Greenprint

Year 2 Final Report

South Gloucestershire Council
West Sussex County Council

31/03/2025

A carbon negative systems model for green infrastructure management

Document Control Sheet

Project Name:	Greenprint
Project Council:	South Gloucestershire Council & West Sussex County Council
Report Title:	Year 2 - End of Year Report
Report Number:	LL2-Y2-SGCWSCC-001

Issue Status/Amendment	Prepared	Reviewed	Approved
Year 2 – End of Year Report	Name: Jean-Christophe Chassard UM&S – WSCC Chris Harris – SGC Date: 15/03/2025	Name: Michele Hulme - West Sussex County Council Barry Wyatt - South Gloucestershire Council Emily See - Amey Date: 04/04/2025	Name: Peter Walley - South Gloucestershire Council Michele Hulme - West Sussex County Council Date: 09/04/2025

ADEPT Live Labs 2: Decarbonising Local Roads in the UK

ADEPT Live Labs 2 is a three-year, UK-wide £30 million programme funded by the Department for Transport, that aims to decarbonise the local highway network. Following the success of the ADEPT SMART Places Live Labs programme (Live Labs 1), the programme will run until March 2026, with a with a five-year subsequent, extended monitoring and evaluation period. The development of new approaches by local authorities to achieve a net zero local highway network will help tackle immediate and emerging problems and prepare us for our uncertain future. Live Labs 2 is overseen by a commissioning board including: ADEPT (chair), AtkinsRealis, Colas, Construction LCA, Core Highways, County Surveyors' Society (CSS) Wales, Department for Infrastructure Northern Ireland, DfT Roads, DfT SciTech, EY, Innovate UK, Kent County Council, Kier Highways, Durham County Council, National Highways, Open Data Institute, Ringway, , Society of Chief Officers of Transportation in Scotland (SCOTS), Transport for London and WSP. www.adeptnet.org.uk/livelabs2

Executive Summary

Project Overview

At the conclusion of Year 2, the Greenprint project has progressed significantly while still facing significant challenges. The project team continues to demonstrate resilience in its approach to investigating and testing new ways to manage the green estate sustainably. Notable advancements include the expansion of operational activities, refinement of the Carbon Model, Biomass innovations tests and conclusions and increased stakeholder engagement. The transition to Year 3 will focus on consolidating findings, providing innovations based on Y2 learnings and preparing for integration into business-as-usual (BAU) practices. All remaining funding will be necessary to achieve in time all the deliverables of the Greenprint project.

Key Milestones & Deliverables Achieved

Throughout Year 2, significant progress was made across multiple work packages.

- WP1 (New Carbon Model) saw the development of an improved carbon measurement methodology, the publication of baseline emissions data, and engagement with FHRG.
- WP2 (Highways Verges Management Operation) successfully scaled up Cut & Collect (C&C) activities, expanded engagement with local parishes and refined verge management logistics.
- WP3 (Biomass Innovations) conducted successful biochar production trials, tested various process options – discarding the technically and/or economically non-viable ones and, challenged at the governmental level, the current classification of anaerobic digestate and other waste feedstocks
- WP4 (Benefit Realisation & Economics) focused on assessing the economic feasibility of verge management strategies and completed a cost analysis comparing Cut & Collect with traditional approaches.
- WP5 (Environmental Impact) baselined verge biodiversity and carried out repeat soil carbon testing.

- WP7 (Whole Life Cycle – Blueprint) developed a roadmap for integrating sustainable green estate management into long-term infrastructure planning.
- WP8 (Equality, Diversity, Equity, and Inclusion) ensured inclusive project participation through targeted engagement strategies.
- WP9 (Communication) strengthened outreach through press releases, stakeholder engagement, videos and a dedicated project website.

Goals and Milestones Reprogrammed

Several objectives were adjusted without significant project scope impact. The expansion of anaerobic digestion trials was delayed due to regulatory challenges. The implementation of rural Cut & Collect trials was postponed to Y3. Additionally, project timelines were adjusted to accommodate regulatory approvals for biomass co-mingling.

Main Roadblocks and Issues

Year 2 encountered challenges, including regulatory delays, technical challenges, operational constraints, and stakeholder resistance. Regulatory approvals for co-mingling cut grass with food waste for anaerobic digestion were withheld, causing project setbacks on this work stream. Procurement challenges arose due to unforeseen supply chain disruptions that impacted equipment acquisition. Operational constraints, such as adverse weather conditions, affected mowing schedules and equipment performance. Furthermore, continued efforts were required to influence behaviour change toward innovation within councils and local authorities, highlighting the need for persistent stakeholder engagement.

Innovations

Innovation remains a core project driver. The refinement of the Carbon Model improved methodologies for emissions tracking. Biochar production expanded through pyrolysis trials, optimising biomass utilisation. Equipment enhancements were made, including the trialling of alternative machinery and working with manufacturers. Data-driven decision-making was strengthened by improving data collection and analytics to optimise operational efficiency.

Project Elevation & Integration

Efforts to embed project learnings into wider industry practices have taken place. Collaboration with other Live Labs initiatives strengthened ties with parallel research projects. Engagement with universities and industry enhanced academic partnerships to support research validation. Stakeholder education remained a priority, focusing on long-term behavioural shifts within local authorities to support sustainable implementation.

Budget

Year 2 expenditure is slightly below forecast due to delays in anaerobic tests and operational setbacks. However, budget realignments ensured that project deliverables were achieved. Year 3 financial planning remains aligned with the Outline Business Case (OBC) and is on track to support continued progress. The peak of spending will occur in Year 3 as we test the full Greenprint system, produce reports, engage stakeholders, and create a Business Case to transition to Business as Usual (BAU). All funding is essential to achieving a credible project outcome in Year 3.

Challenges

Key concerns moving forward include ensuring sufficient data collection to quantify long-term benefits, managing expectations regarding ecological shifts and economic savings, and balancing innovative approaches with practical implementation constraints.

Conclusion

Despite challenges, Year 2 of the Greenprint project demonstrated adaptability and commitment to sustainable innovation. Moving into Year 3, the project will focus on consolidating findings, refining methodologies, and preparing a comprehensive business case for long-term adoption. Continued stakeholder engagement and data-driven decision-making will be pivotal in achieving Greenprint's overarching objectives.

Contents

1. Introduction

The Year 2 report is a crucial milestone in our project journey, aimed at scrutinising and documenting progress and findings aligned with the predefined project scopes and deliverables outlined in the OBC. Its primary objective is to assess progress made within the initial phase of the project and to articulate the outcomes vis-à-vis the Delivery Plans defined in the project's work packages.

This report endeavours to provide a comprehensive overview of the steps taken. It delves into the intricacies of each work package, attempting to explain the trials and actions undertaken, achievements unlocked, and challenges encountered. It also provides reassurance for the remaining budget to be spent in Year 3 as all the processes trials and tests climax into a full integrated system and a Business Case to move to BAU.

The Year 2 report stands as evidence of our collective efforts thus far, highlighting both the achievements and areas with potential to improve. It underscores our commitment to excellence and determination to overcome challenges, pushing towards achieving the overarching project objectives.

As an innovation project we want to ensure that we are constantly learning and evolving to ensure we stay ahead of changes in the sector. This report will highlight key lessons we have learned over the past year that will not only help us moving forward but will also be key to share with other local authorities.

1.1. Project Overview

Below is a short summary of the project. The full details can be found in the approved Outline Business Case.

The Problem:

Decarbonisation efforts in local highways maintenance have traditionally concentrated on blacktop services, aiming to optimise individual elements and processes to cut greenhouse gas emissions. However, this siloed approach often neglects broader highways services like green estate management and the wider scope of local authority operations. By adopting a more system approach that embraces data analytics, carbon modelling, biofuels, and modern waste treatment, new opportunities for reducing emissions can be realised. This will necessitate a comprehensive re-evaluation of decision-making processes and the integration of innovative technologies in the sector.

The Project:

South Gloucestershire Council (SGC) and West Sussex County Council (WSCC) are jointly proposing the development of a 'Greenprint', an innovative green estate management model embedded within a broader carbon management system.

This Greenprint aims to establish a sustainable approach to zero carbon green asset management, encompassing operations, system strategies, and outputs from circular economy trials and research.

Throughout the project, carbon emissions will be measured to assess outcomes, and a data-driven model will be devised to aid decision-making within local highways authorities (LHAs).

Currently, the conventional approach to verge management involves cutting the green estate and leaving the cuttings to accumulate, which leads to increased soil nutrient levels and the proliferation of grasses, but it hampers biodiversity and generates more emissions from grass cutting.

Building upon this, SGC and WSCC intend to experiment with new technologies for cutting and collecting from their green estate, aiming to reduce the frequency of verge cutting, operational emissions, and maintenance costs, while boosting biodiversity and soil carbon sequestration.

The project will explore various processing options for the biomass, such as large-scale anaerobic digestion (AD) and hydrothermal carbonisation (HTC), with the goal of establishing sustainable operational arrangements and maximising the potential applications of biomass outputs.

Additionally, WSCC plans to collaborate with academic and industry partners to trial innovative approaches to small-scale biomass processing, including AD and HTC, as well as supporting pyrolysis research for the production of biochar and bio-oil for various applications, including highway materials and fuel.

Through these initiatives, the project aims to create a mechanism for LHAs to utilise their biomass outputs effectively and sustainably.

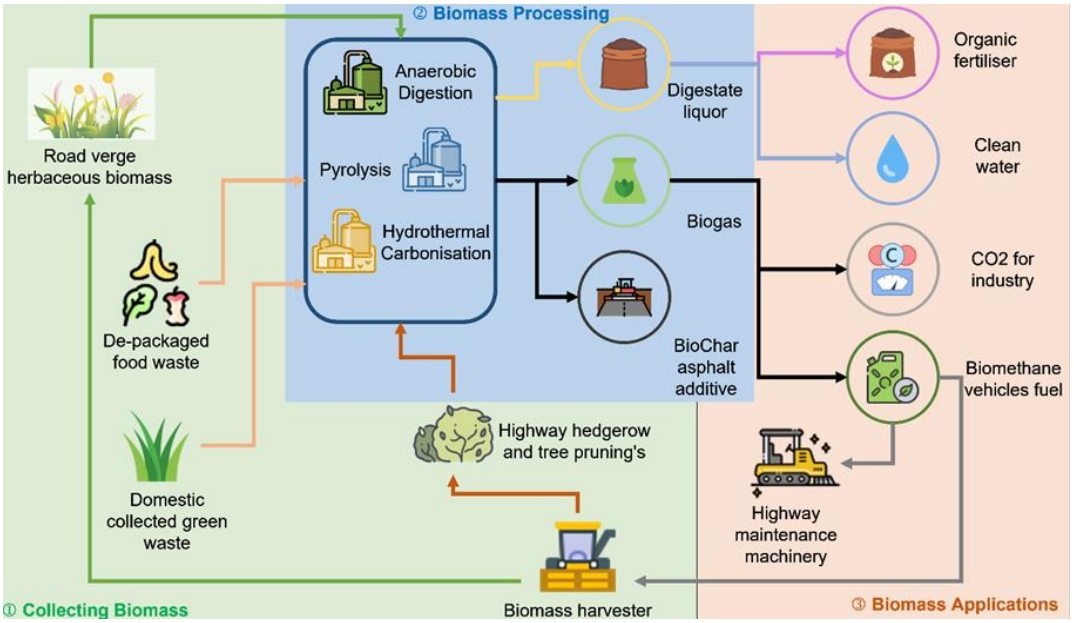


Figure 1: Greenprint green estate model

Project Goals & Objectives

The UK aims to decarbonise all sectors to achieve net zero greenhouse gas emissions by 2050, with the transport sector representing over a quarter of emissions. Innovation and research are crucial for developing new solutions, technologies, and behaviours to meet this challenge.

SGC and WSCC have collaborated on a project to reduce carbon emissions and enhance biodiversity through a holistic approach. They propose developing a 'Greenprint' for highways management, leveraging data-driven models and circular economy methods to optimize innovation and deliver multiple benefits including emissions reduction, cost efficiency, and biodiversity enhancement.

SGC and WSCC have grouped these into 5 core areas with an additional benefit to increase biodiversity. Greenprint will aim to:

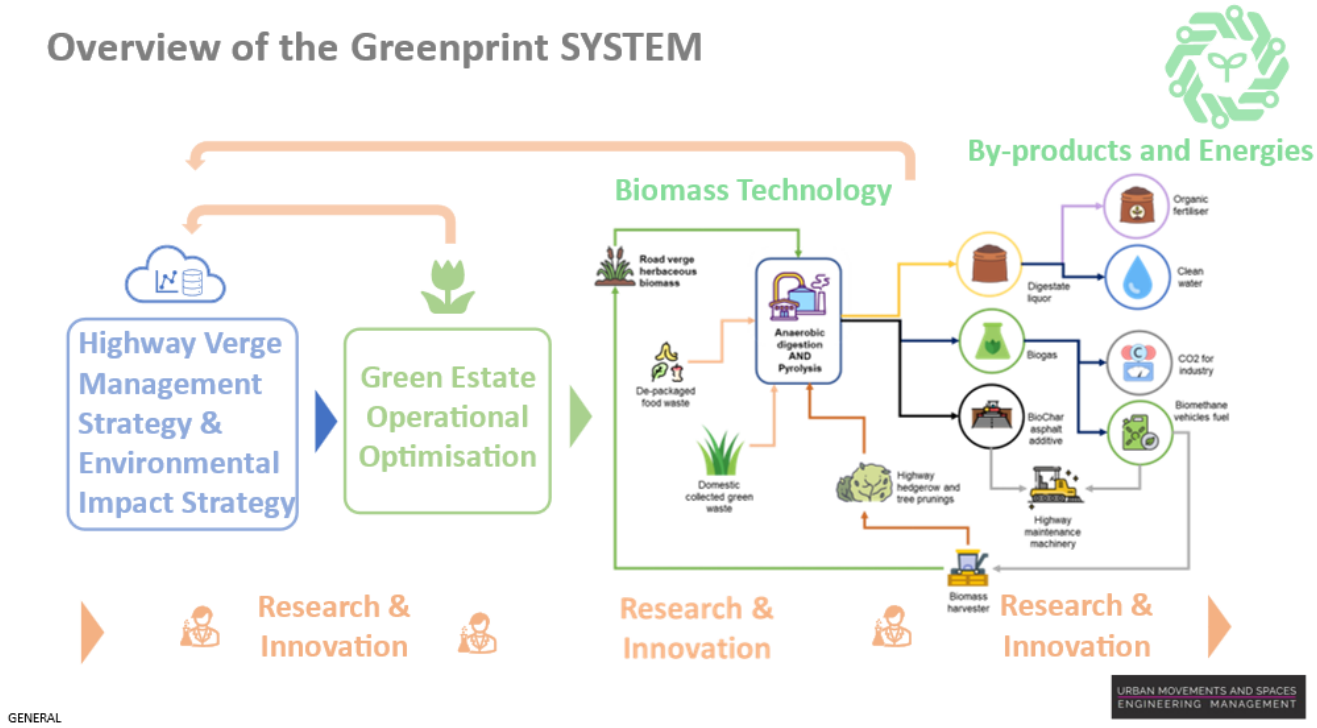
- Achieve net zero
- Ensure an integrated 'ecosystem approach', knowledge sharing and scalability
- Deliver financial savings
- Collaborate across the sector
- Ensure customer satisfaction
- Increase biodiversity

A list of the full set of benefits that this project can deliver has been placed in Appendix A.

Methodology

Live Labs 2 Greenprint project aims to test methods and processes to reduce carbon emissions, increase biodiversity, and optimise costs in managing urban and rural green estates. The project is designed to analyse each step involved in the Green Estate management system and to trial new, more efficient processes. The Green Estate Management system includes the following processes:

1. Highway Verge Maintenance Strategy (Reduced Cuts),
2. Cut & Collect Processes, Methodology and Logistics,
3. Cut & Collect Technology,
4. Verge Litter Analysis and Management,
5. Biodiversity Optimisation,
6. Green Waste Management,
7. Converting Green Waste into valuable resources and sequestrating carbon.



