emissions, with Vehicles & Plant representing 26-27%, Premises & Sites contributing 9-12%, and Staff & Contractors making up the remaining 2%.

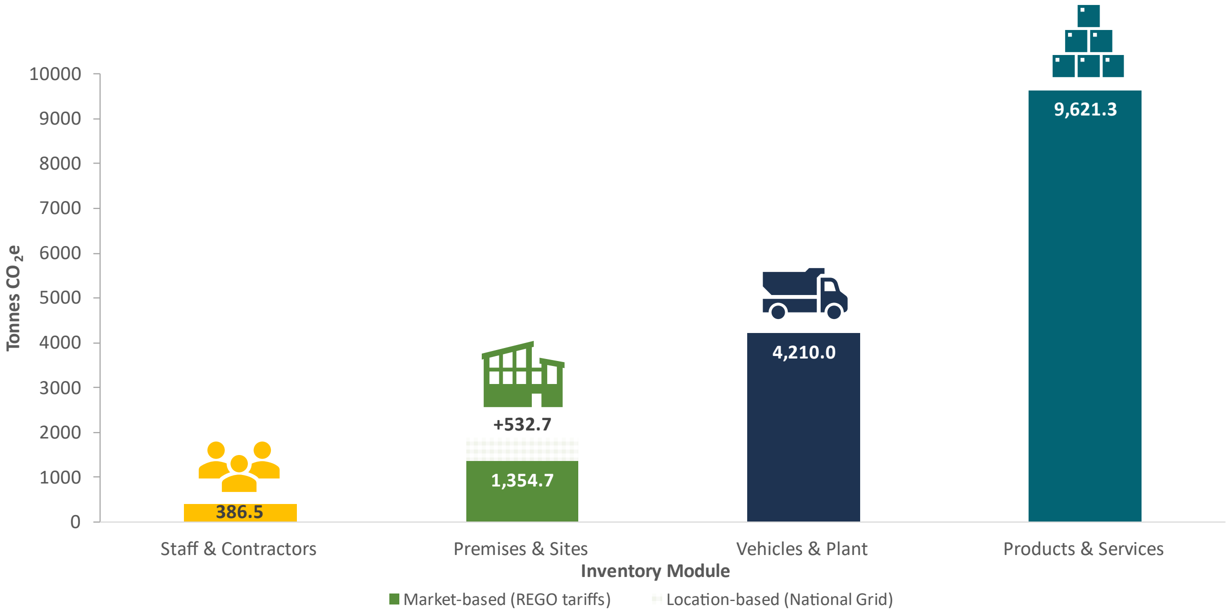

Figure 5. Full-service carbon baseline data for CC.

The range in total emissions arises due to the use of different methods of electricity consumption accounting. The market-based method (**Figure 6.**). uses the emission factor from the supplier's website for electricity consumption in excess of the renewable energy guarantees of origin (REGO) tariff threshold, whereas the location-based method (**Figure 7.**) uses the National Grid emission factor for the total electricity consumption.

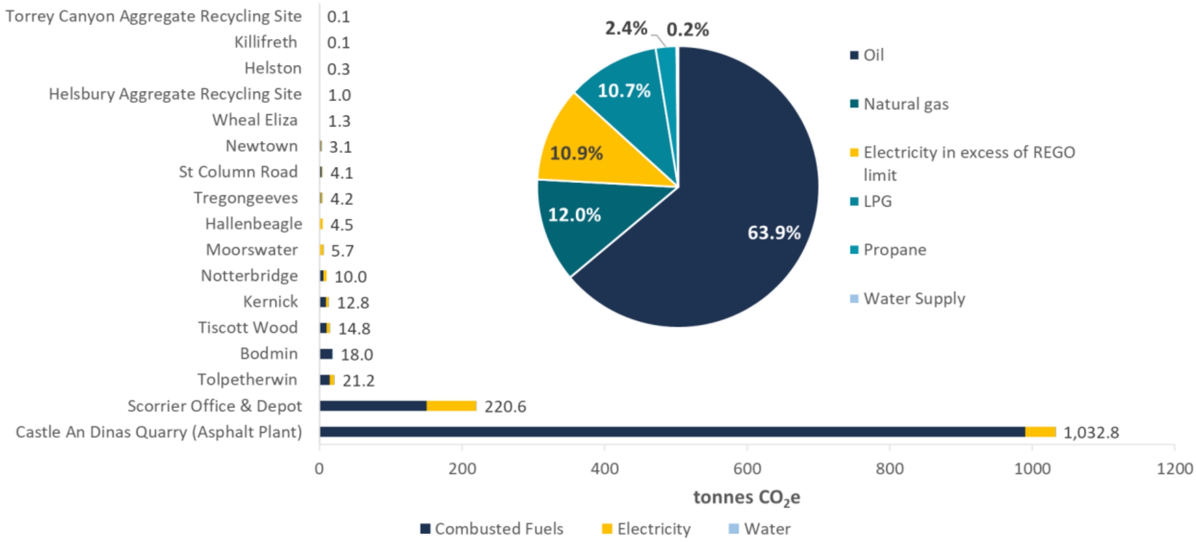

Figure 6. Breakdown of CO_2e emissions from Premises & Sites using the market-based method for CC.

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[7] Assuming distance from Gatwick to JFK airport is approximately 5583.74 miles, using 2024 DESNZ/DEFRA carbon factor for a long-haul flight for an average passenger.

Following the market-based method, electricity contributes 10.9% to the Premises & Sites inventory, putting it at a similar level to natural gas and LPG combined. The Castle An Dinas quarry leads emissions at 76%, followed by the Scorrier office and depot at 16%. Together, these two sites have a major contribution to the total Premises & Sites emissions, with the remaining 15 depots collectively contributing only 8% (**Figure 6.**).

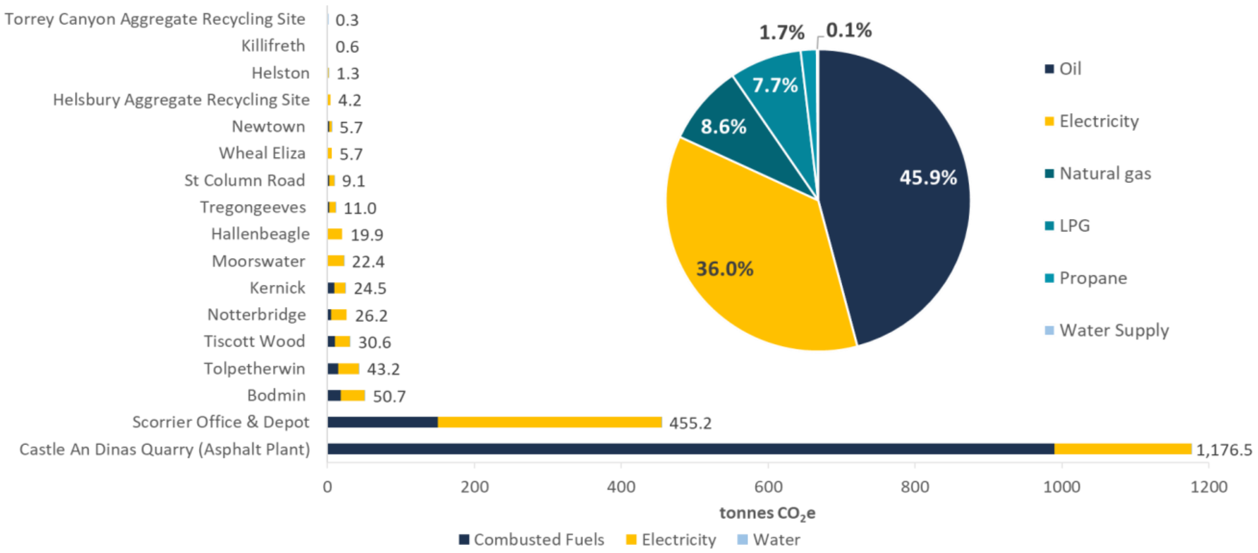

Figure 7. Breakdown of CO_2e emissions from Premises & Sites using the location-based method for CC.

When using the location-based method to calculate electricity emissions, electricity represents a more substantial share of emissions from Premises & Sites, with values comparable to those of oil. The Castle An Dinas quarry contributes 62%, while the Scorrier office and depot now account for 24%. The remaining sites collectively make up 14%, with changes in the order of emissions among these locations (**Figure 7.**).

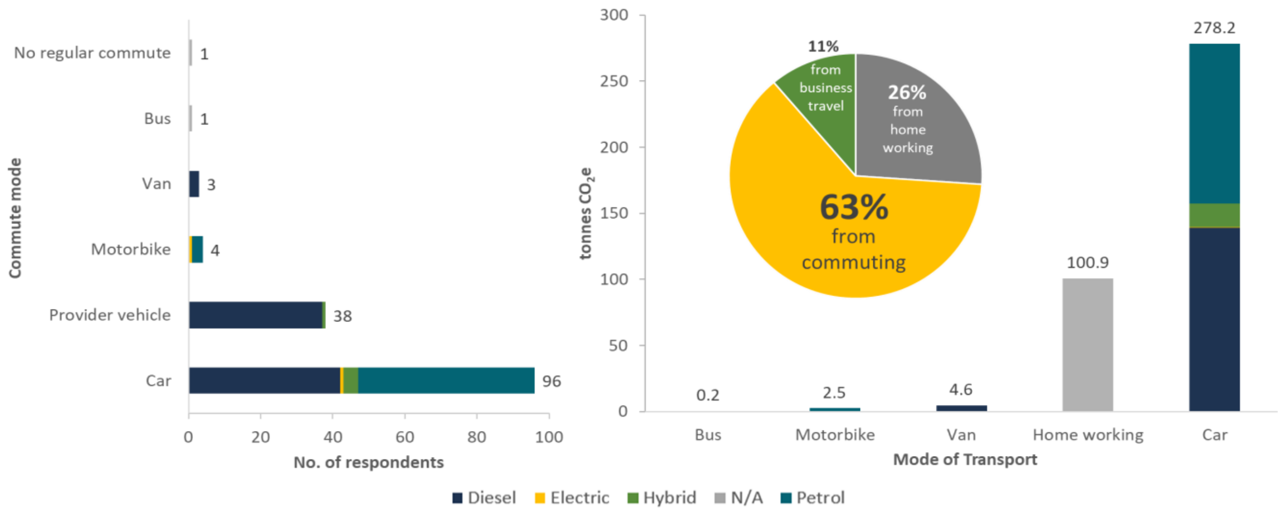

Figure 8. Breakdown of CO_2e emissions from Staff & Contractors for CC.

