



Centre of Excellence  
for Decarbonising Roads

# POLYPAVE LIVE TRIAL EVALUATION REPORT

Live Labs 2 North Campus

This report presents a carbon appraisal of PolyPave, an Ultra Low-Density Polyethylene asphalt additive manufactured by Sima Environment, trialled at Strathclyde Park Car Park, Bellshill, as part of the Live Labs 2 programme. The assessment compares the PolyPave warm mix asphalt against a conventional AC10 FyfePave mix across lifecycle stages A1-A5. The trial demonstrated a 42.83% reduction in carbon emissions, primarily due to reduced virgin bitumen use and the incorporation of waste-derived ULDPE. However, findings remain indicative due to the absence of third-party verified product-specific carbon data and long-term performance results.

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| STATUS/AMENDMENT | PREPARED                                                                                                                                       | REVIEWED                                                                                                                                                                                                                           | APPROVED                                                                                                                                 |
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## Executive Summary

This report evaluates a live trial conducted as part of the Live Labs 2 project, which aims to test innovative highway solutions to improve road performance, reduce maintenance needs, and enhance safety. This trial focused on PolyPave manufactured by Sima Environment. PolyPave is an Ultra Low-Density Polyethylene (ULDPE) asphalt additive which claims to act as a bitumen extender when added to asphalt mixes to replace a proportion of conventional bitumen binder.

The purpose of this carbon appraisal is to focus on the carbon performance of PolyPave within this live trial. PolyPave was trialled on approximately 1,110 m<sup>2</sup> of car park in Strathclyde Park, Bellshill, North Lanarkshire. PolyPave was trialled in a warm mix asphalt contributing to 0.2% of the total asphalt mixture. The findings, limitations, and recommendations presented in this report aim to inform the potential rollout of PolyPave across UK local councils.

This report assesses carbon emissions across cradle to construction lifecycle stages in accordance with EN 15804, covering product stages A1-A3 of this standard (raw material extraction, transportation to processing facilities and manufacturing) and construction stages A4 to A5 (transportation of the finished material to site and installation). EN 15804 classifies carbon and establishes a modular, transparent approach to lifecycle assessment that assigns emissions to defined stages. Using EN 15804 ensures that this live trial is in line with the recognised European standard, follows accepted boundaries and allocation rules, and enables results that are comparable, auditable and consistent across products and projects. Sima Environment is considered a small and medium enterprise (SME) based in Leighton Buzzard, England and therefore has not yet obtained a verified Environmental Product Declaration (EPD) at this stage of the trial due to high cost and resource requirement associated with obtaining an EPD. However, Sima Environment have shared assumptions in the calculation of their carbon figures and the overall carbon figures for the whole warm asphalt mix have been calculated using Holcim's (supplier of the asphalt mix) internal carbon tool and uses the Eurobitume industry standard carbon factor for bitumen.

The findings from the trial have shown that PolyPave demonstrated a reduction in carbon intensity when compared to FyfePave (a standard AC10 mix), with trial results showing a 42.83% reduction in A1-A5 carbon emissions. The primary driver of the carbon savings can be attributed to lower A1-A3 embodied emissions associated with the use of ULDPE which reduces the quantity of bitumen required in the asphalt mix. ULDPE is not currently widely recyclable within the UK due to a lack of economically viable conventional recycling routes, largely resulting from its low density, high contamination potential and limited processing infrastructure. Consequently, significant quantities are sent for disposal. By repurposing waste ULDPE as an asphalt additive, PolyPave provides an alternative end-use pathway that supports circular economy principles by retaining material value within the supply chain and reducing reliance on virgin resources.

# Introduction

This Evaluation Report provides a high-level assessment of PolyPave, an emerging sustainable material in highways, construction and maintenance, focusing on its environmental impact, product viability, and alignment with future infrastructure needs. PolyPave is an Ultra-Low Density Polyethylene (ULDPE) asphalt additive which claims to act as a bitumen extender due to its low density and low melting point. ULDPE is a waste product which if not re-used in asphalt requires incineration. Sima Environment claims that adding 2kg of PolyPave has the potential to replace 5kg of bitumen traditionally used in asphalt production.

Live Labs 2 is a three-year UK-wide programme funded by the Department for Transport (DfT), followed by a five-year monitoring and evaluation period, focusing on how to decarbonise local highways infrastructure and assets. As part of this initiative, North Lanarkshire Council (NLC) are working alongside Transport for West Midlands (TfWM), to establish the UK Centre of Excellence for Materials Decarbonisation in Local Roads.

The Centre of Excellence will act as a central hub within Live Labs 2, supporting research, innovation, and best practices to accelerate low-carbon solutions in road construction and maintenance. By collating findings from Live Labs 2 trials to a single accessible location, the centre will drive sustainable advancements, enabling Local Authority Highway sectors across the UK to adopt more efficient and environmentally responsible materials and methodologies.

The purpose of this report is to present key findings from a comprehensive evaluation of sustainable materials, including their carbon intensity, potential application, and overall benefits by examining carbon appraisals, lifecycle benchmarks, and various factors such as scalability, compliance, durability and supply chain viability. The report aims to provide decision-makers with valuable insights into the material's capacity to meet sustainability goals while maintaining construction quality and durability. The evaluation will inform ongoing efforts to balance environmental considerations with operational efficiency in infrastructure development.

The carbon profiles of materials have been calculated using the Future Highways Research Group (FHRG) tool Carbon Leadership Profiler Toolkit (previously known as Carbon Analyser), an Excel-based tool developed in collaboration with local highway authorities to provide a simple, standardised method for quantifying carbon emissions associated with transport and highways activities, and the OneClickLCA database where embodied carbon data is otherwise unavailable. All carbon profiles have incorporated a local and sector-wide baseline material to benchmark carbon savings. The PolyPave trial has been evaluated against a standard AC10 FyfePave (a standard AC10 mix produced to an EN 13108-1 AC recipe mix).