Project KPIs:

To determine the success of the project, the following KPIs have been established. These have been broken into three stages. The following key is used to determine the status against these KPIs:

Achieved
In Progress
Not being achieved / concerns
Will not be achieved

Stage one is focused on testing the project. This is looking at whether the experiment presented in the outline business case has been trialled. These are as follows:

KPI Category	KPI – Stage 1 (Process Focused)	Progress Comments
Biodiversity Sampling	Soil and vegetation sampling will be undertaken	Vegetation sampling has been done. Need results from soil sampling required. New innovation required as well
Energy Supplies	Conversion of at least one waste into an energy source	Have produced biochar
Innovation Management	This project will seek to test at least 1 innovative process	Change to cut and collect regime
Biochar Production	Biochar will be created for asphalt and carbon trading from the grass clippings on WSCC and/or SGCC	Have produced biochar
Hydrothermal Carbonisation	To trial and record tests with Hydrothermal Carbonisation (HTC) within the project	Have produced hydrochar
Anaerobic Digestion	To trial and record tests with Anaerobic Digestor (AD) within the project	AD has now been secured as a way to process grass. Trials with AD will be done early 2025
Thermal Drying and Direct Carbonisation	To trial and record tests with Thermal Drying and Direct Carbonisation within the project	Have used thermal drying and direct carbonisation within the project to produce biochar
Cut Reductions	To trial and record tests with reduced cutting within the project	Have trailed and recorded the outcomes of parishes across both SGC and WSCC, adding up to a total of 83.3ha
Cut and Collect	To trial and record tests with cut and collect within the project	We have conducted cut and collect operations and recorded financial and carbon quantities attached to these
Carbon	Carbon profile has been calculated for the whole system and the component parts of that system	Carbon profile has been created for the project. Will verify with data collected in 2025
Cost	Cost has been calculated for the whole system and the component parts of the system	Cost has been determined for verge management and pyrolysis. This will be verified with data collected in 2025

Overall Stage 1 KPIs have almost been completed. This shows that the project has stayed on track in setting up the experiment and the processes it was required to test. The only outstanding item is Anaerobic Digestion, which is looking to start soon given that commercial discussions with facilities are now looking promising.

The second set of KPIs is focused around ensuring that the project can be implemented successfully and can provide a valuable output. In this regard, these KPIs are output focused. Whilst achieving these KPIs aren't necessary for achieving the requirements of the project, they provide a focus for the project to achieve something that is practical and valuable to implement. Not achieving stage 2 KPIs are useful in understanding if the design of the system has the capability to provide societal value. Where the project cannot meet these KPIs, it will be made clear which factors are preventing this.

KPI Category	KPI – Stage 2 (Output Focused	Progress Comments
CO2e	The project can show a system-level carbon reduction associated with processes in the project after 5 years.	Operationally, the processes are producing more carbon. However, there has been a large degree of carbon removed through biogenic removal. This currently is showing a negative carbon factor; however, it will require the implementation of biochar.
Cost	The project will provide a model that can demonstrate cost neutrality over 3 years	Currently, the process is not looking cost-effective. Work in 2025 will consider operational efficiency to reduce the cost as well as sourcing revenue for the production of resources from grass.
Biodiversity Net Gain (BNG)	BNG will increase by at least 10% in at least 80% of areas where the experiment is taking place over a period of 5 years.	Whilst in theory, the process is removing grass and reducing cuts increases biodiversity, this hasn't been measured long enough to give a result.
Job Creation	At least 1 new job created	WSCC- a Junior Management Consultant apprenticeship, has been employed and working on the project.
EDI	At least 1 event hosted encouraging individuals of varying backgrounds to contribute.	EDI event occurred March 2024 with 15 individuals from varying backgrounds.
Better communication within councils	There will be a forum established to allow the councils and different elements of each council to collaborate on the Greenprint initiative. There will also be written agreement between councils of the partnership.	There are weekly meetings insuring alignment between SGC and WSCC. This insures that any disagreements are discussed and solutions can be found collaboratively
Innovation Management	1 new process created and evidenced in running innovations in projects	The process of collecting grass and converting that into biochar and hydrochar has not been done elsewhere, and is an innovative approach to converting grass into a resource
Community Engagement	Number of visitors to knowledge sharing platforms exceeds 10:1	Visitors to sharing platforms such as websites and social media has far exceeded 10 views per platform.

Overall, there are concerns about the cost of the process. This is likely the biggest factor that will determine the success of the project. Currently the cost to collect and process grass is looking expensive. For the project to have an output that is useful, consideration on how to reduce cost will be considered. From a carbon perspective, the process shows that it is reducing carbon because of the large amounts of biogenic carbon that is being sequestered with the grass. Biodiversity continues

to be difficult to assess due to it being a slower metric to change and dependant on many ecological factors and dependencies on weather.

Stage 3 KPIs have been developed to ensure that the experiment can be read, understood and adapted by other parties. This will ensure that a successful project can be scaled up and require a lower level of effort from external parties to implement. It will also ensure that even if the experiment doesn't achieve stage 2 KPIs, that there will be appropriate documentation in place demonstrating the decision-making made in the project and showing the various angles that other parties can explore.

KPI Category	KPI – Stage 3 (Scaling and Embedment Focused)	Progress Comments
Carbon	Carbon impact is built in systematically to processes within the Highways sector of at least one council	WSCC has / is in the process of fully embedding carbon measurement across the Highways, Transport and Planning (HTP) function. Collecting data and measuring emissions on a yearly basis (using the FHRG approach)
Behaviour	X % increase in employee satisfaction	There was a behavioural survey done middle of 2024. There hasn't been any done since then.
Behaviour	Local Authorities attitudes towards innovation and risk	There has been support from local members expressing interest in the project and the benefits that it provides
Behaviour of counties	Local Communities attitudes towards a change in verge management to support core challenges faced by the sector including decarbonisation and biodiversity	SROs within the councils are engaged in regular meetings. Events that have been hosted embed the idea within the council that reduction of carbon and increasing biodiversity is of benefit to them. This has not been quantified at this stage.
Knowledge Sharing	Documents produced which present the learnings from Greenprint trials at a level deemed sufficient to ADEPT	Documents in production. Will be finalised end of 2025
Council Engagement	At least one Local Authority signed up to a knowledge sharing communication platform developed from Greenprint	Whilst little engagement through knowledge sharing platforms, engagement is being made with North Lanarkshire and Shrewsbury
Private Sector	At least one private sector has provided considerable interest in Greenprint	There is interest from Invica industries who we are using for biochar production. We have not yet got interest from private parties looking to purchase biochar, however, it is likely this will be achieved before middle 2025. Other SMEs engaging with Greenprint include Cage Technologies and The Small Robot Company.
Survey	Both Authorities have directly engaged with programme outputs through the industry survey	Local Authorities have continued to engage with industry surveys provided by Arup and other groups. There will be continuation of this until the end of the project
Toolkit	At least one Local Authority has adopted the Greenprint methodology and toolkit	Not yet developed

The main concerns in this area surround the difficulty in assessing employee satisfaction and building in better carbon decision making within the councils. Given that stage 3 KPIs follow Stage 2, it is likely to see an increase in the achievement of these KPIs within 2025. Active communication is being made with other councils who are interested in converting their grass into resources, using pyrolysis and measuring the effects of biochar on roads. Knowledge sharing is being done through websites, reporting on progress. Engagement with the private sector is expected to increase as more biochar is produced.

1.2. Project Status

	YEAR 2				
	Schedule & Milestones	Budget	Deliverables	Resources	Y3 Scope & Deliverables
Overall project's status		**Under spent**			
WP0 Project Mngt					
WP1 New Carbon Model		Slightly over			
WP2 Highway Verges Mngt		Under spent			
WP3 Biomass Technical Innovations					
WP4 Economics & Benefit Realisation					
WP5 Environmental Impact		Slightly over			
WP6 Legal & Contracts					
WP7 Whole Life Cycle (Greenprint)					
WP8 EDI					
WP9 Communication		Under spent			

Table 1: Project Status of each of the Work Packages across Greenprint.

At the end of Year 2, the project remains in a strong and healthy state, with budget reprofiling initiated at the start of the year to better align financial resources with the project's evolving needs. Specifically, the innovation process within WP3 has been structured in a back-weighted manner, as the large-scale scaling-up of innovations is only feasible after successful demonstration at a smaller scale. Additionally, the development of justification and strategy documents, which are crucial for transitioning the project to Business as Usual (BAU), can only be effectively undertaken in Year 3. This transition requires extensive investigation, detailed analysis, and comprehensive reporting to ensure a well-supported and sustainable integration into standard operations.

2. Key Milestones & Achievements

During Year 2 the project team has completed tasks and key achievements, catching-up with year 1 reprogrammed deliverables and demonstrating significant progress in the project despite some unforeseen and hard-to-resolve new setbacks. Once again, due to the prompt actions of the project's members and the well-structured governance which allows fast and flexible decisions, we have been able to deliver or reprogram all our milestones. The main achievements of the project team are:

WP0_ Project Management:

Project management activities were focused on ensuring the successful delivery of Year 2. Key efforts included scaling up Cut & Collect operations, as well as monitoring, testing, and evaluating HTC/Pyrolysis and AD options. Additional priorities involved goal-setting, schedule planning, stakeholder engagement, and the management of resources, risks, quality assurance, and budget. Effective communication, adherence to quality standards, and regulatory compliance were established to facilitate smooth progress monitoring and evaluation.

Key Achievements:

- ✓ Progressed into the delivery phase, scaling up Cut & Collect activities and Biomass Innovations toward Business as Usual (BAU).
- ✓ Expanded partnerships with other Live Labs initiatives to enhance project impact.
- ✓ We have accelerated on WP3 to make up the time loss due to the new procurement in Y1.
- ✓ Reprofiled the budget to reflect the changes in the projects and consolidated the Finance Plan, and updated the budget & forecast for WSCC Y3.
- ✓ Updated the Project Delivery Plan, Risk Register, schedule & milestones, developed a new Quarterly Report format for ADEPT, and progressed PM Plan development.
- ✓ Strengthened collaboration with universities, private partners & stakeholders, engaged with local authorities for deployment, held meetings with ADEPT, RRA group & North Lanarkshire, facilitated knowledge sharing,
- ✓ Established a foundation with the Behaviour Insights Team, followed up with ADEPT on Behaviour Change outcomes, and aligned the project with ADEPT's new M&E requirements.
- ✓ Created a Reduced Cut Strategy comprising C&C reduction methods, community engagement, and engaged with local authorities for implementation (East Sussex).
- ✓ Developed a project elevation strategy with Amey and worked on a "Decision Wheel" for council committee discussions on Greenprint.

WP1_New Carbon Model:

WP1 has remained on track throughout Year 2, with significant progress made in establishing carbon baselines and measurement methodologies. The year began with the completion of service level baselines for WSCC and SGC, providing essential context for assessing the carbon impacts of the Greenprint approach. Operational carbon baselines were also developed, covering cut and drop, soil biomass, and cut and collect stages, with findings published by ADEPT alongside other Livelab projects.

A key focus has been developing a carbon measurement methodology and profiles for all project stages, including waste collection, transportation, pyrolysis (biochar production), and anaerobic digestion. This work was supported by collaboration with Nottingham University and site visits to pyrolysis facilities in Immingham. The project continues to use FHRG's Carbon Analyser tool, aligned with the Carbon Calculation & Accounting Standard (CCAS), ensuring consistency with best practices in highways sector carbon accounting.

Challenges in Year 2 included ensuring consistency in baseline reporting, embedding carbon data collection into existing processes, and understanding seasonality in vegetation availability. Efforts have been made to refine data collection requirements, ensuring project partners and work package leads are prepared for Year 3. Contractors have been fully briefed and equipped with mobile tools to improve real-time data collection.

WP1 will continue refining data collection and carbon measurement in Year 3, consolidating carbon profiles at each stage of the project. This will provide a holistic view of emissions and enable direct comparisons between baseline figures and project results, demonstrating the effectiveness of the Greenprint approach in reducing carbon emissions. (for further detail on carbon baseline, biogenic and activities carbon measurement, please click this link).

Key Achievements:

- ✓ Completed service level baselines for WSCC and SGC, enabling contextualisation of carbon impacts.
- ✓ Established indicative project-level operational carbon baselines for key project stages (cut and drop, soil biomass).
- ✓ Published baselines with ADEPT alongside other Livelab project carbon baselines.
- ✓ Developed a carbon measurement methodology covering waste collection, transportation, pyrolysis, anaerobic digestion (AD), and biochar use.
- ✓ Conducted site visits and workshops with Nottingham University and Immingham pyrolysis facilities.
- ✓ Continued collaboration with FHRG using their Carbon Analyser tool, aligning with CCAS for best practice in carbon accounting.
- ✓ Refined data collection processes and prepared project partners for Year 3 data collection.
- ✓ Developed a review paper on carbon storage and sequestration in grassland road verges.
- ✓ Embedded carbon data collection within contractor processes and introduced mobile equipment for on-site data capture.
- ✓ Strengthened collaboration with University of West England, FHRG, and other work package leads to ensure comprehensive carbon accounting.

WP2_Highways Verges Management Operation:

Summary

Work Package 2 is responsible for verge management. This includes the cut-and-collect part of the process and identifying areas of improvement within verge management processes. It also involves providing the yield for WP3 to process.

Year 2 of the Cut & Collect project focused on scaling up operations to gather comprehensive data for analysing and optimising processes related to carbon reduction and cost savings in highway verge management. This involved rigorous trials of various Cut & Collect machines, assessing the logistics of transporting crews and arisings across different geographical locations and cutting frequencies. The aim was to identify the most carbon-efficient and affordable solutions to serve as a blueprint for future operations.

Scaled-up trials were implemented in West Sussex County Council (WSCC) and South Gloucestershire Council (SGC) using defined protocols and equipment to test technologies for cutting, collecting, and transporting verge biomass. WSCC assessed various vehicle options and a three-person team setup, while SGC initially used a council-provided lorry before transitioning to a skip lorry provided by an anaerobic digestion (AD) plant. IT geo-localisation tools and mower demonstrations supported the strategy and communication efforts. Samples of rural and urban Cut & Collect materials were analysed in laboratories. Data from operational teams were collected and analysed regularly to identify inefficiencies and compare different trial scenarios, focusing on efficiency, cost-effectiveness, and sustainability. These analyses culminated in detailed reports with insights and recommendations (see link here).

Challenges encountered during Year 2 included staffing shortages, equipment performance issues (frequent mower breakdowns, limitations in handling long grass) and data management inconsistencies. The project also faced limitations in conducting substantial rural Cut & Collect trials and optimising logistics and transport for collecting arisings. Additionally, discrepancies were found in the baseline "Cut & Drop" activities. These issues are planned to be addressed in Year 3.

The project team also established a data collection system to track fuel use, labour costs, and grass tonnage, supporting carbon and cost analysis. Discussions were initiated with mower manufacturers regarding reliability issues, leading to commitments for upgrades. The grass was sent to the University of Nottingham for the pyrolysis process.

Key Achievements:

1. ***Operational Expansion and Efficiency:***
- ✓ Expanded project scope with new Kubota and Iseki SF5 ride-on mowers and a BigAb B12 hook-lift trailer system, enhancing operational efficiency.
- ✓ Successfully scaled up Urban Cut and Collect (C&C) operations with multiple gangs and tested contractors and DLO operations.

2. ***Innovative Practices:***
- ✓ Successfully trialled a cut-and-collect method for managing highway verges and public open spaces, moving away from the traditional "cut and drop/leave" approach.
- ✓ Undertook small rural C&C trials to explore broader applications.

3. ***Operational Performance:***
- ✓ Completed the cutting season with minimal public complaints despite machinery and staffing challenges.
- ✓ Collected a total of 785 tonnes of grass across all sites.

4. ***Data and Process Improvements:***
- ✓ Established a structured data collection framework for tracking fuel use, labour costs, and grass tonnage, supporting carbon and cost analysis.
- ✓ Developed new standard data collection processes for continued monitoring in 2025.

5. ***Strategic Development:***
- ✓ Developed a Reduce Cut Regime Strategy with public engagement.
- ✓ Priced Cut & Collect operations to ensure financial sustainability.
- ✓ Tested different transport options for grass transport and established a grass storage facility in Yate.