A total of 386.5 tonnes of CO_2e were associated with the inventory of Staff & Contractors. Of this amount, commuting represented the largest share at 63%, followed by home working at 26%, and business travel making up the remaining 11% (**Figure 8.**). This data was collected through the staff travel survey, with a response rate of 37%, which was then extrapolated to the entire staff population. Notably, 67% of respondents reported using their own cars for commuting to work.

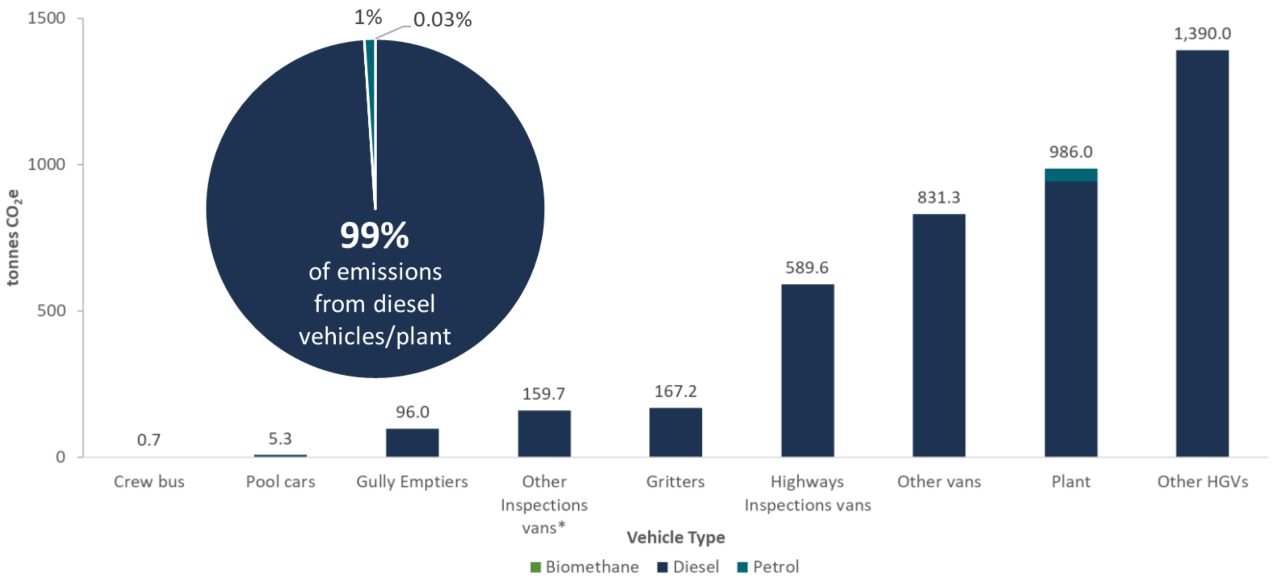

Figure 9. Breakdown of CO_2e emissions from Vehicles & Plant for CC.

Vehicles & Plant produced 4,210 tonnes of CO2e, with diesel accounting for an overwhelming 99% of this total, and petrol for almost all of the remaining 1%, with just 0.03% of emissions resulting from biomethane usage (**Figure 9.**). Electric cars charged onsite are covered by the electricity consumption recorded in Premises & Sites. “Other Inspections vans” include vans used for environment inspections, facilities inspections (50% allocated to highways), and health and safety inspections.

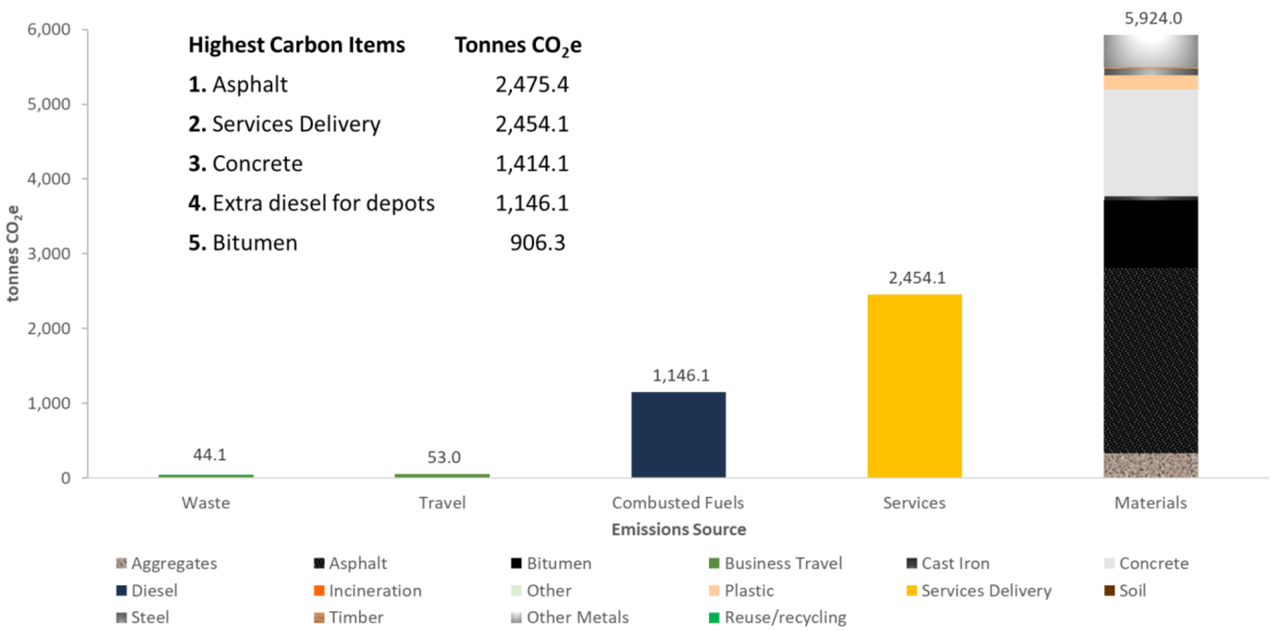

Figure 10. Breakdown of CO_2e emissions from Products & Services for CC.

The Products & Services inventory generated a total of 9,621.3 tonnes of CO_2e. Among these, materials were the largest contributor, responsible for 62%, followed by services at 26% and combusted fuels at 12% (**Figure 10.**). The highest carbon-emitting items included asphalt, concrete, diesel and bitumen, highlighting the need for targeted strategies to reduce emissions across these materials.

4.1.2. Hampshire

Overall, approximately 22,415.4 tonnes CO_2e were attributable to Hampshire County Council's highways maintenance service – roughly equivalent to 13,682 one-way flights from London to New York. 96% of this was attributable to the Tier 1 contractor (Milestone), 97% of which came from the Products & Services inventory; of the remaining 4% of emissions directly attributable to HCC, 48% came from the Staff & Contractors inventory. Overall, the majority (94%) of emissions came from the Products & Services inventory, at 20,982.4 tonnes CO_2e (**Figure 11.**)

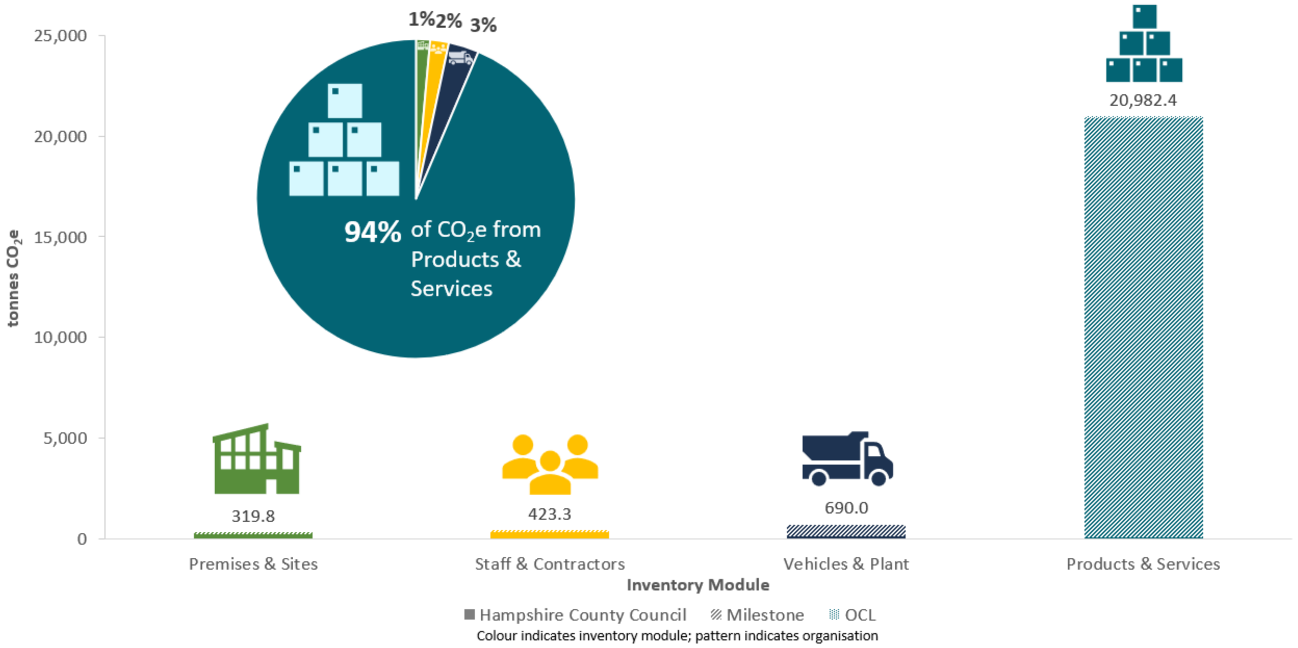

Figure 11. Full-service carbon baseline data for HCC.