The carbon evaluations for PolyPave incorporate whole lifecycle assessments which consider:

- Embodied Carbon;
- Transportation emissions of materials and people;
- Operation of plant and equipment during construction period;
- Operational electricity, fuel and water emissions;
- End of life emissions including deconstruction and waste processing.

| Feature                     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Carbon Intensity                                                                                                                                                                                                                                                                            | Product Prospects                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Material Summary            | Description of material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Specific emissions data (CO <sub>2</sub> e per unit of material)                                                                                                                                                                                                                            | Brief product potential overview                                                                                                                                                                                                                                                                                                                                                                |
| PolyPave – Sima Environment | <p>PolyPave is an asphalt additive which claims to be bitumen enhancing, formed of recycled ultra-low-density polyethylene (ULDPE).</p> <p>ULDPE waste is unrecyclable, unsuitable to export, hazardous for landfill and must be disposed of via incineration which is considered a difficult process as this is costly and requires a suitable facility with appropriate environmental permitting.</p> <p>Sima Environment uses a specialised recycling process to convert the waste ULDPE into granules which are added to the mix at the asphalt plant during production without the need for specialised equipment.</p> | <p>The introduction of PolyPave into warm mix asphalt (WMA) at 0.2% produced 6.82 kgCO<sub>2</sub>e/m<sup>2</sup> and 77.27 kgCO<sub>2</sub>e/t.</p> <p>The trial demonstrated a 42.83% reduction in carbon emissions when compared to FyfePave, a standard AC10 mix with no additives.</p> | <p>In this trial, it is considered that PolyPave has demonstrated its potential for use on highway projects in the UK, particularly on projects where carbon reduction and sustainability are key focuses.</p> <p>The additive reduces the reliance on conventional virgin bitumen while promoting circular economy principles through incorporating an unrecyclable waste product (ULDPE).</p> |

# Methodology

## Trial Design

The PolyPave trial was designed to evaluate the performance, durability, and environmental impact of the material, with application to approximately 1,110m<sup>2</sup> of Strathclyde Park Car Park, Bellshill, North Lanarkshire.

Carbon emissions have been assessed based on the whole lifecycle stages A1-A5 (cradle to construction) in accordance with EN 15804. EN 15804 is the European standard that defines the standards and reporting format for Environmental Product Declarations (EPD) for construction products, providing a consistent, auditable framework for quantifying carbon impacts across a product's lifecycle. These stages cover raw material extraction, transport to and manufacture at the factory, delivery to site and on-site installation, see Figure 1. This clear separation of stages enables precise attribution of emissions to each segment of the supply chain, helping to identify areas for potential reduction measures and ensuring comparability across all trials.

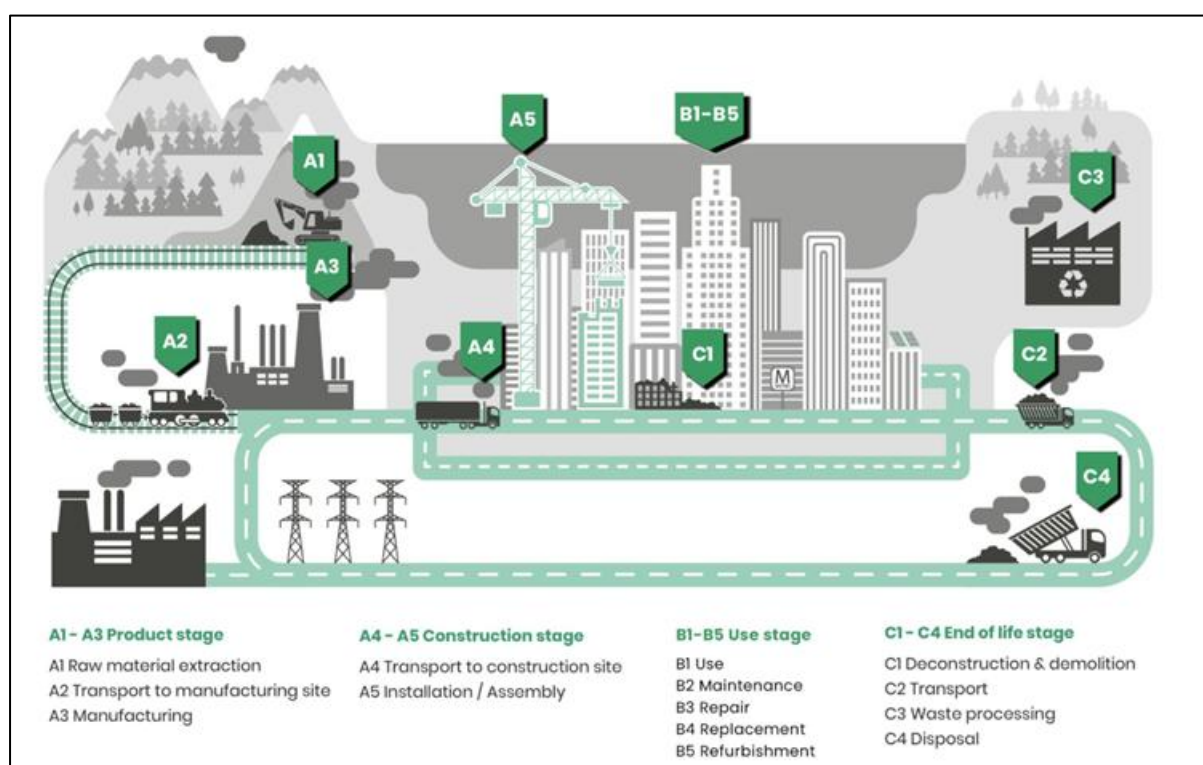


Figure 1: Carbon Lifecycle Stages<sup>1</sup>

<sup>1</sup> <https://help.oneclicklca.com/en/articles/275901-life-cycle-stages>

## Site Selection

The trial sites were chosen based on the following criteria:

- **Traffic Volume:** The site was chosen as it experiences high volumes of light and heavy vehicles allowing for the assessment of the material's performance under differing stress conditions.
- **Environmental Conditions:** The car park site was selected due to varying weather conditions (e.g., temperature, humidity) to evaluate the surfacing material's resilience.
- **Surface Type:** The site was originally laid with asphalt that had severely deteriorated, requiring urgent maintenance.

## Data Collection Plan

The following data items were collected to ensure a thorough evaluation of PolyPave during site trials:

| DATA ITEM                                     | UNIT(S)                                                                     | RESPONSIBLE                                                  | LOCATION OF DATA             | PURPOSE                                              |
|-----------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------|------------------------------|------------------------------------------------------|
| Trial Location                                | Road name, coordinates of location of PolyPave trial                        | Operational Staff                                            | Site Diary                   | Technical comparisons                                |
| Conditions at the time of lay                 | Temperature (°C)<br>Conditions (rain, dry, etc)                             | Operational Staff                                            | Site Diary                   | Operational considerations and technical comparisons |
| Coring                                        | Pen<br>Softening Point<br>DSR                                               | University of Nottingham                                     | Site Diary                   | Technical Evaluation                                 |
| Road Surface Temperature                      | Temperature (°C)                                                            | Inspector                                                    | Site Diary                   | Technical Evaluation                                 |
| Quantity                                      | m <sup>2</sup> of PolyPave used                                             | Operational staff & Carbon Lead                              | Site Diary                   | Cost and Carbon Evaluations                          |
| Cost                                          | Cost for PolyPave<br>Cost for conventional resurfacing                      | Amey Procurement and Suppliers                               | SAP                          | Purchase cost and whole lifecycle cost evaluation    |
| Operational Experience – ease of installation | Subjective – any concerns or benefits experienced by Operations Team        | Project Manager to collect on-site data with Operations Team | Case Study in knowledge bank | Scalability Evaluation                               |
| Health & Safety                               | Ease of installation on-site<br>Temperature required for installation       | Operational staff and supplier information                   | Site Diary                   | Health and Safety Assessment                         |
| Operational Data                              | Time to complete (hh:mm)                                                    | Operational Staff                                            | Site Diary                   | Operational considerations and carbon evaluation     |
| Fuel Usage                                    | Litres of petrol used<br>Type of plant/fleet used (electric, diesel, model) | Operational Staff                                            | Site Diary                   | Carbon evaluation                                    |

