WESSEX LIVE LAB - FINAL REPORT

AUTHORITY CASE STUDY

HAMPSHIRE COUNTY COUNCIL

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1 INTRODUCTION

As a leading local authority Wessex Live Lab partner, Hampshire County Council, supported by its term contractor M Group Highways, has conducted real-world trials to evaluate decarbonisation methods across the highway maintenance asset lifecycle. These investigations endeavoured to achieve carbon reduction across a full spectrum of operations, ranging from large-scale engineering works to routine maintenance and operational activities, by testing innovations across vehicles, plant, fuel, power, and circular materials. Driven by the Council's Climate Emergency declaration and its commitment to achieving carbon neutrality by 2050, the trials sought to accelerate innovation adoption and reveal system-level opportunities across these technical areas.

Beyond these operational shifts, the project aimed to move past purely carbon-centric maintenance metrics, by exploring how enhanced survey solutions and the principles of Doughnut Economics could help integrate social, ecological, and carbon objectives into a more holistic decarbonisation model. The overarching goal for the project was to foster organisational behavioural and cultural change while developing data-driven decision tools. Through these efforts, the project has aimed to provide scalable outcomes, and live insights that can serve as a replicable blueprint for UK-wide highway adoption.

Hampshire utilised three strategic corridors as live laboratories. These corridors have aimed to act as test beds for an iterative process of trialling and refining a full suite of maintenance activities. Aligned to this, Hampshire also trialled fully scaled, service-wide innovations to better understand the constraints and opportunities for fast-paced business-as-usual adoption.

Hampshire has utilised a Carbon Analyser tool developed with the Future Highways Research Group (FHRG), to produce a carbon baseline for the service and to provide standardised comparable evidence-based carbon assessment.

Supported by the University of Exeter, Hampshire alongside its local authority partners has worked to pioneer Carbon Budgeting, providing a quantitative link between site-specific activity trials and national net-zero targets.

2 TRIAL LOCATIONS

Three Hampshire corridors were selected to represent typical highway asset and operational conditions across Hampshire's network in the north, southeast and southwest of the county, to accord with the OBC strategy for corridor trials to act as proxies for wider network decarbonisation. The southeastern corridor was originally routed along the B2150 between Droxford and Denmead, however, to take advantage of more immediate maintenance activities, the decision was taken to shift the location to the adjoining section of the A32 between Droxford and Filmore Hill. For clarity, the geographic scope of the corridors was back of verge to back of verge, within the highway boundary for the full corridor length.

Figure 1 below, shows the Wessex Live Labs 2 locations, with the Hampshire Corridors being routes 4, 5 and 6.

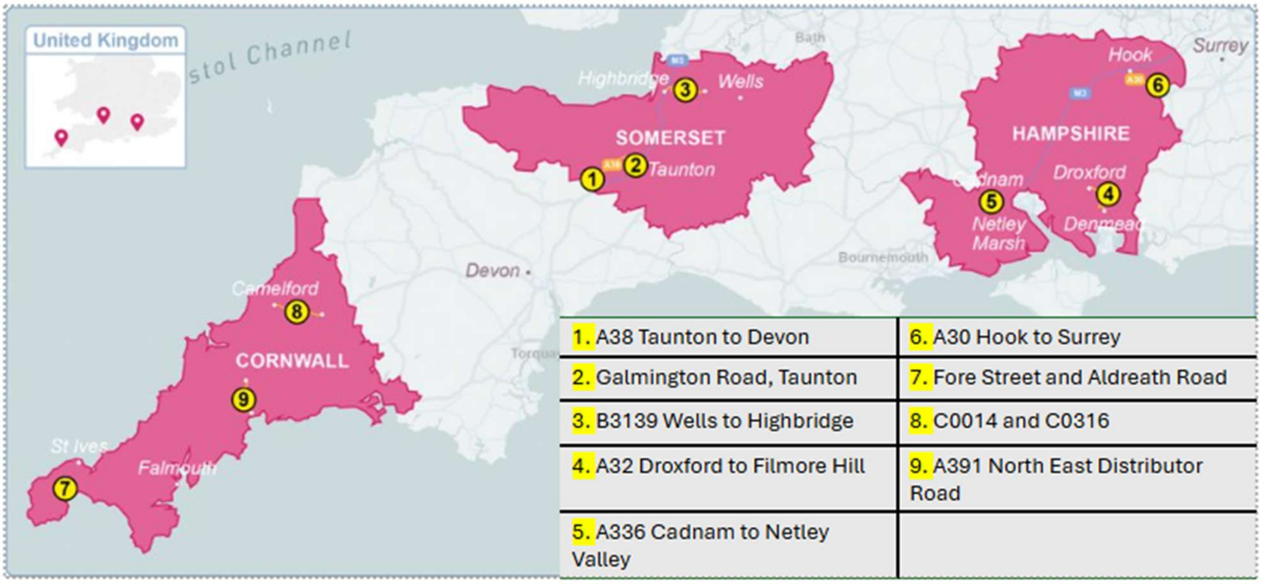

Figure 1: *Wessex Live Labs 2 Locations*

A30 Hook to the Surrey County Boundary

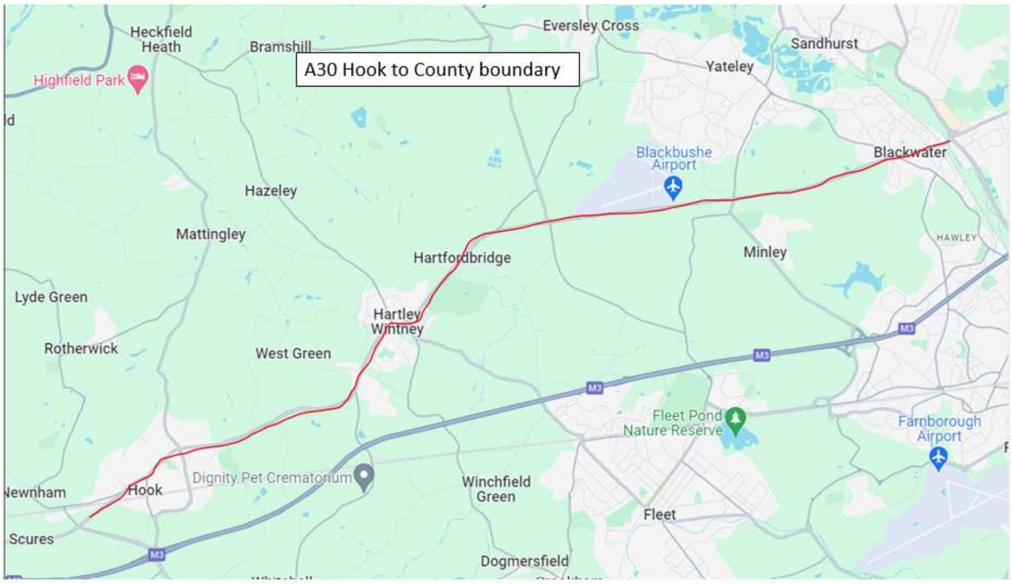

Figure 2: *A30 Hook to the Surrey County Boundary*

This corridor is a vital 16km primary A road section of the A30 in north-east Hampshire, extending from Hook to the Surrey boundary. The route traverses a mixed environment, comprising an 11km rural and 5km urban split, with street lighting through its settled sections. As a major arterial link running parallel to the M3, it serves as the primary strategic diversionary route for the motorway network. Traffic usage is highly volatile; while primarily an inter-urban commuter link with 40–60mph limits, the corridor adapts to handle large spikes in strategic HGV and car volumes during motorway incident and closure events.

The corridor contains an extensive range of highway assets requiring a proactive maintenance regime to manage its role as a high-capacity overflow route. Footway provision is extensive within the Hook and Blackwater urban areas, while cycle infrastructure is mixed, featuring shared-use paths that transition into shared-carriageway sections. Recent infrastructure improvements have focused on creating protected cycle and pedestrian routes near the Surrey border. Consistent with its high-speed nature, vehicle restraint systems are installed on embankments and bridge approaches.

A336 Cadnam to Netley Marsh

Figure 3: *A336 Cadnam to Netley Marsh*

This corridor is a busy 5km primary A road section of the A336 situated in south-west Hampshire, linking Cadnam with Netley Marsh. Functioning as a New Forest gateway, the environment is varied, comprising approximately 3km of developed urban roadway and 2km of rural transition, with street lighting provided throughout the residential and commercial sections. The route serves as a key arterial link connecting M27 Junction 1 with Totton and the western outskirts of Southampton. The traffic mix has historically been defined by heavy HGV movements serving industrial hubs, though stringent 7.5-tonne weight limits and 30–40mph speed zones now better regulate this flow.

The corridor contains a variety of highway assets requiring diverse maintenance interventions to support high traffic volumes. Pedestrian safety is prioritised through continuous footways throughout the 3km urban section in Cadnam and Bartley, providing safe access to residential areas and schools. While there are no fully segregated cycle tracks, the route is a key access point for cyclists entering the New Forest, with speed management used as a primary safety measure. Vehicle restraints are limited, consisting mainly of guardrails at signalised junctions and pedestrian crossing points to prevent kerb-mounting.

A32 Droxford to Filmore Hill

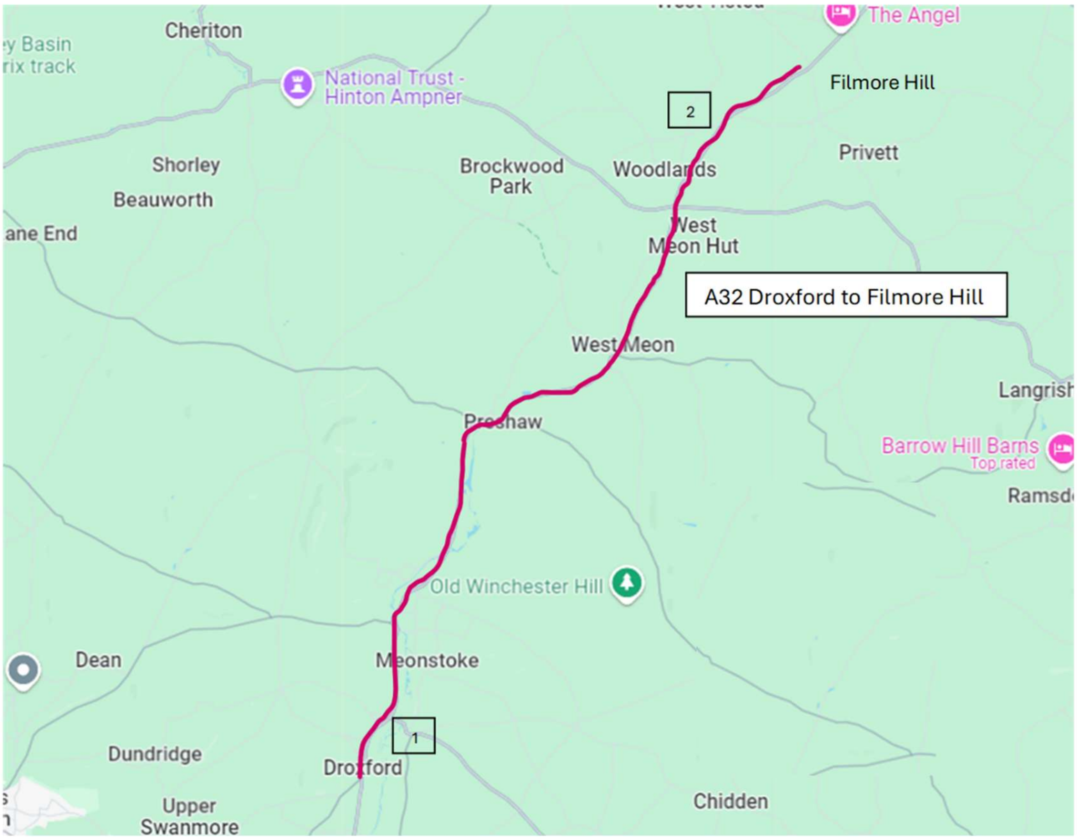

***Figure 4**: Droxford to Filmore Hill*

This corridor is a strategically important 12km non-primary A road section of the A32 between Droxford and Filmore Hill in south-east Hampshire. The corridor is a scenic and predominantly rural, including the linear village of Droxford and several nucleated settlements along the Meon Valley, situated entirely within the South Downs National Park. The route serves as a major connection between Fareham and Alton, intersecting with the A272 at the West Meon Hut junction. Its traffic mix is unique for its high volume of leisure motorcyclists and agricultural machinery, with speeds locally managed by average speed cameras to maintain the 50–60mph limit.

The corridor contains a variety of highway assets with specific maintenance requirements. Footways are limited primarily to the settled section of Droxford village, where formal pavements support local pedestrian movement. The rural 11km stretch largely lacks continuous footways, consistent with its rural nature. There are no dedicated or segregated cycle lanes on this section with cyclists typically sharing the main carriageway with vehicles. Vehicle restraints are concentrated around higher-risk rural bends and the approach to the West Meon Hut junction. Structures are predominantly single-span culverts and small bridges across the River Meon and its tributaries.

Table 1 below, lists all the corridors' summary characteristics.

Category	Characteristic	A30 Hook to Surrey border	A336 Cadnam to Netley Marsh	A32 Droxford to Filmore Hill
Length	Urban - km	5	3	1
	Rural - km	11	2	11
Road Classification	Primary (A Road)	A	A	A
	Evolved roads	Probably	Probably	Probably
Corridor Use	Freight routes	Yes	Yes	No
	Bus routes	Yes	Yes	Yes
	National Highways Diversion Route	Yes	Yes	No
	Winter maintenance network	Yes	Yes	Yes
	Traffic sensitive	Yes	Yes	No
Maintenance	Planned	Resurfacing and Surface Dressing	Surface Dressing	Resurfacing
	Reactive	Yes	Yes	Yes
	Gully Cleansing	Yes	Yes	Yes
	Drainage (Jetting)	Yes	Yes	Yes
	Drainage (Grip/Ditch Clearance)	Yes	Yes	Yes
	Structural Maintenance	RS	RS	RS
	Surfacing Dressing	SD	No	No
	Salting	Yes	Yes	Yes
Features	Street lighting	Yes - Only in settlements	Yes - Only in settlements	Yes - Only in settlements
	Footway and cycleways	Yes	Yes	Yes
	Vehicle restraints	Yes	Yes	Yes
	Street furniture	Yes	Yes	Yes
	Traffic signals	Yes	No	Yes
	Statutory Undertakers Plant (Utilities)	Yes	Yes	Yes
	Verges	Yes	Yes	Yes
	Lining	Yes	Yes	Yes
	Illuminated Traffic Signs	Yes	Yes	Yes
Community	Local resources carrying out maintenance e.g. Parish Stewards	In Part - 2 of 3 Parishes	Yes - 2 Parishes	In Part - 2 of 3 Parishes
	Local highway supply depot	Mitcheldever	Totton	Bishops Waltham
Structures	Multi-span bridges	Yes - 7 no. plus 1 no. footbridge	Yes - 1 no.	Yes - 3 no.
	Ancient structures	No	No	Yes - 1 no.
	Culverts	Yes	Yes	Yes
Drainage	Positive Drainage Systems	Yes - in part	Yes - in part	Yes - in part
	Over the edge drainage	Yes - in part	Yes - in part	Yes - in part

***Table 1**: Corridors' summary characteristics*

Expansion to Service-Wide Measures

The expansion of trials beyond the initial demonstrator corridors was a strategic shift designed to accelerate innovation testing at a wider operational scale, with an aim to more quickly determine their suitability for business-as-usual (BAU) adoption.

By moving beyond the geographical limitations of corridors, the project could implement measures that only deliver significant carbon benefits when applied at scale. For example, the gully waste recycling initiative at the Northington plant is forecast to save 129tCO2e annually, representing 0.6% of Hampshire's baseline emissions. Further to this, certain strategic enablers, such as alternative fuels and waste recycling infrastructure, function more effectively as part of broad service operations. Expanding the trials allowed for a more realistic assessment of how these innovations would perform within real-world highway maintenance requirements.

Service-level implementation also allowed scaled innovations supporting circular economy practices such as the reuse of Type 1 materials. Ultimately, this expansion allows for a better evaluation of the long-term feasibility of various innovations, accelerating the transition to lower-carbon maintenance practices across the entire sector.

3 INNOVATIONS

Overview of Strategy

Hampshire County Council sought to adopt a proactive and collaborative approach to innovation with a primary goal to achieve a "step change" in the normalisation of reduced carbon techniques and materials within its highway maintenance service, underpinned by a minimum 30% carbon reduction target for the trials.

Early Contractor Involvement (ECI)

A cornerstone of Hampshire's approach was the formal engagement of the term maintenance contractor, M Group Highways (formerly Milestone), through a dedicated ECI Task Order. By involving the contractor, designer, and supply chain during the pre-trial phase, the project allowed for the integration of specialist knowledge to help optimise carbon savings through the innovation design, implementation and delivery stages. The ECI process specifically sought advice on innovative materials, beneficial carbon savings, and optimisation of working methods.

Targeted Innovation Assessment

Proposals were validated using a Carbon Analyser tool to model and baseline emissions, to support evidence-based decisions, improving confidence that the chosen innovations should provide measurable carbon saving.

Service-Wide Innovation Mapping

To ensure a comprehensive exploration of highway operations, Hampshire's approach utilised service-wide mapping to identify innovation opportunities across all facets of the service including:

- Strategic and Policy Level: The project reviewed specifications, standards, and local sourcing strategies.
- Operational and Technical Assets: Innovations were explored in vehicles, plant, materials and energy.
- Socio-Ecological Integration: A unique element of this project was the trial of Doughnut Economics, which sought to balance social and environmental impacts in strategic and project level decision-making.
- Lifecycle Management: Innovation was mapped across both planned works—such as the 1st Tranche schemes at Hartley Wintney and Haywards Cottage—and cyclic activities, including drainage and sign cleaning.

By combining structured contractor engagement with broad innovation mapping, Hampshire delivered specific carbon-reducing schemes but also aimed to develop the tools needed to implement net-zero opportunities across the wider highway maintenance sector.

Selection and Scoring

Innovations were selected for each activity on the corridors through a process of iterative evaluation as illustrated in the 'Innovation Funnel' shown in *Figure 5*. A longlist of innovations was firstly collated from various project partners into an Innovations Opportunity Register, from which a shortlist of potential innovations was selected for each corridor by Hampshire County Council and M Group. Shortlisted innovations were then assigned a normalised weighted score in terms of their attractiveness, achievability, and sustainability using the Strategic Change Portfolio Management module of Carbon Analyser. Finally, the innovation scorecards were exported from Carbon Analyser and uploaded to a Power BI dashboard (*Figure 6*) whereupon where feasible, the top-scoring innovations were identified and trialled on the corridors; if not, the theoretical carbon savings that would have been achieved were simulated in the Carbon Analyser / Carbon Profiler Toolkit. In the interests of expediency, further innovations identified by Hampshire County Council and M Group Highways in the later phases of the Live Labs programme were scored directly, bypassing the innovation longlist and innovation-activity mapping phases of the process.

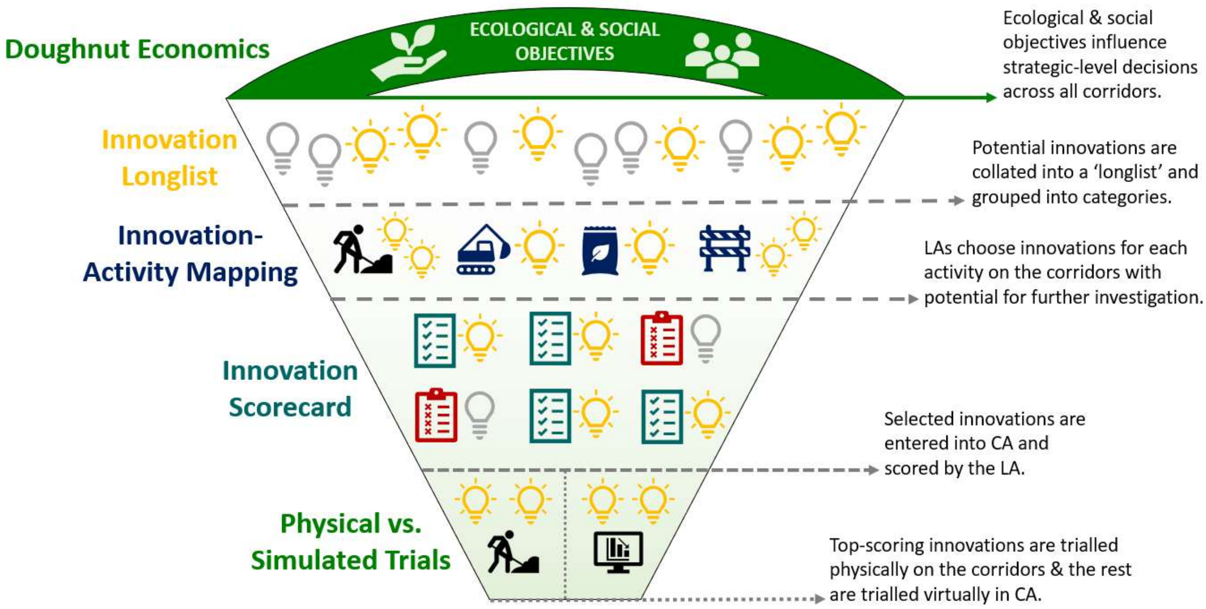

Figure 5: *Innovation Funnel illustrating the process of innovation selection and scoring.*

As shown in *Figure 6* the five top-scoring innovations were as follows:

1. **Recycled Type 1 aggregate –** 72.2 (joint most achievable and sustainable)
2. **Asphalt reheater trial –** 68.7 (joint most sustainable)
3. **Gully waste recycling unit –** 58.5 (most attractive)
4. **Ex-situ Foamix CRBM (cold recycled bound material) –** 56.4
5. **7.5t Electra HGV –** 54.7 (joint most sustainable)

Note, these scores are based upon the assessment of the Live Labs project team and are intended as a comparative indicator of the expected environmental performance and desirability of each innovation within the context of the Hampshire Live Labs 2 trials.