1% (319.8 tonnes) of CO_2e emissions came from Premises & Sites. 53% (169.5 tonnes) of this came from the two depots (Totton and Petersfield) using natural gas, which itself contributed to 12% of emissions in this inventory. However, the majority (87%) of emissions in Premises & Sites came from electricity consumption, as this was the only energy source used at all seven sites (**Figure 12.**).

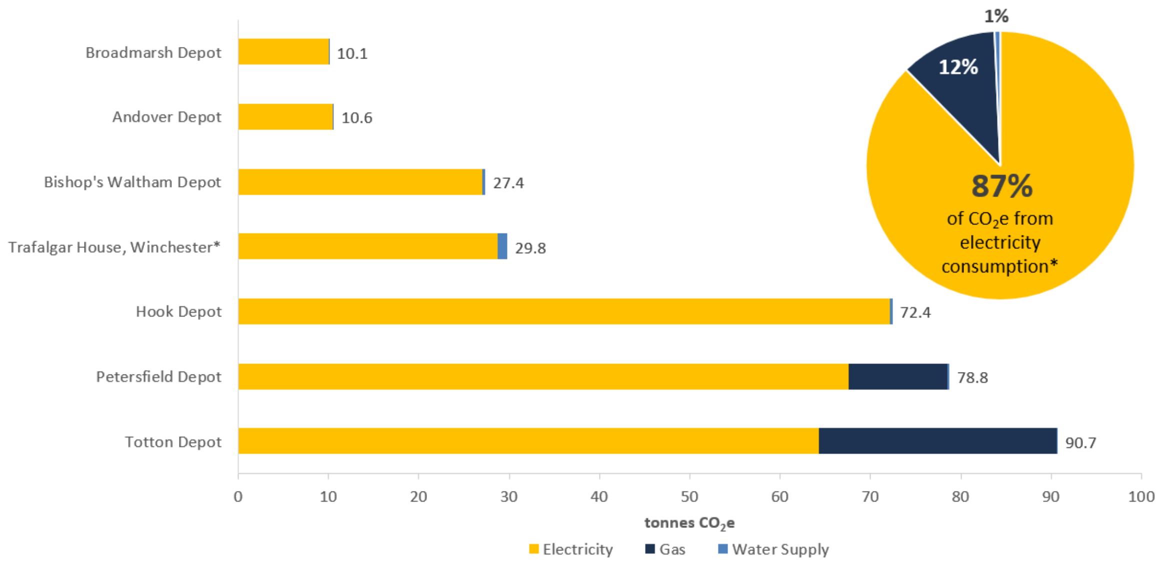

Figure 12. Breakdown of CO_2e emissions from Premises & Sites for HCC.

2% (423.3 tonnes) of CO_2e emissions came from Staff & Contractors, the majority of which (78%) was a result of commuting to and from work. As the majority (62%) of survey respondents used their own car for commuting, this accounted for 76% (322.3 tonnes) of emissions in this inventory (**Figure 13.**). 14% of emissions came from home working, whilst the remaining 8% was attributed to business travel, although it should be noted that additional business mileage claims not attributable to a single survey respondent were allocated to "Products & Services".

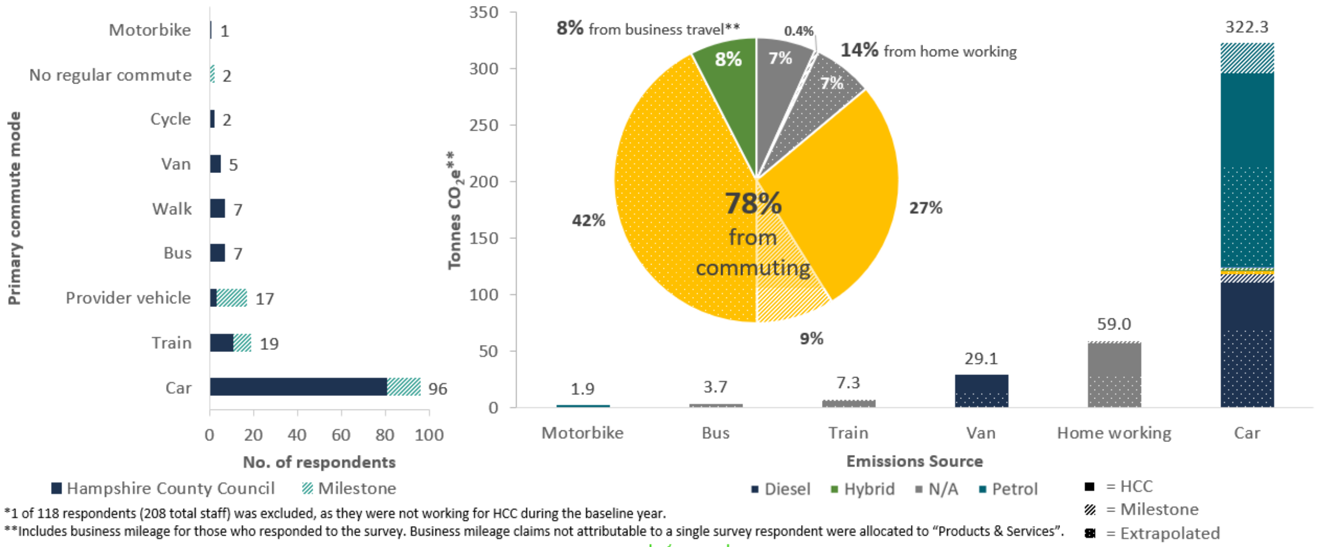

Figure 13. Breakdown of CO_2e emissions from Staff & Contractors for HCC.

3% (690.0 tonnes) of CO_2e emissions came from Vehicles & Plant, of which 82% were attributable to Milestone and 18% to HCC. The largest carbon hotspot in this inventory was mobile plant powered by HVO, which accounted for 46% of emissions. However, across all of the vehicle & plant types, diesel was the highest-carbon fuel type - accounting for approximately 49% of emissions across the two organisations, and 96% of emissions from vehicles owned directly by HCC (**Figure 14.**).

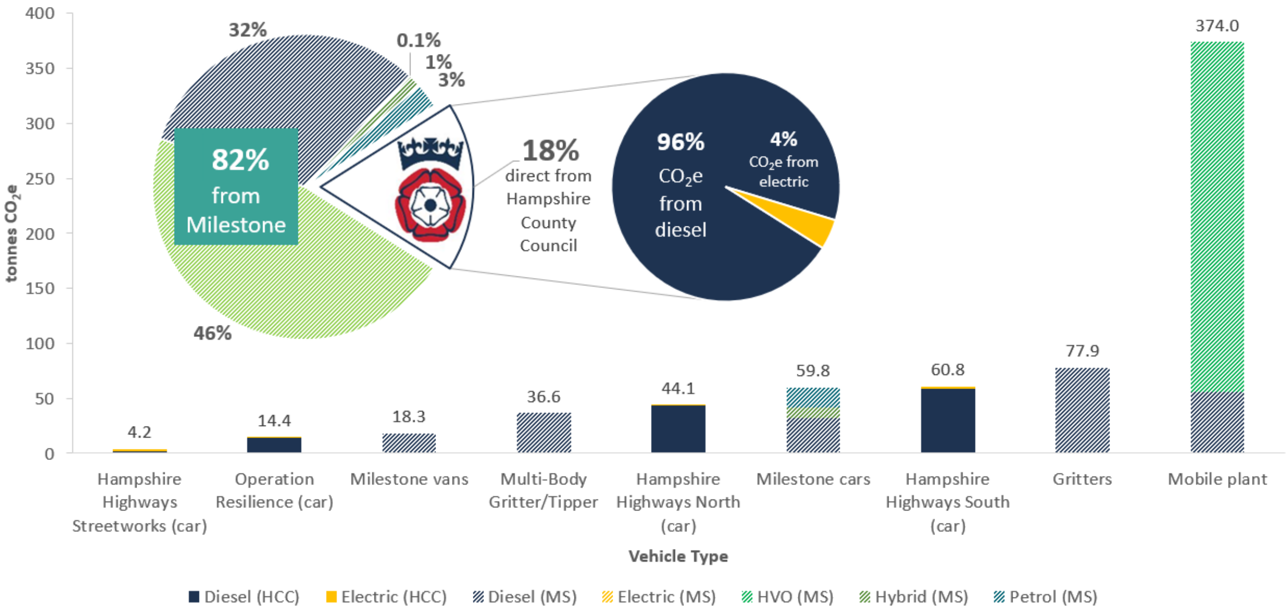

Figure 14. Breakdown of CO_2e emissions from Vehicles & Plant for HCC.