6. ***Stakeholder Engagement and Feedback:***
- ✓ Maintained strong stakeholder support with ongoing monitoring of feedback.
- ✓ Recorded all equipment performance issues to inform future decision-making.

7. ***Collaboration and Research:***
- ✓ Initiated discussions with mower manufacturers regarding reliability issues, leading to commitments for upgrades.
- ✓ Conducted a demonstration of a Ryetec Flail Mower Collector to explore alternative equipment options.
- ✓ Verified that litter contamination is not an issue for the pyrolysis process based on feedback from the University of Nottingham.
- ✓ Installed baseline biodiversity and soil carbon monitoring sites with partner organisations (Plantlife).
- ✓ Completed a comprehensive litter survey in South Gloucestershire via Keep Britain Tidy

8. ***Adaptation and Improvement:***
- ✓ Identified strengths and weaknesses of the process and adapted strategies for future improvements.
- ✓ Established improved Cut & Collect processes for subsequent years.

Year 2 – WP2 Activities

Cut & Collect Initial Plan

Objectives

In the SOBC, one of the core objectives of the LL2 Greenprint is the ***"Review and restructure of the operation for Highway verge management with a view to Whole Life Cycle management, including: Regime, technologies, and processes"*** and ***to "Improve biodiversity and reduce carbon."***

As part of this initiative, we are investigating the performance of various Cut & Collect machines and the transport of crews and arisings in different geographical locations and with different cut frequencies. This investigation aims to understand the potential issues associated with collecting, transporting, and managing arisings on an industrial scale. All lessons learned inform the project analysis for carbon and costs, establishing the most carbon-efficient and affordable solutions to be used as a blueprint.

Purpose / Aim

Our Plan is to provide a systematic and rigorous approach to measure, analyse, and optimise the Cut & Collect processes/operation with regards to our Carbon Reduction and costs savings. The trials are of a sufficient size to extract unbiased information and is coordinated with the Community Engagement/Change of Mind strategy. This strategy is delivered in a positive way that is easily understood by the community, especially in urban areas with reduced cuts.

Year 2 – Cut & Collect Scaling Up Activities

Year 2 was dedicated to implementing large-scale Cut & Collect operations to gather sufficient data for analysing and optimising the processes with regard to carbon reduction and cost savings. This year also involves baselining the Cut & Drop operation, ascertaining the materials tested, and investigating Litter Management. The objectives for Year 3 have been determined based on findings and constraints from this stage.

Cut & Collect Processes and Logistic Trials

Scaled-up trials have been implemented in selected areas using defined protocols and equipment to test technologies for cutting, collecting, and transporting verge biomass. In West Sussex various vehicle options, including 3.5-tonne and potential 7.5-tonne vehicles, have been assessed, along with a three-person team setup for continuous operations.

In South Gloucestershire the Council initially provided the transport via a 6-wheel rigid lorry, with a maximum 16 tonne capacity. This arrangement lasted for 6 trips, after which from 23rd July the Council paid the Cannington AD plant to provide an 8-wheel skip lorry with 12 tonnes capacity.IT geo-localisation tools and mower demonstrations supported the strategy and communication efforts, while rural and urban Cut & Collect materials have been investigated, with samples sent for laboratory analysis. We have baselined and analysed the Cut & Drop processes in urban areas,

evaluating life cycle impacts, travel efficiency, trailer use, and carbon emissions. Data from Year 2 operational teams have been collected and analysed daily using a proforma document to identify inefficiencies and compare different trial scenarios. The analysis focused on efficiency, cost-effectiveness, and sustainability, culminating in a detailed report from WSCC, SGC and Amey our consultant for the Economic and System package, with insights and recommendations. Trials also explored technical solutions for verge litter management, informing a larger trial in Year 3. Findings from these evaluations will guide decision-making for process optimisation and future planning. Results will be used to refine machinery and methodologies to enhance long-term sustainability. The next phases will build on trial outcomes, ensuring continuous improvements and best practice implementation.

A cut and collect trial is planned for Year 3 in a rural area of South Gloucestershire, away from the existing plots already treated in the project.

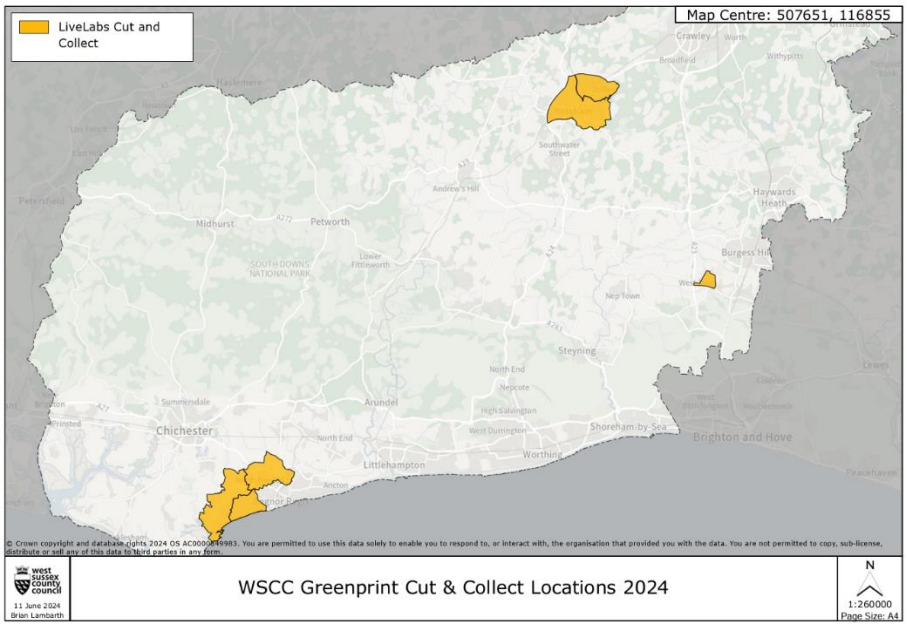
WP2 Work Breakdown Structure (WBS) – Perimeter of action of this plan

The WP2 (Highways Verges Management) and WP3 (Biomass Innovations) processes are crucial for achieving carbon reduction targets. Both work packages have been meticulously divided into sub-processes for detailed analysis, with specific trials and experiments planned. Attachment A is the WBS outlining all tasks in WP2. For this Trials and Experiments Planning document, our primary focus is on Tasks 2, 3, and 4.

Sites Locations & Characteristics

WSCC:

This plan covers the sites maintained by Grasstex within West Sussex County Council (WSCC). The locations selected for the trials, as shown on the map below, have been chosen by WSCC and Grasstex to representatively cover the county. We have meticulously documented and analysed the cutting processes, and the logistics involved in transporting machinery to and from these sites. This includes transporting materials to depots, since Biochar plants are not yet operational in the county. AMEY will extrapolate and model this information as if a Pyrolysis plant were strategically located within the county.

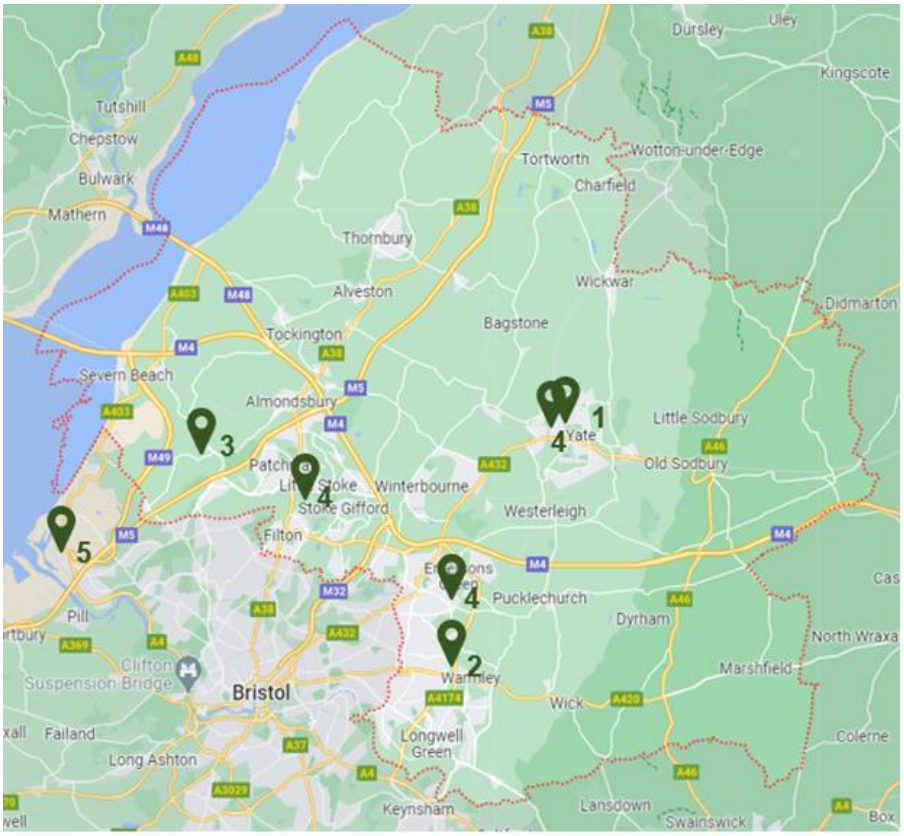


Year 2			
Number of Cuts Planned	Locations	Area (ha)	Comments
5	Pagham Aldwick & Bersted	19.1	No change to the BAU cutting frequency
4	Horsham	27.7	Cutting frequency reduced by one cut from BAU
3/2	Hurstpierpoint	3.7	This area has been reduced to 3 cuts in response to a request from local environmental group and the Parish Council

*This represents 403 tonnes of fresh grass

SGC

In South Gloucestershire, Yate had previously been identified as a suitable pilot area for Greenprint during the Verges and Public Open Space Grass Management Project and had already been subject to trials. In addition, the Council's main StreetCare operational depot is in Yate - making it easier to control costs and monitor the results. The plot areas of the parishes subject to 'cut and collect' in 2024 were as follows:



Year 2			
Number of Cuts Planned	Locations	Area (ha)	Comments
4	Bradley Stoke	3.935	
4	Kingswood, Staple Hill & Mangotsfield	2.872	
4	Patchway	3.491	
4	Stoke Gifford	5.645	
4	Thornbury	7.646	
4	Yate	12.862	

*382 tonnes of grass were collected during 2024.

Cut & Collect Technology

The scope of investigating and testing Cut & Collect technology for lawnmowers encompasses comprehensive trials in both urban and rural highway environments. This project aims to evaluate various models and manufacturers available on the market, examining different configurations to determine optimal performance under diverse conditions. By systematically testing in these distinct environments, the project will assess the effectiveness, efficiency, and practicality of the technology in creating and managing biomass. The findings will provide insights into the best practices for implementing Cut & Collect processes and logistics, ensuring that the chosen solutions are capable of meeting our carbon objectives and commercial constraints.

All the following equipment has been tested during this season's Existing Council equipment with the capability to cut and collect grass prior to Greenprint included the following:

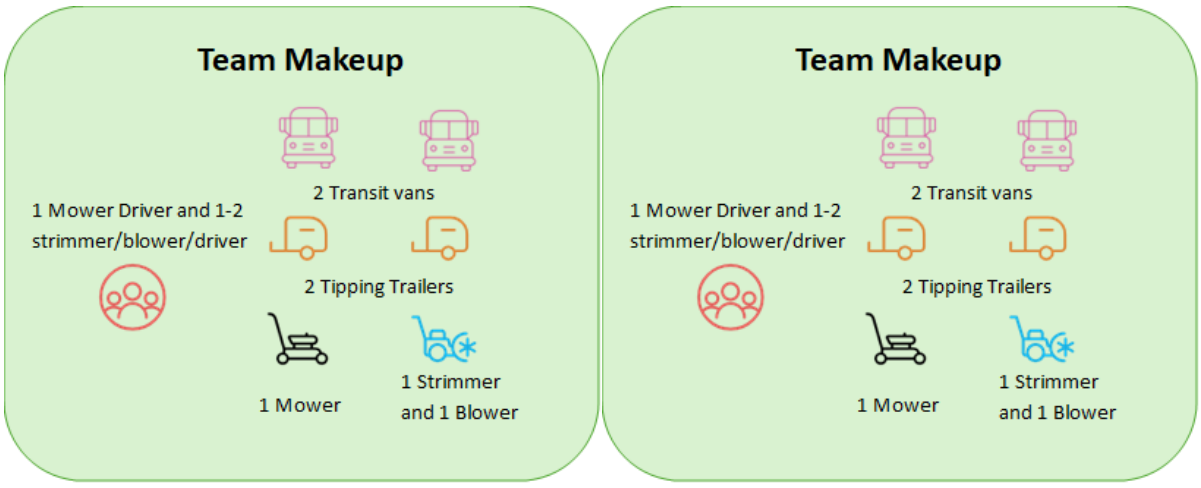
Equipment type	Make / model	Link	Comments
Kubota	FC4-501 Flail Mower	https://kuk.kubota-eu.com/groundcare/series/fc4/	Machines have had reliability issues and difficulty in obtaining spare parts. We have been working with the manufacturer to resolve these issues and have recently received some upgraded parts . The spare part supply chain has also been improved.
Iseki	SF5 ride-on mowers	ISEKI Outfront SF5 Mower Range < ISEKI UK & Ireland	
Muthing Flait Kit	For ISEKI FS5		
Amazone	Profihopper 1500 Flail deck mower	https://amazone.co.uk/en-gb/products-digital-solutions/agricultural-technology/groundcare-equipment-pasture-management/mowers-	Machine proved unreliable and over complicated and not robust enough to handle the rigorous highway environment . Auger collection method prone to frequent blockages and difficult to clear.

		collectors/profihopper-1500-self-propelled-mower-101416	
Ride on mower	Grillo FD2200 TS	FD 2200TS Stage5 4WD Grillo Spa - Agrigarden Machines (grilloagrigarden.co.uk)	Suitable for lighter rough requiring 4-6 cuts per season
Tractor	Case 125 Maxxum	MAXXUM 115-150 (caseih.com)	
Tractor	Case 105 Farmall	Farmall 90-120C | Case IH	
BigAb	B12 hook-lift trailer	BIGAB B12 Hooklift Trailer - Chippenham Farm Sales	
Trailer	Fleming TR8	8 Ton Tipping Trailer | Fleming Agri Twin Axle Tipping Trailer (fleming-agri.com)	Capacity 8 tonnes / 15 cubic metres of grass
Trailer	Fleming TR6	Drop Side Tipping Trailers Fleming Agri 4T - 6T Single Axle Trailer (fleming-agri.com)	Capacity 6 tonnes / 10 cubic metres of grass
Husqvarna	520iRX bushcutter streamer		

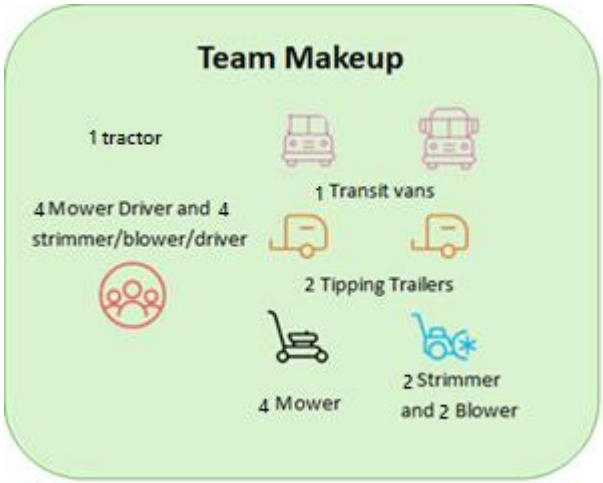
Operational Processes

We tested two systems of operational process. West Sussex operated 2 independent cutting teams, one team cutting the Chichester areas based at the WSCC depot at Drayton, the other based at the Grasstex depot at Rudgwick cutting the Horsham area. While South Gloucestershire operated one larger team.