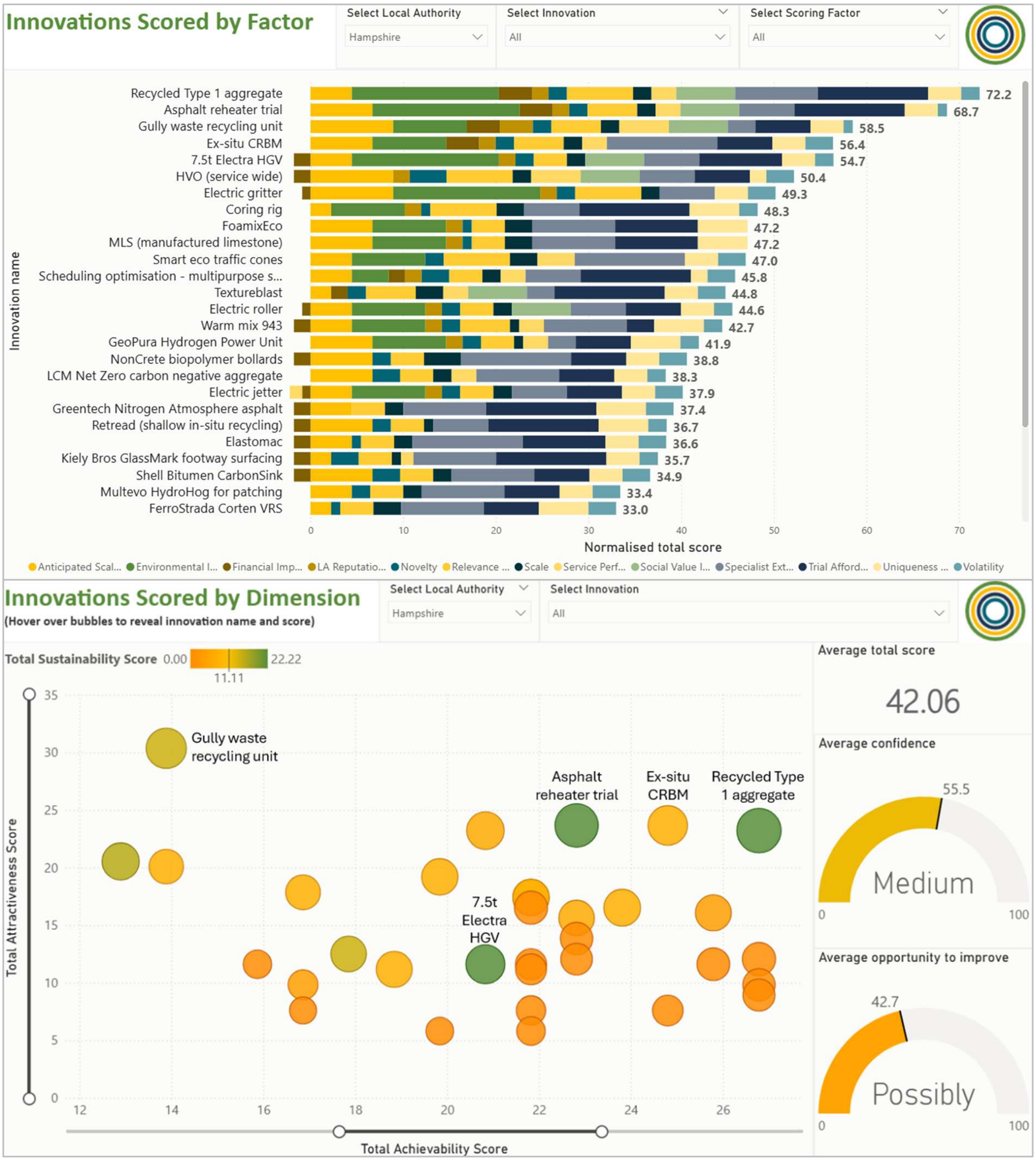

Figure 6: *Innovations scored by each of the 13 scoring factors (top) and 3 dimensions (bottom).*

Multevo Hydrovo

Project Overview

The Multevo Hydrovo was deployed to conduct essential maintenance across the A30 and A32 corridors. The trial focused on high-intensity patching and siding-out operations to evaluate the carbon-reduction potential of hydrogen-combustion technology in a frontline highway environment.

Selection

The Hydrovo was selected for its ability to significantly reduce tailpipe emissions without compromising the high-torque performance required for road planing and heavy-duty maintenance. By substituting diesel with hydrogen (dual-fuel), the unit provides a transitionary solution for heavy plant that currently lacks viable battery-electric alternatives. The unit's ability to swap attachments allowed it to function as a patch planer and siding-out tool, reducing the total number of plant items required on-site. To maximise decarbonisation, the trial utilised Hydrovo technology alongside Hydrotreated Vegetable Oil (HVO) fuel for the supporting fleet and equipment.

Operational Performance

The 13-shift trial demonstrated the Hydrovo's high productivity in a live highway environment:

- Total Repairs: 2271m^2 of permanent repairs completed.
- Quantity: 126 individual patches addressed.
- Logistics: 471 miles driven across the A30/A32 corridors.
- Supporting Fleet: The operation was supported by a 26t Hotbox, 15t Sweeper, Ride-on Roller, and 3.5t Welfare units, all integrated into the low-carbon refuelling strategy.

Carbon Benefits and Environmental Impact

The trial successfully quantified the "Carbon-Saved" metric for small-to-medium scale maintenance interventions:

- Total Emissions Saved: 10,400 kg CO2e saved during the transport and construction phases.
- Efficiency Metric: The methodology achieved a saving average of 4.5 kg of CO2e per square metre of repair compared to traditional diesel-only operations.
- Decarbonisation Vector: These savings were achieved through the dual-fuel hydrogen combustion in the Hydrovo and the displacement of white diesel with HVO across the secondary plant (Sweepers, Rollers, and Hotboxes).

Conclusion

The A30/A32 trial confirms that the Multevo Hydrovo holds potential to provide a viable, high-productivity alternative to conventional diesel plant. For end-of-project reporting, the data demonstrates that hydrogen-integrated workflows can deliver immediate, scalable carbon reductions while maintaining the pace of permanent "first time fix" repairs required for strategic corridors.

OCL Foamix - Cold Recycled Bound Material (CRBM)

Technical Objective and Innovation

The primary objectives of the OCL Foamix trial was to evaluate the structural and environmental performance of Cold Recycled Bound Material (CRBM) as a high-performance alternative to traditional AC20 binder course and Hydraulically Bound Material (HBM), and to assess the carbon savings when recycling and batching this material at a local plant over a national plant.

The innovation centres on an ex-situ cold-mix recycling process at Hampshire County Council's Micheldever Recycling Depot. This process facilitates the encapsulation of Asphalt Waste Containing Coal Tar (AWCCT), converting a hazardous waste stream into a compliant, structural road-base material (SHW Clause 94) while eliminating the energy-intensive heating required for conventional hot-mix asphalts.

Operational Methodology and Engineering Controls

The OCL Foamix trial took place on the A32 between Woodlands and Filmore Hill, and involved a 14,000m² site area, utilizing a 100mm planing depth for haunching repairs and a 60mm CRBM overlay, topped with a 40mm Hot Rolled Asphalt (HRA) surface course. To maximise plant and vehicle utilisation, a dual-load backhauling strategy was implemented. Utilising split-tail HGVs, the project synchronised the disposal of 2,200 tonnes of site-won planings with the delivery of 3,500 tonnes CRBM in a single circular trip.

A Vögele MT 3000-3 Power Feeder was deployed to provide a non-contact, continuous material feed to the pavers. This mitigated the risk of mechanical damage to the 100mm haunching joints by eliminating HGV trafficking on the prepared sub-base and ensured consistent material temperature and density during placement.

The adoption of a 24/7 working window, facilitated by the efficiencies of the dual-load model, compressed the construction programme from a baseline of 40 shifts to 15 shifts, a 62.5% reduction in network occupancy.

Carbon Mitigation

The trial achieved a verified reduction in Scope 3 emissions through three primary routes:

- Material Embodied Carbon: CRBM delivered a 39.4% CO2e saving over AC20, driven by its 90% recycled aggregate content and cold-mix production process.
- Logistical Efficiency: The dual-load model reduced HGV requirements from 285 to 175 journeys, saving 12.2 tonnes of CO2e.
- Network Impact: The 25-day programme reduction avoided 400,200 miles of traffic diversion, preventing an estimated 803 tonnes of CO2e in tailpipe emissions from the public.

Outcomes

By internalising the processing of 2,200t of waste, including 600t of hazardous coal tar, the project avoided significant external disposal costs. Further cost avoidance was also achieved through the reduced traffic management duration, plant hire periods, and fuel consumption.

Structural Evaluation & Longitudinal Performance

A six-month post-construction review indicates high structural integrity across the majority of the 2,000m linear site. Minor cracking (approx. 25m section) was observed; technical analysis suggests this is localised edge-failure due to verge geometry rather than a deficiency in the CRBM binder.

Conclusion and Recommendations for BAU Adoption

The A32 trial confirms that CRBM is a technically equivalent and commercially superior alternative to traditional asphaltic binder courses. Early-stage contractor and client collaboration is essential to manage the specific curing requirements of CRBM (>24 hours) and to mitigate the risks associated with cold-weather placement. Following this success, future iterations will focus on the integration of bio-binders and warm-mix technologies to further drive Hampshire's highway maintenance net-zero trajectory.

Textureblast Retexturing

Project Overview

The Textureblast captive shot blast treatment was deployed at the A336 / A31 Cadnam Roundabout as a sustainable alternative to traditional resurfacing. Whilst this is very much an established process, the objective was to assess and record the carbon savings available, through restoring skid resistance and extending the asset's service life. An area of 2,362m² of existing pavement was treated that remained structurally sound but had become polished.

Technical Methodology

The Textureblast system utilised a high-velocity HGV-mounted captive shot blast unit to mechanically re-profile the surface aggregates. By recycling the steel shot in a closed-loop vacuum system, the process restored both micro-texture and macro-texture without damaging the pavement's structural integrity. This mobile works approach allowed for rapid intervention with minimal traffic disruption compared to conventional planing and paving.

Operational Logistics and Site Data

- Primary Plant: 1x HGV Diesel Textureblast Unit.
- Support Plant: 1x Transit Van (Welfare Unit).
- Plant Transit: 142 miles total (50 miles from preceding site in Dorset; 92 miles return to Wellington, Somerset).
- Site Supervision: 3x HCC staff (42-mile round trip from Winchester via diesel vehicle).
- Traffic Management: 1x Impact Protection Vehicle and 2x 3.5t pickups (22-mile transit from Eling Wharf, Totton).

Sustainability and Carbon Performance

While a loss of texture might normally be managed through treatments such as surface dressing or application of a micro asphalt, these options were not suitable due to the road layout. This left the options of resurfacing with a 45mm HRA with pre-coated chippings, or a captive shot retexture. The project delivered significant carbon savings by avoiding the HRA.

By delaying the need for 45mm HRA resurfacing, the project bypassed the high embodied carbon associated with bitumen production and the quarrying of virgin aggregates. Based on independent validation, the Textureblast process typically generates 0.32kg CO_2e/m^2, representing a 98% carbon reduction compared like-for-like with HRA resurfacing. This reduces to 0.55kg CO_2e/m^2 (91%) when adjusted for longevity over a 40-year period, assuming a 3-5 year lifespan for retexturing and 20-25 years for resurfacing. The treatment successfully preserved the existing surface course in-situ, eliminating the need for the disposal of planings and the procurement of new high-PSV stone.

Metric	BAU Resurfacing	Textureblast Innovation
Intervention	45mm HRA + Pre-coated Chips	Captive Shot Blast Retexturing
Emissions process/m²)	11.50 kg CO2e	0.32 kg CO2e
Total Process Emissions	27,163 kg CO2e	749 kg CO2e
Logistics Emissions	(Not calculated*)	245 kg CO2e
Total Estimated Carbon	**27.16 Tonnes CO2e**	**0.99 Tonnes CO2e**

**BAU logistics typically involve significantly higher emissions due to heavy plant transport, asphalt delivery lorries, and waste disposal trucks.*

Table 2: *Carbon Comparison Summary: BAU resurfacing v Textureblast A336 / A31 Cadnam Roundabout (based on 2,362m²)*

Estimated Total Savings

The use of Textureblast at Cadnam Roundabout resulted in an estimated like for like saving of 26.17 tonnes of CO2e or 25.86 tonnes of CO2e against a 40-year timespan.

Technical Breakdown of Savings

- Material Preservation - by restoring the existing surface in-situ, the project avoided the production and transport of approximately 250+ tonnes of new asphalt (assuming 45mm depth).
- Process Efficiency - the Textureblast HGV unit and support vehicles contributed 0.25 tonnes of CO2e in transit and operational logistics, including the 142-mile HGV journey and staff/TM travel.
- Overall Impact - this intervention represents a 96.3% reduction in carbon emissions for the treated area compared to a full surface replacement.

Conclusion

The application at Cadnam Roundabout demonstrates a low-carbon, high-efficiency model for junction maintenance. The results support the Wessex Live Lab's objective of assessing and measuring available treatments that balance road safety needs with stringent net-zero targets.

AiDash

Project Overview

AiDASH AI-driven satellite mapping technology was trialled on the three corridor routes to assess the benefits of modernising how environmental data is captured. By replacing traditional, higher-cost desk studies with automated habitat mapping, the surveys aim to deliver rapid, high-resolution insights at a lower cost. The data quickly equips highway maintenance teams to proactively identify opportunities for carbon reduction, Biodiversity Net Gain (BNG), and added social value. This data-driven approach supports the project's Doughnut Economics goals, for promoting highway maintenance activities with improved awareness to better consider the needs and requirements for ecological protection and improved community wellbeing.

Objectives

The primary objective was to assess whether AiDash could:

- Provide a more efficient and scalable baseline of existing habitats
- Improve identification of biodiversity enhancement opportunities
- Support highway maintenance decision-making aligned with improved carbon, natural capital, and ecosystem service outcomes

Approach and Methodology

The project followed a structured methodology:

1. Definition of Corridor Boundaries
   Redline boundaries were established using GIS (based on a 25m buffer and refined using asset and land ownership data).

2. Baseline Habitat Mapping
   AiDash was used to map habitat types, condition, and biodiversity units across approximately 185 hectares using satellite imagery and AI classification.

3. Data Integration and Analysis
   Habitat data was combined with environmental constraints, scheme extents, and socio-environmental datasets to create a comprehensive spatial baseline.

4. Opportunity Identification
   Multidisciplinary review identified areas for:

   - Habitat enhancement and connectivity
   - Ecosystem service improvements (e.g. noise, air quality, drainage)
   - Alignment with wider corridor interventions

5. Stakeholder Workshop
   Findings were tested and refined through a collaborative workshop with HCC and delivery partners to inform future management strategies.

Key Outcomes

- High-resolution habitat baseline established across all three corridors
- Improved visibility of ecological opportunities, including habitat connectivity and targeted enhancements
- Integration of natural capital and carbon data into decision-making processes
- Enhanced alignment between engineering interventions and environmental outcomes
- Framework established for corridor-wide biodiversity net gain (BNG) delivery

Benefits Realised

- Efficiency gains: Significant reduction in time and cost compared to traditional ecological surveys
- Improved data quality and usability: Standardised, GIS-compatible outputs enabling rapid updates and scenario testing
- Better-informed decision making: Inclusion of ecosystem services and carbon sequestration metrics
- Wider social value potential: Opportunities identified for health, wellbeing, education, and community engagement
- Scalability: Approach demonstrated potential for wider rollout across the highway network

Challenges and Limitations

- Reliance on remote sensing: Some limitations in habitat condition accuracy compared to detailed field surveys
- Need for ground-truthing in targeted areas

- Integration of social value metrics required further development to fully realise Doughnut Economics objectives
- Long-term management and monitoring costs not defined at this stage

Risk Profile

The project presented low delivery risk, supported by:

- Proven application of AiDash on previous schemes
- One-off cost model with no long-term contractual commitment
- Strong alignment with existing HCC data and processes

Lessons Learned

- Combining AI mapping with existing constraint data provides a powerful evidence base
- Early multidisciplinary engagement (e.g. workshop format) is critical to maximise value
- Spatial data integration is key to linking environmental and engineering outcomes
- Future phases should prioritise:
    - Targeted field validation
    - Clear valuation of social benefits
    - Defined long-term monitoring strategy

Conclusion

The use of AiDash successfully demonstrated a cost-effective, scalable, and data-rich approach to baseline habitat mapping within the Live Labs programme. It enabled a more strategic, corridor-wide understanding of biodiversity and natural capital, supporting HCC's ambitions for decarbonisation, resilience, and biodiversity net gain. The approach provides a strong foundation for future corridor management planning and wider adoption across the highway network.

HCC Recycled Type 1

Recycled Type 1 Trial: Micheldever Highways Recycling Facility

Overview & Objective

The trial aims to establish a circular economy solution for the Hampshire Highways Service Contract (HHSC) by processing depot waste from M Group sites into SHW Clause 803 Recycled Type 1. The project seeks to close the loop on material usage—turning site-generated waste into high-quality construction aggregate.

The Trial Process

Assessment: Waste streams from Totton and Hook depots were analysed and found to be primarily asphalt breakout and concrete, with minimal soil contamination, making them ideal for high-grade recycling.

Production: Example loads were processed at the Micheldever facility using an integrated impact crusher and 50mm screening unit.

Quality Control

The resulting aggregate was free of foreign matter (wood/plastic). Due to the high asphalt/concrete content and strict segregation of clays at the source, the material was clean and homogenised.

Key Benefits

Carbon Reduction: Provides an estimated 23.1 tCO_2e annual saving by enabling "backhauling" (tipping waste and collecting recycled material in a single trip), the trial significantly reduces vehicle movements, logistics emissions, and network disruption.

Financial Savings: Diverting waste from costly disposal routes and reducing the need for virgin aggregate creates a double-sided financial gain for the contract.

Compliance: All materials are produced under the OCL Quality Protocol and Factory Production Control Manual (FPCM) to ensure engineering integrity.

Measuring Success

Material Performance (Technical Success)

The trial’s primary success is the production of a recycled material that matches the engineering integrity of virgin aggregates. Extensive testing by CTS (Construction Testing Solutions) confirmed a 100% pass rate against SHW Clause 803 standards:

Structural Integrity: Achieved a Los Angeles (LA) value of 23 (well within the LA50 limit), proving the material's resistance to fragmentation.

Durability: Recorded a Frost Heave of 9.7mm (15mm limit), ensuring long-term performance in adverse weather.

Consistency: Particle Size Distribution SD) was fully compliant, resulting in a clean, homogenised aggregate with no deleterious fines.

Carbon Savings

A significant carbon reduction is achieved through logistics optimisation.

Reduced Vehicle Movements: By enabling backhauling—where vehicles tip waste and collect recycled Type 1 in a single trip—the trial eliminates redundant "empty mile" journeys.

Emissions Mitigation: This reduction in traffic movements directly lowers Scope 3 emissions and minimises congestion-related carbon output on the Hampshire network.

Resource Preservation: Every tonne of recycled material produced preserves virgin mineral stocks and avoids the carbon-intensive extraction processes associated with primary aggregates.

Financial Benefits

The trial provides a high-value alternative to traditional "linear" waste management, driving savings in two directions:

Disposal Cost Avoidance: Diverting asphalt and concrete waste from depots to the Micheldever facility eliminates the high 'muck-away' and landfill costs typically associated with highway breakout.

Procurement Savings: Using site-won recycled Type 1 reduces the contract's reliance on expensive virgin materials, lowering the overall cost of material supply for HHSC.

Operational Efficiency: Localised processing at Micheldever reduces fuel spend and driver hours, further protecting the contract's bottom line.

Final Conclusion

The trial confirms that provided source segregation remains consistent at the depots, the Micheldever facility can reliably produce a compliant, high-quality Recycled Type 1. This provides a scalable blueprint for sustainable material management across the Wessex region.

Foamix Eco Trial

Project Overview

This trial assessed the use of Foamix Eco, a low-carbon cold-lay asphalt developed by Aggregate Industries, as part of the Hampshire County Council (HCC) Live Labs programme. It uses up to 94% recycled road materials alongside carbon-negative aggregates and biogenic (plant-based) binders. The material was trialled on a footway scheme at Saville Crescent, Bordon, as a potential alternative to traditional hot-mix asphalt (AC20).

The initiative supports broader programme objectives to reduce carbon emissions in highway maintenance while promoting circular economy principles.