Table 1: Data collection plan

## Trial Location Plan

The primary aim of the PolyPave trials is to undertake a comparison analysis of PolyPave with the benchmark, conventional AC10 (FyfePave).

In the trial PolyPave content was 0.2% of the total hot asphalt mix. AC10 (FyfePave) produced by Holcim served as the benchmark for PolyPave. The PolyPave mix was produced in asphalt plant at Duntilland Quarry while the standard AC10 FyfePave mix was produced at Blantyre Quarry. While these are different asphalt plants, both were produced by the same company ensuring energy use and production conditions are comparable. Using this as the baseline provides a clearer comparison and highlights the carbon savings achieved through incorporating recycled materials.

The trial areas are as defined in the table below. Preference was given to locations which experience high traffic loads.

| TRIAL SITE | SITE                      | TRIAL LOCATION |
|------------|---------------------------|----------------|
| 1          | Strathclyde Park Car Park | Bellshill      |

*Table 2: PolyPave Strathclyde Park Trial information*

## Procedure

**Site Preparation:** The selected site was cleaned, prepared and planned for the application of PolyPave. Loose debris and water were removed to ensure proper adhesion.

**Material Application:** Roads were prepped as per manufacturer's instructions prior to the product's application. PolyPave asphalt mix was applied by Hochtief via a paver following conventional asphalt processes.

**Monitoring and Data Collection:** The trial sites were monitored over a period of 12 months. Data on surface condition, material performance, and environmental impact were collected at regular intervals.

**Performance analysis:** The performance of PolyPave was evaluated based on criteria such as durability, resistance to traffic stress, and environmental impact. Comparisons were made versus conventional resurfacing for NLC to benchmark performance.

## Data Analysis

The collected data was analysed to assess the effectiveness of replacing a proportion of the asphalt mix with PolyPave. Performance was evaluated by comparing the PolyPave mix against a control section (AC10 FyfePave).

The analysis focused on:

- **Durability:** Assessing the longevity of the treated site and resistance to traffic and environmental stress;
- **Environmental Impact:** Evaluating the reduction in carbon emissions and use of recycled materials; and
- **Cost- Effectiveness:** Comparing the costs associated with PolyPave, including material, application, and maintenance costs.

The embodied carbon factor for trialled materials has been developed based on supplier product data and supported by carbon factors sourced from OneClick LCA where required. An Environmental Product Declaration (EPD) had not been produced at the time of this trial. PolyPave has not gained third-party verification for the carbon figures they provided. However, they have shared the assumption taken that carbon savings have been calculated based on its close processing methods as ‘film waste’ through open loop recycling as per the Government’s Experimental Statistics on the carbon impact of waste from households managed by local authorities in England<sup>2</sup> and for the remainder of the mix uses the Eurobitume 4.0 Life Cycle Assessment (LCA) bitumen carbon figure<sup>3</sup>, which is considered the industry standard bitumen figure at the time of this assessment.

The absence of an EPD and a third-party verification results in a degree of uncertainty over the reported carbon figures. The methodology adopted by PolyPave relies on proxy assumptions based on similar processing methods to film under open-loop recycling and does not use product specific data. However, it is important to recognise that Sima Environment is an SME at an early stage of development. The production of EPDs and obtaining third-party verification is resource intensive and costly, which may present a barrier to the company at this time. This should not detract from the potential carbon saving benefits of PolyPave or limit its consideration within trials and innovation led schemes such as Live Labs 2. As the product matures and seeks wider adoption, progressing towards third-party verification and the development of an EPD would be a key step in strengthening data credibility.

Holcim have provided A1-A3 carbon value for the manufacturing of the PolyPave at their Duntilland Quarry, the third-party verified LCA has been used in the calculation of this value. Holcim provided A1 -A3 carbon figures from manufacturing AC10 FyfePave at Blantyre Quarry which was applied side-by-side at the Strathclyde Park site. This figure has been used as the baseline figures to benchmark PolyPave against.

Holcim’s internal carbon tool was used to calculate these values. This tool follows the principles of EN 15804 and has been third party verified by Circular Ecology Ltd. The tool uses primary activity data from Holcim operations, secondary data coming primarily from the UK Government GHG emission factors and Inventory of Carbon and Energy v4.0 by Circular Ecology and University of Bath, with additional data supplied by Carbon Trust.

<sup>2</sup> [Experimental Statistics on the carbon impact of waste from households managed by local authorities in England - GOV.UK](#)

<sup>3</sup> [EB-GWP-Report-to-LCA-4.0-2025.pdf](#)

# Carbon Appraisal

## Carbon appraisal

Drawing on data collected through trials, a carbon assessment has been undertaken. Table 4 establishes the parameters of the model, defines assumptions and outlines product specifications.