West Sussex Teams:



South Gloucestershire Team



Key Achievements

- Expanded the project scope in 2024 with new Kubota and Iseki SF5 ride-on mowers and BigAb B12 hook-lift trailer system, increasing operational efficiency.
- Successfully trialled a cut and collect method for managing highway verges and public open spaces, moving away from the traditional "cut and leave" approach.
- Successfully completed the cutting season with minimal complaints from the public, despite operational and staffing challenges.
- 785 tonnes of grass collected, and 86.95 hectares cut across all sites.
- Established a data collection system, which improved operational tracking (a structured data collection framework for tracking fuel use, labour costs, and grass tonnage, supporting carbon and cost analysis).
- Initiated discussions with the mower manufacturer regarding reliability issues, leading to the commitment to upgrades.
- Conducted a demonstration of a Ryetec Flail Mower Collector, providing insights into alternative equipment options.
- Verified that litter contamination is not an issue for the pyrolysis process, based on feedback from the University of Nottingham.
- Installed baseline biodiversity and soil carbon monitoring sites with partner organisations (Plantlife).

Key Issues

- Operational Challenges
  - Staffing shortages led to a reduction in the number of crews, delaying the final Horsham cut until late December.
  - Operatives initially struggled with new equipment and operational requirements, leading to mower blockages and uneven cuts.
  - Wet weather conditions further hindered mower performance, especially when handling long grass.
  - Delays in anaerobic digestion trials due to grass-fiber-related processing challenges, requiring adjustments in disposal strategy.

- The Cannington AD plant rejected co-mingled grass and food waste due to processing blockages, requiring a switch to separate delivery into crop digesters.
- Interim reliance on composting while resolving anaerobic digestion issues.

- Equipment Performance Issues:
  - Frequent mower breakdowns due to design flaws (e.g., broken lift arms, small chute openings causing blockages, poor welding on jockey wheels).
  - Extended repair times due to supply chain delays, with some equipment out of action for up to five weeks.
  - Kubota mowers found to be overcomplicated, better suited for urban use, and lacking durability.
  - Equipment limitations affected performance—initial Grillo FD2200 TS ride-on mowers struggled with long grass, requiring replacement with more suitable models.
  - Battery-powered equipment had mixed results—electric blowers performed well, but electric strimmers lacked power.
- Data Management Challenges:
  - Data inconsistencies due to multiple staff handling data monitoring (resolved).
  - Issues with hardware reliability of tablets required some retrospective data entry (resolved).
  - The baseline carbon modelling data was incomplete, requiring estimates from a limited desktop study (to be reconducted in Y3).
  - The baseline biodiversity dataset was delayed, reducing time for long-term impact analysis.
  - Need for improved coordination between litter collection and grass cutting teams—currently only synchronised on major roads.
- Limited Trials and Expansion:
  - No significant rural cut & collect trials conducted.
  - Tests for verge litter management were postponed to Y3.

<u>Lessons Learned</u>

Improving Recruitment & Workforce Planning:
- Streamlining hiring processes and offering competitive wages can reduce workforce gaps.
- Investing in training programs can help operatives adapt to new equipment more efficiently.

Reducing Equipment Downtime:
- A preventive maintenance strategy and adequate spare parts inventory are critical to minimising disruptions.
- Engaging with manufacturers can drive improvements in machinery development and reliability.

Enhancing Data Collection & Accuracy:
- Implementing standardised data entry protocols and automated validation tools will improve data consistency.
- Assigning a dedicated staff member to oversee and check data collection ensures more reliable reporting.

Future Planning & Equipment Trials:
- Rural cut & collect requires further exploration in Y3 for South.
- Testing a wider range of equipment will help identify more durable and effective solutions for long grass cutting.

Optimising Grass Processing:

- There is a requirement for working closely with AD plant in Y3 to avoid processing blockages with food/grass co-mingling biomass.
- Additional storage infrastructure helps manage grass logistics (to be investigated).

Equipment Selection & Maintenance:

- Early trials showed mowers must be suited for handling long grass—investment in better-suited models (e.g., Iseki SF5) proved essential.
- Regular equipment maintenance schedules and backup units are necessary to prevent delays due to breakdowns.

Improved Data Tracking & Analysis:

- A standardised daily data collection process for fuel, labour, and grass volumes was key for accurate cost and carbon analysis.
- Having a single designated data-checking officer improves data consistency and reliability.

Cost Report Summary 2024

When assessing the results of the experiment, it is important to understand the cost of implementation. This will determine whether the experiment has practical implications as well as meet the goal set to reduce cost around verge management.

This summary outlines the costs associated with verge management under the experimental C&C (Cut & Collect) methodology versus the standard BAU (Business As Usual) approach which is C&L (Cut & leave). The analysis focuses on OPEX (operational expenditure) and CAPEX (capital expenditure) for WSCC and SGC sites, including grass collection, disposal, and transport costs.

<u>WSCC Total Cost Analysis:</u>

OPEX costs for C&C were derived from CONFIRM data collected daily by operatives performing the work. These costs included labour, fuel, and grass disposal. Future biomass processing methods, such as pyrolysis, could eliminate this disposal cost, reducing OPEX costs. Transport costs between the cut site and disposal site were included, and these may change if the disposal location changes. The cut grass was taken to the Grasstex depot, but alternative processing plants could impact transport expenses. BAU OPEX costs were calculated as a proportion of C&C costs, using data from Worthing and Chichester, which had comparable conditions. It was found that C&C costs were twice the BAU costs, though future data collection from more BAU sites will improve accuracy. CAPEX costs for C&C were based on the purchase price of machinery, annualised over its expected lifespan. Since the experiment required two teams, the CAPEX cost was doubled to reflect the total machinery investment. A similar method was used for BAU CAPEX calculations, and the combined CAPEX and OPEX costs determined the total TOTEX expenditure.

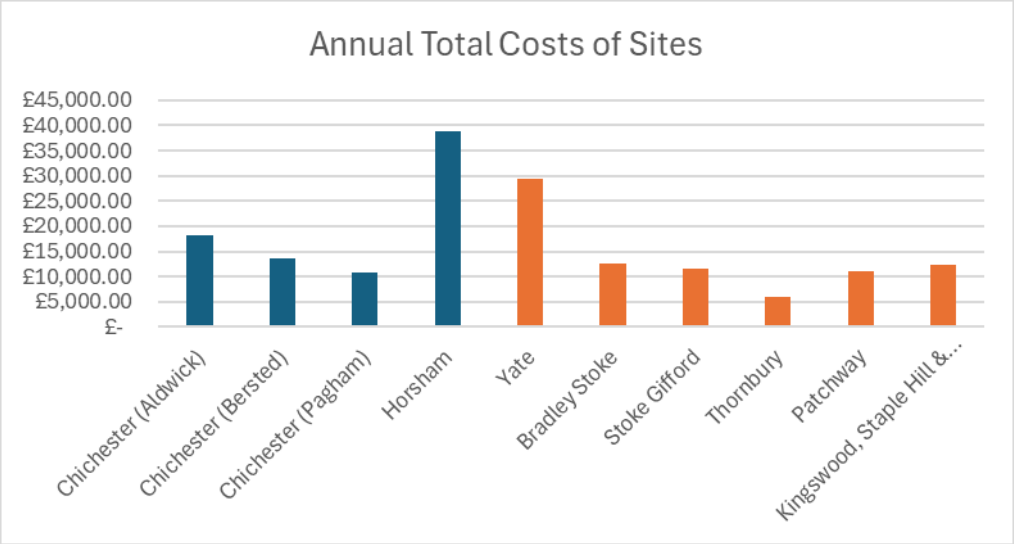
<u>SGC Total Cost Analysis:</u>

The OPEX costs for C&C were based on daily site forms filled out by operatives, covering labour, fuel, and grass disposal. A notable disposal cost was incurred, which could be avoided in future if grass processing via anaerobic digestion (AD) eliminates gate fees. Excluding disposal costs would

reduce C&C OPEX cost, lowering overall C&C costs. Transport costs, a variable factor, were included as grass was disposed of at sites in South Gloucestershire and Somerset. Future changes in disposal location would impact transport costs. BAU OPEX costs were estimated as 0.6 of C&C costs, derived from comparisons between Dodington (BAU) and Yate (C&C), though differences in cutting methodology and frequency complicate direct cost attribution. More granular BAU data from 2025 will improve cost comparisons. CAPEX costs for C&C were calculated by annualising machinery purchase costs over expected operational years. BAU CAPEX followed a similar method but used BAU machinery and lifespan. Combining CAPEX and OPEX provided the total TOTEX costs.

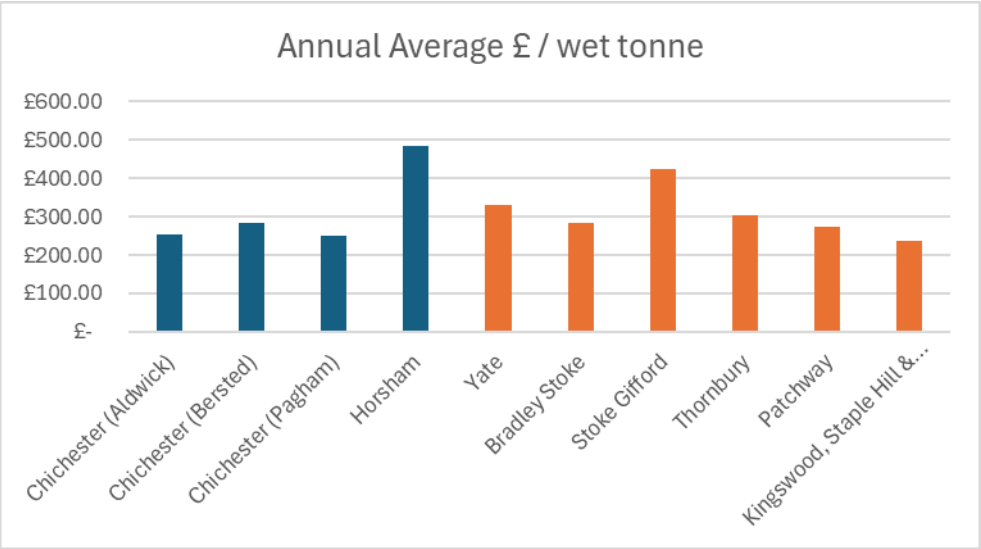
Costs Graphs:

The OPEX cost for cutting each of the sites is recorded as follows. This includes a buildup of costs from fuel and labour.



This demonstrates that the cost of cutting Kingswood is disproportionately large, whilst the cost of cutting Thornbury is disproportionately low. This is due to there being lots of grass in Kingswood, making the area challenging to cut and therefore resulting in cost from slow progress.

It is also relevant to look at the cost of collecting the yield within that area. The following graph depicts the cost to collect the grass in that area.



The areas that have lower costs are usually ones where there is a higher density of grass and where the transport between site and where the grass is dropped is reduced.

West Sussex County Council (WSCC) sites maintained relatively stable costs per square meter, with the exception of fluctuations between cuts 2 and 3 in Bersted and Pagham, attributed to varying grass growth rates. At South Gloucestershire Council (SGC) sites, Kingswood exhibited elevated costs during the first cut, largely due to crews adapting to new machinery and managing long, uncut grass. These operational inefficiencies contributed to increased labour costs.

Key Observations

- Our calculations of BAU costs are more indicative than accurate. This is due to anomalies in tracking of these costs within 2024. This number will likely change when we measure them more accurately in 2025.
- Disposal cost had a significant impact on costs. Depending on the processing option, disposing of grass in future may generate a revenue when there has been more progress made on determining how the grass waste is used.
- Transport cost increases the OPEX cost as well. In the experiments transport was included from site to depot, however in future when a plant has been identified or built, there may be increased transport costs required to move the grass.
- The experiment was done on a meaningful but smaller scale. It is anticipated that when done at a much larger scale, efficiencies will be seen. This includes being able to use the machinery over much larger areas and reducing annualised CAPEX costs. It would also mean that crews become more familiar with the type of work and reduce the time taken to carry out tasks.
- Cost fluctuations across different sites are more influenced by breakdowns or unpredictable events rather than specific methodologies.
- It is also likely that machinery will improve in dealing with these types of conditions and operational requirements, resulting in reduced annualised costs by increasing the life of the equipment and decreasing downtime when cutting the grass. In the experiment time was also b taken up due to breakdowns in machinery, trying to deal with grass at longer lengths. This has resulted in larger OPEX costs in the Cut & Collect scenarios.

- Consistency in grass collection costs between SGC and WSCC councils indicates that variations in methodology have not significantly impacted expenses.
- Geographical differences, such as lower grass yield in Horsham, have resulted in higher per-tonne collection costs, despite similar cutting expenses compared to other areas.

Conclusion

The cost analysis conducted in this report highlights the financial implications of different verge management methodologies, comparing Cut and Collect (C&C) with Business-As-Usual (BAU) practices across South Gloucestershire and West Sussex. As expected, the findings indicate that C&C is significantly more expensive than BAU in terms of both operational (OPEX) and capital (CAPEX) expenditures. The biggest cost increase in OPEX is from transporting grass between site and disposal. Efficiencies in this process will be addressed in Year 3 with a transport model based on a viable Business Case for each council.

The study also underscores the need for more accurate BAU cost tracking, as current estimates are indicative rather than definitive. Furthermore, scaling up C&C operations could potentially reduce costs through improved efficiencies, better machinery utilisation, and reduced downtime. The potential for technological advancements in machinery may also contribute to cost reductions over time. Ultimately, while the C&C methodology presents higher upfront costs, its long-term viability will depend on refining processes, optimising disposal strategies, and leveraging economies of scale.

Stakeholder Engagement

A project webpage had been set up during 2023 on the Councils' public website to facilitate the dissemination of information (here) The webpage provided contact details for further information, including an email address monitored by the climate emergency team. Emails were periodically reviewed, and relevant queries were forwarded to the Greenprint team. This process began with a pilot project in 2023 and continued in 2024.

SGC

A Communications and Engagement Strategy was completed in June 2023 - setting out the stakeholders involved with the project, including project partners and internal / external groups. This sets out the internal / external stakeholders, the key messaging and communication channels, an indicative timeline of activities and the sign off process for working with ADEPT.

The Project Manager was directly involved in negotiating with parish councils alongside the Grounds Operations Manager to determine the plots of grass to be included in the pilot area of Yate in 2023 and later the wider roll out into other areas from 2024. This involved sharing details of the project and its objectives and maps of the council-maintained grass in scope for possible 'cut and collect'. A series of virtual and face to face meetings were arranged to discuss both individual plots and details of any cost implications - as some parishes already paid for a set level of service which would alter when subject to the reduced frequency of cutting required by the project. This engagement ran from October 2023 to March 2024 when the final parish agreed to participate.

The Project Manager drafted project Briefing Notes for local ward members in February and August 2023. A more recent Briefing Note was presented by the project manager in February 2024 to the Senior Leadership Team, Executive Member and Informal Cabinet meetings.

From spring 2024, in addition to continuing the activity in Yate the cut and collect operation was expanded out into the following parishes:

- Bradley Stoke
- Kingswood
- Patchway
- Staple Hill and Mangotsfield
- Stoke Gifford
- Thornbury

Requests for changes to Live Labs plots, submitted by parish councils or individuals, were recorded on a central spreadsheet and assessed at the end of the season to adjust project plans before the first cut of 2025. Most change requests in 2024 came from Stoke Gifford, where long grass prompted resident concerns. An FOI request was submitted regarding risk assessments, and the project manager attended a community forum on July 9, 2024, to address concerns. From November to February 2025, parishes and ward members were contacted to confirm the proposed Live Labs plot distribution for the 2025 season, which remained largely unchanged from 2024.

WSCC: Grass cutting and pollinator-friendly verge projects in West Sussex

West Sussex currently carries out five road verge grass cuts annually in urban areas and one visibility splay safety cut, one 1 metre cut and 1 end of season full cut full cut in rural areas. Since 2020, two wild verge programmes have been introduced: Community Road Verges (CRVs) and Pollinator Highways. These areas typically receive one mow per year, with variations as needed. Pollinator Highways are usually led by parish councils and environmental groups, while CRVs are selected by local people in collaboration with parishes.

A partnership with South Downs National Park (SDNP) and local parish councils focuses on enhancing biodiversity on selected rural verges. The mowing schedule remains unchanged but cut and collect has replaced the cut and leave method. Additionally, cut and collect trials are underway in two urban locations: Hurstpierpoint (three cuts) and Midhurst (five cuts). These trials aim to assess the benefits of cut and collect for all mowing cycles.