Objectives

The primary objective was to:

- Evaluate the performance and practicality of Foamix Eco as a like-for-like replacement for conventional asphalt materials

The trial also aimed to:

- Assess carbon reduction potential across material production and transport
- Understand operational impacts, including plant, programme, and workforce requirements
- Explore opportunities for wider adoption across the HCC highways contract

Approach and Methodology

- A live trial was undertaken on 11 March 2025, with 33.92 tonnes of Foamix Eco laid as a binder course
- The material was produced off-site (Micheldever depot) and delivered in three loads
- Standard construction plant and processes were used, consistent with existing Foamix and AC20 operations
- Observations were recorded across:
  - Installation and performance
  - Safety and operational considerations
  - Carbon and logistical impacts

Key Outcomes

- Successful installation with no operational issues reported
- No discernible difference in handling, laying, or compaction compared to standard Foamix
- Full compatibility with existing plant and workforce, requiring no additional training or equipment
- Positive feedback from site teams, supporting practical viability

Carbon and Environmental Performance

- Significant carbon savings achieved through:
  - Cold-lay manufacturing process (reduced energy demand)
  - High recycled content (up to 92% reclaimed materials)
  - Use of biogenic binder and carbon-sequestering aggregates
- Transport-related carbon reduction:
  - 59% saving compared to traditional AC20 supply routes
  - Approx. 923 kgCO2e saved through reduced haulage distances
- Foamix Eco has the potential to be carbon neutral (A1–A and potentially A1–A5 when produced and applied in situ

- Supports circular economy principles through reuse of tar-bound planings and reduction in virgin aggregate demand

Operational Performance

- Ease of adoption: Identical construction methodology to existing Foamix products
- Flexibility: Can be stored and reused, unlike hot-mix asphalt
- Safety improvements:
  - Eliminates high-temperature risks
  - Reduces fumes and associated hazards
- Material performance considerations:
  - Requires timely overlay
  - Sensitive to weather conditions (rain and low temperatures)
  - Vulnerable to early-life deformation if trafficked too soon

Cost Considerations

- Material cost is higher than traditional AC20, but:
  - Lower density (~15% less material required) offsets cost
  - Reduced transport distances and fuel use provide additional savings
  - Avoided disposal costs for hazardous materials improve overall value

Overall, the trial indicates cost parity is achievable, particularly when whole-life and carbon costs are considered.

Challenges and Limitations

- Weather sensitivity impacted original site selection and programme
- Curing constraints require careful planning and sequencing
- Full carbon benefits were not fully realised, as:
  - Material was not mixed in situ
  - Additional transport was still required
- Lack of a formal Environmental Product Declaration (EPD) limited detailed carbon verification

Risk Profile

- Low operational risk, due to:
  - Proven methodology aligned with existing practices
  - No requirement for new equipment or skills

- Key risks relate to:
    - Weather dependency
    - Early-life material performance if not properly managed

Lessons Learned

- Foamix Eco provides a low-risk, high-impact carbon reduction opportunity with minimal operational change
- In-situ production and recycling is critical to maximising carbon benefits
- Early planning must account for weather constraints and curing requirements
- Strong potential for integration into BAU delivery

Conclusion

The trial demonstrated that Foamix Eco is a practical and scalable low-carbon alternative to traditional asphalt, delivering significant environmental benefits without compromising operational performance.

Its compatibility with existing processes, combined with strong carbon savings and circular economy benefits, positions it as a viable option for wider adoption across the HCC highways contract.

Next Steps

- Progress further trials incorporating:
    - In-situ mixing and recycling to achieve full lifecycle carbon neutrality
    - Integration with other low-carbon materials and interventions

  Develop:
    - Standard application guidance for wider rollout
    - Improved carbon reporting and verification (e.g. EPDs)
- Explore programme-level adoption to maximise cumulative carbon savings across the network

Econ EQCB Salt Spreader & Electric Trailer

Innovation Overview

The trial evaluated the Econ EQCB, a 19-tonne Volvo FE Electric chassis featuring a demountable body system (gritter, tipper, and hotbox). It was supported by a Kempower movable fast charger (40kW) installed at the Totton Depot and an auxiliary Electric Trailer Spreader for smaller applications.

Performance Review

- Operational Capability: The vehicle performed like-for-like with diesel equivalents regarding weight and carrying capacity. Drivers reported a positive experience once familiar with the electric drivetrain.
- Range & Reliability: While the manufacturer cited 170 miles, the real-world range was approximately 120 miles. This proved sufficient for the 81.65-mile test route but highlighted risks for back-to-back treatments.
- Charging & Logistics: The fast charger effectively recharged the unit within two hours. However, logistical constraints (salt loading at Ower vs. charging at Totton) led to operational delays, as vehicles could not be off-loaded until the following day.
- Tipper Innovation: The tipper body was found to be impractical for site waste collection due to its excessive side height, which prevented manual/mechanical loading on-site.

Carbon & Environmental Impact

- Tailpipe Emissions: Zero (ULEZ exempt).
- Savings: The trial achieved a net carbon saving of 88.2 kgCO2e per run.
- Total Impact: Over 12 runs, the innovation saved 1,058 kgCO2e.
- Noise: Significant reduction in noise levels, making it ideal for urban or night-time operations.

Financial Appraisal

- Operational Cost: The EV model was 158% more expensive per week than the diesel equivalent.
- Capital Investment: Required significant one-off costs for power supply installation and the procurement of the movable DC charger.

Conclusion & Recommendations

The innovation successfully proved the technical feasibility of ZEV winter maintenance but faces significant barriers to BAU adoption:

- Infrastructure: Current depot power capacity is insufficient for fleet-wide rollout.

- Operational Risk: Range limitations make it unsuitable for severe weather events or long/back-to-back routes without increasing fleet size or shortening routes—both of which are currently financially unsustainable.
- Next Steps: The technology is best suited for urban/city contracts with shorter routes. Future adoption should focus on improving body design (lower tipper sides) and monitoring improvements in battery density before wider scaling.

Revised Gritting Routes

Innovation Overview

Hampshire County Council has implemented a comprehensive strategic redesign of its winter service operations. The innovation focuses on two pillars: Network Rationalisation (aligning Priority One routes with national guidance) and Precision Forecasting (transitioning from broad climatic domains to granular, route-specific decision-making).

Network Rationalisation Review

The service has moved from a broad coverage model to a streamlined, high-efficiency network.

- Coverage Adjustment: The total network length was reduced by 14.6% (from 2,866km to 2,466km).
- Operational Footprint: Total road network treatment coverage was refined by 5% (from 35% down to 30%).
- Resource Efficiency: Fleet requirements were reduced by 9%, moving from 44 vehicles to 40.

Forecasting & Decision-Making Innovation

A phased transition from a 3-domain model to a 6-domain network and ultimately to Route-Based Forecasting allows for surgical treatment of the network rather than blanket applications.

- Precision Targeting: By providing individual forecasts for each of the 40 routes, the service can avoid treating areas where temperatures remain above freezing, even if adjacent areas are at risk.
- Modelling Results: Comparison data from the 2024/25 season suggests that adopting the route-based model offers significant resource savings:
    - Distance Travelled: Estimated reduction of 25,000 km.
    - Material Usage: Estimated reduction in salt consumption of 1,251 tonnes.

Environmental & Operational Impact

- Carbon Reduction: An expected 134.5 tCO_2e annual saving. Significant Scope 1 and Scope 3 emissions savings are achieved through a double-impact approach: shorter total network distances and fewer unnecessary treatment runs via precision forecasting.

- Strategic Alignment: The overhaul directly supports organisational decarbonisation targets by reducing the mechanical wear on the fleet and the environmental impact of salt runoff into the local ecosystem.

Conclusion & Next Steps

The shift to a route-based operating system represents the most significant efficiency gain in the service's history.

- Status: Full implementation of the six-domain network and route-based forecasting is scheduled for the 2025/26 winter season.

- Recommendation: Future reporting should track the actual versus modelled savings of the route-based forecasts to validate the efficiency of the new climatic domains.

Tarmac Bio Binder – Shell Carbon Sink CS250

Technical Objective and Innovation

The primary objective of the Bio Binder trial was to evaluate the technical performance and carbon reduction potential of Shell Carbon Sink CS250, a bio-derived polymer modified binder (PMB), as a sustainable alternative to conventional petroleum-based bitumen.

The innovation centres on the partial substitution of fossil-derived binder components with biogenic materials, targeting reductions in embodied carbon without compromising mechanical performance. Developed in partnership with Shell, the CS250 binder integrates into standard Tarmac asphalt production processes and is compatible with both hot-mix and warm-mix asphalt applications, providing flexibility in deployment while supporting decarbonisation across resurfacing programmes.

Operational Methodology and Engineering Controls

The trial was undertaken on the A30 London Road, Blackwater, a heavily trafficked dual carriageway representative of typical highway resurfacing conditions. The scheme enabled a controlled comparison between traditional PMB binder and the Shell CS250 bio binder across both hot and warm mix asphalt configurations.

A key operational advantage observed during delivery was that the bio binder required no modification to standard laying practices. Existing plant, workforce, and methodologies were utilised without adjustment, ensuring seamless integration into business-as-usual operations.

The site scale was also critical in facilitating the trial, as the product requires large batch production due to its limited storage life (approximately one month in silo), necessitating efficient logistics and material planning to maintain viability.

Carbon Mitigation

The trial demonstrated measurable reductions in embodied carbon through material innovation and process optimisation:

- Material Embodied Carbon: The bio binder achieved a reduction of approximately 13.94 $kgCO_2e$ per tonne compared to conventional PMB asphalt mixtures.
- Mix Type Optimisation: Additional savings were realised when combining the bio binder with warm-mix asphalt, reducing emissions from 81.48 $kgCO_2e/t$ (hot conventional mix) to 61.02 $kgCO_2e/t$ (warm bio mix).
- Total Scheme Impact: Across approximately 1,300 tonnes of material, this equated to a total carbon saving of 18.1 tCO_2e.

While supplier-reported carbon savings are based on recognised methodologies (PAS 2050 and asPECT), the absence of a formal Environmental Product Declaration (EPD) introduces a degree of uncertainty in independently verifying carbon sink claims.

Outcomes

The trial confirmed that the Shell CS250 bio binder delivers equivalent in-situ performance to traditional bitumen binders, with no observed differences in laying, compaction, or finished surface characteristics.

Operationally, the material offers additional benefits when paired with warm mix technologies, including reduced fumes and lower burn risk, improving on-site safety conditions.

Key constraints identified include:

- Requirement for large production volumes to maintain commercial viability
- Limited storage life, restricting flexibility for use on smaller schemes

Structural Evaluation & Longitudinal Performance

Initial observations indicate that the bio binder provides comparable resistance to deformation and cracking relative to conventional Cariphalt Ultra PMB.

Performance is consistent across both hot and warm mix applications, suggesting suitability for a wide range of resurfacing conditions. Ongoing monitoring will be required to validate long-term durability and whole-life performance under sustained traffic loading.

Conclusion and Recommendations for BAU Adoption

The A30 trial demonstrates that Shell CS250 bio binder is a technically viable and lower-carbon alternative to traditional petroleum-based binders, capable of being deployed within existing operational frameworks without additional complexity.

The most effective implementation pathway is on large-scale resurfacing schemes, where production efficiencies and short workable life can be optimally managed. Early contractor–supplier collaboration is essential to align production volumes, delivery timings, and site readiness.

Future adoption should prioritise:

- Integration with warm-mix asphalt technologies to maximise carbon savings
- Development of verified EPDs to improve transparency and confidence in carbon reporting
- Continued in-service performance monitoring to validate durability over standard asset lifecycles

The innovation represents a credible step toward reducing Scope 3 emissions within highway maintenance and supports wider decarbonisation objectives across the network.

HCC Fleet Decarbonisation – EV Transition Feasibility Study (Dynamon ZERO Platform)

Technical Objective and Innovation

The primary objective of the Hampshire County Council (HCC) Fleet Decarbonisation study was to evaluate the technical feasibility, infrastructure requirements, and carbon reduction potential associated with transitioning the Hampshire Highways operational fleet from diesel to battery electric vehicles (EVs).

The innovation centres on the application of Dynamon's proprietary ZERO simulation platform, which utilises real-world telematics data and synthetic duty cycle modelling to assess EV suitability at an individual vehicle, route, and depot level. The study combines 90 days of operational data across 164 vehicles and 6,096 duty cycles, providing a high-resolution, evidence-based roadmap for fleet electrification and infrastructure deployment.

Operational Methodology and Engineering Controls

The assessment covered a mixed fleet of 164 vehicles across six depot locations, incorporating both HCC and M Group Highways operations. Analysis was based on 333,000+ miles of operational data, including live telematics from 120 vehicles and synthetic routing models for specialist assets such as gritters.

The ZERO platform simulated each vehicle's daily duty cycle against equivalent EV specifications, incorporating:

- Battery state-of-charge modelling
- Route feasibility assessment
- Charging dwell time and depot return patterns
- Infrastructure capacity and energy demand profiling

Two charging scenarios were evaluated:

- 7kW AC (baseline) – representing minimum infrastructure deployment
- 50kW DC (enhanced) – representing optimal operational performance

This dual-scenario modelling enabled identification of engineering constraints, particularly around charging availability rather than vehicle range, which was found to be the primary limiting factor in fleet electrification.

Carbon Mitigation

The study identified significant carbon reduction potential through full fleet electrification:

- Baseline Emissions: The fleet currently generates approximately 844 tCO_2e annually (Scope 1) from diesel consumption.
- Full Transition Impact: Dynamon's modelling indicates that a fully electrified fleet could remove up to 1,086 tCO_2e per year of modelled fleet emissions. This figure is based on an annualised telematics model and is therefore not directly comparable to the reported baseline of 844 tCO_2e, which is derived from actual diesel consumption data.
- Fleet Composition: Medium panel vans and 7.5t HCVs account for over 61% of total fleet emissions, representing priority decarbonisation targets.
- Operational Efficiency: Additional indirect carbon savings are achievable through fleet rationalisation, with current utilisation at just 38.8%, indicating potential to reduce total vehicle numbers prior to electrification.

Outcomes

The study confirms that the Hampshire Highways fleet is highly suited to electrification, based on its operational profile:

- Strong EV Suitability: Average daily mileage of 56 miles represents only approximately 25% of typical EV range, providing substantial operational headroom.
- High Route Feasibility: Approximately 98% of all duty cycles are achievable with current EV capabilities.
- Infrastructure Sensitivity: Fleet-wide feasibility increases from 83.9% (7kW) to 91% (50kW), confirming that charging infrastructure is the key deployment constraint.
- Vehicle Class Variability:
    - Cars and small HCVs show near-immediate transition readiness
    - Panel vans represent the primary constraint class due to operational patterns
    - Heavy vehicles demonstrate strong feasibility with appropriate charging

Structural Evaluation & Longitudinal Performance

Simulation modelling indicates that EV adoption is not constrained by route distance or energy demand, but by charging access and operational behaviours, particularly depot return patterns.

Vehicles returning to depot overnight achieved 99–100% operational feasibility, confirming that infrastructure provision is the critical determinant of long-term performance.

Longitudinal success of the transition will depend on:

- Deployment of depot-based charging infrastructure
- Integration of home charging for non-depot vehicles
- Ongoing telematics-led optimisation and monitoring

Conclusion and Recommendations for BAU Adoption

The fleet decarbonisation study confirms that large-scale electrification of the Hampshire Highways fleet is technically viable, operationally deliverable, and strategically aligned with net-zero targets, with infrastructure provision representing the primary delivery risk.

A phased implementation programme is recommended:

- Phase 1 (2026–2028): Prioritise low-complexity assets (cars, small HCVs), deploy baseline charging infrastructure, and initiate fleet rationalisation
- Phase 2 (2028–2030): Scale transition to panel vans and medium HCVs, supported by expanded 50kW DC charging
- Phase 3 (2030–2035): Complete transition of specialist and heavy assets, including gritters, alongside integration of renewable energy systems

Key enabling actions include:

- Immediate submission of grid connection applications (18–36 month lead time)
- Deployment of mixed charging strategy (7kW AC + 50kW DC) across depots
- Implementation of home charging or mandated depot return policies
- Continued data-driven optimisation via annual simulation updates

The study demonstrates that fleet electrification has the potential to eliminate over 1,000 tonnes of CO_2 annually, representing one of the most significant opportunities for reducing Scope 1 emissions within Hampshire's highways operations.

Electric Plant Trial

Technical Objective

The primary objective of the Electric Plant trial was to evaluate the operational performance, feasibility, and carbon reduction potential of battery-powered construction plant as a direct alternative to conventional diesel and petrol-powered equipment within highways maintenance.

The innovation centres on the deployment of fully electric plant and tools—including excavators, dumpers, compaction equipment, and welfare units—across a live footway resurfacing scheme. This approach targets the elimination of on-site fuel combustion, thereby reducing Scope 1 emissions, improving local air quality, and mitigating noise impacts, particularly in urban and sensitive environments.

Operational Methodology and Engineering Controls

The trial was conducted on a footway resurfacing scheme on the A32 High Street, Droxford, incorporating breaking out and reconstruction activities using a fully electric plant setup.

A range of electric assets were deployed, including:

- 1.5T electric tracked excavator
- 1.5T electric dumper
- Battery-powered compactor plate
- Battery-powered disc cutter and breaker
- Solar-assisted eco welfare unit

Operational delivery closely mirrored conventional practices, with no requirement for significant process adaptation. However, a key engineering constraint was identified in relation to charging logistics, as limited on-site space required plant batteries (for excavator and dumper) to be charged off-site, increasing transport movements and introducing additional logistical complexity.

Despite this limitation, plant utilisation was effectively managed through overnight charging cycles and battery rotation strategies for handheld tools, demonstrating practical deployment within a live highway environment.

Carbon Mitigation

The trial demonstrated substantial reductions in carbon emissions across the plant lifecycle:

- Material/Operational Emissions: Traditional diesel and petrol plant generated 798.45 $kgCO_2e$, compared to 28 $kgCO_2e$ for the electric alternative, representing a significant reduction in embodied and operational carbon.
- On-Site Emissions: Core plant items (excavator, dumper, tools, welfare unit) recorded zero on-site emissions, eliminating fuel-related carbon output during operation.
- Transport Impact: Carbon associated with plant transport increased slightly due to off-site charging requirements, highlighting the importance of localised charging infrastructure to maximise overall carbon savings.
- Carbon Savings: The greatest carbon savings were achieved through electrification of larger plant and welfare units, which traditionally consume the highest volumes of fuel.

Outcomes

The trial confirmed that electric plant is operationally viable across typical highway maintenance activities:

- Performance:
  - Most plant delivered equivalent performance to diesel counterparts
  - Minor reduction in excavator power was observed but did not impact productivity
- Battery Efficiency:
  - Excavator achieved 4–5 hours per charge
  - Dumper demonstrated potential to operate for the full scheme duration on minimal charging
- Operational Benefits:
  - Significant reductions in noise and vibration
  - Elimination of fumes, improving site safety and working conditions
- Cost Consideration:
  - Higher hire costs partially offset by fuel cost savings and reduced consumables

Additionally, the eco welfare unit demonstrated strong performance with integrated solar charging, achieving zero fuel use during the trial.

Structural Evaluation & Longitudinal Performance

Performance results indicate that electric plant can reliably support typical construction activities, with limitations primarily linked to energy management rather than machine capability.

Long-term viability will depend on:

- Availability of on-site charging infrastructure
- Continued improvement in battery capacity and runtime
- Effective integration into project planning and logistics

The trial also highlighted strong potential for deployment in noise-sensitive or emission-restricted environments, including night works and urban settings.

Conclusion and Recommendations for BAU Adoption

The A32 Droxford trial demonstrates that electric plant is a technically viable and environmentally superior alternative to traditional diesel and petrol equipment for highway maintenance operations.

While minor performance limitations were observed in specific plant types, these were not operationally prohibitive and are likely to reduce as technology matures. The primary barrier to widespread adoption is charging infrastructure and logistics, rather than plant capability.

Key recommendations for BAU implementation include:

- Prioritising deployment on larger schemes, where charging logistics can be better managed
- Developing site-based or depot-supported charging solutions to eliminate transport inefficiencies
- Expanding use in urban and night-time works to exploit noise reduction benefits
- Focusing initial rollout on high-impact plant (excavators, dumpers, welfare units)
- Embedding electric plant into procurement frameworks and specifications

The trial confirms that electric plant offers a clear pathway to reducing construction-related emissions, improving site conditions, and supporting Hampshire's wider decarbonisation objectives.

NOTE*: the following innovations are still in their assessment phase, and reviews will be added as they become available:*

- *Tarmac Warm Mix 943*
- *Reheater trial*
- *GeoPura Hydrogen Power Unit*
- *Conway Wastewater Recycler*
- *Electric Coring Rig*
- *Electra 12.5t Electric HGV*

4 CARBON ASSESSMENT

Approach to Carbon and Data Analysis

The carbon baselining and analysis process was carried out in accordance with the Carbon Calculation and Accounting Standard (CCAS) guidance for local highways authorities, developed by the Future Highways Research Group (FHRG). This was undertaken at two spatial scales using contrasting approaches: a top-down, inventory-based approach for the authority-wide ‘full-service’ carbon baseline, and a bottom-up, activity-based approach for the corridor-level carbon profiles (*Figure 8*). All carbon calculations for the full-service baselines were conducted in the FHRG Carbon Analyser tool by the project Carbon Analyst; calculations for the corridor-level carbon profiles were initially conducted in Carbon Analyser, and later in the Excel-based Carbon Profiler Toolkit (CPT) which replaced Carbon Analyser. Both the full-service carbon baseline and corridor-level carbon profiles have been visualised in an interactive Power BI report, allowing for in-depth analysis of carbon ‘hotspots’ and potential carbon savings at full-service, corridor, activity, and scheme level.