The remaining 94% (20,982.4 tonnes) of CO_2e emissions came from Products & Services, of which over 99% came from the Tier 1 contractor Milestone. Purchased materials accounted for approximately 71% (14,876.3 tonnes) of the emissions from this inventory, with asphalt, steel, and concrete being among the top four highest-carbon items (**Figure 15.**). In fact, asphalt was the highest-carbon item in the whole baseline at 7,702.6 tonnes CO_2e (accounting for 37% of Products & Services, or 34% of the whole baseline). Purchased fuel was also a major source of emissions at 25% (5,212.5 tonnes) of CO_2e from this inventory, with diesel and fuel oil also being among the top five carbon hotspots.

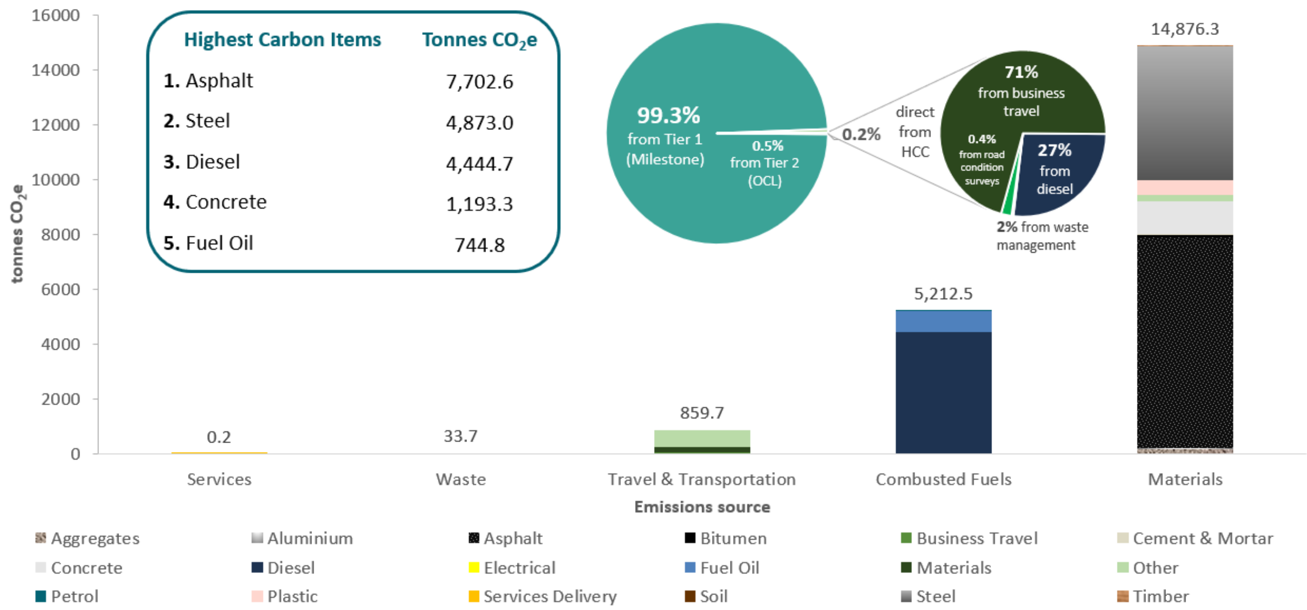

Figure **15.** Breakdown of CO_2e emissions from Products & Services for HCC.

4.1.3. Somerset

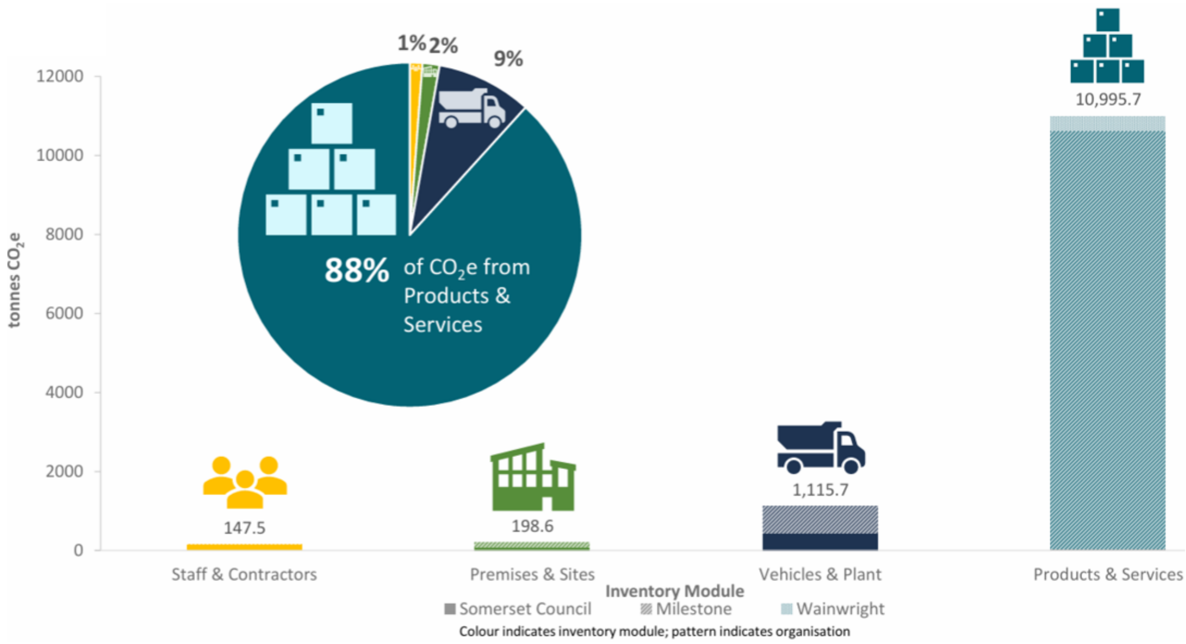

Figure 16. Full-service carbon baseline data for Somerset Council's highway maintenance services.

In summary, approximately 12,457.5 tonnes CO_2e were attributed to Somerset Council's highways maintenance service - roughly equivalent to 7,604 one-way flights from London to New York. 88% of this was attributed to Products & Services, 9% to Vehicles & Plant, 2% to Premises & Sites and 1% to Staff & Contractors (**Figure 16.**). Of the total 12,457.5 tonnes CO_2e, 92% of this was attributed to the Tier 1 contractor (Milestone), 3% came from the Tier 2 subcontractor (Wainwright) and the remaining 4% of emissions were directly attributed to Somerset Council. The latter was primary made up of emissions from Vehicles & Plant (66%), followed by Premises & Sites (21%). Staff & Contractors contributed to 11% and Products & Services to 2%.

198.6 tonnes (2%) of the total CO_2e came from Premises & Sites (**Figure 17.**); 37% of this was directly from SC. The majority of CO_2e emissions in the Premises & Sites category came from electricity (68%), for both SC (21%) and Milestone (47%). The second highest CO_2e source was gas, which contributed to 31% of emissions in this inventory. Water accounted for 0.6% of the emissions. The depot with the greatest emissions, Glastonbury, used only electricity as an energy source. The following three highest CO_2e sites (Dunball Depot, County Hall and Priorswood Depot), all used both gas and electricity.

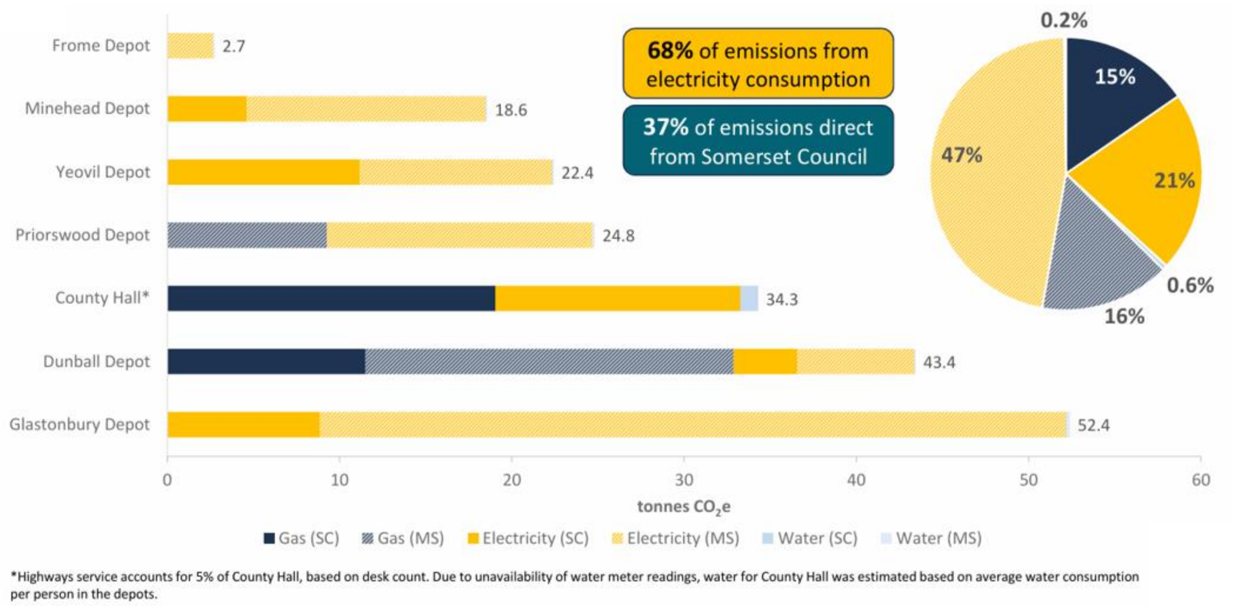

Figure 17. A breakdown of the CO_2e emissions from Premises & Sites for Somerset Council.