Community Engagement Learnings

- **Local Involvement Matters:** In Hurstpierpoint, the trial stemmed from a community-led CRV project, ensuring active local participation and monitoring. Conversely, in Midhurst, the trial was introduced without proactive local consultation, leading to limited engagement and reduced legacy potential.
- **Expectation Management:** Two CRV projects ceased due to community concerns—one over long grass posing a hazard, and another due to impatience with results. Future initiatives should set realistic expectations on timelines and costs to prevent premature abandonment and scepticism.
- **Shifting Public Opinion:** Previously, opinions were split on wildflower verges. Recently, there has been growing public support for wilder spaces, with increased requests for wildflower verges.
- **Nature Verge Network:** Quarterly meetings since 2020 have facilitated discussions, fostering greater community involvement and more robust solutions.
- **Community Groups as Stakeholders:** Organisations like Cootes Farm play a key role in leading verge initiatives, highlighting the importance of their inclusion.

- **Transparency Improves Engagement:** Lincolnshire Council successfully increased public acceptance of cut and collect cycles by publishing schedules online and keeping the community informed. West Sussex could benefit from similar transparency to enhance community trust and participation.

Year 3 Plan – Verge Cutting Activities

Year 3 will focus on refining and expanding verge cutting activities across WSCC and SGC, with an extended trial in East Sussex using a two-cut approach. The key objectives for the final year include:

- **Seasonal Growth Assessment & Data Validation:** Verify and refine data collected in Years 1 and 2 to better understand seasonal variations in grass growth and optimize cutting schedules.
- **Efficiency Improvements:** Implement lessons learned from Year 2 to enhance cutting processes, improve machinery performance, and streamline staff operations.
- **Optimising Cut & Collect (C&C) Practices:** Scale up rural C&C operations to assess long-term feasibility and efficiency.
- **Litter Management:** Investigate and trial effective litter removal solutions alongside verge cutting to improve overall roadside maintenance.
- **Machinery Development & Alternative Fuels:** Enhance cutting equipment design and test operations using Hydrotreated Vegetable Oil (HVO) to assess environmental and operational benefits.
- **Arisings Utilisation & Biochar Production:** Collect sufficient cuttings to produce biochar for road trials and explore additional applications where possible.
- **Cost & Logistics Modelling:** Develop a full-scale costing model and assess logistical requirements to support the transition of verge-cutting activities into Business as Usual (BAU).

As the final year of the project, it is essential that all trials, tests, and surveys are completed accurately. The findings will be compiled into the final technical report and the **Greenprint How-To Guide**, ensuring a clear framework for future verge cutting operations and sustainable management practices.

WP3_Biomass Innovations:

Summary

This paragraph details the progress of Work Package 3 in Y2, focusing on biomass conversion into hydrochar and biochar. The project evaluated hydrothermal carbonisation (HTC) and pyrolysis, exploring different biomass conversion pathways using verge biomass. While HTC was deemed economically unattractive due to high capital costs and lack of gate fees, pyrolysis of co-mingled grass and green waste/woody biomass emerged as the most viable option. Small-scale lab testing and pilot-scale trials were conducted to analyse biochar production and properties. The project is now planning road trials using biochar in asphalt mixtures, with phases focusing on planning, lab testing, and site selection. The ultimate goal is to integrate biochar into asphalt for improved sustainability and carbon sequestration.

The second stream of tests with AD is facing a blockage from the industry and needs to be removed. Year 3 is a crucial year for AD route for testing a defined viability.

Key Achievements:

- ✓ Successful pilot-scale pyrolysis of grass cuttings and co-mingled biomass.
- ✓ Characterisation of hydrochar and biochar from various processes.
- ✓ Identification of co-mingled grass and green waste/woody biomass as the most viable feedstock for biochar production.
- ✓ Planning for road trials using biochar-modified asphalt.
- ✓ Identified the potential for co-mingling food waste and grass cuttings in AD

Year 2 Biomass Innovations Activities

In Year 2, WP 3 aimed to assess the performance of two technologies for converting verge biomass and anaerobic digestion residues: (i) hydrothermal carbonisation (HTC) and (ii) pyrolysis. The experiments were conducted to evaluate how the solid outputs, hydrochar and biochar, could create additional value and contribute to carbon savings locally.
WP3 consists of five tasks:

- **WP3.1**: Production of hydrochar and biochar in tonne quantities.
- **WP3.2**: Characterisation of hydrochar and biochar.
- **WP3.3**: Asphalt test programme.
- **WP3.4**: Evaluation of biochar for non-asphalt applications.
- **WP3.5**: Contribution to techno-economic and life cycle analysis.

This outlined report compares HTC and pyrolysis, outlines Year 2 progress, details biomass conversion pathways, and presents selected process routes. It also summarises key test results, plans for locking up' biochar in roads by incorporating it into asphalt or burying it beneath road surfaces, lifecycle and techno-economic assessments, and alternative applications for biochar. Further details can be found in the full report here.

Overview of Biomass Conversion Processes

Hydrothermal Carbonisation (HTC)
HTC uses heat and pressure to convert wet biomass into structured carbons, renewable fuels, and bio-fertilizers. The process operates at temperatures below 300°C for up to four hours in the presence of water. The primary product, hydrochar, serves as a soil ameliorant or feedstock for bio-products. Other outputs include process water and gas. HTC efficiently processes high-moisture feedstocks but faces challenges due to limited supply chain and high capital costs. Hydrochar can also be further carbonised into biochar via pyrolysis.

Pyrolysis
Pyrolysis thermochemically converts biomass into char, condensable liquid (bio-oil or tar), and non-condensable gas in an oxygen-free environment. The process requires pre-drying biomass to 10-

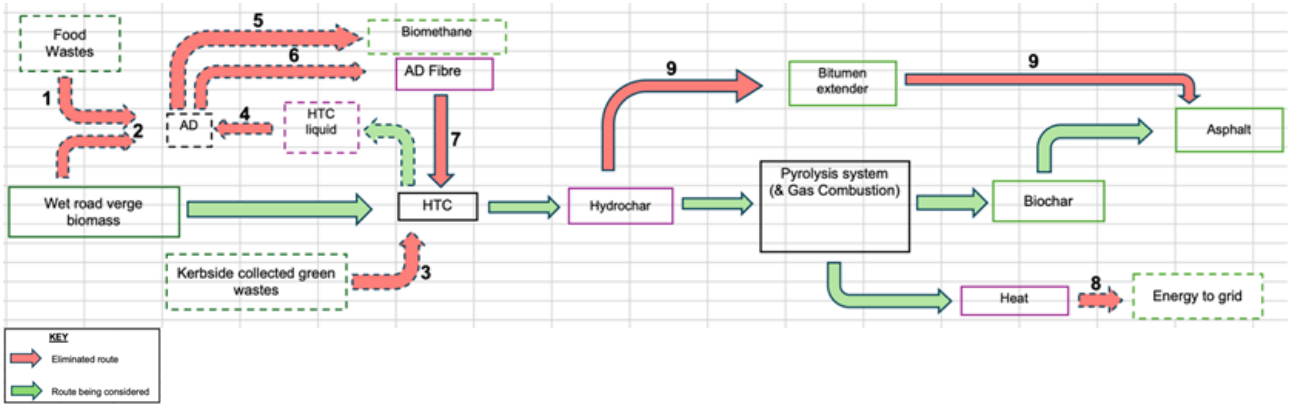
20% moisture content to enhance biochar output and process efficiency. Biomass is then superheated at temperatures above 350°C in an inert atmosphere, producing biochar as a solid carbon-rich material. This technology enables energy recovery but necessitates precise control over drying and heating conditions for optimal output.

Progress against Year 2 Deliverables

Year 2 Deliverables as stated in the Delivery Plan	Progress against deliverables and comments	Progress against schedule?
Develop plan and budget	Completed	
Plan preliminary tests	Completed	
AD biomass sourcing	Being handled by South Gloucestershire Council (SGC)	
Initial aggregate material tests	Initial aggregate lab tests underway	
HTC and pyrolysis lab tests	Completed – full details of testing and results are given in **Appendix 1**	
Biochar characterisation	Characterisation is completed as/when biochar is produced	
Pilot tests	Pyrolysis pilot test with 100% grass cuttings completed and 50:50 mix of wood and grass cuttings. HTC pilot test with 100% grass completed	
Plan aggregate road testing	The overall plan is presented in section 6.	
Support Ricardo pyrolysis trials	Completed	
Techno-economics and lifecycle assessment	Work has been completed and approved by Simon Wilson. Aspects such as seasonality of biomass supply/storage to be discussed	

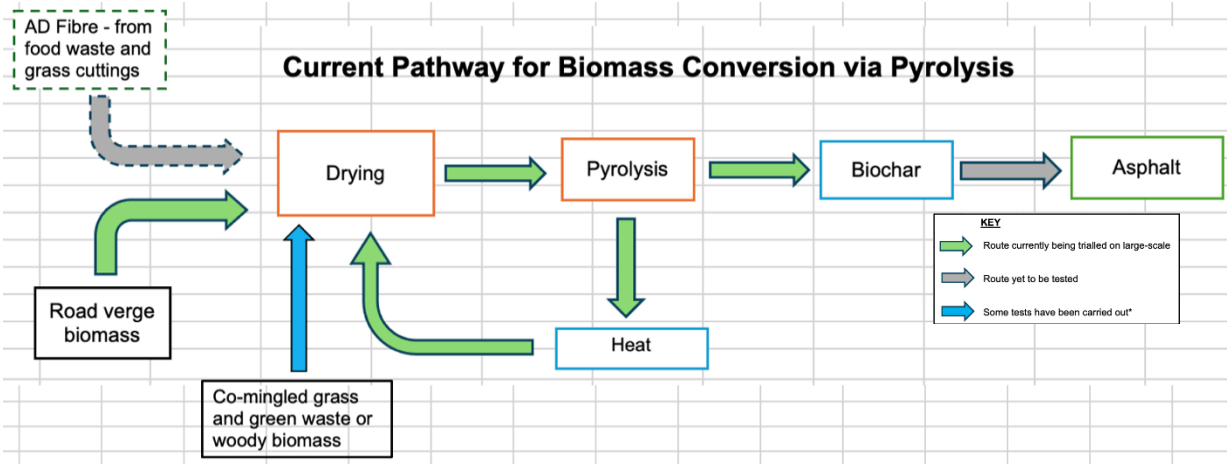
Conclusions about HTC processing

The results obtained from processing food waste AD fibre as part of the DESNZ Phase 2 GGR project demonstrate that plastics degrade HTC performance causing too much moisture to remain after the filter press step. This negates the benefit of HTC in using lower energy consumption for water removal compared to drying (the first stage before pyrolysis). Comingling small proportions of grass cuttings with food waste does not change these results. Furthermore, the hydrochar obtained from the HTC process can only be considered as a solid biofuel since its stability is too poor for carbon sequestration owing to the low processing temperature of ca. 200C. As a result post-pyrolysis would be needed to convert hydrochar into biochar. In addition, capital costs for HTC are high therefore, the process is only economically feasible if there are high gate fees, as for sewage sludge. Thus, although HTC can process verge biomass, the lack of a significant gate fee makes this process economically unattractive. For these reasons, only the initial pilot-scale HTC test is being carried out. HTC has been ruled out as a method for verge biomass processing in the Greenprint project.



Conclusions on pyrolysis

Invica Industries has successfully processed solely grass cuttings but technoeconomic analyses show that there is not enough grass available from West Sussex County Council's (WSCC) for the economical operation of a locally located pyrolysis plant. Grass cuttings could be sourced from a wider area however, transport costs would be very high, making the process uneconomic. Furthermore, the seasonal availability of grass cuttings would mean that additional biomass would need to be considered for a facility (processing 10,000 tonnes of feedstock p.a.) to operate during winter. Data from WSCC show that there are large quantities of green waste available which would satisfy the additional biomass requirement. Therefore, pyrolysis of co-mingled grass and green waste/woody biomass has been deemed the most viable processing option going forward. Some of this testing has already been done at the Ricardo facility.



Summary of Options Tested

The table below presents the evidence that co-mingled grass and green waste/woody biomass is the only viable option for the production of biochar.

Testing Option	Process	Feedstock	Comments incl. any justification for ruling out the option
1	AD	Grass	Issue with Geneco
2	AD	Grass + food waste	
3	HTC	Digestate from 1	HTC not technically or economically feasible for this feedstock
4	HTC	Digestate from 2	
5	HTC	Grass	Technically feasible but uneconomical – high transport costs to source more grass
6	Pyrolysis	Grass	
7	Pyrolysis	Digestate from 1	Technically feasible but only economical if digestate contains plastic and doesn't meet requirements of PAS 110
8	Pyrolysis	Digestate from 2	
9	Pyrolysis	HTC hydrochar from 3	No hydrochar available as HTC is not technically or economically feasible
10	Pyrolysis	HTC hydrochar from 4	
11	Pyrolysis	HTC hydrochar from 5	Technically viable and some hydrochar will be produced but, uneconomical – high transport costs to source more grass
12	Pyrolysis	Co-mingled grass and green waste/woody biomass	Most viable option given the large quantities of green waste available in WSCC. Some testing has already been carried out at the Ricardo plant

Summary of Other Tests Carried Out in Year 2

A. Small-scale lab testing at the University of Nottingham

A summary of the tests conducted, and their findings is provided below. For a more detailed report, please refer to **Appendix 1** of the full report.

Brief description of tests

Urban grass from Horsham, West Sussex – Cut 1 carried out March 2024 was collected and sent to the University of Nottingham (UoN) by Grasstex Ltd. At UoN the grass was stored in freezer to prevent further degradation. The grass was processed end June/early July 2024. Processing was as follows:

i. HTC at 200C, residence time 1h. Followed by post-carbonisation at 650, 700 or 750C
ii. Pyrolysis at 650, 700 or 750C

Each experiment carried out on 19 and 30 g grass (ca. 80% moisture) for pyrolysis and HTC, respectively, followed by characterisation of the biochars.

Summary of findings

This project investigated the pyrolysis of grass cuttings under laboratory conditions to generate biochar. Two methods were investigated, direct carbonisation and hydrothermal carbonisation (HTC) combined with post-carbonisation at 650, 700 and 750 °C. For direct carbonisation, the dry ash-free (daf) mass and carbon yields are 24 – 26 wt.% and 33.1–33.3 wt.%, respectively. Figure 3 shows images of the raw grass cuttings and hydrochar obtained at 200 °C together with the liquid product and Figure 4 shows the biochar obtained from pyrolysis in a Gray-King report. The direct

carbonisation of grass cuttings resulted in biochar with a grass-like structure compared to post-HTC biochar where the biochar was agglomerated.
The biochar yield was ca. 30% on a dry ash free basis for the grass cuttings. However, when HTC was performed at 200 °C before carbonisation, the biochar mass yield was reduced to ca. 24 – 26 wt.%. This is a common trend for all feedstocks and arises due to material being extracted as oil during the HTC stage.

B. Pilot scale pyrolysis trial – Ricardo

A summary of the tests conducted, and their findings is provided below. Please refer to **Appendix 2** for a more detailed report

Brief description of trial

WSCC delivered approximately 2.5 tonnes of grass to the BIOCCUS demonstrator plant on Monday, November 25th, 2024. This grass was cut on Wednesday, November 20th, 2024.. The grass was mixed with ca. 1.5 tonnes of woodchip, dried and processed into biochar. Once dried to the target moisture content the mixture should have contained an approximate 50:50 mass ratio of grass to woodchip.

Summary of findings

The plant was able to process the 50:50 feedstock and in total produced ~50 kg of biochar which is now undergoing laboratory analysis. Further processing of the grass, and production of biochar was not possible due to the challenges with feeding the grass cuttings described in **Appendix 2**.

C. Pilot scale pyrolysis trial – Invica Industries

A summary of the tests conducted, and their findings is provided below. For a detailed description of the pilot plant, please refer to **Appendix 3**.