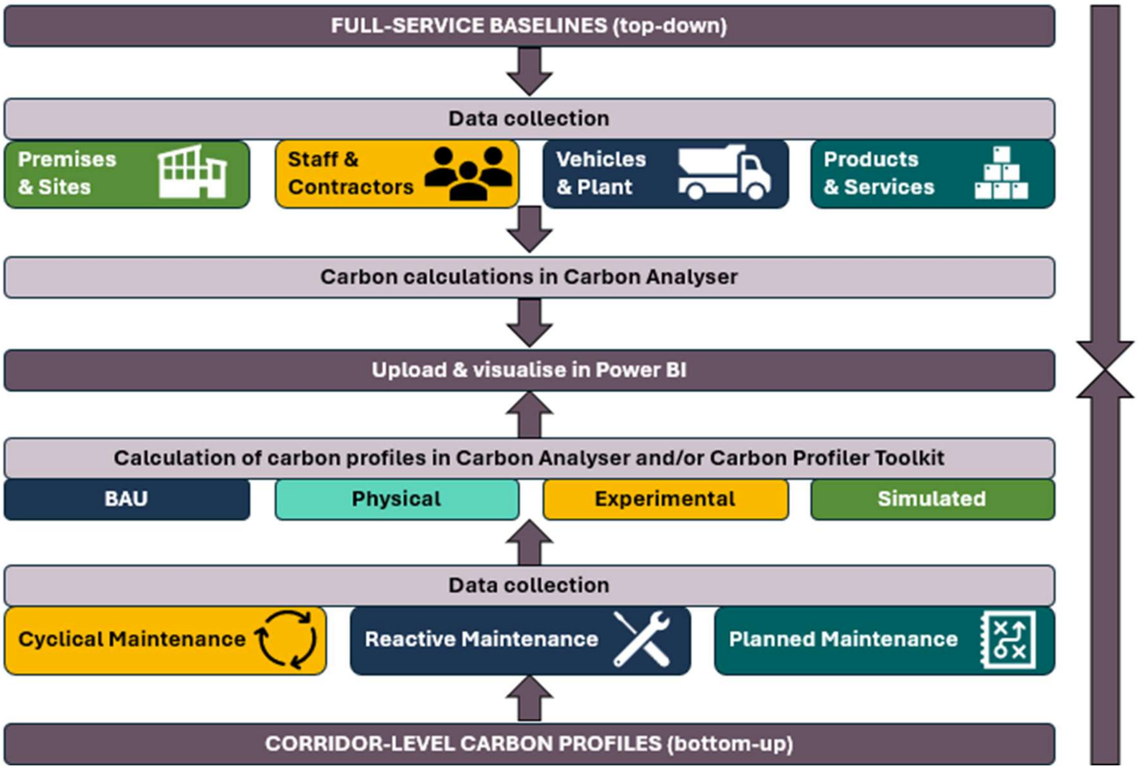

Figure 8: *Carbon analysis workflow.*

Full-service carbon baselining

A data collection proforma template was provided by the FHRG to collate data for each of the four carbon inventories from HCC Highways and their Tier 1 contractor, M Group. The majority of the data for the full-service carbon baseline was either submitted via the proforma template itself or provided in a format consistent with the requirements of the template. This covered the financial year 1st April 2022 – 31st March 2023, in accordance with the carbon baselines for the other two Wessex Live Lab Local Authorities.

For the **Premises & Sites** inventory, electricity, gas, and water consumption figures were provided by M Group for each of their highway depots in Hampshire, as well as Trafalgar House (the Highway service HQ). Where meter readings were not available for the full 12 months of the baseline year, they were extrapolated from the available data. For Trafalgar House, no water meter readings could be obtained, so water consumption was estimated based on the head count and average per-capita water consumption in the depots. The proportion of emissions from Trafalgar House allocated to the Highways maintenance service was calculated based on the proportion of desks occupied by HCC or M Group staff.

For the **Staff & Contractors** inventory, an MS Forms survey was produced to gather data on the commuting and home working habits of Highways staff from HCC. Key information provided in the survey included:

- Organisational unit
- Annual number of days working from home
- Annual number of days commuting to work
- Miles travelled per day to and from work
- Primary commuting mode
- Vehicle size class and fuel type, if applicable
- Vehicle ownership (personal, employer-owned, or lift share), plus vehicle registration number if employer-owned
- Primary mode of business travel
- Annual business mileage

A separate MS forms survey was sent to M Group, adapted at their request to ascertain the average number of times each respondent visited each depot per week, and the average commute distance from their home to each of the depots. This data was then used to calculate the annual commuting distance for each contractor. As it was infeasible to obtain a 100% response rate on the surveys (57% of HCC staff and 38% of M Group contractors responded), 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. Business mileages could not be obtained for the whole Highway service due to GDPR restrictions, so the business mileages recorded by the survey respondents were extrapolated to the non-respondents and allocated to the Products & Services inventory, as advised by the FHRG.

For the **Vehicles & Plant** inventory, the primary function, fuel type, make, model, and annual mileage was provided for each vehicle in the HCC and M Group highway fleets. M Group also provided the annual fuel consumption in litres (or kWh for electric cars), which was used in preference to the mileage, since the carbon factors for fuel consumption are deemed to be more accurate. The quantities of HVO and gas oil consumed by all plant items were provided in bulk by M Group.

For the **Products & Services** inventory, data on purchased materials, purchased services, third-party plant and transport, and waste management were provided by HCC and M Group, as described in *Table 3* below:

***Table 3**: Data provided for each category in the Products & Services inventory.*

Category	Data provided	
Purchased materials	• Provider • Material type • Material description	• Quantity • Unit of measure
Purchased services	• Provider • Service type • Service description	• Quantity • Unit of measure
3rd-party plant & transport	• Provider • Vehicle/plant type • Fuel type	• Distance / fuel quantity • Unit of measure • Purpose
Waste management	• Provider • Disposal method • Waste type	• Quantity • Unit of measure

As the Eurobitume carbon factor for bitumen has since been updated to 530 $kgCO_2e$/tonne,[1] the carbon factors for all bituminous materials have now been retrospectively updated to ensure comparability between the full-service baseline and any carbon savings calculated at corridor level since this update. For M Group, no data was available on the fuel consumption or mileage of third-party plant and transport; instead, the transportation spend for each supplier was provided, and the average cost of diesel from April 2022-March 2023 (£1.8106 per litre) was used to estimate the quantity of diesel consumed.

Corridor-level carbon profiles

A carbon baseline was calculated for each of the three corridors using a bottom-up, activity-based approach, focusing on three categories of Highways maintenance: cyclical, reactive, and planned maintenance. These categories were broken down into activity types for cyclical and reactive maintenance, and individual schemes for planned maintenance (*Figure 9*). To provide a representative baseline for the low-carbon innovations implemented 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 four years), whilst the baseline for planned works is a theoretical representation of the BAU alternative to the low-carbon innovation trialled. The baseline carbon profile for each activity or scheme on a corridor is therefore termed the BAU carbon profile. All carbon profiles have been uploaded to the Power BI dashboard for visual comparison between corridors, activities, and options for decarbonisation.

[1] See https://eurobitume.eu/wp-content/uploads/2025/03/EB-LCA-4.0-2025.pdf

	Cyclical Maintenance	Reactive Maintenance	Planned Maintenance
When was the data provided for?	2022-2023	2022-2023	Live Labs scheme delivery phase (2024-2026)
What activities did the data include?	• Drainage cleansing (gullies, catchpits, & weir kerbs) • Verge cutting • Urban grass / vegetation • Arboriculture • Vegetation obstructions • Highways safety inspections Bridge inspections • Solar powered bollard cleaning • Sign cleaning • Grip cutting	• Potholes & patching • Drainage & vegetation combined works • Line markings • Winter maintenance (gritting) • Ironworks • Arboriculture • Signage / bollard / guardrail replacement • Jetting works • Kerbing & siding out • Footway defects • Debris / spillage / obstruction • Other minor works	• Carriageway resurfacing • Patching • Combined resurfacing & patching works • Retexturing • VRS (Vehicle Restraint Systems)
How was the data collected?	• Inspections data extracted from Confirm. • Other cyclical maintenance data provided via an Excel spreadsheet by the Highway Manager. • Gully cleansing report also provided.	• Defect data extracted from Confirm. • Winter maintenance was downscaled from full-service level.	• BoQ provided where available. • Carbon factors for specific products provided by the supplier if possible. • Transport information deduced from depot/supplier locations.

Figure 9: *Data collection methods for each of the three types of maintenance on the corridors.*

For activities or schemes on which a low-carbon innovation was trialled, a 'physical' carbon profile was also created to illustrate the as-built carbon emissions compared to the baseline. Where a low-carbon innovation was proposed, but not physically trialled, a 'simulated' carbon profile was created to illustrate the maximum carbon savings that could have been achieved on that activity/scheme. 'experimental' carbon profiles were also created to illustrate intermediate scenarios that were lower-carbon than BAU but higher-carbon than simulated or otherwise did not fall into the other three profile categories.

For **cyclical maintenance**, a spreadsheet was provided by the Highway Manager detailing the frequency and number of gullies cleansed; the number of grips cut; the number of solar bollards cleaned; the length of rural verge cut (swathe, visibility, central reservation, and full cut); the length of rural and urban hedges trimmed; and the m^2 of urban grass and shrubs cut, for each of the three corridors. In order to calculate the total distance driven by the gully tankers, a drainage cleansing report was also provided, including data on the number and location of gullies, catchpits, and weir kerbs cleaned per day. Data on the frequency, type, and length of highway inspection routes were extracted from Confirm. All travel was assumed to be carried out from the nearest depot using an average diesel van, unless otherwise specified. The carbon factor for the decomposition of grass cuttings was provided by the Greenprint Live Lab.

For **reactive maintenance**, a Schedule of Rates for each activity on the corridors was extracted from Confirm and provided as an Excel spreadsheet. Where the dimensions or quantity of material required for a given defect were not specified, the average known dimensions or quantity for that defect type were assumed. The fuel consumption rates of plant items were estimated based on data from the CEDR and Liverpool Live Labs, as well as internet research. Transport distances were deduced from the location of the nearest M Group depot or supplier, depending on the type of material being transported. For winter maintenance, the distance travelled by the gritters and the quantity of salt required per corridor were deduced by downscaling the total gritter mileage and salt usage for Hampshire to the proportion of the priority gritting network covered by each corridor.

For **planned maintenance**, a Bill of Quantities was provided for each scheme where available; otherwise, the quantities of material and plant usage required were deduced from a diagram or description of the scheme. EPDs (Environmental Product Declarations) were provided for specific products where available; otherwise, an approximate carbon factor was deduced from the available online information on materials such as warm mix asphalt[2] and biogenic binder[3]. The fuel consumption rates of plant items were estimated based on data from the CEDR and Liverpool Live Labs, as well as internet research, whilst the transport distances were deduced from the location of the nearest M Group depot or supplier, depending on the type of material being transported. The carbon factors for all bituminous materials have now been retrospectively updated to reflect the recent increase in the Eurobitume carbon factor for bitumen.

Carbon Hotspot Studies

Identifying the highest-carbon items and activities - or 'carbon hotspots' - within Hampshire County Council's carbon baseline is vital for determining which aspects of the Highways maintenance service should be prioritised for decarbonisation, allowing for more cost-effective allocation of budgetary and operational resources. At full-service level, purchased Products & Services were the highest-carbon inventory, comprising 94% of the carbon baseline. Within this, materials were the greatest carbon hotspot at 72% of the Products & Services inventory, with the highest-carbon materials being asphalt at 39% of the inventory, steel at 22%, and concrete at 5%. Combusted fuels also made a notable contribution to the carbon baseline at 24% of the Products & Services inventory, with the highest-carbon fuels being diesel at 20% and fuel oil at 3%, as shown in *Figure 10.*

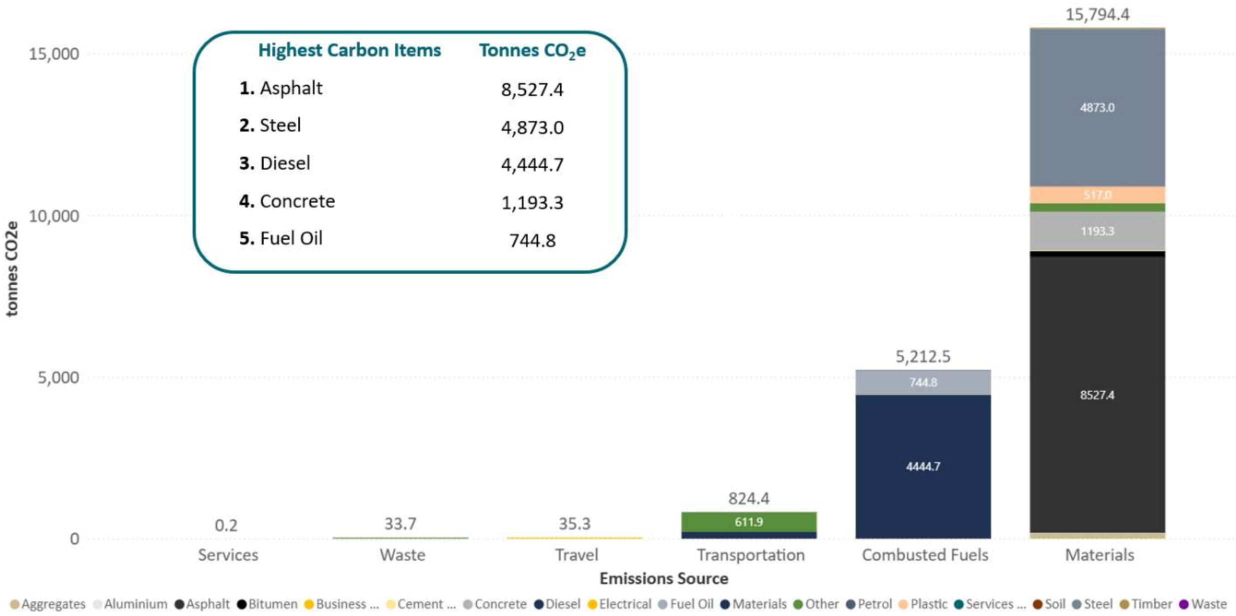

Figure 10: *Breakdown of carbon emissions within the Products & Services inventory.*

At corridor level under the BAU scenario, planned maintenance was the highest-carbon maintenance type for all three corridors, at 91% of the baseline for the A30; 98% for the A32; and 72% for the A336. Carriageway resurfacing was the highest-carbon activity for all three corridors, at 50% of the baseline for the A30; 98% for the A32; and 55% for the A336 (although this was as a theoretical alternative to retexturing, rather than a planned resurfacing scheme).

[2] See https://www.tarmac.com/products/asphalt/ultilow
[3] See https://www.shell.fr/professionnels/shell-bitumes/shell-bitumen-carbon-sink.html

The majority of emissions associated with each activity came from material usage - particularly asphalt, which accounted for 55% of the baseline for the A30; 63% for the A32; and 47% for the A336. *Figure 11* summarises the breakdown of carbon sources for all three corridors combined, with 83% of emissions coming from carriageway resurfacing, 62% from materials, and 60% from asphalt.

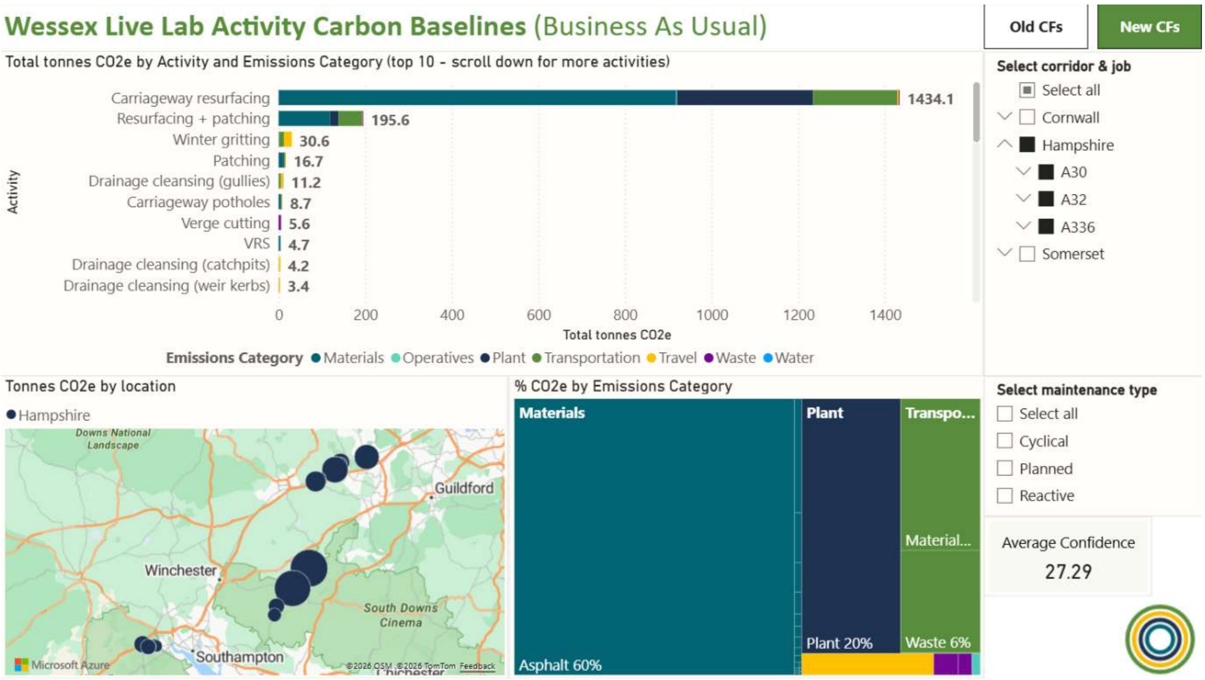

Figure 11: *Breakdown of carbon emissions sources for each activity on the three corridors.*

Baselines and Experimental Profiles

Full-Service Carbon Baseline

Following the update of the carbon factors for bituminous materials, the full-service carbon baseline for the HCC highway maintenance service in 2022-23 was 23,333.5 tCO_2e, which is roughly equivalent to 22,600 passengers taking a one-way flight from London to New York.[4] Normalised by network length, this equates to approximately 2.68 tCO_2e per km of Hampshire's local highway network. Products & Services was the highest-carbon inventory at 94% of the total baseline, followed by Vehicles & Plant at 3%; Staff & Contractors at 2%; and Premises & Sites at 1% (*Figure 12*). The majority (96%) of emissions were attributable to the Tier 1 contractors M Group, with 3% being directly attributable to Hampshire County Council and 0.5% to the Tier 2 subcontractors OCL Regeneration.

[4] Assuming distance from Gatwick to JFK airport is approximately 5583.74 miles, using 2025 DESNZ/DEFRA carbon factor for a long-haul flight for an average passenger.

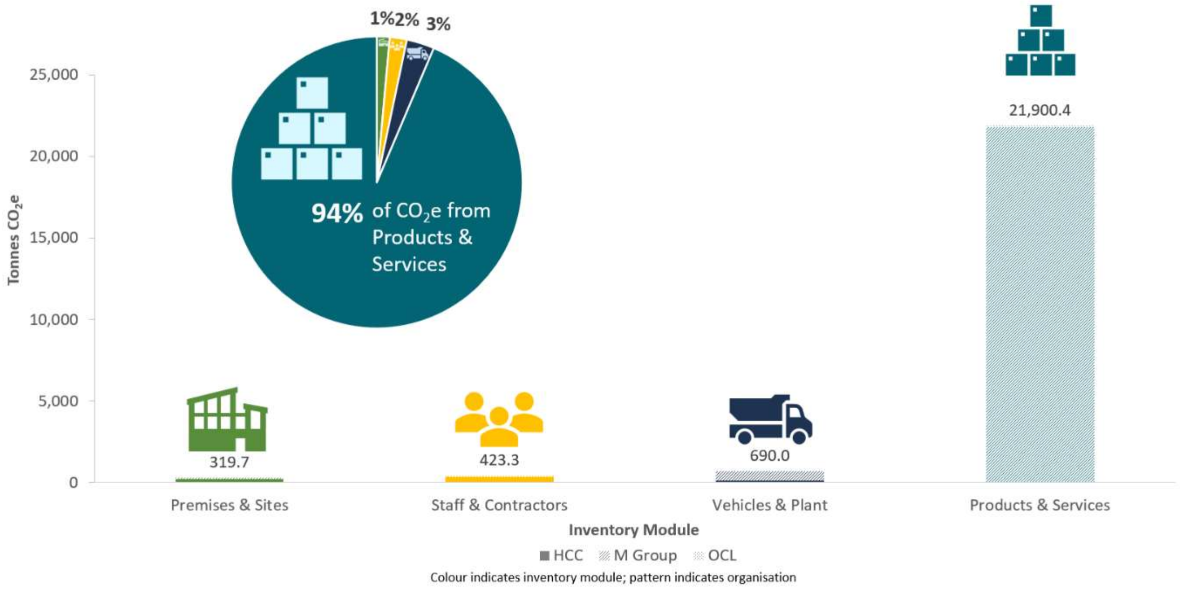

Figure 12: *Full-service carbon baseline for Hampshire County Council's Highways maintenance service, 2022-23.*

Premises & Sites accounted for 319.8 tCO_2e of emissions, of which 87% were from electricity consumption, 12% from natural gas, and 1% from water. The majority of emissions came from the two depots which used natural gas: Totton at 90.7 tCO_2e and Petersfield at 78.8 tCO_2e (*Figure 13*).