1% (147.5 tonnes) of the total CO_2e emissions came from Staff & Contractors (**Figure 18.**). This was primarily from home working (49%), while 46% was from commuting to and from work and 5% was from business travel. These values were calculated using from the results from 76 survey respondents out of a total of 194 staff. The results of survey showed that cars (used by 36 recorded individuals) were the most commonly used mode of transport, followed by provider vehicles (24). Additionally, 7 of the survey respondents walked, 4 used the bus, 3 used a van and 2 cycled.

For commuting and Business travel, diesel cars made up the majority of the emissions, followed by petrol cars, in total cars accounted for 39.9% of the staff & contractor emissions. 9.7% was attributed to vans and 1.6% to bus journeys.

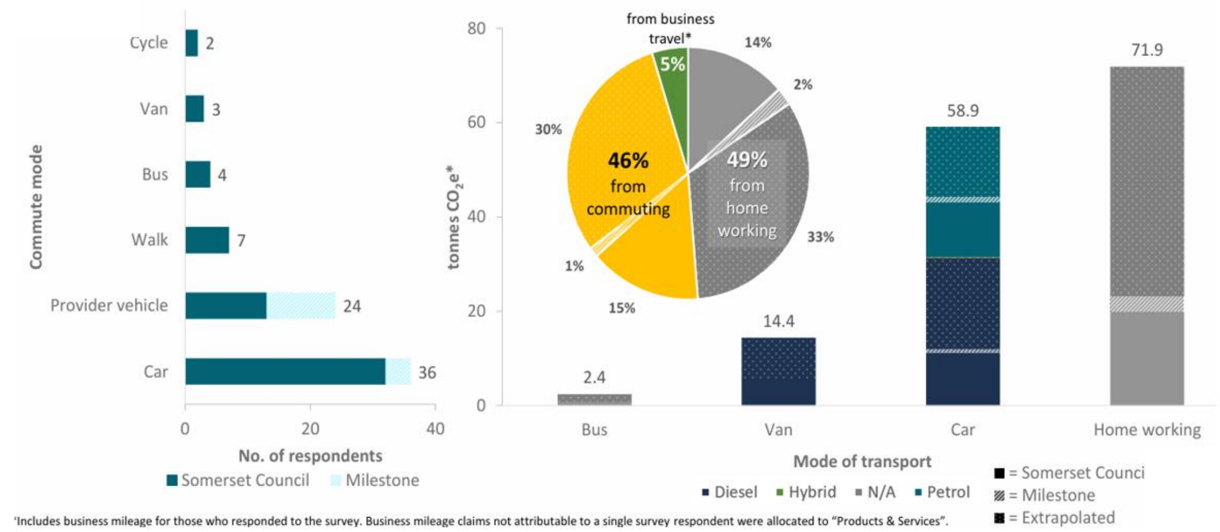

Figure 18. The breakdown of CO_2e emissions from Staff & Contractors for Somerset Council.

Vehicles & Plant made up 9% (115.7 tonnes) of the total CO_2e emissions. Of this, 61% was attributed to Milestone and 38% to Somerset Council. The largest carbon hotspot in this inventory was pool vans powered by diesel, which accounted for 30.5% of Vehicles & Plant emissions. Diesel was also the highest carbon fuel type across all vehicle & plant types, accounting for 93% of emission across the two organisations, and 99.9% of emissions from vehicles owned directly by SC (**Figure 19.**).

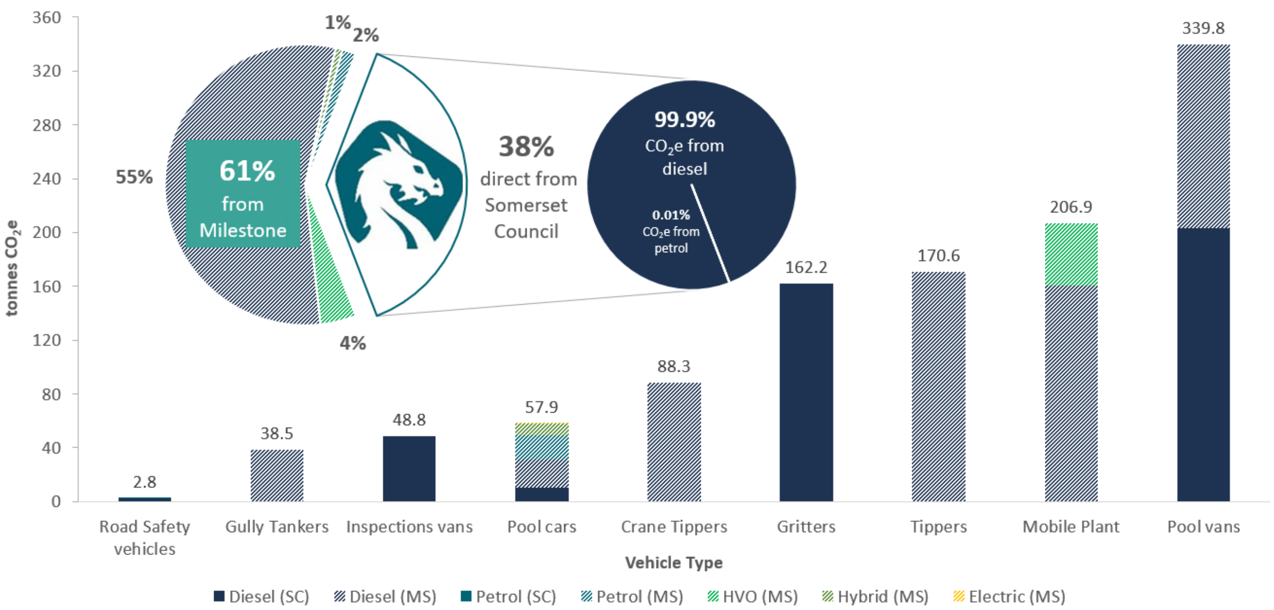

Figure 19: A breakdown of CO_2e emissions from Vehicles & Plant for Somerset Council.

The remaining 88% (10,995.7 tonnes) of CO_2e emissions came from Products & Services. Of this, 97% were from the Tier 1 contractor Milestone, 3% from the Tier 2 contractor Wainwright and the remaining 0.1% directly from Somerset Council (**Figure 20.**).

Of the 10,995.7 tonnes, purchased material accounted for 4% (8,616 tonnes). The materials asphalt, steel, and plastic were the top three highest carbon items in Products & Services, additionally, concrete was fifth. Asphalt was the highest carbon item in the whole baseline at 3,352.9 tonnes CO_2e, accounting for 30.55% of the products & services emissions and 26.9% of whole baseline. Purchased fuel was also a major source of emissions, contributing 17% (1966.3 tonnes) of CO_2e from this inventory, with fuel oil also being the 4th highest carbon item.

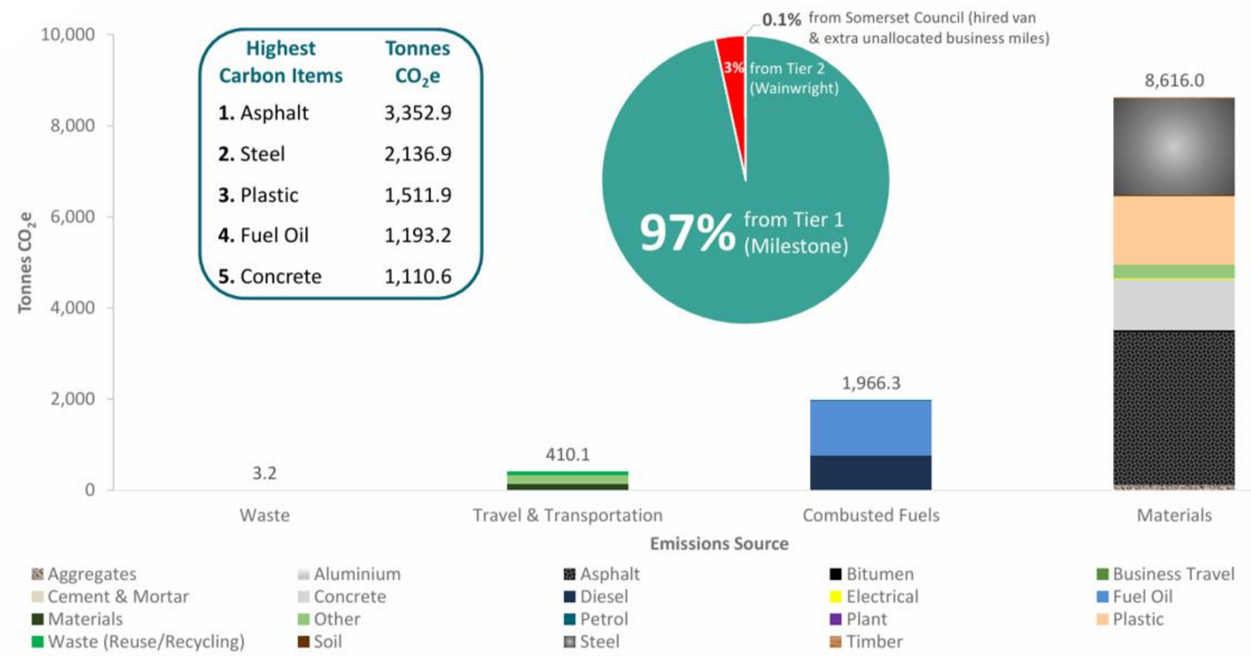

Figure 20. A breakdown of CO_2e emissions from Products & Services for Somerset Council.