| ASSUMPTIONS                                                                                                                                                                                                                                                                                                                                     | JUSTIFICATION                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| All transportation is undertaken via diesel HGV.                                                                                                                                                                                                                                                                                                | Based on standard modelling assumptions from similar schemes.                                                                                                                                                                  |
| Unit of measurement used is 'kgCO <sub>2</sub> e/ m <sup>2</sup> '.                                                                                                                                                                                                                                                                             | Based on the best available data used to conduct carbon appraisals.                                                                                                                                                            |
| Traffic management activities were not included within this carbon assessment.                                                                                                                                                                                                                                                                  | Traffic management differs between sites and local authorities so requires separate capturing, as part of standard practice.                                                                                                   |
| GHG-conversion-factors-2025-full-set has been used for delivery vehicle emission factors when the fuel usage is unknown.                                                                                                                                                                                                                        | Based on the best available data at the time of this carbon appraisal.                                                                                                                                                         |
| This carbon analysis does not incorporate planing activities within this assessment.                                                                                                                                                                                                                                                            | This is a BAU activity therefore is not influenced by this innovative process.                                                                                                                                                 |
| Where specific machine hour carbon emission factors were unavailable emission factors have been selected based on average kW power, sourced from OneClick LCA.                                                                                                                                                                                  | Based on the best information available at the time of the carbon appraisal.                                                                                                                                                   |
| To calculate the CO <sub>2</sub> e emissions per tonne of aggregate from each quarry, Holcim utilised the total energy consumption from the quarry over the previous 12 months. Each quarry's energy use was converted to an equivalent CO <sub>2</sub> emission value then divided by the total tonnage of aggregate sold in that same period. | Based on the most up to date information Holcim (the main contractor) had available at the time of this carbon analysis.                                                                                                       |
| Holcim utilised Eurobitume's 4.0 Life Cycle Assessment (LCA) 2025 carbon emission factor for bitumen, 530kgCO <sub>2</sub> e/ tonne.                                                                                                                                                                                                            | This figure is the most recent bitumen emission factor and is considered the industry standard.                                                                                                                                |
| Fuel consumption of dryers has been calculated by the amount of fuel used divided by the tonnage of asphalt supplied. Giving the CO <sub>2</sub> e value per tonne of asphalt mixed can vary plant to plant based on tonnage supplied, fuel type, efficiency etc.                                                                               | Based on the best available data at the time of this carbon appraisal.                                                                                                                                                         |
| The emission factor used for fibre pellets was sourced from ASPECT.                                                                                                                                                                                                                                                                             | Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follows the principles EN 15804. |
| The emission factor used for limestone filler was sourced from ICE v.3 2020.                                                                                                                                                                                                                                                                    | Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follows the principles EN 15804. |

| ASSUMPTIONS                                                                                               | JUSTIFICATION                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Application rate of bondcoat is assumed to be 0.35/m <sup>2</sup> .                                       | Based on application rate stated in Colas Colbond 50 product data sheet.                                                                                                                                                                                                                                  |
| Machine hours at the site were assumed based on laying records on site as recorded by Hochtief.           | Based on the best available data used to conduct the carbon appraisal.                                                                                                                                                                                                                                    |
| Vehicles transporting materials are assumed to travel fully laden to site and return empty.               | The assumption that vehicles travel fully laden to site and return empty reflects standard haulage practice for material deliveries. Applying this assumption ensures carbon calculations accurately represent typical operational behaviour and avoid artificially reducing transport-related emissions. |
| Fuel usage for HGVs on site at Strathclyde Park has been calculated based on the assumption 0.05l/minute. | Based on typical on-site HGV operations where vehicles are largely idling or moving at low speeds.                                                                                                                                                                                                        |
| Number of operatives on site has been assumed to be 10 for the trial at Strathclyde Park.                 | Based on average number of operatives on similar surfacing trials as part of Live Labs 2.                                                                                                                                                                                                                 |

*Table 3: Carbon appraisal matrix*

## Carbon Modelling

The carbon modelling for the trials was conducted using the Future Highways Research Group (FHRG) Carbon Leadership Profiler Toolkit to collect primary carbon data from the trials, detailing emissions from materials, transport, construction activities and equipment use. Using this information the tool generated carbon profiles that identified emission hotspots and using the toolkit's emission database providing verified emissions factors to improve data accuracy.

One Click LCA was also utilised in modelling to support the FHRG Carbon Leadership Profiler Toolkit due to its large database of emission factors supported by Environmental Product Declaration (EPD). The carbon emission factor for PolyPave has been supplied by Holcim as the manufacturer of the asphalt mix. This value was calculated using Holcim's carbon calculator and data provided by Sima Environment. It is important to note at the time of this assessment PolyPave does not hold an EPD or independent third-party verification. However, as an SME this should be considered in the context of the significant cost and resource requirements associated with obtaining an EPD.

Indicative results from carbon modelling for the PolyPave trial, expressed in  $\text{kgCO}_2\text{e}/\text{m}^2$  and  $\text{kgCO}_2\text{e}/\text{t}$  are presented below. This presentation of emissions enables direct comparison across different low-carbon innovations, to highlight carbon-efficient options and support data-driven decision making for reduction strategies. Results for the trial are presented graphically in Figure 2, Figure 3 and Figure 4:

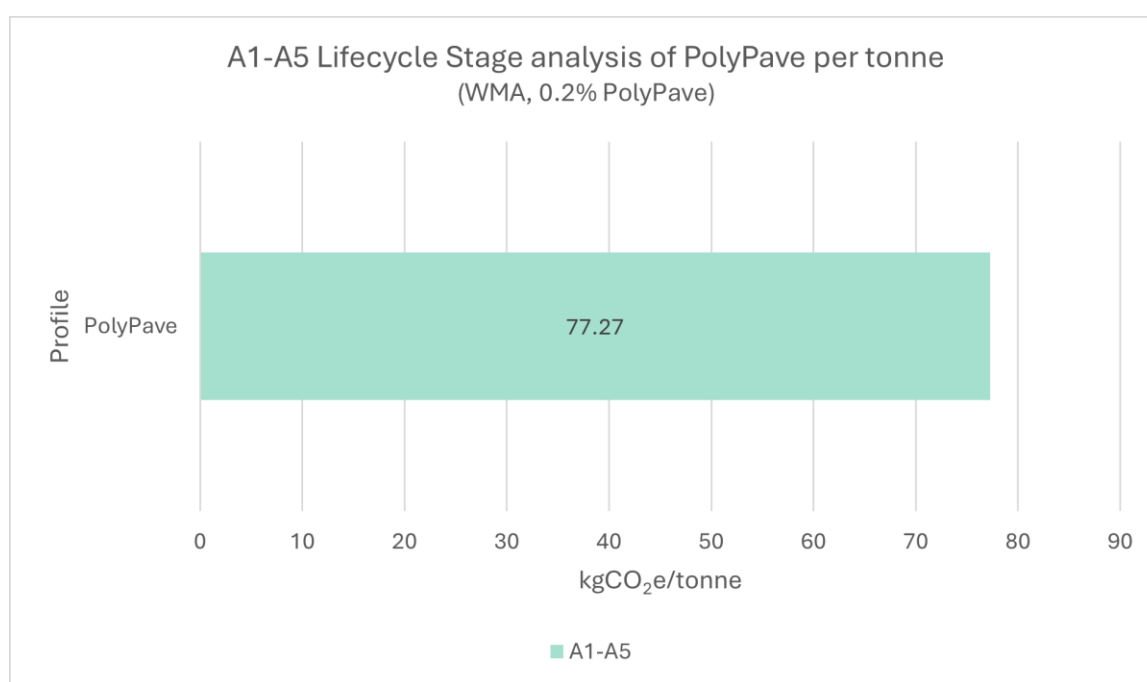


Figure 2: Carbon analysis of PolyPave (WMA, 0.2% PolyPave) per tonne

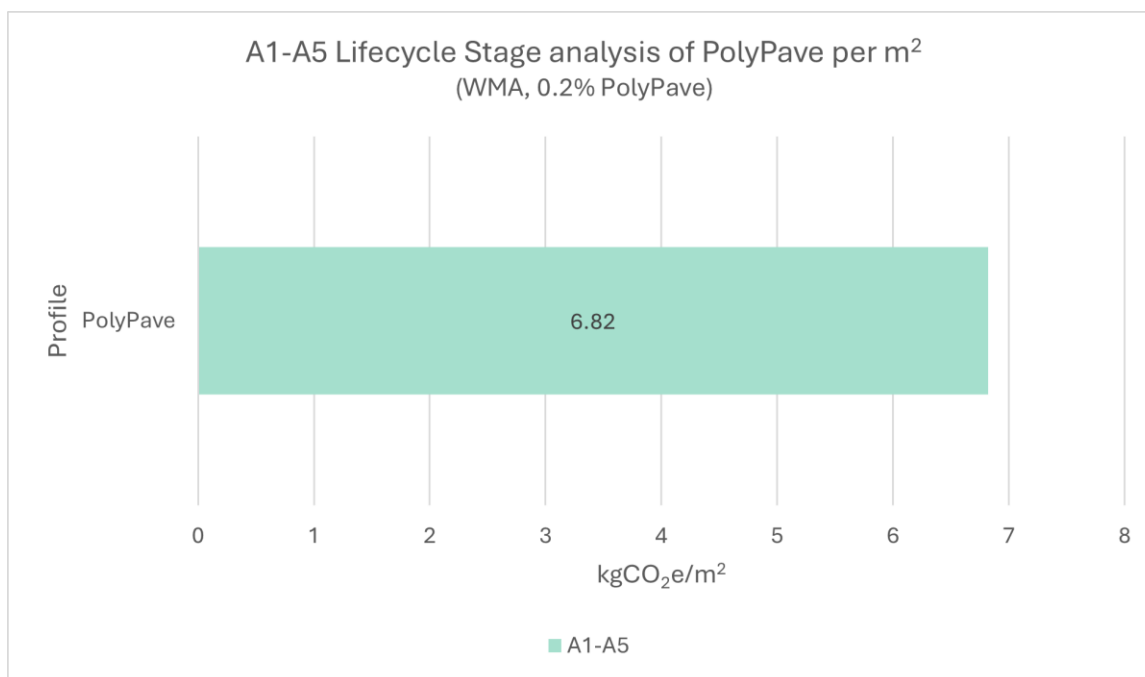


Figure 3: Carbon analysis of PolyPave (WMA, 0.2% PolyPave) per m<sup>2</sup>

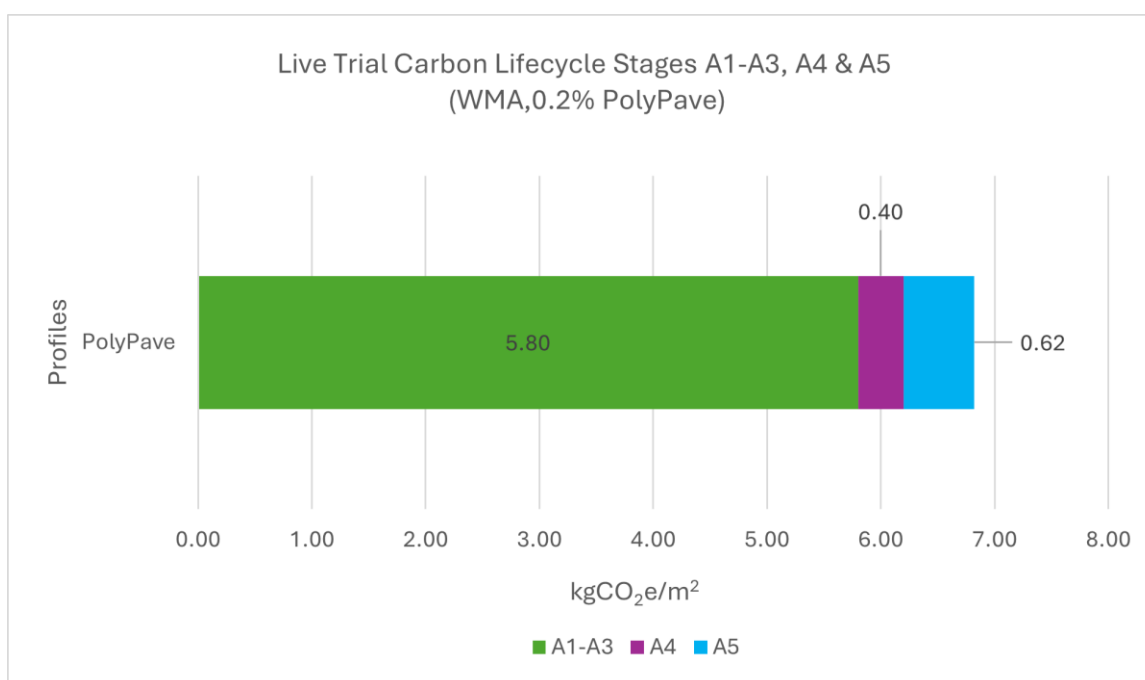


Figure 4: Carbon analysis of PolyPave (WMA, 0.2% PolyPave) lifecycle stages A1-A3, A4 & A5 per m<sup>2</sup>

## Benchmarking

PolyPave is yet to be fully evaluated against AC10 FyfePave in terms of performance and long-term viability in North Lanarkshire, as prior to this trial PolyPave had not been used in the UK. These trials are to allow for an analysis of the performance of PolyPave in comparison to conventional warm mix asphalt. This would be an alternative option for re-surfacing if PolyPave was not used. This allows for comparisons between PolyPave versus BAU surfacing within the carbon analysis.