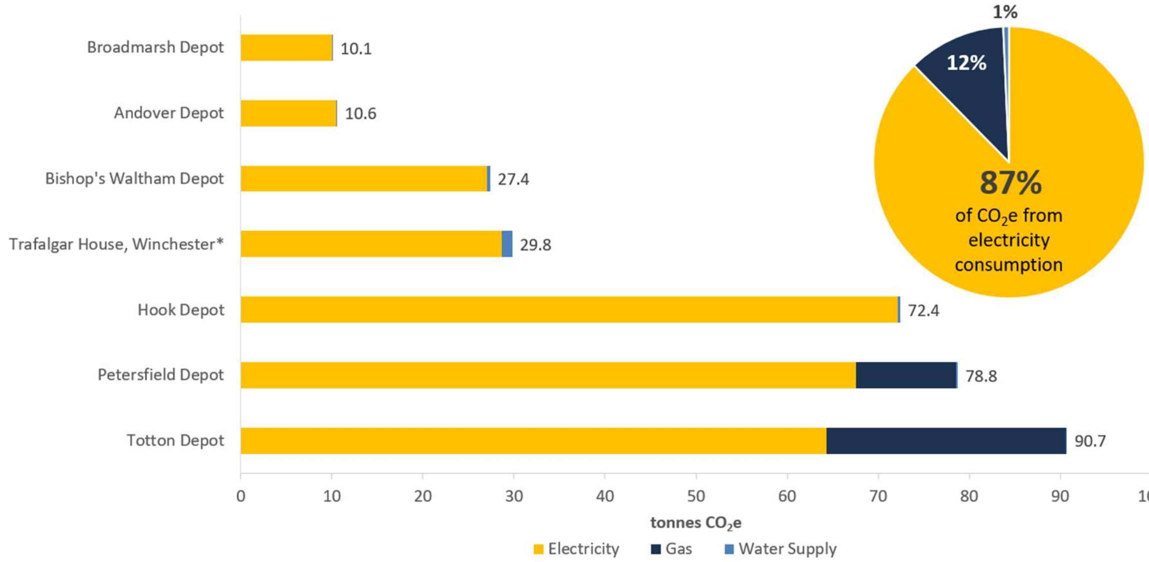

Figure 13: *Breakdown of carbon emissions from the Premises & Sites inventory.*

Staff & Contractors accounted for 423.3 tCO_2e of emissions, of which 78% were from commuting, 14% from home working, and 8% from business travel. Note, additional business mileage claims which could not be attributed to a single survey respondent were allocated to Products & Services, as recommended by the FHRG. As the majority (62%) of the 156 survey respondents commuted to work using a private car, these were the largest source of emissions at 322.3 tCO_2e, of which 197.9 tCO_2e came from petrol cars (*Figure 14*).

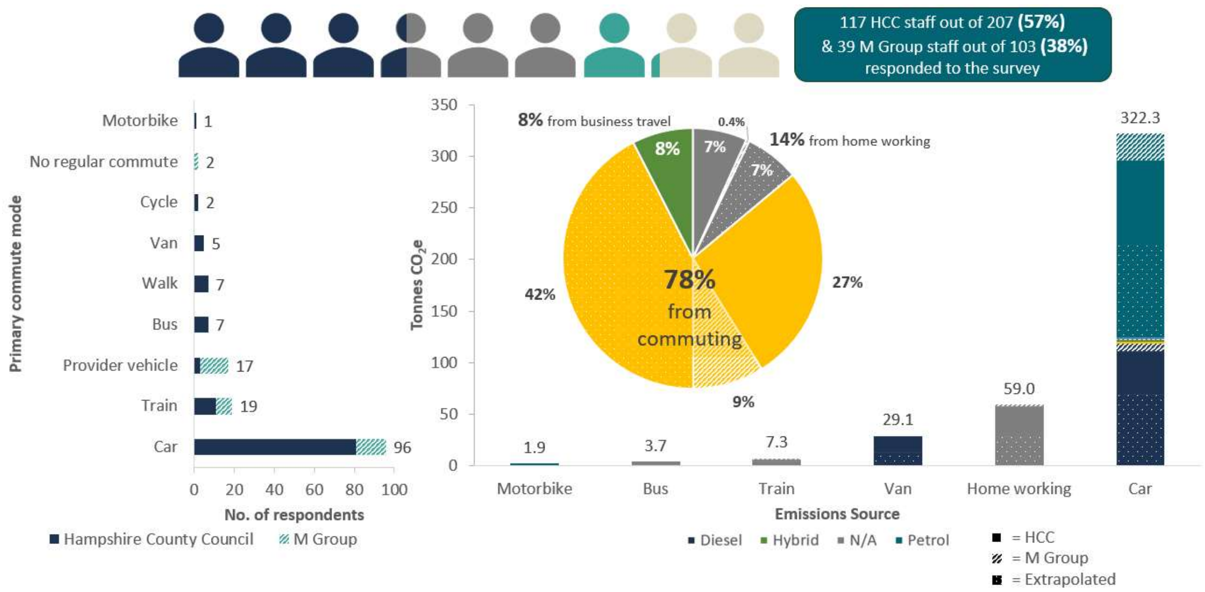

Figure 14: *Breakdown of carbon emissions from the Staff & Contractors inventory.*

Vehicles & Plant accounted for 690.0 tCO_2e of emissions, of which 49% came from diesel, 46% from HVO, 3% from petrol, 1% from hybrids, and 1% from EVs. Mobile plant was the main source of emissions at 374.0 tCO_2e. 18% of emissions were directly attributable to HCC vehicles, with the remaining 82% coming from M Group vehicles and plant (*Figure 15*).

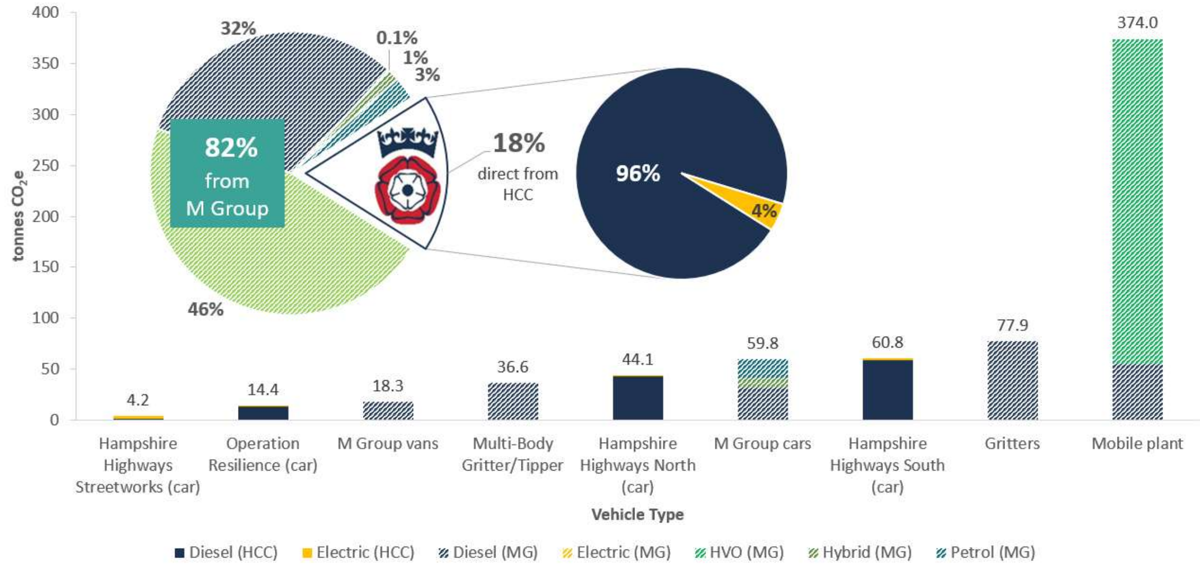

Figure 15: *Breakdown of carbon emissions from the Vehicles & Plant inventory.*

Products & Services accounted for 21,900.4 tCO_2e of emissions, of which 72% came from materials, 24% from combusted fuels, 4% from transportation, 0.2% from business travel, 0.2% from waste, and 0.001% from subcontracted services. Asphalt was the top carbon hotspot at 8,527.4 tCO_2e, followed by steel at 4,873.0 tCO_2e, diesel at 4,444.7 tCO_2e, concrete at 1,193.3 tCO_2e, and fuel oil at 744.8

tCO_2e (**Figure 16**).

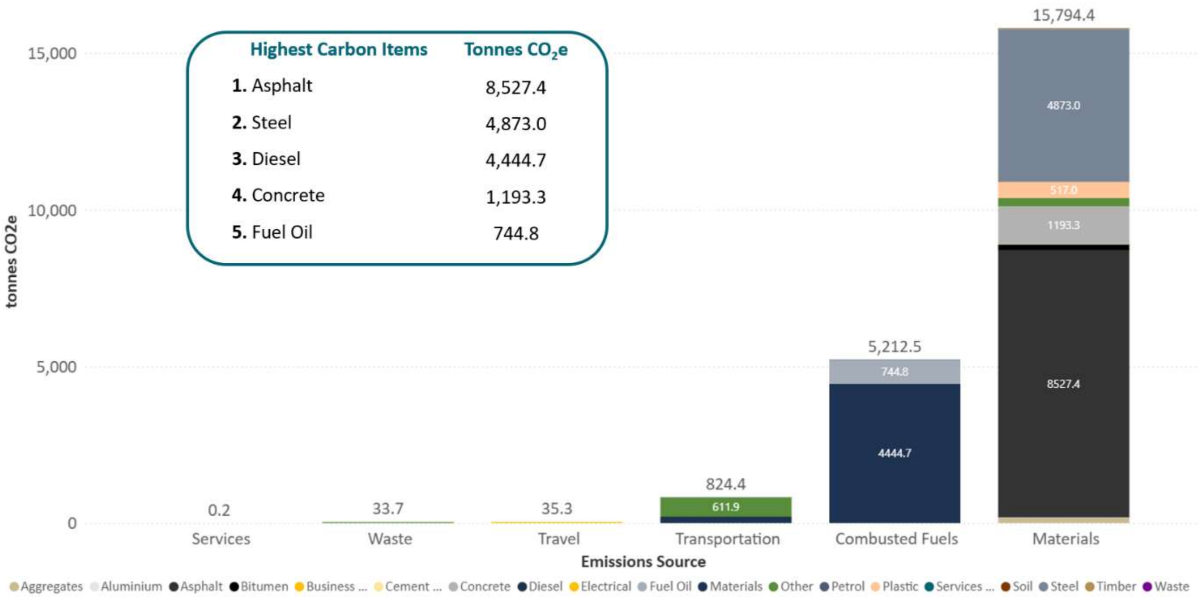

***Figure 16:** Breakdown of carbon emissions within the Products & Services inventory.*

Corridor Carbon Baselines

In the BAU scenario, the A32 was the highest-carbon corridor at 1,181.3 tCO_2e, followed by the A30 at 495.5 tCO_2e and the A336 at 55.2 tCO_2e. When normalised by corridor length, this equates to approximately 98.4 tCO_2e/km for the A32; 30.2 tCO_2e/km for the A30; and 11.0 tCO_2e/km for the A336. 95% of emissions came from planned maintenance, with 3% from reactive maintenance must and 2% from cyclical maintenance (*Figure 17*).

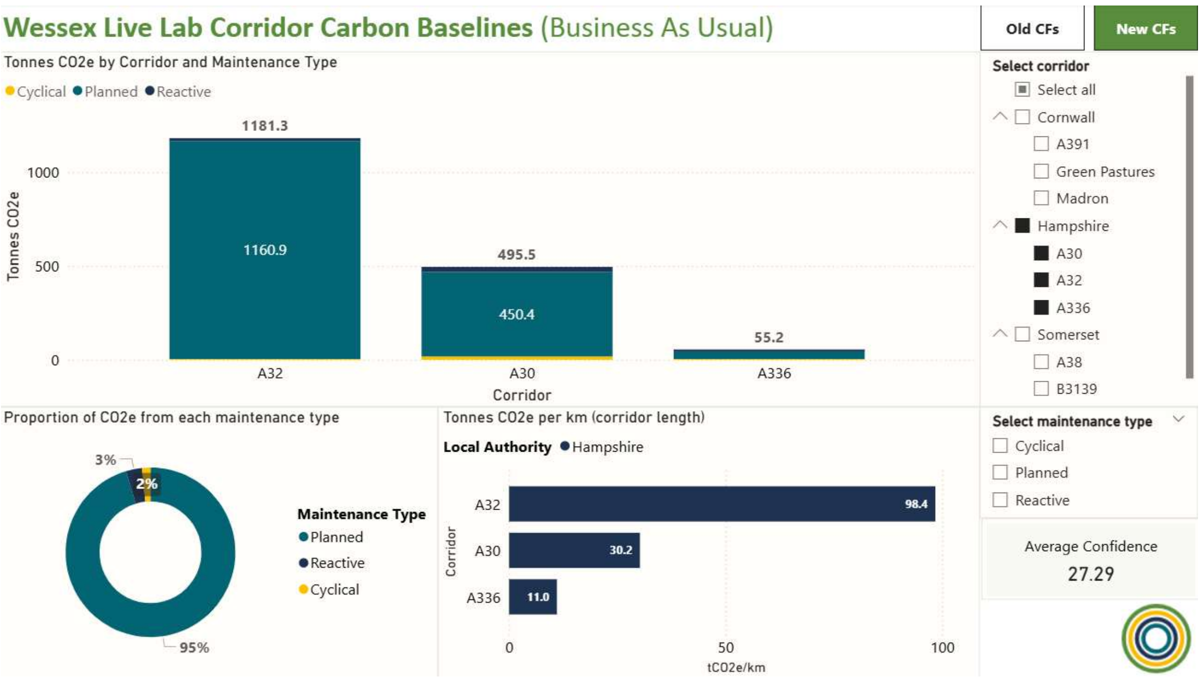

***Figure 17:** Corridor-level carbon baselines for the A32, A30, and A336 corridors.*

On the A32 corridor, 98% of emissions came from planned maintenance, with 1% from reactive maintenance and 0.4% from cyclical maintenance. The vast majority (1,156.2 tCO_2e) of emissions came from carriageway resurfacing at East Tisted (614.4 tCO_2e) and Filmore Hill (541.8 tCO_2e). The next highest-carbon activity was winter gritting at 11.2 tCO_2e. At emissions category level, 63% of emissions came from materials, 24% from plant, 11% from transportation, 1% from travel, 0.2% from waste, and 0.1% from operatives/subcontracted services. Almost all of the emissions from materials came from asphalt, which accounted for 63% of the baseline (*Figure 18*).

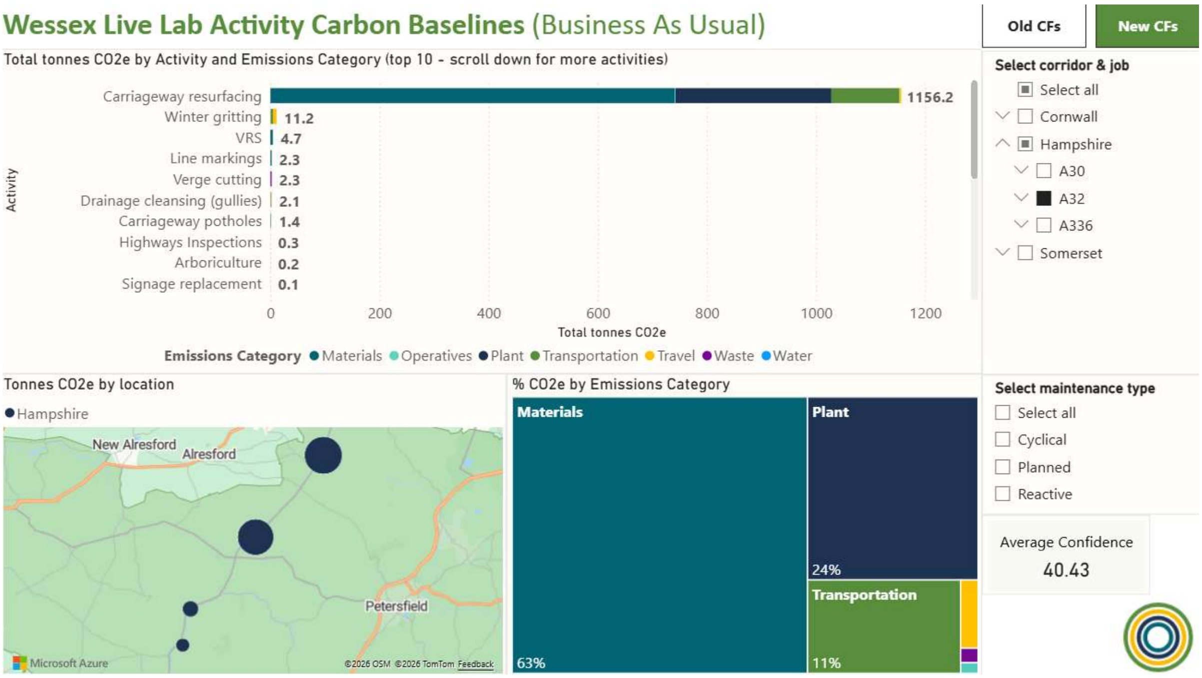

Figure 18: *Breakdown of carbon emissions at activity and category level for the A32.*

On the A30 corridor, 91% of emissions came from planned maintenance, with 5% from reactive maintenance and 4% from cyclical maintenance. 247.8 tCO_2e of emissions came from carriageway resurfacing at Haywards Cottage (169.4 tCO_2e) and The Hogget junction (78.5 tCO_2e), whilst 195.6 tCO_2e came from a combined resurfacing and patching scheme between Bracknell Road and Odiham Road. At emissions category level, 59% of emissions came from materials, 26% from transportation, 9% from plant usage, 4% from travel, 1% from waste, and 0.1% from operatives/subcontracted services. The majority of the emissions from materials came from asphalt, which accounted for 55% of the baseline (*Figure 19*).

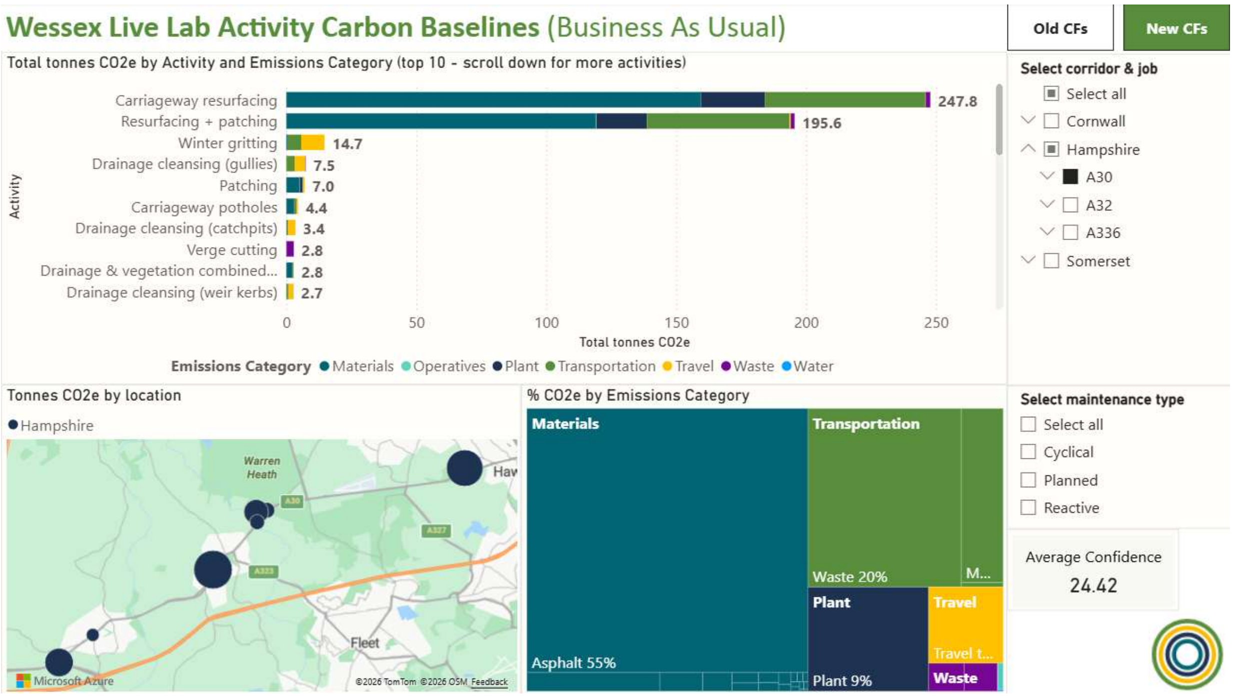

Figure 19: *Breakdown of carbon emissions at activity and category level for the A30.*

On the A336 corridor, 72% of emissions came from planned maintenance, with 19% from reactive maintenance and 9% from cyclical maintenance. 30.1 tCO_2e of emissions came from carriageway resurfacing on the A336/A31 roundabout, whilst 9.6 tCO_2e of emissions came from patching on Ringwood Road (7.2 tCO_2e), Bourne Lane junction (1.5 tCO_2e) and Netley Marsh School (1.0 tCO_2e). At emissions category level, 49% of emissions came from materials, 24% from transportation, 12% from plant usage, 11% from travel, 3% from waste, 0.4% from operatives/subcontracted services, and 0.01% from water. The majority of the emissions from materials came from asphalt, which accounted for 47% of the baseline (*Figure 20*).