Brief description of trial

Urban grass from West Sussex – final cut carried out November 2024 with ~10 tonnes sent to Invica Industries pilot plant at Immingham by Grasstex Ltd
Grass was processed December2024/January 2025 in the pilot plant pyrolysis at 700 °C. this temperature was chosen based on findings from the small-scale tests (see **Appendix 1)**
From 10 tonnes of wet grass (~80% moisture) 2 dry tonnes was processed, two thirds of the dried grass was processed on its own and one third was mixed with the same mass of wood before processing.

Summary of findings

100% grass was successfully processed. ~1300 kg dry grass resulted in 162 kg of biochar (with 38.9% moisture). The ~ 700 kg 50/50 mix of dry grass and wood produced 225 kg of biochar (with 39.15% moisture). Full analysis according to the European Biochar certificate will be obtained on both the biochars produced.

D. Pilot scale HTC trial - Ingelia

Brief description of trial

Urban grass from West Sussex – Final cut carried out November 2024 ~10 tonnes sent to Ingelia HTC plant in Valencia, Spain (see Figure 6 for the HTC process steps at the Ingelia plant)
Grass was processed to hydrochar during February 2025

Hydrochar pellets will be sent to the pilot plant at Immingham for further processing via pyrolysis to produce biochar. Further details on the trial and findings will be shared once the report from Ingelia is received.

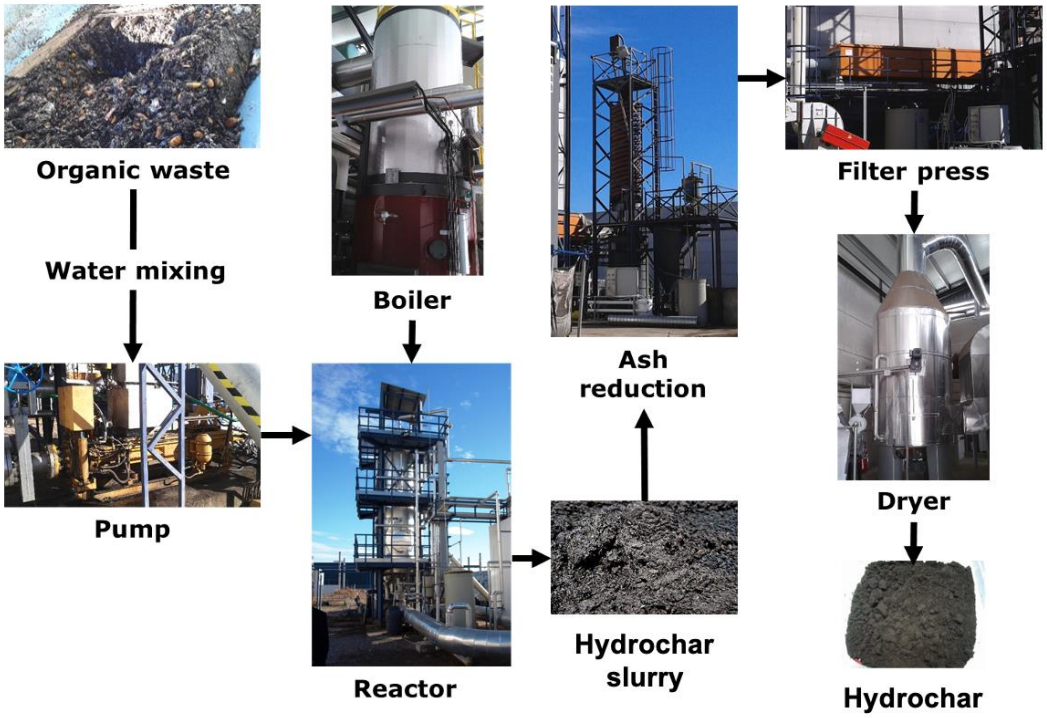


Figure 6 *Hydrothermal carbonisation process steps at the Ingelia plant*

Summary of Life Cycle Assessment and Technical Economic Assessment

The complete LCA and TEA are provided in Appendix 4 of the main report.

This LCA and TEA evaluated the environmental and economic feasibility of biochar production in WSCC using grass and green waste as a feedstock. The analyses demonstrates that a 100% grass-based biochar production approach (Scenario 1) is not viable due to insufficient local grass availability and the high cost and emissions associated with long-distance transportation. Instead, a co-mingling approach (Scenario 2), using a 10:90 mass ratio of grass to green waste, provides a sustainable and economically feasible solution.

Among the two biochar production methods assessed, pyrolysis is identified as the preferred route over hydrothermal carbonisation (HTC). Pyrolysis results in higher biochar yield, lower greenhouse gas emissions, and significantly lower production costs – making it the most practical and scalable option for commercial biochar production in WSCC. In contrast, HTC is less favourable due to high capital and operational costs, primarily driven by increased electricity and natural gas consumption. Overall, this LCA and TEA highlight the potential of utilising WSCC's available biomass resources for biochar production while emphasising the importance of feedstock selection, transportation logistics, and process optimisation in ensuring sustainability. Implementing a pyrolysis-based

biochar facility with a grass and green waste co-mingling strategy would provide a cost-effective and environmentally beneficial pathway for carbon sequestration and circular economy development in WSCC.

Biochar new Road Binder and Materials Development and Road Deployment Plan

This project explores biochar as a partial fine aggregate/filler replacement in asphalt mixtures through lab testing and road trials.

Phase 1: Planning & Preparation (Feb – April 2025)
- Source biochar in sufficient quantities.
- Engage collaborators (local authorities, contractors).
- Assess biochar supply chain and material variability.

Phase 2: Laboratory Testing & Optimisation (Feb – May 2025)
- Characterise biochar (moisture content, particle size, density).
- Test asphalt mixtures (Stone Mastic Asphalt, Asphaltic Concrete, Hot Rolled Asphalt).
- Evaluate mechanical properties (stiffness, deformation, durability).
- Determine optimal biochar content for durability and carbon benefits.

Phase 3: Site Selection & Risk Management (Feb – Aug 2025)
- Identify suitable trial locations (quarry roads, B-roads, remediation sites).
- Confirm site commitments and develop a risk management strategy.

Phase 4: Small-Scale Field Trials (June – Aug 2025)
- Conduct small-scale trials (e.g., quarry roads).
- Sample and test field-laid material for performance validation.
    - Monitor durability and compare with conventional asphalt.

Phase 5: Full-Scale Field Trials (Aug – Oct 2025)
- Expand trials to public roads with local authority collaboration.
- Explore biochar integration with recycled asphalt.
- Continue performance monitoring.

Phase 6: Evaluation & Scaling (Jan 2026)
- Conduct long-term performance assessment.
- Analyse data, economic viability, and environmental impact.
- Provide final recommendations for future implementation.

WP4_Benefit realisation & Economics:

This section focused on determining the benefits of the project. The following table is a summary of the benefits that are being considered as an outcome of this project and the time horizon that they would likely be achieved.

Benefit Category	Benefit	Timeframe for Realisation
Economic	Cost Reduction associated with verge management processes (£) allowing councils and other parties involved to dedicate resources in other areas	Long term (7 years or more)
	Revenue Increase (£) allowing councils and other parties involved to dedicate resources in other areas	Short Term (in the next year)
Reduction of CO2e	Reduce Emissions (CO2e) required for processes reducing impact on Climate Change	Short Term (in the next year)
	Increase Carbon Sequestration (CO2e) reducing impact on Climate Change	Long Term (7 years or more)
Biodiversity	Increase in biodiversity, from reducing nitrogen and ammonia in the soil, particularly with vegetation that thrive in low nitrogen soils	Long term (7 years or more)
	Decreased eutrophication, from reducing nitrogen and ammonia in the soil, resulting in increased biodiversity and avoiding other negative ecological impacts that are unknown.	Long term (7 years or more)
	Decreased acidification in soils, resulting in increased biodiversity and avoiding other negative ecological impacts that are unknown.	Long term (7 years or more)
Job Creation and EDI	Increased number of jobs involved in the project	Short Term (in the next year)
	Promotion of STEM encouraging more people into a needed area of society	Medium Term (1-7 years)
	Encouraging diversity of workforce allowing a greater variety of perspectives through different backgrounds which are necessary to solve complex problems.	Medium Term (1-7 years)
Behaviour	Workforce and customer levels of satisfaction and wellbeing increased as their awareness that the council is working towards a target that is good for the planet.	Short Term (in the next year)
	Increase in happiness of councils from aesthetics associated with biodiverse verges.	Long term (7 years or more)
Better communication within councils	Removal of siloes, enabling bigger solutions to bigger problems	Medium Term (1-7 years)
Systems Thinking	Being able to think at scale over several years encourages long term systems thinking	Short Term (in the next year)

Water conservation	Increased percentage of plants which hold water	Long term (7 years or more)
Invasive species control	Increased percentage of plants that provide a better habitat for native animal life	Long term (7 years or more)
Nature Pathways	Increase feeding options for insects and mammals as well as animals, resulting in increased biodiversity	Long term (7 years or more)
Compliance with Environmental Regulations	Benefits achieved from the environmental regulations	Short Term (in the next year)
Diversification of Energy Supplies	Production of energy from different sources means that there is more resilience for energy production as well as options which can provide greater gains in different circumstances	Medium Term (1-7 years)
Increased knowledge within the industry	Greater likelihood that others will be able to solve problems that need solving at a national or international scale. Allow others to replicate processes at lower cost, resulting in all benefits at a larger scale.	Medium Term (1-7 years)
Industry and legislative innovation (aka OFGEM)	Recording of legislative procedures that were necessary to go through to enable ease for other councils and parties to do the same later.	Short Term (in the next year)
Innovation Management	Working and recording innovative processes can allow for greater knowledge in the industry	Short Term (in the next year)
Traffic Efficiency	Reduction in traffic movements means that there is less traffic on the roads	Long term (7 years or more)
Increased road durability	Increasing production of biochar into asphalt will result in better material for ensuring road durability	Medium Term (1-7 years)
Verge Litter	Reduction of verge litter and plastics as they are being removed in the process	Short Term (in the next year)
Verge Management	Improved logistics and efficiencies within verge management	Short Term (in the next year)
Agriculture	Creation of fertilisers to improve agricultural yields	Medium Term (1-7 years)

As this is an innovation project, it's possible that many of these benefits are not achieved, however, the project is targeting resources to ensure that these benefits are being realised and are known. It is worth noting that in trying to develop a successful project, the benefits with the greatest focus are cost, carbon and biodiversity. This is due to these benefits being the largest drivers of stakeholders on the project. ADEPT is most interested in seeing a reduction in carbon, the councils are interested in this being a cost-effective solution and the residents within the councils appreciate increased biodiversity within their verges. The preceding benefits listed in the table are secondary benefits that come as a consequence of the work done to achieve the primary benefits. Many of the benefits have a time horizon longer than the period of the project. Therefore, it is critical that some form of evaluation remains in place to determine the success of the activities completed.

WP5_Environmental Impact:

The purpose of this work package was to focus on understanding the environmental benefits of Greenprint in regard to biodiversity. This work package will oversee the biodiversity surveys and soil carbon sampling to understand the impacts that the project will have.

In Year 2 we established a baseline for monitoring vegetation changes on roadside verges in South Gloucestershire and West Sussex. Greenprint aims to reduce carbon emissions from highway verge maintenance by also trialling nature-based solutions. The study surveyed plant species richness, frequency, and other metrics on selected road verge sites, considering factors like location (rural/urban), soil type, and mowing regime. The goal is to compare the effects of a "cut-and-collect" management approach against the current management practices Cut & Drop. The baseline data will be used to assess future changes in vegetation. The study found 149 plant species and suggests that urban verges, despite often being subject to more intensive mowing, can be species-rich.

Key Findings & Potential Achievements Highlighted:

- ✓ Baseline Establishment: The report provides a crucial baseline dataset of plant species and vegetation metrics on roadside verges. This allows for future comparison to assess the impact of altered verge management practices (specifically "cut-and-collect") on biodiversity.
- ✓ Biodiversity Opportunity: The study highlights the potential for enhancing biodiversity through sustainable road verge management.
- ✓ Impact of Mowing Regimes: The results suggest that current mowing practices significantly influence plant species composition and richness. Urban areas tend to have more frequent and intensive mowing, which favors certain species.
- ✓ Verge Variation: The study acknowledges the variation in species richness and composition across different verge locations (edge, middle, back) and between rural and urban settings.
- ✓ Soil Properties: The study found no direct correlation between ecological traits and soil, suggesting vegetation management is key.

WP7_ Whole Life Cycle (Blueprint):

The project believed that in order to achieve the greatest benefit, it will provide documentation detailing results and the processes used within the project. This would help others in adopting best practices of the project and understand what was done and why. It was determined that this information would be spread across 3 different documents. These include:

- ✓ A process report detailing the various processes that were used within the whole system. This is separated into two divisions. The first gives insight into why processes were used and some of the advantages and disadvantages of trialling some over others. The second part is a clear how-to guide for another party wishing to set up what was seen as best practice. This document will be developed with the understanding of what was the best practice at the time of conducting the experiment as well as with the knowledge and resources available to WSCC and SGC. It is expected that over time, greater efficiencies and equipment will become known, which will improve the success of the practice that is being carried out.
- ✓ An experiment report will be developed. This will be a report detailing the processes that were set up for the purposes of carrying out and tracking the experiment. This does not focus

on this specific innovation project; however, it looks at the steps that were taken to support the experiment, which can be transferrable to other different large-scale experiments. This includes details such as setting up data and information collection on costs, carbon and biodiversity. It also considers procurement and community engagement required to run a successful innovation project. This report was decided on later, as many of the challenges relating to information collection and community engagement were more difficult than initially understood. Sharing these learnings can help projects run faster and better in the future, as informed parties will be more prepared for setting up similar large-scale projects.

- ✓ The third and final report is a Thought Leadership Report. This will be a report focusing on an analysis of the project. This will include a discussion around what was simple and what was difficult in running the project. It will include a view on whether the project was successful and an opinion on whether it should be rolled out further. This will be in consideration of the whole life cost, carbon and biodiversity net gain that was recorded as part of the experiment. It will detail challenges that occurred within the specific project and point to areas to improve in the process overall in the future, both within this specific project and within the Live Labs program overall.

As these documents are final documents, they have not been developed yet. Significant progress is likely to be made within year 3, following the completion of the processes undertaken within the experiment. One of the challenges that will be faced with the development of these reports will be communicating the vast and complex learnings of the project in a way that is simple for external users to digest and understand. If done successfully, this can dramatically scale the benefits gained from this project.

WP8_Equality, Diversity, Equity and Inclusion:

This work package focuses on ensuring that EDEI has been considered within Greenprint. This provides assurance that investment from ADEPT is going towards EDEI.

Key Achievements:

- ✓ Briefing for StreetCare staff on Weds 24th January
- ✓ Equalities Voice Event at Grimsbury Farm on 31st January 24
- ✓ Putting EDEI into practice half day workshops
- ✓ Inclusive leadership for managers half day workshops
- ✓ Women in leadership programme
- ✓ Highways UK – Greenprint EDEI work package leads invited to help curate a panel discussion on EDEI for the highways UK autumn 2024 conference.
- ✓ Apprenticeships – WSCC have been proactively developing work-based learning opportunities for apprentices through the programme

WP9_Communication:

This work package is involved with communicating Greenprint throughout the project, so that the community continues to be engaged and aware of the project.

Achievements

We have been able to maintain a steady communication stream from the project with press releases, social media posts, articles in local magazines and newspapers and coverage in the national and trade press.

In July 2024, the project was featured in an article in the Sunday Times, 'Cooking with grass: roadside trimmings will power your home', bringing the work of the project to a much wider audience and highlighting the collaborative nature of the project.
The project has a quarterly newsletter which focusses on four key strands of the project: verge management, carbon, biodiversity and biochar, providing an update on each area. We're gradually building the subscribers to the newsletter. More detailed information is available in the ADEPT COM monthly report.

We also participated in Online seminars with the CIHT.

Challenges
The project, by its nature, has a big seasonal dimension with people seeing much of the work during the cutting season. Maintaining a steady stream of communications is one of the challenges of the project.