4.2. Corridor carbon baseline – A30 Hook-Surrey, Hampshire

The overall carbon baseline for this corridor was calculated to be approximately 410.4 tonnes CO_2e, equating to around 25.0 tCO_2e/km. The majority (93%) of emissions were attributable to planned works - including resurfacing (312.3 tCO_2e) and patching (5.3 tCO_2e) – whilst cyclical maintenance accounted for 3% (13.7 tCO_2e) and reactive maintenance for 4% (14.4 tCO_2e) of total emissions (**Figure 21.**).

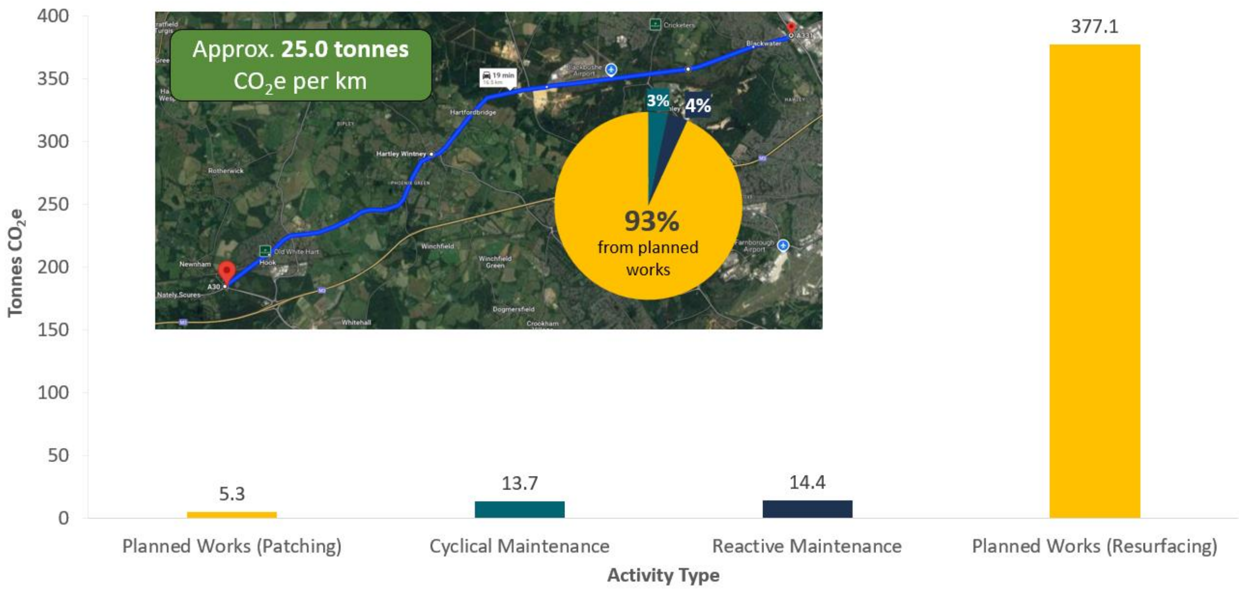

Figure 21. Overview of the corridor carbon baseline for the A30 Hook-Surrey corridor, split down by maintenance type.

The majority of emissions from cyclical maintenance were due to the cleansing of drainage assets - primarily gullies, which accounted for 4.3 tCO_2e, or 31% of emissions from cyclical works. 68% of cyclical maintenance emissions were due to travel in operational vehicles, whilst 27% were from waste (**Figure 22.**), which was primarily due to the biodegradation of grass cuttings left to decompose on the verge or in urban areas.

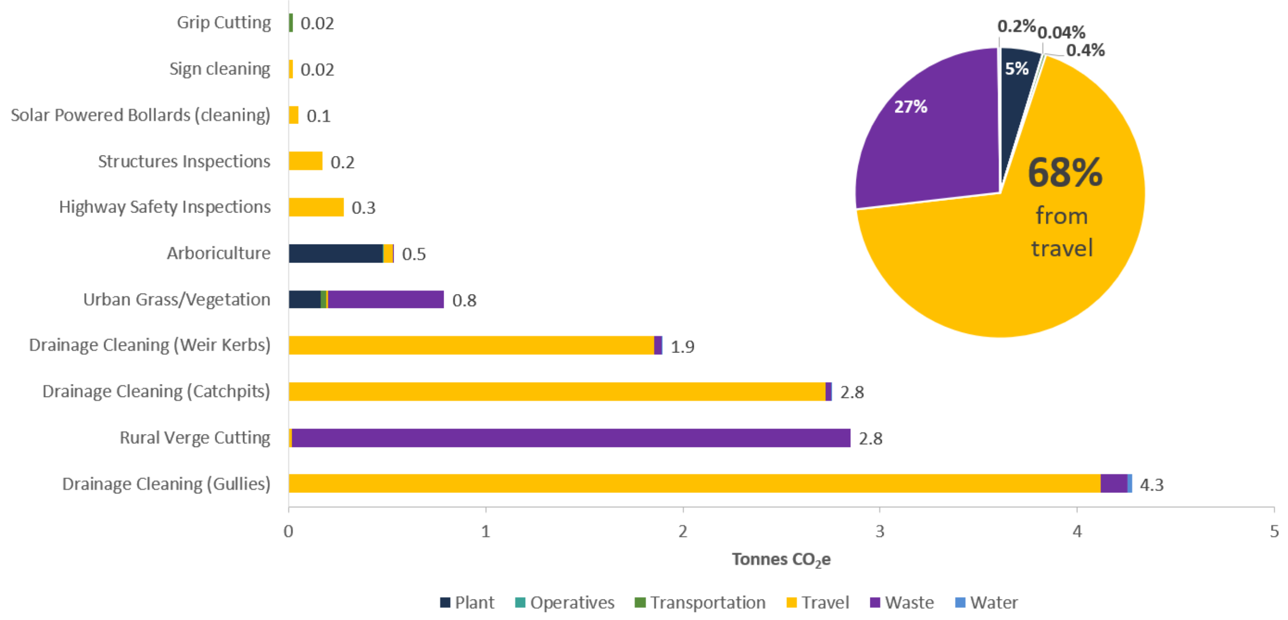

Figure 22. Carbon profiles for cyclical maintenance activities on the A30 Hook-Surrey corridor.

In contrast to the cyclical works, for which no purchased materials were used, the majority (63%) of emissions from reactive maintenance came from materials, although travel still accounted for a large proportion (24%) of emissions (**Figure 23.**). Whilst the single highest-carbon activity was a combined drainage & vegetation maintenance operation at 2.8 tCO_2e, pothole patching activities accounted for at least 2.9 tCO_2e across the carriageway and footways combined. Winter gritting was also a relatively high-carbon activity at 2.3 tCO_2e, due to the amount of travel carried out in a heavy vehicle.

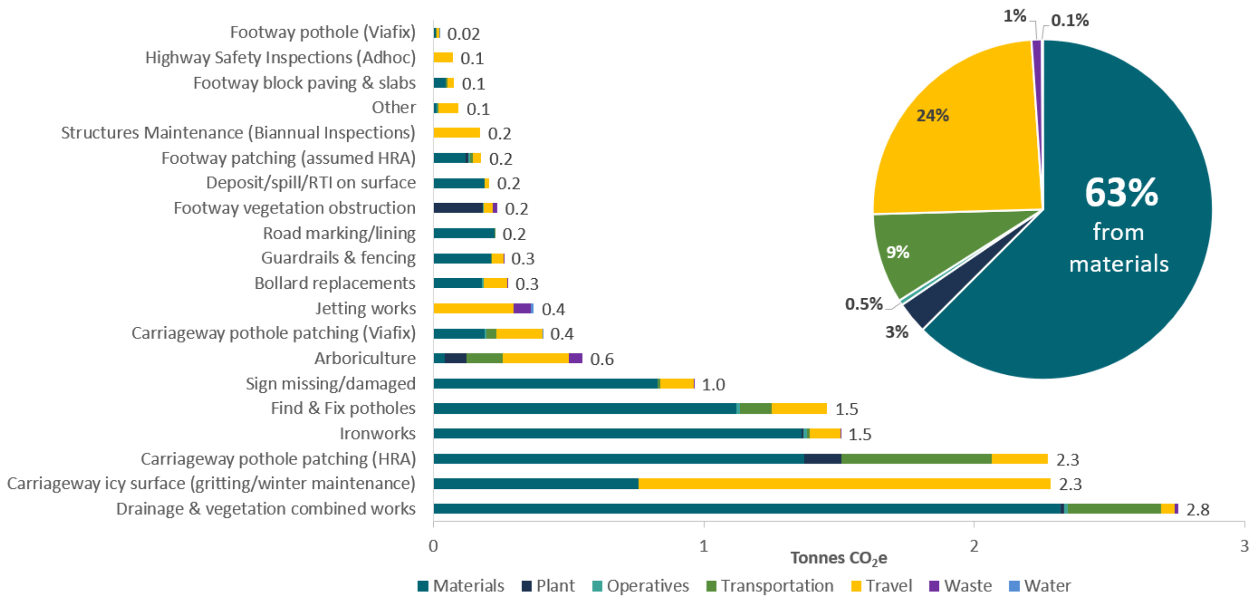

Figure 23. Carbon profiles for reactive maintenance activities on the A30 Hook-Surrey corridor.