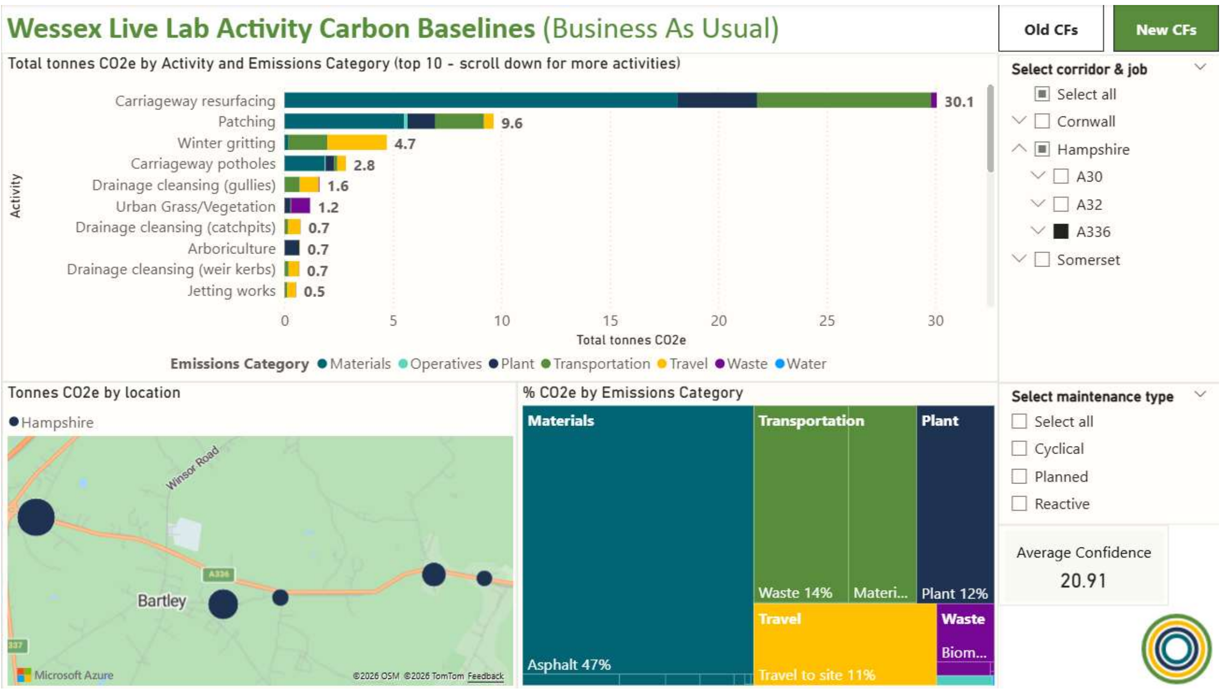

Figure 20: *Breakdown of carbon emissions at activity and category level for the A336.*

Experimental Profiles

Overall, the experimental carbon profiles for Hampshire's three corridors indicate that a total of 472.6 tCO_2e (27%) were saved across all three corridors. Whilst this did not meet the hypothetical 30% saving estimated in the Strategic Outline Business Case, two corridors exceeded this target (the A32 at 33% and the A336 at 69%). However, had all of the potential innovations identified been implemented on the corridors, a saving of up to 1,517.0 (88%) could have been achieved across all three corridors, as shown in *Table 4* and *Figure 21*. Furthermore, several innovations were introduced at a service-wide level which achieved carbon savings greater than those assigned to the corridors, taking the service-wide carbon saving to 1,346.7 (6% of the 2022-23 baseline). These service-wide innovations are discussed at the end of this chapter.

Table 4: *Summary of the physical carbon savings achieved and simulated carbon savings achievable on each of the three corridors and maintenance types.*

Corridor	Physical carbon saving		Simulated carbon saving	
	tCO_2e	% of BAU	tCO_2e	% of BAU
A30	49.4	10%	311.4	63%
A32	385.0	33%	1,163.8	99%
A336	38.1	69%	41.8	76%
Maintenance type	tCO_2e	% of BAU	tCO_2e	% of BAU
Planned	458.5	28%	1,482.1	90%
Reactive	6.6	12%	19.7	37%
Cyclical	7.3	26%	15.1	54%
Total	**472.6**	**27%**	**1,517.0**	**88%**

Due to the predominance of carbon emissions from planned maintenance activities, this was the source of 97% of both physical and simulated carbon savings across all three corridors, with only 1% of physical carbon savings being attributable to changes in reactive maintenance activities and 2% to changes in cyclical maintenance activities (*Figure 21*).

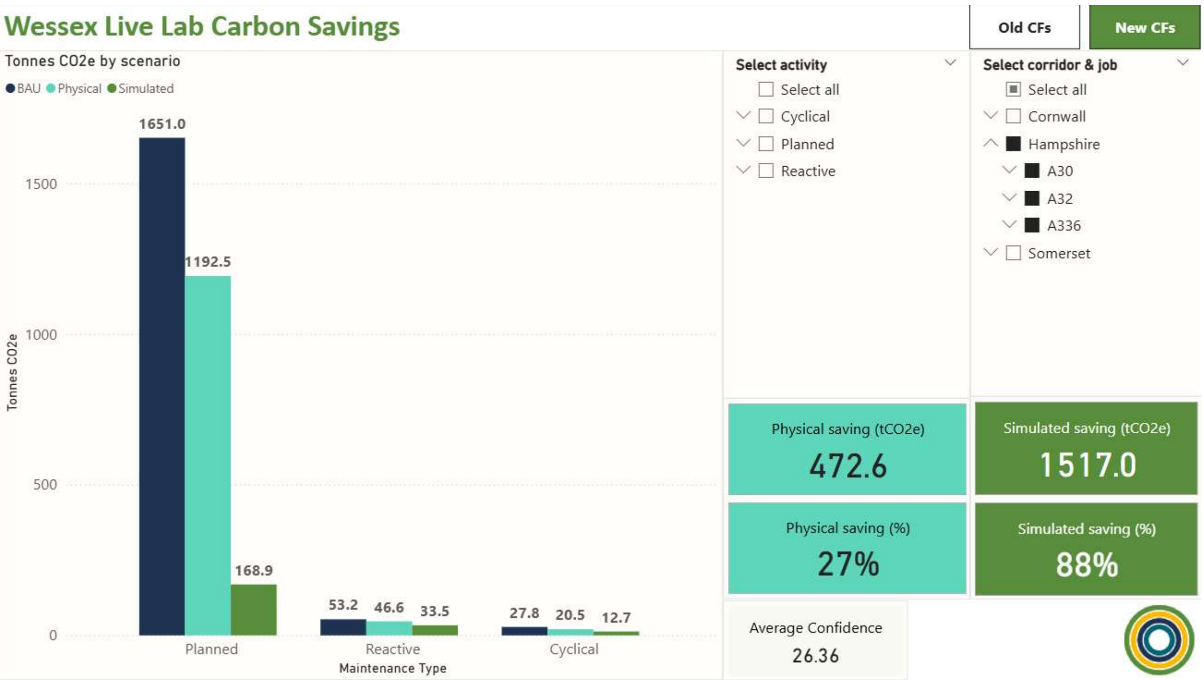

Figure21: *Total physical and simulated carbon savings from planned, cyclical, and reactive maintenance activities across the three corridors.*

On the **A30 corridor**, the majority (40.7 tCO_2e) of physical carbon savings came from the use of warm and hot asphalt mixes with a biogenic binder for the carriageway resurfacing scheme at Haywards Cottage, Blackwater (HR764). This achieved a 24% carbon reduction compared to the baseline approach of using a standard HRA with a bituminous binder. However, further carbon savings could have been achieved by applying additional innovations such as: 'eco cones' with smart sensors along diversion routes, to reduce the need for driven inspections; cold-applied MMA line markings instead of hot-applied thermoplastic; entirely warm mix asphalt (WMA) with biogenic binder; and hydrotreated vegetable oil (HVO) for vehicles and plant items. Overall, these innovations could have increased the carbon saving to 106.7 tCO_2e (63%). Although the potential longevity of WMA with biobinder is not confirmed, provisional estimates indicate that it is likely to be 15-22 years, compared to 20-25 years for HRA. Therefore, the long-term carbon emissions over a 40-year period may increase by up to 47.4 tCO_2e (14%) using the current methods or decrease by up to 150.6 tCO_2e (44%) if further innovations are applied in future (*Figure 22*).

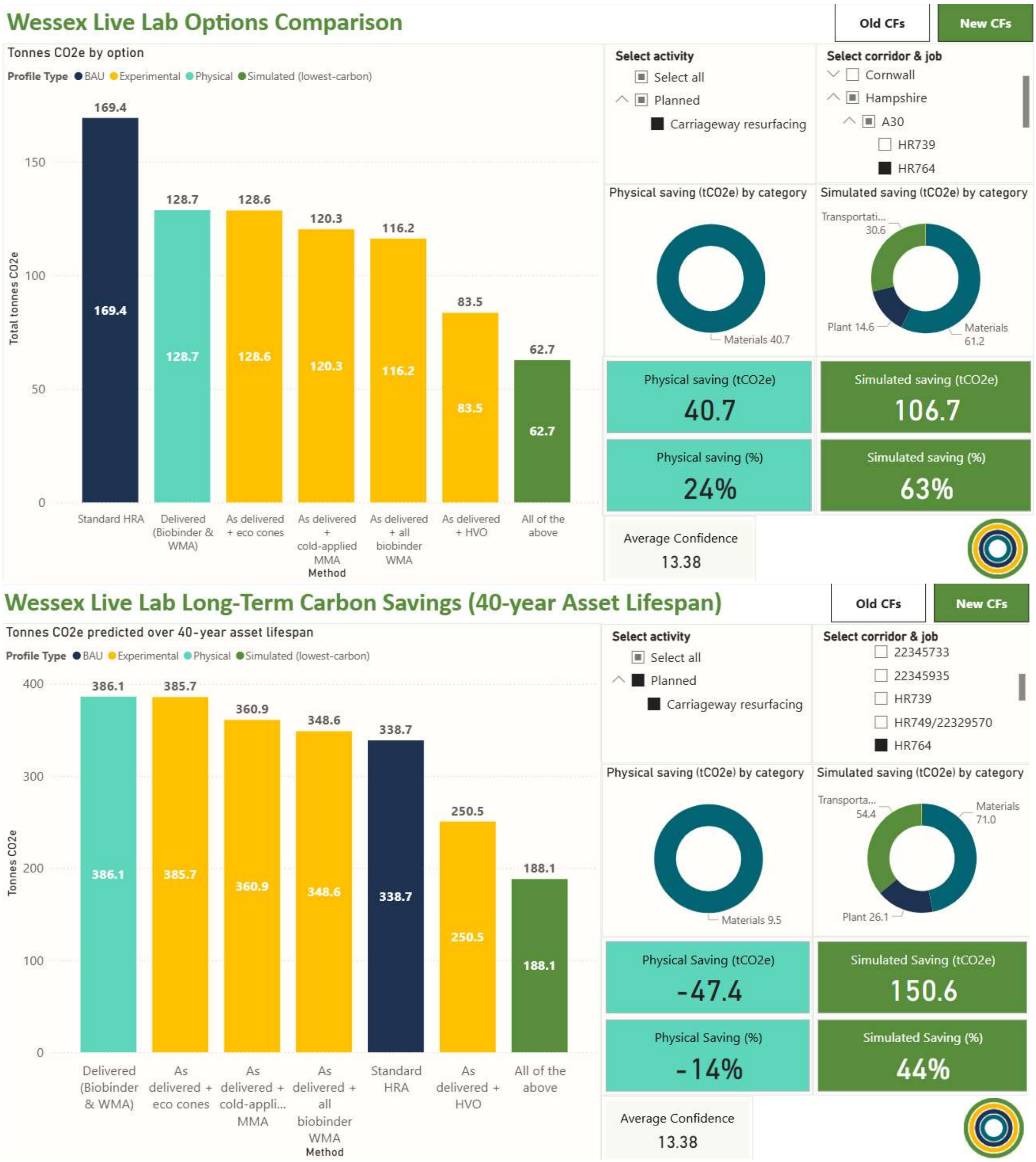

Figure22: *Comparison between BAU, physical, experimental, and simulated carbon profiles for the carriageway resurfacing works at Haywards Cottage, Blackwater, including upfront carbon emissions (top) and over a 40-year asset lifespan (bottom).*

A minor carbon saving of approx. 1.9 tCO_2e was also achieved on two patching schemes with the HVO- and hydrogen-powered Hydrovo: 22345733 on Star Hill (1.0 tCO_2e), and 22345935 on Hare's Lane to Hulfords Lane (0.8 tCO_2e). Compared to the baseline approach of cut & fill patching with a standard HRA, the use of the Hydrovo (along with HVO for all vehicles and plant) achieved a 29% carbon reduction - including 28% on Star Hill and 30% on Hare's Lane to Hulfords Lane - despite the use of a higher-carbon asphalt mix than usual. Had the WMA with biogenic binder been used instead, the total carbon saving could have increased to 4.6 tCO_2e (72%). Whilst the use of the Hydrovo was deemed infeasible for the remaining two patching schemes on this corridor (22316857 from Newnham Road to Station Road Roundabout and 22329570 at Hartley Wintney), this could have saved an additional 1.8 tCO_2e, or 4.4 tCO_2e including the WMA with biobinder. In the long term, the 40-year carbon savings on the two Hydrovo schemes are estimated at approx. 1.9 tCO_2e (29%) with HRA - assumed to last up to 10 years - or 4.6 tCO_2e (72%) with WMA with biobinder, estimated to last approx. 7.5 years (*Figure 23*).

Figure 23: Comparison between BAU, physical, experimental, and simulated carbon profiles for the patching works at Star Hill and Hare's Lane to Hulfords Lane, including upfront carbon emissions (top) and over a 40-year asset lifespan (bottom).

On the **A336 corridor**, the majority (29.5 tCO_2e) of physical carbon savings came from the use of shotblast retexturing (Textureblast) on the A31/A336 roundabout at Cadnam, achieving a 98% carbon saving compared to the baseline approach of resurfacing with a standard hot rolled asphalt. Although shotblast retexturing only lasts for approximately 3-5 years, compared to 20-25 years for HRA, this still delivers a long-term carbon saving of 54.9 tCO2e (91%) over a 40-year period (*Figure 24*).

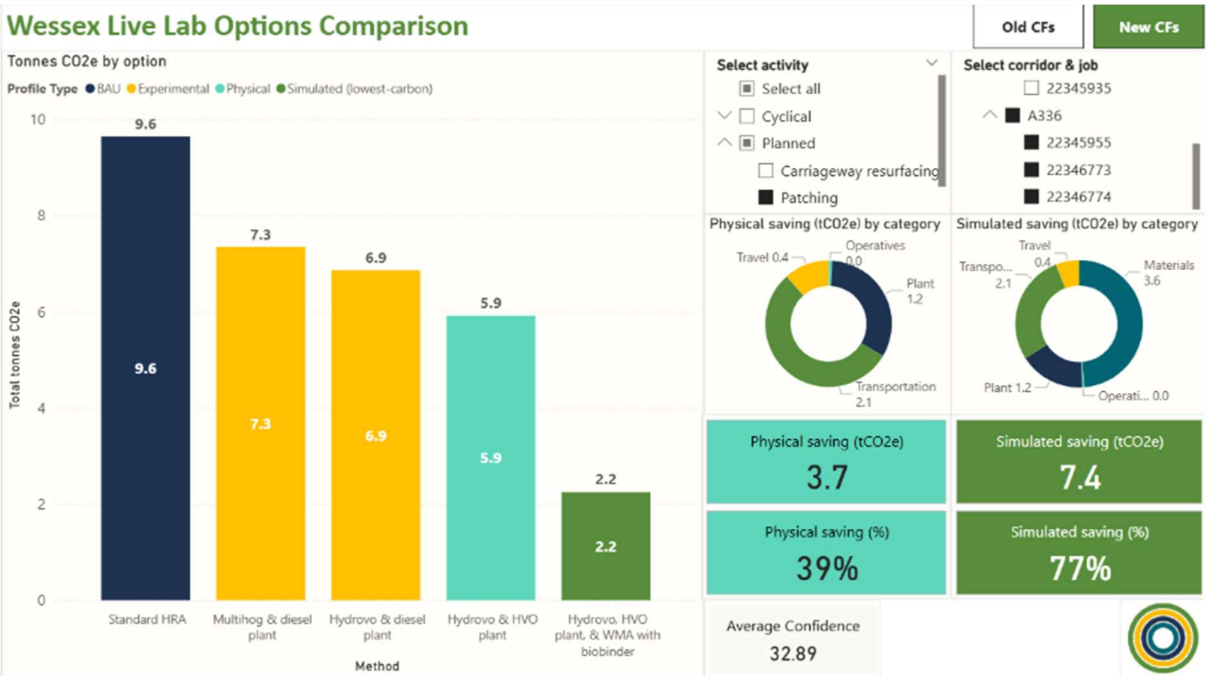

Figure 24: *Comparison between BAU and physical carbon profiles for the shotblast retexturing scheme on the A31/A336 roundabout at Cadnam, including upfront carbon emissions (top) and over a 40-year asset lifespan (bottom).*

A smaller carbon saving of 3.7 tCO_2e was also achieved on three patching schemes, including 22345955 at Netley Marsh School (0.3 tCO_2e), 22346773 on Ringwood Road (2.8 tCO_2e), and 22346774 on the Bourne Lane junction (0.6 tCO_2e) through the use of the Hydrovo and HVO-fuelled vehicles & plant. This achieved a 39% carbon reduction compared to the baseline approach of cut & fill patching with a standard HRA, including 35% at Netley Marsh School; 39% on Ringwood Road; and 38% on the Bourne Lane junction. Had a WMA with biogenic binder been used instead of a bituminous HRA, the total carbon saving could have increased to 7.4 tCO_2e (77%). In the long term, the 40-year carbon savings are estimated at 14.9 tCO_2e (39%), or up to 25.1 tCO_2e (65%) with the warm mix with biobinder (*Figure 25*).

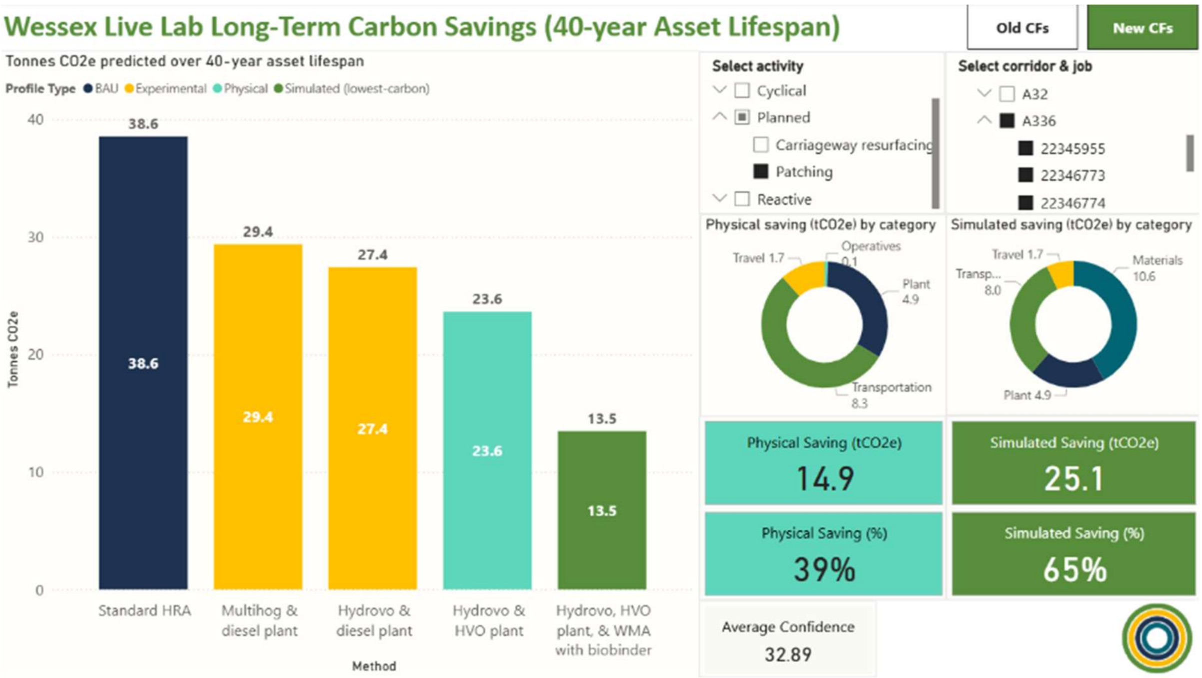

Figure 25: *Comparison between BAU, experimental, physical, and simulated carbon profiles for the patching schemes at Netley Marsh School, Ringwood Road, and the Bourne Lane junction, including upfront carbon emissions (top) and over a 40-year asset lifespan (bottom).*

A carbon saving of 2.1 tCO_2e (44%) was also achieved on the A336 through the use of an electric gritter, the ECON E-QCB, for winter maintenance. If this innovation was adopted on the other two corridors, this carbon saving could increase to 13.8 tCO_2e (45%) per year. Hampshire County Council also switched from a domain-based winter maintenance forecasting system to a route-based system in the winter of 2025-26. Across the three corridors, route-based forecasting would save 1.5 tCO_2e (5%) with diesel gritters; 3.6 tCO_2e (12%) with the ECON E-QCB on the A336 only; or 17.6 tCO_2e (57%) with electric gritters on all three corridors (*Figure 26*).