One way we have tackled this is by focussing on industry and stakeholder communications over the winter and more public-facing comms, targeted at residents, during the cutting season, when people will see the mowers out and the difference in the verges and green spaces included in the project.
The technical nature of the project means that the focus of the messaging needs to change for the different audiences. From bringing people in around biodiversity with a very high-level overview of the project itself to much more technical information for people with a professional interest.
Due to the collaborative nature of the project, and the number of partners involved, we are also able to tap into existing networks each partner brings with them and target our messages and communications appropriately.

Next Steps
As the project enters its third year, we will be looking to do more to share our learning, the tools and approaches we have developed in the preceding two years as we develop our Greenprint.
We plan to do this by exploring more opportunities to present our project at industry events and through webinars. As well as growing our newsletters mailing list and continuing to share updates and insights about our work.

3. Goals and Milestones reprogrammed without any major impact

Live Labs as a programme is designed to be flexible and agile, adapting to challenges and changes in the project environment. The project managers across both authorities monitor any changes and ensure there is minimal impact on the overall scope of the project. Some of the goals and milestone changes that have occurred in the project include:

- ✓ WP2 - Trial rural Cut & Collect equipment on lease (short duration): Reprogrammed in Year 3

- ✓ WP2 – containers and mowers ordered by South Gloucestershire in May/June 2023 were not delivered until December – testing of logistics was therefore delayed, and the full trial will be tested in Year 3
- ✓ WP3 - Large-scale pyrolysis trials of AD fibre: following the AD plant blockage the pyrolysis of AD fibre obtained from co-mingled food and grass has been postponed to year 3

4. Main Roadblocks and Issues

Innovation projects often come across roadblocks throughout the life of the project as they are often new ways of working. For Greenprint it is critical to understand and share what these have been with the wider sector to ensure that we can learn from them and ensure our Greenprint helps local authorities avoid these in the future – our learning will make more efficient projects in the future.

- ✓ WP0_Underestimated the workload on internal staff to deliver WP0/1/2/5/6/9.
- ✓ WP0_Project governance requires early attention to develop the structure of the project and allow for transparency with robust decision making. In a joint authority project defining responsibilities takes longer and has the potential to delay start up. Work package leads need commitment and capacity in order to contribute effectively, which can be a challenge when resources are stretched.
- ✓ WP0_Budget monitoring / spend forecasting is more complex with two local authorities jointly involved in procurement. Although a Partnership Agreement and Accountable Body Agreement were not signed until January 2024, a process of tracking costs had already been developed by project managers in discussion with respective finance teams.
- ✓ WP1_Ensuring Consistency in Baselining Reports - The process of baselining reports required rework to ensure consistency with other Livelabs. Aligning methodologies, data formats, and reporting structures has been a challenge, necessitating additional effort to meet standardization requirements.
- ✓ WP1_ Embedding Carbon Measurement Data Collection into Existing Processes - Integrating carbon measurement data collection into existing workflows has been complex. The challenge lies in ensuring minimal disruption while effectively capturing relevant carbon-related metrics within routine operations.
- ✓ WP1_Establishing Carbon Figures and Emission Factors for Innovative Processes - A key obstacle has been the determination of carbon figures and emission factors for novel processes. Due to their innovative nature, standardised emissions data may not be readily available, requiring additional research and validation efforts.
- ✓ WP1_Accounting for Seasonality in Grass and Vegetation Availability - Variations in grass and vegetation availability due to seasonal changes pose difficulties in establishing accurate carbon baselines. These fluctuations need to be accounted for to ensure data accuracy and reliability.
- ✓ WP1_Reliance on External Teams for Carbon Baseline Data Collection - The process of gathering carbon baseline data for FHRG has been heavily dependent on cooperation from teams not directly involved in the project, including climate, fleet transport, and HR teams. Although much of the required data exists, it has often been incomplete or stored in varying formats. This has necessitated significant effort in data interpretation and consolidation, requiring both time and accuracy to align with FHRG requirements.

- ✓ WP2_Resistance to change in the reduced cutting regime, driven by anticipation of public backlash and contractor demands. We have a conjoint Change of Mind strategy to introduce change gradually and through examples like South Down National Park (SDNP) and Hurstpierpoint, a better understanding of the benefits can be achieved.
- ✓ WP2_Scaling up of cut and collect operations depends on securing agreement and participation from various parishes and boroughs. Early stakeholder engagement is crucial to enable confident planning. Without this, there is a risk of newly purchased equipment standing idle or insufficient resources, such as labour, machinery, or plant, to meet demand. Additionally, recruiting temporary agency staff is impractical without a firm work schedule.
- ✓ WP2_ The seasonal nature of green estate management significantly impacts delivery plans. While this has always been a factor, added flexibility is essential for cut and collect operations, especially if viability is marginal. Longer, damp grass can lead to equipment faults or blockages, posing additional challenges.
- ✓ WP2_ Staffing shortages led to a reduction in crews, delaying the final Horsham cut until late December. Operatives initially struggled with new equipment and operational requirements, leading to mower blockages and uneven cuts. Wet weather further hindered mower performance, particularly when handling long grass. The Cannington AD plant rejected co-mingled grass and food waste due to processing blockages, necessitating a switch to separate delivery into crop digesters.
- ✓ WP2_ Frequent mower breakdowns occurred due to design flaws, including broken lift arms, small chute openings causing blockages, and poor welding on jockey wheels. Repair times were extended due to supply chain delays, with some equipment out of action for up to five weeks. Kubota mowers were found to be overly complicated and better suited for urban use, lacking durability for the required tasks. Initial Grillo FD2200 TS ride-on mowers struggled with long grass, necessitating their replacement with more suitable models. Battery-powered equipment had mixed results—electric blowers performed well, but electric strimmers lacked the necessary power.
- ✓ WP2_ Data inconsistencies arose due to multiple staff members handling monitoring, though this issue has been resolved. Hardware reliability problems with tablets necessitated some retrospective data entry, which has also been addressed. The baseline carbon modelling data was incomplete, requiring estimates from a limited desktop study; this will be re-evaluated in Year 3.
- ✓ WP2_ No significant rural cut and collect trials have been conducted to date. Plans for verge litter management were postponed to Year 3, delaying progress in this area.
- ✓ WP3_ Hydrothermal Carbonisation (HTC) faces several challenges that limit its feasibility for verge biomass processing within the Greenprint project. The presence of plastics in the feedstock, particularly food waste AD fibre, hinders HTC performance by increasing moisture retention even after filtration. Additionally, hydrochar produced at lower temperatures (~200°C) lacks stability, making it unsuitable for carbon sequestration without further post-pyrolysis treatment. The high capital costs of HTC plants further add to the economic burden, as the process relies on substantial gate fees, which are unavailable for verge biomass. As a result, HTC is not considered economically viable for this application, and only an initial pilot-scale test is being conducted.
- ✓ WP3_ The main challenges for local pyrolysis include insufficient grass cuttings from West Sussex County Council (WSCC) alone to sustain economical operations, as a plant requires 5,000–10,000 tonnes of dry feedstock annually. Expanding the sourcing area would result in

prohibitively high transport costs. Additionally, the seasonal nature of grass cuttings necessitates alternative biomass sources to ensure year-round operation, especially during winter.

- ✓ WP3_Geneco have agreed lately to test in year 3 the grass/food co-mingling AD process.

4.1. Common Challenges

The common challenges encountered across the project came from the diverse array of stakeholders and specialists involved, necessitating intricate interface coordination efforts between both directly employed personnel and externals.

The innovative nature of the project necessitates a departure from traditional approaches, presenting challenges in adapting to new procedures and workflows.

One particular challenge relates to the implementation of relevant reduced Cuts regime as recommended by Plantlife Verge management guide (only 2 cuts a year) as the public and political ground is not ready for it. Addressing these challenges demands proactive measures, communication campaign, encompassing budgetary consolidation, exploration of supplementary funding avenues, strategic partnerships, and securing grants tailored to innovation, environmental sustainability, operational efficiency, and holistic well-being.

4.2. General Concerns

The duration of the project falls short of adequately capturing the comprehensive benefits linked with the system. With procurement delayed, valuable time has already been forfeited. Many anticipated ecological shifts are projected to manifest considerably later, perhaps spanning over a period of seven years. This timeline is essential as it signifies the gradual reduction in soil fertility, culminating in a noteworthy impact and, consequently, economic savings through a reduced frequency of cuts annually.

5. Innovations

At the heart of the LL2 initiative, the project has embraced forward-thinking approaches, as evidenced by the streams of work below. These initiatives demonstrate a focus on exploring new technologies and solutions, enhancing project efficiency, and hopefully opening possibilities for additional funding and collaboration with industry partners.

Innovations Log:

Innovations	Description	Status
Reduce maintenance regime in line with Plantlife guidelines	We have developed a strategy for reducing annual maintenance costs in line with Plantlife's recommendations. This strategy comprises two work streams: ii. Community Engagement Plan: Our initial intention is to roll out experiments in the supportive parishes/boroughs and work closely with local communities.	Trials In Progress

Innovations	Description	Status
	iii. Change of Mind Plan: In the second phase, we will focus on the parishes/boroughs that need more convincing. This stream of work will extend beyond the LL2 Greenprint project. In theory, reducing the number of cuts per year should also reduce carbon emissions. Our experiments are designed to confirm this assumption.	
Operation of Cut and Collect of arising (biomass)	The innovation resides in three work streams: 1) Testing the Cut & Collect equipment: We are evaluating various topographical and cutting regime configurations. Specifically, we have purchased three different models/brands of urban mowers and trained our operators. 2) Testing the logistics of storing and transporting the arisings: We are currently testing two systems: a) Direct transport to depots/plants b) Strategically deposited skip systems across the county. 3) Optimisation of all processes for work streams 1 and 2: This involves an in-depth scrutiny and analysis of existing protocols and potential improvements. Our goal is to develop the best How-To guide for minimising carbon emissions. The cut and collect activities for Y2 has now been completed in the areas where stakeholder engagement paved the way for this - all the costs associated with this have been recorded and will be used to assess the operational, financial and carbon impacts. We are now planning for Year 3 trials	Testing Scalability of Innovation
Purchase & use of specialist cut and collect equipment	We are we working with Cut & Collect lawn mowers manufacturers to improve the efficiency of their machines in terms of cut (issues with production when grass is longer) and conversion to bio energies for their engines. This applies to Urban and Rural areas. Records have been kept of machinery performance and breakdown and the associated costs recorded in order to track the full impact of trialling new machinery. Working with manufacturers to improve their machinery.	Testing Scalability of Innovation
Biomass Processing (arisings)	The partnership will explore different biomass processing methods to evaluate and compare their effectiveness. SGC will transport harvested biomass via its waste contractor to an established central Anaerobic Digestion (AD) plant. The AD process generates biogas, which is burned to produce electricity. The additional electricity generated from verge biomass will be measured to assess its impact. WSCC will test a decentralised biomass processing model to minimise transport logistics and demonstrate the feasibility of small-scale operations. The vision is to establish a network of local processing sites to handle verge biomass and other organic waste, such as material from District and Borough activities or school playing fields. Potential locations include Highways depots, Household Waste Recycling Centres, contractor facilities, or other suitable sites. However, in West Sussex, biomass collected through recycling centres, green bin waste, and potential future kitchen waste collections are managed under the central waste processing contract and will	Testing Scalability of Innovation

Innovations	Description	Status

	required a change in contract terms if some are in the scope of this project.
	WSCC's biomass processing will begin with Hydrothermal Carbonisation (HTC), a process that applies heat and pressure to biomass mixed with water. The resulting material will then undergo AD, where bacteria further break it down. This innovative combination has been shown to improve Energy Return on Investment and reduce processing time.
	Given the objectives of this funding competition, the project will focus on minimising emissions associated with highway maintenance. However, the processing methods can be adjusted to produce various outputs, including:
	• **Hydrochar** – A material that can be incorporated into asphalt to extend road surface lifespan and reduce carbon content, acting as a long-term carbon sink.
	• **Biogas**, which can be:
	  ○ Burned in a CHP engine to generate electricity and heat, or
	  ○ Upgraded into biomethane for use as a transport fuel.
	• **Fertiliser, CO_2, and other byproducts** with potential commercial or environmental applications.	

Development of new Road Binder and Aggregates	Asphalt test programme (Lead Dr Airey, with support from Prof Snape, bot from Uni of Nottingham) The proposed programme comprises three elements: (i) Binder modification/extension testing/assessment The impact of hydrochar and biochar on bitumen will be investigated by: (ii) Asphalt mixture – replacement aggregate testing/assessment Approximate range of between to 5% by mass of total asphalt mixture: Note that HTC hydrochar will only be considered as a bitumen modifier and not an aggregate replacement since it will not have the required stability for long-term carbon sequestration due to the low production temperature of close to 200°C (see Section 2). The tests will include: (iii) Road trial on biochar-containing asphalt A road trial using at least 100 tonnes of aggregate which will correspond to a length of road in the region of 100 meters. The aim is to compare a control asphalt to an asphalt with biochar added and the possibility to monitor the degradation over a prolonged period, going beyond the end of the project in 2026.	Trialling / Prototyping
Carbon Measurement	The project has used the tools offered by the Future Highways Research Group (FHRG) to assess and baseline the interventions in the live lab programme. This included an exercise to confirm what data was required for the carbon baseline and feedback data to baseline the New Carbon Model with FHRG support. In doing so, the Greenprint Live Lab is using the FHRG Carbon Calculation & Accounting Standards, (CCAS), step-by-step guidance to assist local highways authorities, (LHAs), in implementing the greenhouse	Testing Scalability of Innovation

Innovations	Description	Status
	gas protocols for measuring and reporting carbon emissions. As a result, both WSCC and SGC have completed a 2022 / 2023 carbon baseline for the Highways, Transport and Planning (HTP) and Highways Services, respectively. This will provide context for the Greenprint project to make comparative and contextual claims to highlight the decarbonisation impact of the project over the course of the trial. Publication of a review paper on carbon storage and sequestration in grassland road verges (Deborah Adkins)	
Bio Energy	The project is collaborating with Cage Technologies project (Advance Propulsion system) to convert biogas from AD process into bio energies for use in lawn mowers and other machinery in the grass-cutting operation	Product Definition
Greenprint "How-To" document	The main deliverable of this project is to develop a blueprint (Greenprint) document that can be used by other local authorities as a guide to implement similar management of their Green Estate	Product Definition

6. Carbon

As Year 2 concludes, WP1 remains on track in establishing and refining carbon measurement methodologies. At the beginning of Year 2, baseline assessments were completed for WSCC and SGC service levels, covering Highways, Transport, and Planning services. These baselines provide critical context for quantifying the carbon impacts of the Greenprint approach and evaluating potential carbon savings. Additionally, indicative project-level operational carbon baselines were established for the cut-and-drop and soil biomass stages, allowing for comparison with the cut-and-collect approach. These assessments have been published by ADEPT alongside other Live Labs project baselines.

Throughout the year, WP1 has focused on refining carbon measurement methodologies across all project stages, including waste collection, transportation, pyrolysis (biochar production), anaerobic digestion (AD), and biochar use cases. A key milestone was a collaborative workshop with Nottingham University and a visit to pyrolysis facilities in Immingham, facilitating valuable discussions on carbon profiling.

The Carbon Analyser tool developed by FHRG has continued to be instrumental in this process, ensuring alignment with the Carbon Calculation & Accounting Standard (CCAS) and maintaining consistency across Live Labs projects. The remainder of Year 2 has been dedicated to refining data collection processes, preparing project partners, and equipping work package leads for effective data gathering as the project transitions into Year 3.

<u>Challenges</u>

- Ensuring consistency in baseline reporting across Live Labs, requiring rework

- Embedding carbon measurement data collection into existing processes
- Establishing emissions factors for innovative processes
- Accounting for seasonality in grass and vegetation availability

Innovations

- Continued collaboration with FHRG to enhance the Carbon Analyser process for green estate maintenance, capturing scope 1, 2, and 3 emissions
- Publication of a review paper on carbon storage and sequestration in grassland road verges (Deborah Adkins)

Progress and Future Direction

A comprehensive carbon measurement methodology has now been established for all project stages, guiding data collection and identifying key gaps to ensure robust carbon accounting. Collaborative sessions with the University of the West of England, FHRG, and Greenprint work package leads (particularly WP2 and WP3) have been pivotal in ensuring accurate and holistic carbon measurement across the project lifecycle.