Indicative comparative analysis results are presented graphically in Figure 5 and Figure 6:

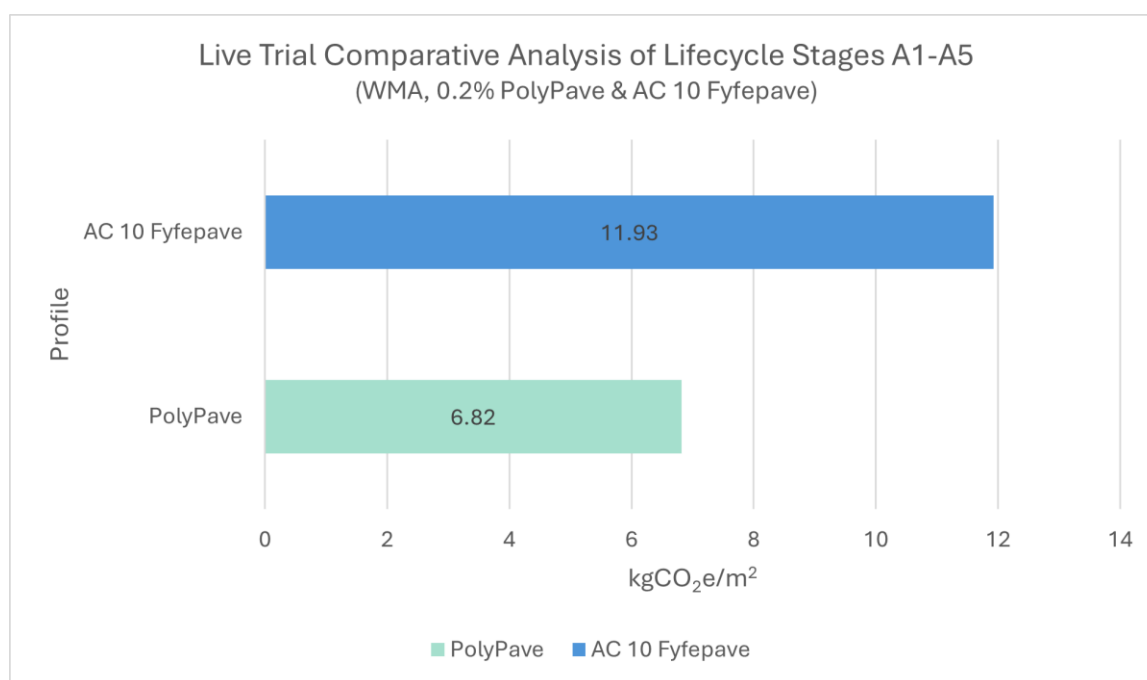


Figure 5: Comparative carbon analysis PolyPave versus AC10 FyfePave per m<sup>2</sup>

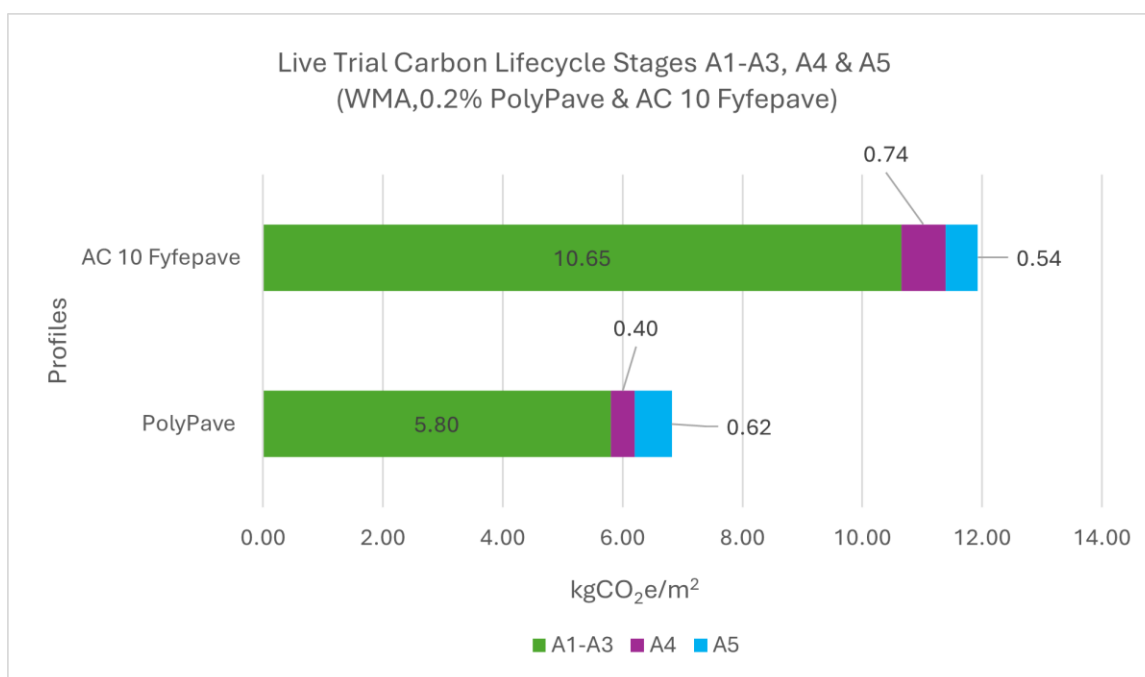


Figure 6: Comparative carbon analysis of PolyPave versus AC10 FyfePave lifecycle stages A1-A3, A4 & A5 per m<sup>2</sup>

| MATERIAL      | COMPOSITION                                                                                                                                                                                                                                                                                                                                                                                                                                             | APPLICATIONS                                                                                                                                     | PERFORMANCE                                                                                                                                                            | INSTALLATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | SUSTAINABILITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AC10 FyfePave | <p>FyfePave is a standard AC10 product produced to a EN 13108-1 AC recipe mix.</p> <p>It does not include any additives or modification mechanisms.</p> <p>Uses conventional bitumen binder (100/150 pen).</p>                                                                                                                                                                                                                                          | <p>FyfePave is typically used for low traffic areas such as car parks, footways and access roads.</p>                                            | <p>FyfePave is considered to have moderate durability, fatigue resistance and rutting resistance hence typical use is in low trafficked areas.</p>                     | <p>Follows conventional asphalt production methods and is laid to relevant BS standards.</p> <p>Application follows standard asphalt laying techniques.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>At the time of this assessment no specific sustainability claims for FyfePave were available. However, as FyfePave follows standard AC mix design, it can be assumed that it predominantly comprises of virgin materials, including aggregates, limestone filler and bitumen binder.</p> <p>FyfePave can incorporate reclaimed asphalt pavement (RAP), with approximately 5% RAP content included within the mix laid at Strathclyde Park.</p>                                     |
| PolyPave      | <p>PolyPave is an asphalt additive composed of ULDPE waste. Sima Environment claims that PolyPave acts as a bitumen extender, with the low-density polymer replacing a proportion of the bitumen binder.</p> <p>Sima Environment state that approximately 2kg of PolyPave can replace approximately 5kg of bitumen due to its low density.</p> <p>It can be added into standard asphalt mixes; in this trial it was added to standard AC10 at 0.2%.</p> | <p>It is assumed that PolyPave can be used in a variety of asphalt mixes, this includes warm mix asphalt (WMA) and hot rolled asphalt (HRA).</p> | <p>The manufacturer claims that PolyPave adds performance enhancements to the asphalt mix including improved stiffness, durability and reductions in deformations.</p> | <p>The PolyPave additive allows for asphalt modification at the plant prior to site arrival.</p> <p>Application follows standard asphalt laying techniques.</p> <p>Operational feedback for the Strathclyde Park trial described the material as slightly harder to work with on-site however it was generally in line with conventional equivalent materials.</p> <p>PolyPave was also planned to be involved in a previous Live Labs 2 trial however issues were experienced at the asphalt plant due to blockages in dosing systems due to its low density. However, PolyPave overcame this and it was successfully laid in the Strathclyde Park trial without any difficulties experienced at the asphalt plant.</p> | <p>PolyPave reduces the reliance on virgin binder due to its partial substitution of bitumen.</p> <p>This trial has demonstrated that PolyPave can be incorporated in WMA with a percentage of RAP (10%), demonstrating that it can be used alongside other carbon reducing technologies to maximise savings.</p> <p>Promotes circular economy principles using waste ULDPE. This avoids the incineration of waste plastic, as well as finding a use for problematic ULDPE waste.</p> |