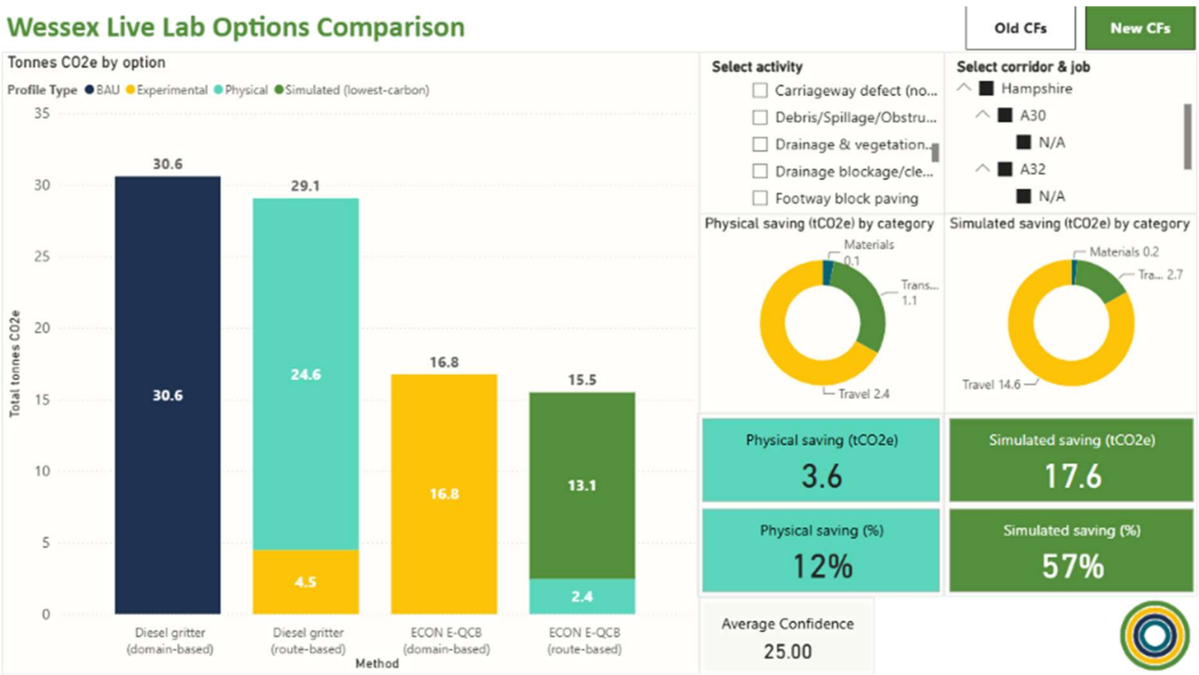

Figure 26: *Comparison between BAU, physical, experimental, and simulated carbon profiles for winter maintenance (gritting) across the three corridors. Note that the ECON E-QCB was only trialled physically on the A336 corridor.*

Full-Service Carbon Savings

Several innovations also achieved carbon savings at a full-service level; where possible, these carbon savings have been apportioned to each corridor, based on the proportion of assets and/or defects covered at corridor level vs. full-service level, as detailed in *Table 5***.** below. Some innovations (e.g. the gully waste recycling unit and the hydrogen power unit) are applied in combination with one another, so the carbon savings are cumulative. Note that the savings assigned to the corridors do not directly scale up to full-service level on the basis of corridor length, as all of the corridors are A-roads and thus not directly representative of the variety of roads on the Hampshire highways network. The overall carbon saving from these innovations is 890.7 tCO_2e (41%), although 13.4 tCO_2e of this saving has already been allocated to the corridors, so the remaining saving outside of the corridors is 877.3 tCO_2e.

Table 5: *Carbon savings from innovations applied at service-wide level.*

Physical Innovations	Full-service carbon emissions (tCO_2e)		Full-service carbon saving		Carbon saving assigned to corridors (tCO_2e)		
	BAU	Physical	tCO_2e	%	A30	A32	A336
Asphalt reheater trial	612.1	89.6	522.5	85%	2.1	0.6	1.5
Waste water cleansing unit	138.6	9.8	128.8	93%	4.8	1.5	1.2
Hydrogen power unit	80.9	18.5	62.4	77%	0.1	0.1	0.03
Type 1 recycled aggregate	115.7	92.6	23.1	20%	n/a	n/a	n/a
FoamixEco footway schemes	9.6	1.3	8.3	86%	n/a	n/a	n/a
Electric coring rig	1.0	0.7	0.3	32%	n/a	n/a	n/a
Route-based winter forecasting	1,205.2	1,070.7	134.5	11%	0.7	0.6	0.2
Electra 12t HGV	17.7	6.9	10.8	61%	n/a	n/a	n/a
Total	**2,180.8**	**1,290.1**	**890.7**	**41%**	**7.7**	**2.8**	**2.9**

A carbon saving of 522.5 tCO_2e is expected to be achieved through a trial to reheat spent and recovered asphalt at the Micheldever asphalt plant. This includes 245.3 tCO_2e from the reduction in embodied carbon from virgin asphalt production; 254.7 tCO_2e from the use of ECO-BOX electric hotboxes at Micheldever instead of traditional diesel-powered static hotboxes; and 22.5 tCO2e from the use of a mobile E-Box driven by HVO fuel, in place of a traditional LPG mobile hot storage unit. Overall, this represents an 85% saving compared to the BAU scenario of purchasing virgin asphalt (*Figure 27*). Scaling up this trial to full annualised operations would increase the carbon saving to 1,535.6 tCO_2e per year.

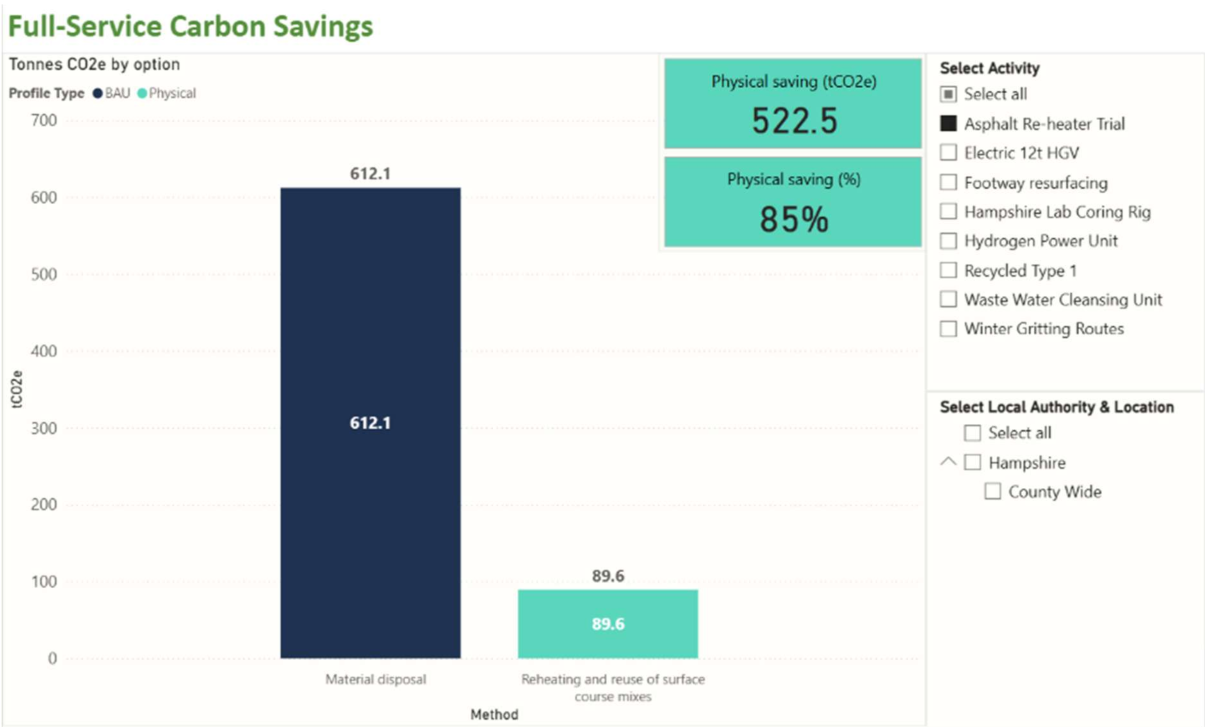

Figure 27: *Full-service carbon savings from the asphalt reheater trial in Hampshire.*

A carbon saving of 128.8 tCO_2e per year is expected to be achieved through the introduction of a wastewater cleaning unit to the Northington Depot, allowing clean water and recyclable aggregates to be extracted from gully waste. This represents a 93% saving compared to the BAU approach of sending gully waste to West Sussex for recycling and then transporting the recycled aggregates back to Micheldever, due to the reduction in transport distances (*Figure 28*).

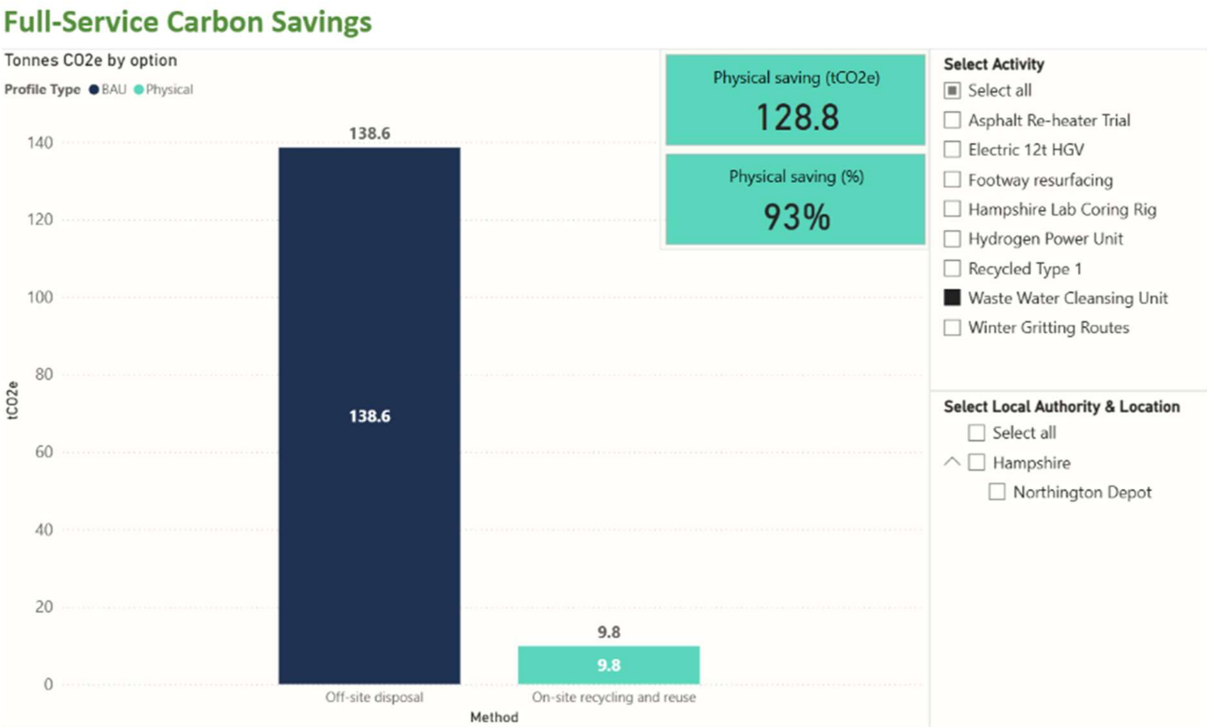

Figure 28: *Full-service carbon savings from the waste water cleaning unit at the Northington depot.*

Alongside the waste water cleansing unit, the introduction of a GeoPura Hydrogen Power Unit to the Northington depot is expected to save 62.4 tCO_2e per year compared to a standard diesel generator producing 5,000 kWh per week. This represents a 77% saving compared to the baseline (*Figure 29*) taking into account the delivery of hydrogen from the supplier in a diesel HGV.

Figure 29: *Full-service carbon savings from the GeoPura hydrogen power unit at the Northington depot.*

A carbon saving of 23.1 tCO_2e per year is expected to be achieved by producing recycled Type 1 aggregate from soil and stone waste at the Micheldever depot. This represents a 20% saving compared to the BAU approach of sending soil and stone waste to Lockhams (Southampton). Had the BAU approach been to purchase virgin aggregate and send the soil and stone waste to landfill, an even greater saving of 155.1 tCO2e per year (63%) would have been achieved (*Figure 30*).

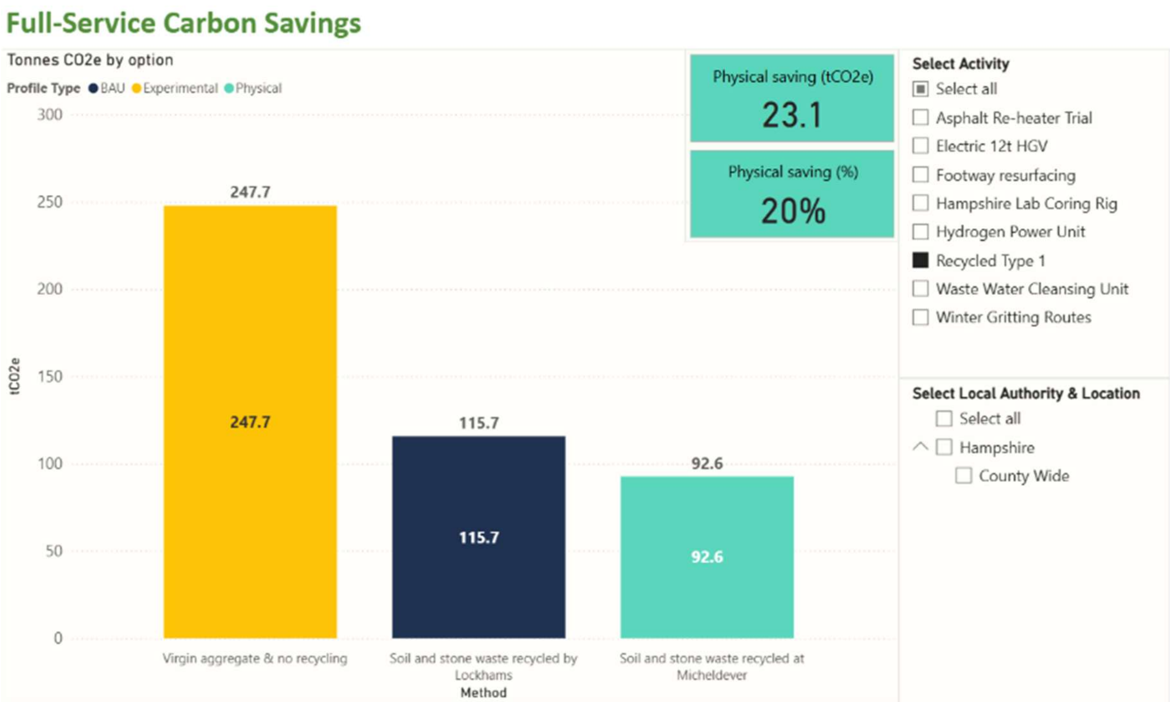

***Figure 30**: Full-service carbon savings from the production of recycled Type 1 aggregate at Micheldever.*

A carbon saving of 8.3 tCO2e was achieved on two footway resurfacing schemes – at Raven Close, Yateley, and Savile Crescent, Bordon - through the use of the carbon-neutral CRBM FoamixEco with MLS (manufactured limestone), along with electric plant on the Raven Close scheme. Compared to the baseline scenario of using standard AC20 and diesel plant, this represents an 86% saving, including 5.3 tCO_2e (90%) on Raven Close (0.8 tCO_2e of which was from the use of electric plant) and 3.0 tCO_2e (79%) on Savile Crescent. Had electric plant been used for both schemes, the total saving would have increased to 8.7 tCO_2e (91%), as shown in *Figure 31*.

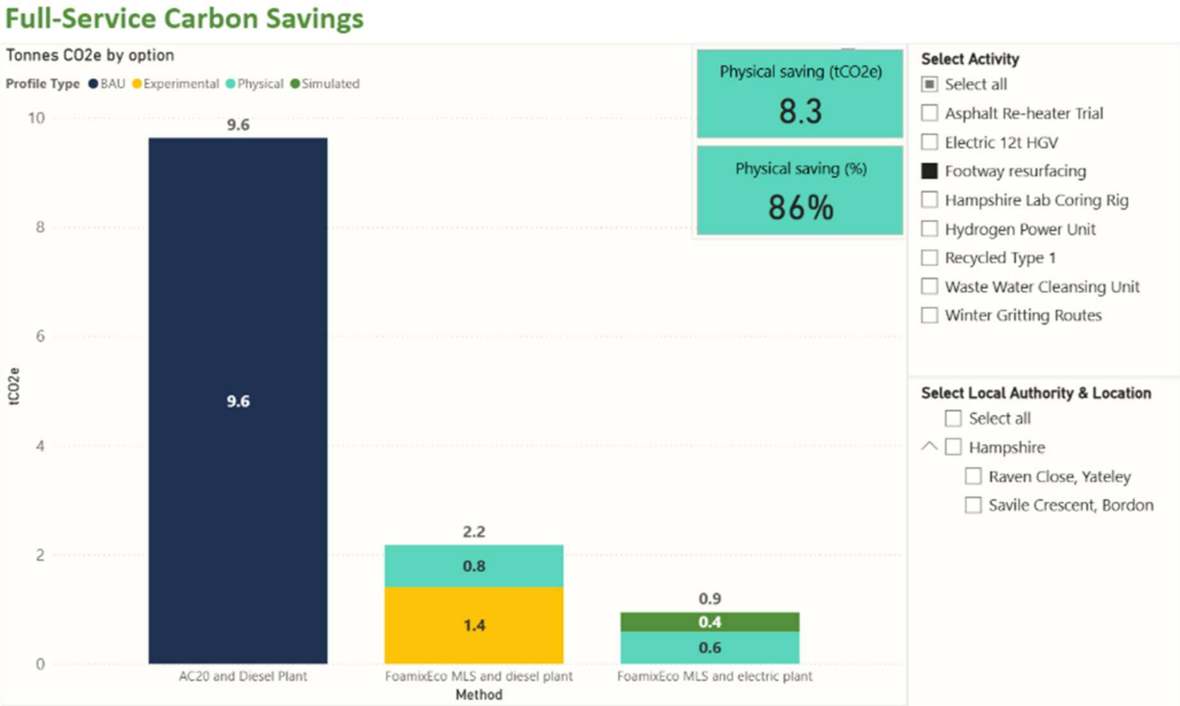

***Figure 31:** Full-service carbon savings from the use of FoamixEco MLS on Savile Crescent and FoamixEco MLS with electric plant on Raven Close.*

A carbon saving of 0.3 tCO_2e per year is expected to be achieved through the use of an all-electric asphalt coring drill rig at the Hampshire Lab. Compared to the baseline scenario of using a standard diesel-powered coring rig, this represents a 32% saving (*Figure 32*).

Figure 32: *Full-service carbon savings from the use of an electric coring rig at the Hampshire Lab.*

A carbon saving of 134.5 tCO_2e per year is expected to be achieved by adopting a more efficient set of winter gritting routes, with reduced routes and smarter treatment plans supported by two additional weather stations with improved forecasting provision and accuracy. Compared to the existing gritting routes, this represents an 11% saving (*Figure 33*), of which 30.4 tCO_2e is due to the reduced distances travelled by the gritters; 8.8 tCO_2e is due to the reduced quantities of gritting salt consumed; and 95.4 tCO_2e is due to the reduction in emissions from the delivery of salt to the depots.

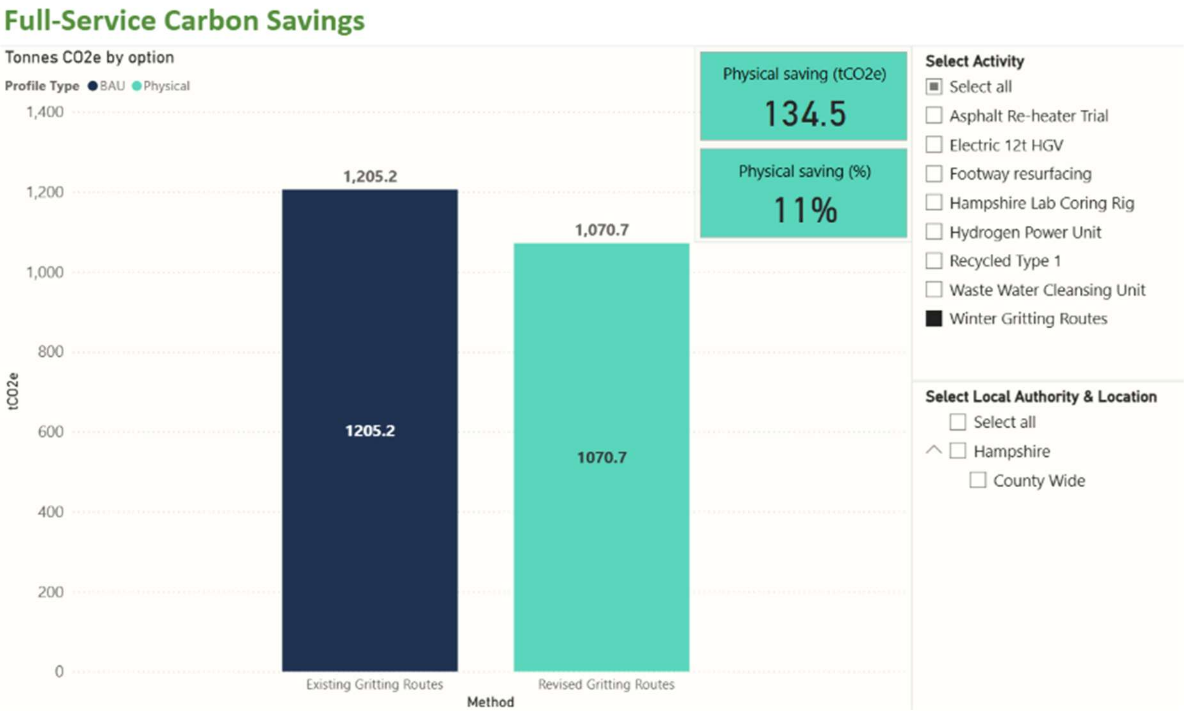

Figure 33: *Full-service carbon savings from the revision of Hampshire's gritting routes.*

A carbon saving of 10.8 tCO_2e per year is expected to be achieved through the addition of an Electra 12-tonne electric HGV to the Highways fleet. Compared to a standard diesel HGV, this represents a 61% saving (*Figure 34*).