Overall, planned patching works accounted for more carbon emissions (5.3 tCO_2e) in total than reactive patching works, primarily due to their larger extent. Hot-rolled asphalt (HRA) accounted for around two-thirds of the CO_2e emissions across the three patching schemes, whilst plant usage accounted for a fifth of CO_2e emissions. At only 0.5 tCO_2e, Job 2 (Newnham Road to Station Road) was notably lower-carbon than the other two patching schemes at 2.1-2.7 tCO_2e (**Figure 24.**) due to the smaller extent of the works, as well as the fact that a higher carbon factor for HRA was provided for Jobs 6 and 7.

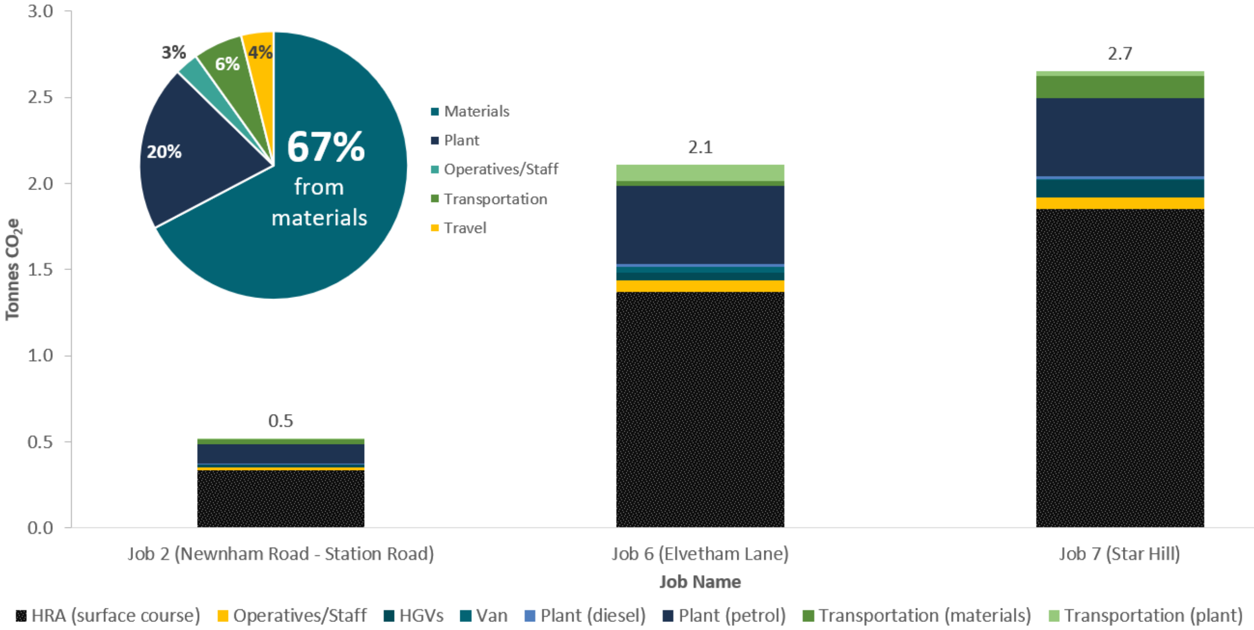

Figure 24. Carbon profiles for planned patching schemes on the A30 Hook-Surrey corridor.

Planned resurfacing works were by far the largest source of CO_2e emissions on the A30 Hook-Surrey corridor, of which 56% was due to materials (**Figure 25.**). A large proportion (31%) is also attributable to transportation, particularly of waste asphalt planings, which are transported for extensive distances across Hampshire and/or into Somerset.

The highest-carbon resurfacing scheme was Scheme HR749 in Hartley Wintney at 171.8 tCO_2e, as this required the largest quantity of asphalt, which accounted for 94.0 tCO_2e (55%) of the scheme carbon profile (**Figure 25.**). The scheme included 11,740m^2 of carriageway resurfacing with HRA & precoated chipping between Odiham Road and Bracknell Road, 922m^2 of which also included a binder course comprised of cold recycled bound material (CRBM) and AC20. Scheme HR749 also involved the raising or replacement of multiple drainage covers and the removal of the road studs, although these activities only contributed approx. 0.7 tCO_2e (0.4%) to the overall scheme carbon profile.

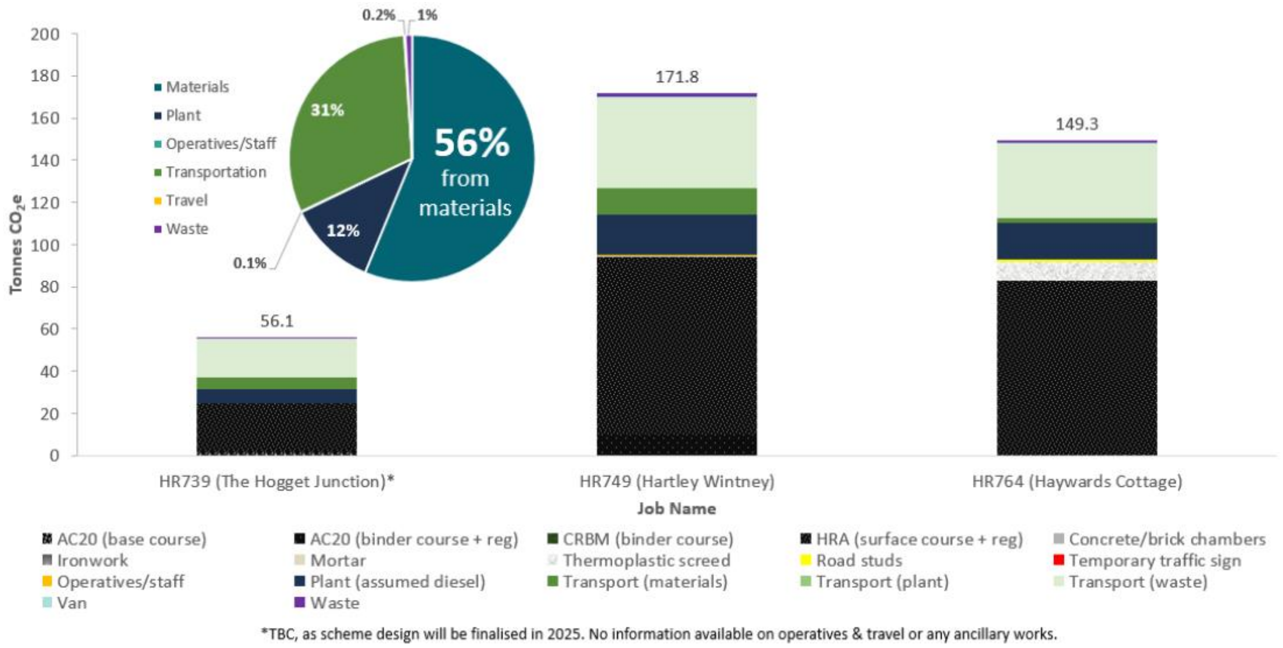

Figure 25. Carbon profiles for planned resurfacing schemes on the A30 Hook-Surrey corridor.

Scheme HR764 was similarly carbon-intensive at 149.3 tCO_2e, of which 82.7 tCO_2e (55%) came from asphalt (**Figure 25.**). The scheme included 11,077m^2 of carriageway resurfacing (surface course only) on the dual carriageway south of Haywards Cottage, Blackwater, using HRA with precoated chippings; this activity accounted for 138.9 tCO_2e (93%) of the scheme carbon profile, whilst the renewal of the thermoplastic screed line markings and reflective road studs accounted for 10.3 tCO_2e (7%). An additional 0.1 tCO_2e (0.08%) was attributable to traffic management, due to the setup and daily monitoring of a 4.3km diversion route.

The smallest and least carbon-intensive of the three schemes was Scheme HR739 at 56.1 tCO_2e, of which 24.5 tCO_2e (44%) came from asphalt (**Figure 25.**). The scheme included 3,689m^2 of carriageway resurfacing with HRA and precoated chippings on the junction between the A30 and A287/Old School Road in front of The Hogget pub, with 737.8m^2 of AC20 for the base courses. As this scheme is not due to take place until March 2025, no ancillary works have yet been planned, so all emissions are for carriageway resurfacing only.

5. Caveats & Limitations

5.1. Full-service carbon baselines

As a general caveat to all carbon baselines, the carbon accounting process is a dynamic exercise, and the absolute accuracy of any carbon baseline cannot be guaranteed. As a result, all figures are potentially subject to change if new data becomes available, particularly with regards to the corridor baseline, as we are still developing and progressing through this phase of the project.

5.1.1. Cornwall

For Premises & Sites, a breakdown of the electricity consumption in excess of the renewable energy guarantees of origin (REGO) limit was not available by depot. To address this, the total amount of electricity consumption that exceeded the REGO limit was allocated to each depot based on the percentage of total electricity consumption attributed to them. This method allowed for an estimated distribution of excess consumption across the depots.

For Staff & Contractors, a response rate of 37% was achieved for the travel survey, representing a statistically significant sample of the entire population. However, to apply the results to the full population, the emissions data had to be extrapolated using the averages for each commuting mode. It is important to note that this extrapolation can introduce some level of error in the final emissions estimates.

For Products & Services, the data on purchased services was only available in monetary terms (£), and since Carbon Analyser does not provide emissions factors for monetary values, alternative methods were needed for estimation. Emissions factors were derived from the Office for National Statistics (ONS) dataset on greenhouse gas (GHG) intensity by industry, following Cormac's original approach. However, relying on industry averages may not accurately capture the specific emissions profiles of individual services. Additionally, fluctuations in service costs over time may not directly correspond to changes in GHG emissions, which could further affect the accuracy of these estimates.