Table 4: PolyPave Appraisal\*

\*All factors assessed as part of the appraisal of PolyPave has been built on supplier-provided material and are not drawn from the live trial, unless otherwise stated.

| Life Cycle Stage | Baseline Carbon Emissions (AC10 FyfePave)<br>(kgCO <sub>2</sub> e/m <sup>2</sup> ) | PolyPave Carbon Emissions<br>(kgCO <sub>2</sub> e/m <sup>2</sup> ) | Difference (%) (Increase/ Reduction) |
|------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------|
| A1 – A3          | 10.65                                                                              | 5.80                                                               | 45.56%                               |
| A4               | 0.74                                                                               | 0.40                                                               | 45.99%                               |
| A5               | 0.54                                                                               | 0.62                                                               | 14.89%                               |

Table 5: Lifecycle Stage Comparison to BAU

## Carbon Benefits and Considerations (Matrix)

Table 6 presents the findings of the carbon benefits and considerations matrix for PolyPave application as a surfacing material. **All scoring is bold and underlined.**

Technical data used during benchmarking and the carbon benefits and considerations matrix were supplied by the manufacturer and are not derived from the PolyPave live trials in North Lanarkshire. While reliance on supplier-provided information may introduce uncertainty in confidence levels, the information and data represents the best available evidence at the time of the appraisal. Data quality has been considered when selecting supplier information and, where possible, supplier values were chosen from manufacturers' standard test reports, specifications and product datasheets that reference recognised test methods and certification.

| BENEFIT/LOAD UNDER REVIEW      | CONSIDERATIONS                                     | SCORING SYSTEM                                                                                                                                                                                                                                         | JUSTIFICATION                                                                                                                                                                                                                                                                                   |
|--------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Costs                          | Transport, operational, material procurement       | 1 - Significant additional costs<br><b><u>2 - Costs approximate baseline</u></b><br>3 - Costs significantly lower than baseline                                                                                                                        | There is potential for cost saving due to the requirement for less bitumen in the mix.<br><br>However, any material procurement savings may be offset by additive processing and plant dosing requirements. Therefore, overall costs have been assumed to be approximate to the baseline.       |
| Maintenance                    | Design life, maintenance burden, on time for plant | 1 – Significantly more maintenance/lower longevity<br><b><u>2- Approximately same maintenance/similar longevity</u></b><br>3 – Significantly less maintenance/higher longevity                                                                         | Supplier information suggests that PolyPave provides improvements in stiffness and deformity resistance which may reduce maintenance demands. However, long-term service performance has not been independently verified.                                                                       |
| Scalability                    | Manufacturing facilities                           | 1 - Lab testing only<br><b><u>2 - In process of commercialisation w. small scale manufacture</u></b><br>3 - Already has market presence with developed supply chain                                                                                    | PolyPave is currently moving beyond the laboratory stage, and a production facility is reported to be operational in the UK, indicating a degree of commercialisation. However, this remains to be small scale with a still developing supply chain rather than a fully mature market presence. |
| Compliance with specifications | Requirements for standards departures              | 1 - Requires significant departure(s) from standard and has not been used before by end client<br><b><u>2 - Requires some departure from standard, but has been used before by end client</u></b><br>3 - Does not require any departure from standard. | The PolyPave additive is not a part of conventional standard AC10 recipe mixes. Therefore, requires project specific approval.                                                                                                                                                                  |
| Environmental                  | Nature-based solution                              | 1 - Would have significant net disbenefit for environmental factors                                                                                                                                                                                    | PolyPave is not a nature-based solution and is not expected to alter local                                                                                                                                                                                                                      |

| BENEFIT/LOAD UNDER REVIEW  | CONSIDERATIONS                                                                                           | SCORING SYSTEM                                                                                                                                                                                                                                                   | JUSTIFICATION                                                                                                                                                                                                                                                                                      |
|----------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            |                                                                                                          | (noise, AQ, biodiversity, landscape etc)<br><b><u>2 - Would have negligible net benefit/disbenefit or no overall change regarding environmental factors</u></b><br>3 - Would have significant net benefit/disbenefit for environmental factors.                  | environmental factors such as landscape, air quality or noise.<br>Its principal environmental benefit is considered to be carbon and waste reduction.                                                                                                                                              |
|                            | Road noise                                                                                               | 1 - Would have significant net disbenefit<br><b><u>2 - Would have negligible net benefit/disbenefit or no overall change regarding</u></b><br>3 - Would have a significant net benefit                                                                           | It is not anticipated that PolyPave will lead to any changes in road noise when compared to a conventional AC10 surface course                                                                                                                                                                     |
|                            | Climate resilience/future proofing                                                                       | 1 - Would have significant net disbenefit<br>2 - Would have negligible net benefit/disbenefit or no overall change regarding<br><b><u>3 - Would have a significant net benefit</u></b>                                                                           | PolyPave may improve resistance to deformation and reduce the demand for virgin bitumen.                                                                                                                                                                                                           |
| Risk and safety            | H&S impacts, safety testing data                                                                         | 1 - Would present increased risk or safety versus BAU option<br><b><u>2 - Would present no overall risk increase or safety impact versus BAU option</u></b><br>3 - Would present lower risk or safety impact versus BAU option.                                  | No increase in safety risk is anticipated when compared with conventional asphalt in terms of production and installation.                                                                                                                                                                         |
| Technology Readiness Level | Is it commercially available, is there enough R&D?                                                       | 1 - Not yet commercially available<br>2 - Commercially available from worldwide suppliers<br>3 - Commercially available from European suppliers<br><b><u>4 - Commercially available from UK suppliers</u></b><br>5 - Commercially available from local suppliers | PolyPave is commercially available from a UK supplier (Sima Environment) and has moved beyond pure R&D with an operational production facility in the UK.<br>The product is still at an early stage of market adoption.                                                                            |
| Constructability           | How easy is it to handle on site, install, recover, curing time, specialist equipment/training, storage? | 1 - Specialist contractors, time on site and/or equipment required<br><b><u>2 - No considerations required above and beyond baseline solution</u></b>                                                                                                            | PolyPave uses standard asphalt laying equipment and processes. No specialist plant is required for mixing or installation of the mix.<br>In a previous planned trial, experienced bridging/blockage issues within the gravity fed fibre dosing systems while mixing at the asphalt plant. This was |