Figure 34: *Full-service carbon savings from the adoption of a 12t electric HGV.*

5 Doughnut Economics

Introduction

Doughnut Economics is an economic model developed to better balance social and ecological needs, by considering how development and growth can be optimised to strengthen social foundations and remain within global ecological ceilings. Working alongside Circle Economy, Colas Ltd, the Doughnut Economics Action Lab (DEAL), and partner authorities, HCC Highways has played a central role in adapting the strategic Doughnut model to the local highway maintenance environment in the form of a 'Highways Doughnut Toolkit'. To bring theory into practice, the toolkit was trialled in a workshop setting to assess real-world maintenance schemes.

Framework and Methodology

The primary objective of the workshop was to move 'beyond the basics'. While highway maintenance had historically been viewed through a functional lens, the Doughnut Tool forced a cross-disciplinary examination of wider social and ecological impacts. To facilitate this, traditional Doughnut principles were mapped onto 18 distinct highway maintenance themes, establishing a defined 'Doughnut State' for each category. The workshop brought together a diverse cohort of technical experts, alongside tier-one contractors and local supply chain partners, to break down operational silos. The methodology was structured to first demystify the core principles of the model and then applied the principles to the tangible constraints of a local highway maintenance project.

Successes and Friction Points

The pilot provided useful insights and participants praised the tool's ability to foster multifaceted discussion. The application revealed critical friction points and showed the difficulty in quantifying the incremental social and environmental impacts of highway maintenance schemes. Another primary concern was resource intensiveness. The high demand on time and expertise suggested that a one-size-fits-all approach hindered efficiency. Participants noted that the tool, in its pilot iteration, felt overly complex for routine, small-scale maintenance. Furthermore, the terminology used within the tool, rooted in high-level economic theory, created ambiguity, which led to inconsistent interpretations across different teams. This highlighted a clear need for a more bespoke, infrastructure-ready version of the framework better aligned to the language of local government and civil engineering.

Critical Evaluation and Technical Limitations

When critiquing the tool's performance, its greatest strength was its 'Check-List Effect'. It ensured that no single dimension of sustainability was ignored. Yet, its applicability to the built environment specifically required refinement. The pilot indicated that while it might be relatively simple to apply these principles to large-scale, greenfield developments, it was significantly harder to quantify the incremental social and environmental impacts of maintaining an existing highway asset. The difficulty in measuring these smaller-scale shifts remained a technical barrier to full integration at the conclusion of the workshop.

Strategic Recommendations for Scaling

To successfully embed Doughnut Economics into the HCC Highway service and scale the toolkit for wider local authority adoption, the following strategic actions were identified:

• Scale-Appropriate Tooling: The development of a 'Lite' version of the evaluation tool was recommended for routine maintenance, reserving the full-scale analysis for major infrastructure projects.
• Contextual Definition: There was a clear need to redefine key terms to align with local authority KPIs, engineering standards, and local government language to ensure consistency in data reporting.
• Capacity Building: The workshop highlighted the need for a structured training programme to familiarise teams and supply chain partners with the tool before project commencement, which would reduce the 'familiarisation lag' observed during the pilot.
• Institutional Alignment: Participants noted that securing a top-down mandate was essential to ensure that findings from these evaluations actually influenced budget allocation, procurement scoring, and project design.

Conclusion

The workshop findings support the use of Doughnut Economics as a viable lens for highway maintenance planning. While the tool required adaptation to be more agile and context-specific, the pilot successfully laid the groundwork for a more inclusive, sustainable approach to managing Hampshire's physical assets.

6 Benefits Analysis

Carbon Savings Analysis

The total carbon emissions for BAU activities across all projects is 3,563 tCO2e; through various innovations, a total of 1,356 tCO2e was saved (*Table 6*).

- Percentage Carbon Saved: 38% compared to BAU.

- Cost Efficiency: The total innovation uplift cost was £955,477, resulting in a project cost of £704.63 per tCO2e saved.

Metric	Value
Total BAU Carbon	3,563 tCO2e
Total Carbon Saved	1,356 tCO2e
Percentage Saved	38.0%
Cost per Tonne Saved	£704.63

Table 6: *carbon savings*

Figure 35 below visualises the current impact and a 5-year projection assuming a 10% annual increase in the adoption and efficiency of these innovations.

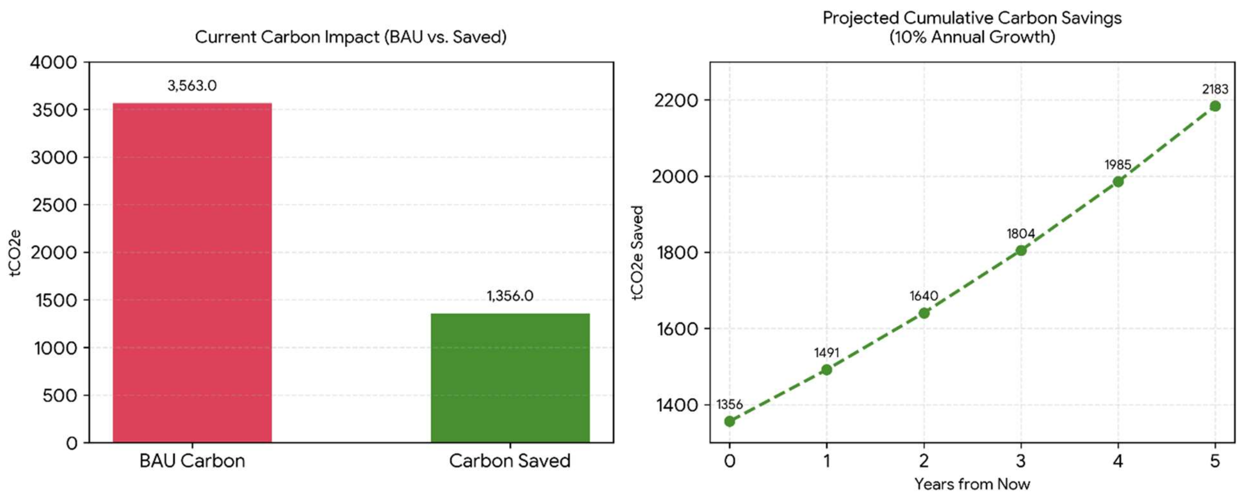

Figure 35*: current impact and a 5-year projection assuming a 10% annual increase*

Activity Efficiency and Cost-Effectiveness

The high cost-per-tonne is largely driven by pilot trials like the Hydrogen Power Unit and the Asphalt Re-heater, which have a more significant upfront cost but also offer substantial long-term financial and carbon benefits. *Table 7* and *Figure 36* below compare innovation uplift cost per tonne of CO2e saved to cost-effectiveness, to identify the best return.

Activity	**Cost per tCO2e Saved**	**% Carbon Saved vs. BAU**

Retexturing	£0.00	68.4%
Resurfacing	£282.04	38.5%
Patching	£414.00	35.5%
Asphalt Re-heater Trial	£448.04	85.2%
Hydrogen Power Unit	£2,429.66	77.8%
Electric 12t HGV	£5,510.29	76.8%

Table 7: *innovation uplift cost per tonne of CO2e saved*

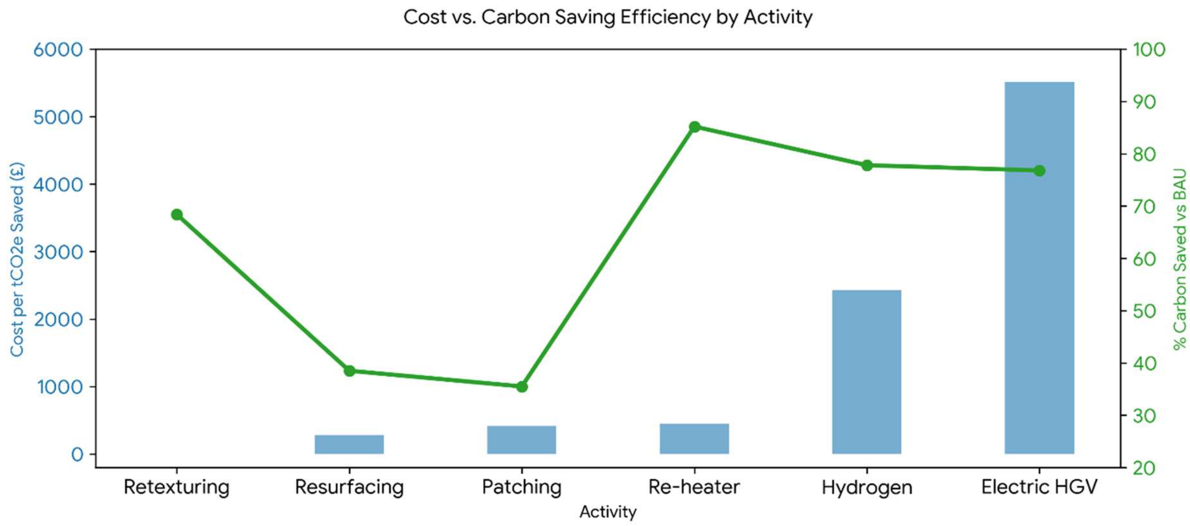

Figure 36*: cost v carbon saving efficiency*

Key Strategic Insights

- **High Efficiency:** Retexturing offers a significant carbon saving with zero additional innovation cost given its product maturity.
- **Scalable Pilots:** The Asphalt Re-heater Trial appears highly effective, with forecast saving over 85% of carbon at a relatively moderate cost of £448/tonne. This represents a strong candidate for wider sector adoption.
- **High-Cost Innovations:** Specialised equipment like the Electric HGV and Hydrogen Power Units have high initial costs (£2.4k–£5.5k per tonne). While expensive now, these types of innovation are considered important for addressing remaining hard-to-decarbonise emissions.
- **Percentage Carbon Saved:** The current 38% carbon savings compared to the baseline is expected to improve as pilot technologies like hydrogen and electric mature. As these innovations transition from early trials to service-wide standards, economies of scale will lower upfront costs and further reduce the cost per tonne saved.

Full-Service Impact Summary

If the sample's current 38% savings rate were scaled to the entire Hampshire Highways' network, the immediate results would be:

- **Annual Carbon Saved:** 8880 tCO2e (equivalent to roughly 11,526 one-way flights from London to NY).
- **Residual Footprint:** Reduction from 2.68 tCO2e/km down to 1.66 tCO2e/km.
- **Projected Investment:** To achieve these annual service-wide savings, an estimated annual innovation budget of £6.26 million would be required, based upon a £704.63/tonne uplift cost.

Future Projection Analysis

The HCC Highway maintenance 2022-23 carbon footprint was 23,333.5 tCO2e, which is roughly equivalent to 22,600 passengers taking a one-way flight from London to New York. Normalised by network length, this equates to approximately 2.68 tCO2e per km of Hampshire's local highway network. Applying these trials across the entire service could yield sizeable further reductions, equivalent to grounding thousands of these flights.

If high-efficiency methods like those trialled, can prove suitable for a larger percentage of the total work volume, the overall carbon savings could feasibly reach 45-55% within 3-5 years without a proportional increase in budget.

Potential 10-Year Cost Efficiency (2025–2035)

Table 8 indicates that the potential cost per tonne of CO_2e saved could reduce by around 45% by 2035 if low-carbon innovations continue to mature and achieve wider adoption across the highway maintenance service. This potential reduction being driven by two main factors:

- Technology Maturity: As low-carbon technologies move into the mainstream, unit costs typically reduce through economies of scale, manufacturing improvements and wider adoption. For example, solar panel prices fell by around 84% between 2014 and 2024, demonstrating how rapidly costs can fall as a technology matures. Government grants of up to £120,000 for new electric HGVs are also helping to accelerate market growth and reduce future capital premiums.

- Operational Savings: If Products & Services (94% of HCC footprint) shift to lower carbon options like Warm Mix Asphalt, the initial innovation uplift becomes the new baseline cost.

Technology Type	2025 Cost/tCO2e (Trial)	2035 Projected Cost/tCO2e	Key Driver for Drop
Material Innovation	£282–£448	£150–£220	Adoption of WMA and bio-binders.
Specialist Plant	£2,429	£850–£1,100	Green hydrogen scaling.
Heavy Vehicles (EV)	£5,510	£1,800–£2,300	Battery density & tCO parity.

Table 8*: projected tCO2e costs and drivers*

Revised Cost per Tonne Adjusted for Technology Maturity

By spreading the innovation uplift costs over the 40-year lifespan of the asset and accounting for a 15-20% decrease in technology costs per decade (as markets mature), the economic outlook becomes more favourable as shown in ***Table 9*** below.

Period	Projected Cost per tCO2e Saved	Rationale
2023-2030	**£704.63**	Initial trial cost profile.
2031-2040	**£528.47**	25% reduction due to mass adoption of HVO & Re-heating.
2041-2050	**£369.20**	Maturation of Electric/Hydrogen plant & low-carbon asphalt.

Table 9*: innovation uplift costs over a 40-year lifespan*

Service-Wide Net Zero Trajectory (2050)

Figure 37 below combines the updated simulation with the Hampshire Baseline to show the path to 2050. The green shaded area represents the ‘Innovation Gap’ to be closed.

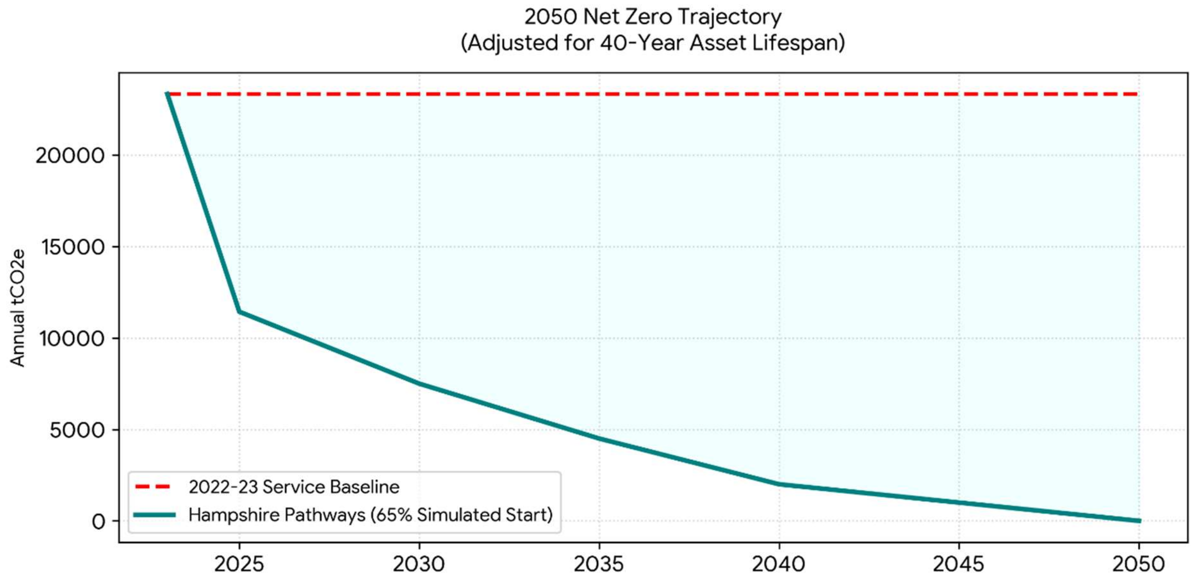

***Figure 37**: 2050 net zero trajectory*

7 Trial Inventory Data

Activity	Location	BAU Method	Quantity	Inn Method	BAU Carbon (tCO2e)	Carbon Saved (tCO2e)
Asphalt Re-heater Trial	County Wide	Material disposal	Lot	Reuse of surface course	612.1	522.5
Electric 12t HGV	County Wide Depots	Diesel Vehicle	1	Electra Electric HGV	17.7	10.8
Footway resurfacing	Seville Crescent, Bordon	AC20	331m2	FoamixEco MLS	3.7	3.0
Footway resurfacing	Raven Close, Yateley	AC20 and Diesel Plant	200m2	FoamixEco MLS and electric plant	5.9	5.3
Hampshire Lab Coring Rig	Hants Lab	Diesel Rig	1	Infra Test Electric Coring Rig	1.0	0.3
Hydrogen Power Unit	Northington Depot	Diesel Generator	1	GeoPura Hydrogen Power Unit	80.9	62.4
Patching	A336 Bourne Rd junction	Diesel Plant	73m2	Multevo Hydrovo	1.5	0.6
Patching	A336 Ringwood Road	Diesel Plant	1708m2	Multevo Hydrovo	9.7	3.7
Patching	A30, Hartfordbridge	Diesel Plant	200m2	Multevo Hydrovo	2.6	0.8
Patching	A30 Star Hill, Hartfordbridge	Diesel Plant	200m2	Multevo Hydrovo	7.9	5.3
Recycled Type 1	County Wide	New material	Lot	Recycled soil and stone waste	115.7	23.0
Resurfacing	A30 Haywards Cottage	HRA & Chips	11077m2	Tarmac Warm Mix 943 / Shell Bio binder	169.4	40.7
Resurfacing	A32 Woodlands to Filmore Hill	AC20	21000m2	Foamix CRBM	541.8	172.7
Resurfacing	A32 Lower Farringdon	AC20	24181m2	Foamix CRBM	614.4	209.8
Retexturing	A336 / A31 Rbt	45mm Inlay HRA & Chips	2362m2	Textureblast	30.1	29.5
Revised Gritting Routes	County Wide	Existing Gritting Routes	Lot	Smarter treatment plans	1205.2	134.5
Waste Water Cleansing Unit	Northington Depot	Off-site-disposal	1	On-site recycling and reuse	138.6	128.8

Winter Salting	Totton incl A336	Diesel Gritter	1	Econ Electric gritter	4.7	2.1
Totals					**3563**	**1356**

Table 10: *Trial Inventory Data*

8 Conclusion

Hampshire County Council, through its participation in the Wessex Live Lab, has sought to demonstrate that meaningful decarbonisation can be achieved within the realities of maintaining a large and complex highway network. Through the three live laboratory corridors and an expanding portfolio of service-wide initiatives, the project has moved beyond theory and into practical delivery. The trials have validated that significant carbon reductions can be achieved through a combination of alternative materials, circular economy techniques, electrification, hydrogen technologies, smarter operational planning, improved data, and behavioural change. Across the project, verified carbon savings have already been realised, with further opportunities identified that could deliver substantially greater reductions as technologies mature and barriers to adoption reduce.

The legacy of the project is not limited to carbon alone. The project has increased organisational awareness of carbon impacts and encouraged greater consideration of carbon alongside safety, serviceability, resilience, biodiversity and social value. Tools such as Carbon Analyser, Carbon Budgeting and the Highways Doughnut Toolkit enable a shift in decision-making towards a more holistic and evidence-led approach, helping to further embed carbon literacy and sustainability thinking within day-to-day operations.

The project has also demonstrated that successful decarbonisation relies upon behavioural and cultural change as much as technological innovation. Early contractor involvement, collaborative supply chain engagement, improved understanding of carbon hotspots, and improving confidence in new delivery methods have all contributed to challenging organisational risk aversion and promoting a stronger appetite for innovation. The lessons learned throughout the programme provide a foundation for further incorporating carbon considerations into business-as-usual planning, procurement, asset management and service delivery.

Several trials remain subject to ongoing monitoring and evaluation, including assessment of long-term asset performance, durability, maintenance interventions and whole-life carbon outcomes. These findings will be critical in validating the full benefits of innovations and the programme's five-year monitoring period will ensure that decisions continue to be informed by robust evidence rather than short-term assumptions.

Looking ahead, the focus now shifts from trialling innovation to embedding proven solutions within normal operations. The challenge is no longer identifying opportunities but determining the tipping points at which emerging technologies become operationally and financially viable at scale. This is particularly relevant for fleet electrification, electric plant, hydrogen-powered equipment and renewable energy infrastructure, where rapid technological advancement and market maturity are expected to drive improved affordability and performance in the coming years.

The programme has also highlighted wider benefits that extend beyond carbon reduction. Reduced noise from electric vehicles and plant, improved local air quality, reduced network disruption through smarter maintenance techniques, enhanced biodiversity opportunities and more efficient use of finite resources demonstrate the broader value of a net-zero approach. These co-benefits align strongly with Hampshire's wider transport and environmental ambitions.

In this regard, the outcomes of Wessex Live Lab directly support the objectives of HCC's Local Transport Plan 4, providing practical evidence that decarbonisation, resilient infrastructure, efficient asset management and sustainable growth are mutually reinforcing goals. The programme has established a proven pathway towards substantially lower-carbon highway maintenance while maintaining service performance and network resilience.

Ultimately, the greatest success of the programme may be the influence it has had beyond Hampshire itself. The evidence, tools, methodologies and lessons generated through Live Labs provide a blueprint that can help accelerate change across the highways sector. The programme has demonstrated that achieving net zero is not dependent upon a single breakthrough technology, but upon the cumulative impact of many incremental improvements, intelligent decisions and collaborative partnerships.

As Hampshire moves from innovation into implementation, the legacy of Wessex Live Labs will be a service that is more carbon-aware, more resource-efficient, more resilient and better equipped to meet future challenges. Hampshire's participation in the Wessex Live Lab has better defined the County's direction for change, improved awareness and confidence in the benefits offered, and improved the foundations for enabling and realising long-term sector-wide change.