For certain materials, the exact emissions factors were unavailable, prompting the selection of general emission factors recommended by the FHRG. However, these carbon factors may not accurately reflect the specific emissions associated with these materials, potentially leading to inaccuracies in the overall emissions calculations.

5.1.2. Hampshire

For Premises & Sites, no water meter readings were available for Trafalgar House (the service HQ) and were only partially available for several of the depots. Water consumption for Trafalgar House was therefore estimated based on head count and per-capita water consumption in the depots, which in turn was extrapolated to 12 months from the available water meter readings. Electricity consumption also had to be extrapolated to the full 12 months of the baseline year from partial records for some of the depots, and from electricity meter readings for January-November 2022 for Trafalgar House.

For Staff & Contractors, the combined response rate from HCC and their Tier 1 contractors was 50%. Whilst this was still a statistically significant proportion, the total emissions had to be calculated by extrapolating up from the average responses for each commuting mode, using the inbuilt Extrapolate function in Carbon Analyser. Business mileage claims were not available for HCC, so these were also extrapolated up from the survey responses.

For Products & Services, the exact emissions factors were not known for most materials due to the generic nature of the product description (e.g. "Asphalt"), so the closest general emissions factor was selected from the NICS database, using FHRG-recommended factors where possible. As this carbon baseline was completed before the updated 2024 carbon factor had been published by Eurobitume, the carbon factors used for bituminous products are likely to increase in future.

5.1.3. Somerset

For Somerset Products & Services, the limitation of exact emissions factors not being known for some materials, like with Hampshire, was prevalent. In these cases, the closest general emissions factor was selected from the NICS database, using FHRG-recommended factors where possible.

Additionally, in the Staff & Contractors section, the commute survey results were extrapolated based on average responses for each commuting mode and days spent homeworking to determine the commuting and home working CO_2e emissions. This was done using the inbuilt Extrapolate function in Carbon Analyser. The response rate of the survey was 39%, which is statistically significant; however, it is still important to note that the emissions from this section are not an exact value.

For Premises & Sites there was no electricity or water meter readings available for County Hall for the full baseline year. To account for this, electricity consumption was estimated from Sept 2021-Aug 2022 meter readings and water consumption was estimated from head count & per capita water consumption at the depots.

For Vehicles & Plant, mileages for pool vehicles not assigned to survey respondents were unavailable, so were calculated from the difference in odometer readings between the closest MOTs to the start & end of the baseline year, scaled to 365 days.

5.2. Corridor carbon baseline - A30 Hook-Surrey (Hampshire)

For cyclical maintenance activities, the exact vehicle type used was generally unknown, so the carbon factor for an average diesel van was used unless otherwise specified. Whilst the type of gully tanker used for drainage cleaning was known, details on the waste production and water usage associated with this activity were estimated based on internet research and conversations with the gully tanker manufacturer. For verge cutting and urban grass cutting, the carbon and density factors provided by Greenprint were for a verge cut four times a year; it is not known how these factors would differ for green assets in HCC, which were cut at a different frequency. The decomposition of woody green waste (i.e. hedges and shrubs) was ignored due to a lack of data.

For reactive maintenance activities, some defects in the Confirm report (e.g. Find & Fix potholes) were not accompanied by details of their dimensions or the material quantities required. In this case, an average of the dimensions provided for similar defects was used. Carbon factors for certain asphaltic products were unavailable from the supplier, so the carbon factor for a similar material was used as a proxy. Where multiple defects were reported with no details on location or mode of transport, travel to site was assumed to be in an average diesel van from the nearest depot to the centre of the corridor. Transportation of materials was assumed to be from the main supplier's nearest depot to the contractor's depot in an average HGV, unless otherwise specified. Plant fuel consumption was estimated based on internet research and data from the CEDR Live Lab.

For planned works, data on plant fuel consumption was also unavailable, so assumptions were made based on internet research, along with data from the CEDR Live Lab (for patching) and the Liverpool Live Lab (for resurfacing). As the design for Scheme HR739 has not yet been finalised, the quantity of asphalt was estimated based on the proposed scheme area and layer depths, whilst details on plant and transport were extrapolated from the other two resurfacing schemes. As a result, the baseline emissions are likely to increase if other ancillary works are ultimately included on this scheme. Two of the patching jobs (Schemes 6 and 7) were known to use HRA from a specific supplier, for which a carbon factor was provided; as it was not known whether this specific mix was used for any other works, the National Highways carbon factor for HRA was used for all schemes except for Schemes 6 and 7. However, as this corridor baseline was completed before the updated 2024 carbon factor had been published by Eurobitume, the carbon emissions attributed to asphalt are likely to increase in future.

6. Key challenges, opportunities, and lessons learned

One of the key lessons learned from the Wessex Live Lab is that collaboration between three different Local Authorities brings both challenges and opportunities. Due to differences in the organisational structure, contracting model, and approaches to recording data in each local authority, it was difficult to maintain consistency of scope and methodology across all three counties. By attempting to start gathering baseline data before we had clearly established the differences and commonalities between local authorities, we discovered the need to have agreed upon more explicit scope boundaries and 'common currencies' for comparability from the very beginning of the project. However, working with three different Local Authorities also showcased how different approaches to Highways maintenance and contracting can influence a Local Authority's carbon emissions in different ways, and allowed all three to benefit from shared learning and resources across the project.

This project also highlighted the challenges of accessing information which is held by multiple disparate sources, or not recorded at all. Extensive stakeholder engagement was required to collate information across all four CCAS carbon inventories. For example, the staff surveys required engagement from the whole Highways department in each Local Authority, as well as their Tier 1 contractors; despite the number of responses increasing after multiple prompts were given, the overall response rate remained relatively low. This issue was overcome when the automatic Extrapolate function was added to the Staff & Contractors module in Carbon Analyser, although this did not guarantee high levels of accuracy. A key learning was that stakeholders need to be made aware of the importance of the information they are asked to provide; for instance, the survey response rate was notably higher in HCC where a recorded briefing was delivered to staff before they completed the survey. As the majority of carbon emissions are attributable to the wider supplier chain, sustained engagement of Tier 1 and 2 contractors/subcontractors is also required to obtain the necessary information. In future, an ECI-based task order may be issued to contractors, mandating regular data provision to prevent delays with the carbon accounting process.

Determining appropriate metrics and carbon factors for specific materials and plant items has also been a challenge, particularly at corridor level. Whilst the duration of scheduled plant usage was generally available from Confirm, this did not provide the fuel consumption rates or the actual time spent operating a given plant item. Assumptions were made based on data shared by the CEDR and Liverpool Live Labs, demonstrating the value of collaborative knowledge and resource sharing between the Live Labs. For materials, suppliers were rarely able to provide an EPD or other form of carbon data – particularly for bituminous materials, as most suppliers were still awaiting the publication of the new carbon factor for bitumen by Eurobitume. More openness and transparency is required across the sector to ensure that carbon factors for specific products are accurate, robustly calculated, and readily available, with support given to suppliers who lack the resources to calculate carbon factors for their own products.

Whilst it was initially anticipated that data from Confirm could be directly imported into Carbon Analyser to calculate carbon profiles for reactive maintenance activities, this has not been as simple as expected. As data is not currently entered into Confirm with carbon accounting in mind, the data outputs are not always sufficiently detailed or comprehensible from a non-Confirm user's perspective; intensive manual processing is also required due to the structural format of the data. For example, the dimensions of a defect are not always provided, or need to be manually extracted from the free-text section of a defect report. In future, it would beneficial if Confirm users could be briefed on the importance of entering more detailed, specific, and consistently structured data, and/or if the structure of Confirm itself could be adapted to enforce this.

7. Next steps

As the Wessex Live Lab moves into the corridor baselining and experimental carbon profiling phase of the project, our next steps are as follows:

Obtain data for the planned works on the A391 St. Austell NEDR and A38 Taunton-Devon corridors

↓

Complete the carbon baselines for the A391 St. Austell NEDR and A38 Taunton-Devon corridors

↓

Determine the carbon factors for each innovation which will be applied to the corridors (both physically and simulated).

↓

Calculate an experimental (simulated) carbon profile for each corridor and determine the theoretical carbon savings achieved.

↓

Repeat the process for the remaining six corridors. At least two corridor baselines in each Local Authority will be a 'deep dive', whilst the remainder may be extrapolated from the existing corridors.

↓

Once works have been completed on the corridors, calculate an experimental (physical) carbon profile for each corridor to determine the actual carbon savings achieved.

We will also review the existing carbon baselines and update the carbon factors for specific materials when more accurate data becomes available. In addition, we will liaise with the other Live Labs to determine how to account for carbon emissions over the full lifecycle horizon of a given asset, in order to calculate the long-term carbon savings achieved by adopting materials and processes with an increased lifespan.

8. Summary

This report demonstrates that carbon baselining provides a valuable insight into the distribution of CO2e emissions sources at both the scale of a whole local Highways maintenance service, and at the level of specific activities within a highways corridor. Whilst carbon baselining provides evidence for the significance of predictable carbon hotspots such as asphalt, diesel, and steel, it also reveals the nuances and differences that exist between different Local Authorities, as well as providing a vital benchmark against which to measure the holistic decarbonisation of Highways maintenance operations. Overall, having a robust and consistent approach to quantifying carbon emissions across local Highways authorities is a key step in determining the optimum route to Net Zero Highways.