| BENEFIT/LOAD UNDER REVIEW | CONSIDERATIONS        | SCORING SYSTEM                                                                                                                                                                                                                                                   | JUSTIFICATION                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                       | 3 - Significant benefits to on-site activity / ease of installation                                                                                                                                                                                              | experienced due to the low density of the additive however Sima Environment overcame these issues with modifications leading to successful mixing and application at the Strathclyde Park trial.                                                                                                                                                                               |
| Supply Chain              | Material availability | 1 - Novel materials used with limited supply<br>2 - Materials are available with some supply restrictions<br><b>3 - Materials are readily available</b>                                                                                                          | ULDPE is an unrecyclable waste product that traditionally is disposed of via incineration. This suggests that the material for the additive should be readily available in the UK.                                                                                                                                                                                             |
| Circular Economy          | Recycled content      | 1 - Virgin materials are used with little or no recycled content<br>2 - Materials contain a level of recycled content<br><b>3 - Materials are predominantly recycled and/or use novel sources of recycled content that would otherwise be discarded as waste</b> | PolyPave is manufactured from waste ULDPE that would otherwise require disposal, including incineration, and it displaces a proportion of virgin bitumen in the asphalt mix.<br><br>This demonstrates strong circular economy principles using a novel recycled feedstock that would otherwise be discarded as waste due to a lack of conventional routes in the UK.           |
|                           | Ease of recycling     | 1 - Minimal recycling of material possible upon removal<br><b>2 - Limited recycling is possible and/or significant reprocessing required</b><br>3 - Reuse/recycling is easy and convenient                                                                       | Asphalt incorporating PolyPave can likely still be removed and recycled as RAP in principle due to its small dosage in the overall asphalt mix.<br><br>However, the effect of repeated recycling on mixes containing PolyPave is not yet well evidenced.<br><br>Therefore, recycling is considered possible, although some uncertainty and reprocessing considerations remain. |

Table 6: Carbon benefits and considerations matrix

# Long-Term Performance Analysis

The carbon analysis within this report does not contain lifespan analysis. This will be finalised dependent upon the publishing of longevity test results in partnership with the University of Nottingham.

These tests will focus on the following:

- Durability and Aging Resistance,
- Skid Resistance and Surface Integrity,
- Lifecycle Carbon Savings,
- Traffic and Environmental Stress Testing,
- Optimal Reapplication Intervals.

# Conclusion & Recommendations

## Conclusions

The PolyPave live trial has demonstrated that the use of Ultra Low-Density Polyethylene (ULDPE) as an asphalt additive presents a promising opportunity to reduce the carbon emissions of asphalt within local highway applications. The incorporation of PolyPave at a dosage of 0.2% with a warm mix asphalt has shown a 42.83% reduction in A1-A5 lifecycle stage emissions when compared to a conventional AC10 FyfePave mix. These reductions are primarily attributed to the partial replacement of virgin bitumen through the substitution with PolyPave which utilises waste derived ULDPE that otherwise would be incinerated. Long-term durability, maintenance requirements and end of life performance have not yet been confirmed. These factors will be important in determining whether the carbon benefits identified at A1-A5 are maintained across the full asset lifecycle.

Operationally, the trial has shown that PolyPave can be successfully incorporated into standard asphalt production processes and laid using conventional plant and equipment. While the initial trial attempt identified challenges associated with dosing and material handling due to the low density of the additive, these issues were subsequently resolved, indicating that constructability risks have been mitigated.

The absence of a third-party EPD and reliance on proxy carbon assumptions does introduce a level of uncertainty around the reported product specific carbon benefits. However, this does not remove the potential benefits identified through the trial and considering Sima Environment is an SME, at the early stage of development, the cost and resource demands of obtaining an EPD should be considered.

Overall, the trial indicated that PolyPave has potential as a low carbon asphalt additive for local highway applications, particularly where carbon reduction and circular economy outcomes are key objectives. However, wider implementation should be dependent on awaiting long-term performance information is available.

## Recommendations

To support the progression of PolyPave from this trial to wider implementation, it is recommended that a programme of long-term monitoring is undertaken at trial sites over a minimum of five years. This further monitoring will allow for more expansive carbon modelling to assess end-of-life scenarios to provide a more comprehensive understanding of whole lifecycle carbon emissions.

The next steps for Sima Environment should be to make progress towards the development of independently verified carbon data. This should include the production of a third-party verified Environmental Product Declaration (EPD) in accordance with EN 15804. The availability of verified data will improve validity, enable robust benchmarking and strengthen confidence in reported carbon savings, particularly when comparing PolyPave against established materials.

When verified figures are available further carbon modelling should be undertaken. Future assessments should move beyond the use of proxy assumptions and incorporate product-specific primary data where available and then expand the assessment scope beyond A1–A5 lifecycle stages to include whole-life carbon emissions.

Consideration should also be given to the role of PolyPave within a circular economy framework beyond initial installation. Further investigation to understand how PolyPave-modified asphalt behaves during milling, processing, and reuse as reclaimed asphalt pavement (RAP) should be explored. This will determine whether the circular benefits associated with the additive can be realised across multiple lifecycle stages.

If future trials of PolyPave are commissioned, consideration should be given to distinguishing the carbon reduction contribution of PolyPave from that of other mix design modifications. Where practicable, future trials should seek to isolate the effects of PolyPave from variables such as WMA additives and RAP content, to improve understanding of the additive's specific contribution to overall carbon reduction.

Subject to independently verified carbon data, it is recommended that a programme of expanded trials should be undertaken across a wider range of road types, traffic conditions, and asphalt mix designs. This should include trials on higher traffic routes and testing of varying additive dosages to establish optimal carbon reduction. This broader evidence base will support decision-making and provide the confidence required for future business-as-usual implementation. Future trials should include data capture for material quantities, transport, plant use, laying conditions, cost, defects, maintenance interventions and end-of-life recyclability. This will support more robust whole-life carbon and cost assessment and provide the evidence base required to determine whether PolyPave is suitable for wider business-as-usual implementation.