Greenprint remains committed to achieving significant carbon reduction, embedding this goal into every decision. Recognising the challenges of implementing data collection processes, contractors have been briefed and provided with mobile equipment to streamline carbon data capture in Year 3. This approach will drive long-term behavioural change, ensuring carbon measurement becomes an integral part of ongoing project activities.

Looking ahead, WP1 will continue refining data collection and carbon measurement, consolidating carbon profiles at each stage of the project. This will enable a comprehensive comparison between baseline emissions and project results, providing a clear understanding of Greenprint's effectiveness in reducing carbon emissions.

Carbon reduction remains Greenprint's highest priority, and while challenges persist—particularly in shifting traditional mindsets from cost efficiency to carbon-conscious decision-making—there has been a notable transformation in perspectives. The project has identified gaps in baseline data and is actively addressing them, ensuring a more streamlined approach to data collection moving forward.

As part of the Live Labs 2 programme, Greenprint aligns with the overarching ambition:

"Through deployments at demonstrable scale, we will achieve a step change in the normalisation and uptake of zero-carbon techniques, solutions, and materials in the local roads realm to meet the needs of today and prepare us for an uncertain tomorrow." (ADEPT, 2022)

While carbon reduction remains a complex challenge, Greenprint continues to drive forward innovative methodologies and behavioural shifts to make carbon-conscious decision-making the standard within local authority operations.

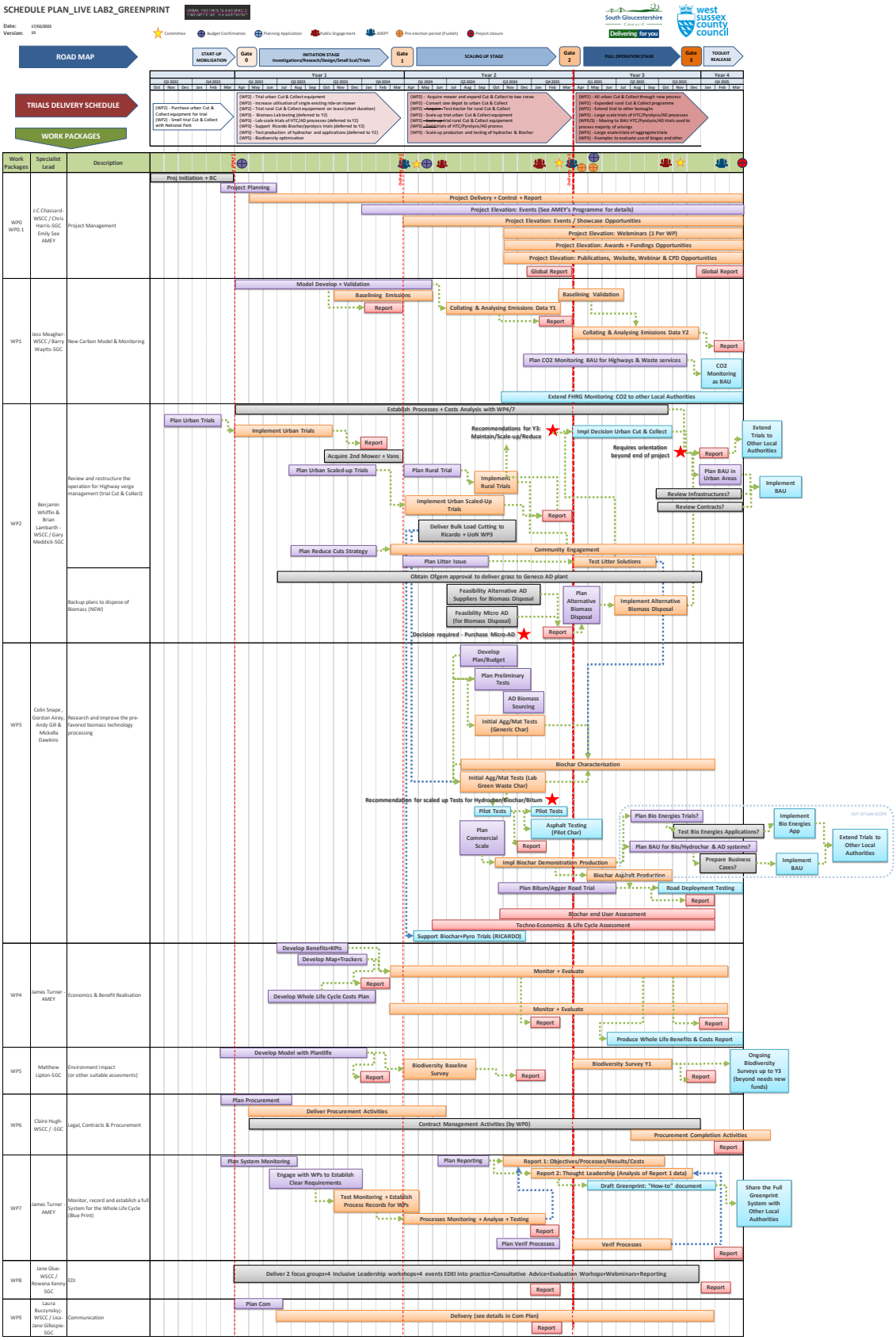
7. Project Elevation & Integration

In addition to the communications activities delivered by the project directly or in support to ADEPT Comms team, we have also dedicated some specific budget to reach out and seek the involvement of stakeholders like universities, local enterprise partnerships, and the knowledge transfer network, considered vital for integrating project knowledge into regular operations and ensuring long-term legacy across the UK. We understand that in order for the sector to achieve a step change in carbon reduction, other local authorities will need to take on these innovations in the future. This year with the support of our partners and LL2 participants we have achieved the following:

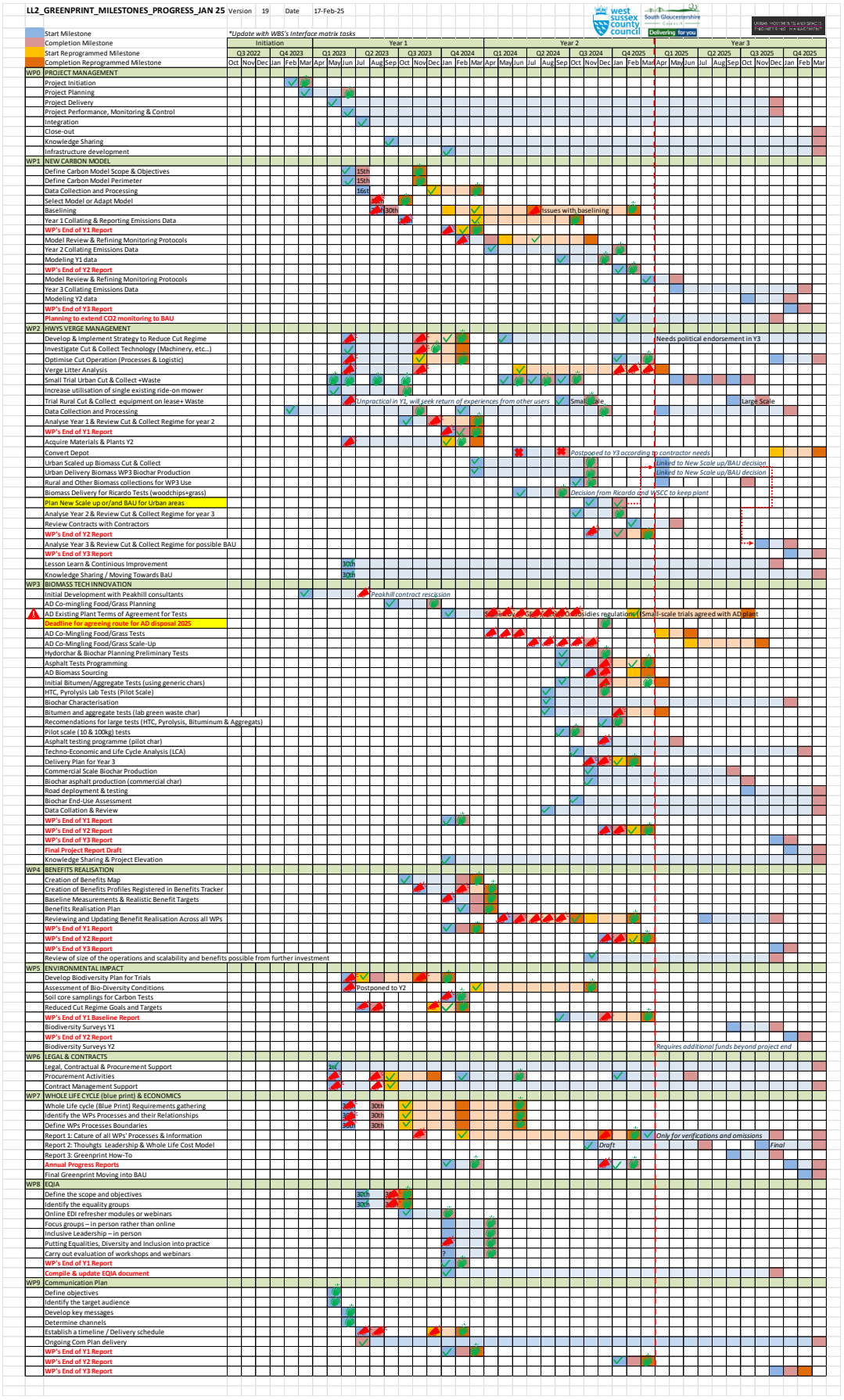
- ✓ Engagement with National Highways promoting Greenprint to the Roads Research Alliance – this is great exposure to National Highways and key industry partners.
- ✓ Collaborating with the Centre of Excellence to trial Biochar.
- ✓ Engagement with CIHT to promote Greenprint to the wider sector
- ✓ Engaging with the CIHT - Highways Infrastructure Decarbonisation Group to share lessons and learnings from Greenprint.
- ✓ Presenting Greenprint at the first of its kind conference focused on green infrastructure – see the overview here.
- ✓ Great liaison with AD Plant GENeco
- ✓ Great engagement across other Live Labs
- ✓ We have closely engaged with the local communities in order to expand the trial programme.
- ✓ We have been elevating issues around legislation with regards to waste with University of Nottingham.

8. Project Scope and Deliverables

Below is the project's Schedule Plan with Road Map, Trails Delivery Schedule and Work Packages outlined tasks.



Year 2 Progress Vs Deliverables



9. Risks

In our initial assessment prior and during to Year 2, we identified and addressed a range of potential direct and indirect risks to ensure the smooth progression of our project. We do manage a live risk register however we have summarised below:

1. **Seasonal Factors**

- Weather may delay cut and collect activities or naturally reduce yield.
- Trial activities and processes are heavily weather-dependent, requiring flexibility in scheduling.

2. **Machinery & Equipment Issues**

- Machinery has shown weaknesses (breakdowns), reducing cutting frequencies and potentially limiting the planned surface area.
- Long delivery times for equipment may impact project timelines.

3. **Community Engagement Challenges**

- Lack of response to biodiversity messaging and reduced cut regime.
- Delay in engaging with local communities, leading to resistance or opposition.
- Failure to embed the project internally, especially with Waste and Highways teams.

4. **Waste Processing & Logistics**

- Geneco and AD recycling centres may not accommodate the quantity of grass collected in Y3.

5. **Scale-Up Challenges & Budget Impact**

- Outcome of project may prevent scaling up Cut & Collect activities at the end of Y3 moving to BAU

6. **Technical & Innovation Risks**

- Creating new road binder and materials may not be successful due to limitations of biochar (mechanical properties, absorption, binding, etc.). Alternative partnerships with suppliers may be necessary.

7. **Procurement & Contractor Risks**

- Procurement challenges could cause delays or quality compromises.
- Unplanned work will required external contractor support.

<u>Indirect Risks:</u>

8. **Workload & Resource Constraints**

- Underestimation of Workload: Inaccurate workload assessments may lead to inefficiencies and shortfalls. To mitigate this, careful workload planning and continuous monitoring have been implemented to maintain productivity.
- Departure of Key Personnel: The loss of key team members can disrupt operations. Contingency plans and knowledge transfer mechanisms have been established to ensure continuity.

9. Ecological Impact

- Procurement Delays: Delays in procurement may affect ecological shifts, prolonging the realisation of expected benefits. Efforts are being made to minimise these delays and maintain project momentum.
- Environmental and Ecological Uncertainty: The long-term impact of cut-and-collect methods on biodiversity, soil, and vegetation remains uncertain. Steps are being taken to assess and mitigate potential negative effects.

10. Political & Social Resistance

- Political Risks: Political resistance may create obstacles to project implementation. Strategies have been developed to engage stakeholders and ensure continued progress.
- Resistance to Change: Adapting to new procedures may face resistance. Comprehensive support and training for stakeholders are being provided to facilitate smooth transitions.
- Lack of Community Support: Insufficient public or community engagement may threaten project sustainability. Active outreach and awareness campaigns are being implemented to build support.

11. Financial & Economic Risks

- Budgetary Constraints: Limited financial resources require careful allocation to ensure efficient project execution.
- Higher Costs of Cut-and-Collect: The cost of this method compared to traditional verge management presents a financial challenge. Alternative funding sources are being explored for long-term feasibility.
- Uncertain Revenue from Biochar: Revenue streams from biochar production remain uncertain. Efforts are ongoing to assess and enhance its market viability.

12. Operational Adaptability

- Challenges in Adapting to New Procedures: The introduction of new processes may slow progress and require additional stakeholder support.
- Seasonality & Weather Dependency: Many project activities, such as cut-and-collect operations, are weather-dependent. Schedule flexibility and adaptive planning have been incorporated to account for seasonal variations.

13. Long-Term Viability Risks

- Scaling Challenges: The pathway for expanding the project to other local authorities remains unclear. Strategies are being developed to facilitate broader adoption.
- Uncertain Adoption of Knowledge-Sharing Platforms: The effectiveness of toolkits and knowledge-sharing platforms depends on external stakeholder engagement. Measures are being taken to encourage their use and long-term sustainability.

10. Work Packages Integration: Delivering a System

The Greenprint project adopts a systems approach to green estate management by integrating its various Work Packages (WPs). The project analyses each step involved in the Green Estate Management system and trials new, more efficient processes. These processes encompass Hwy Verge Maintenance Strategy (Reduced Cuts, Cut & Collect Processes, Methodology and Logistic, Cut & Collect Technology), Verge Litter Analysis and Management, Biodiversity Optimisation, Green Waste Management, and Converting Green Waste into valuable resources and sequestrate carbon.

Supporting these processes are additional steps introduced for this innovation project, including WP1, WP4, WP6, WP7, WP8, and WP9, which support and promote various work streams. This holistic integration aims to create a sustainable zero-carbon green asset management model, incorporating data analytics, carbon modelling, biofuels, and modern waste treatment to reduce emissions, enhance biodiversity, and optimise costs in managing urban and rural green estates.

11. Priority Areas

In the final year of the project (year 3), we will focus on the following deliverables:

Highways Verges Management:

Our focus will be on confirming the data for all C&C operations to validate Year 2. To support this, we will conduct a large-scale rural C&C trial and explore way of making each process more efficnet finding carbon and cost savings. Additionally, we will implement a two C&C only approach to test the process and machinery. Collaboration with manufacturers will continue to enhance the development of improved lawnmowers. Furthermore, we will extend our practices to other local authorities to broaden the impact of our initiatives.

Biomass Innovations:

In Year 3, the primary focus will be the road deployment test. To support this, we will produce sufficient biochar to meet the requirements set by the University of Nottingham (UoN) for these tests. Additionally, we have engaged with the LL2 North Campus project to conduct bed tests as part of this effort. Furthermore, we will develop a Life Cycle Assessment (LCA) and Techno-Economic Analysis (TEA) to evaluate potential business cases, providing critical insights should the project transition to business-as-usual (BAU) operations beyond its current scope.

Greenprint “How-To” Guide / Behavioural Changes:

The third focus area will be the delivery of the Greenprint document and its dissemination across the industry. For this purpose, we need to assess the attitudes of Local Authority employees towards innovation and risk in these large-scale innovation programs, which aim to cultivate an innovative culture at SGC and WSCC. This shift is essential for addressing challenges such as decarbonisation in an industry traditionally resistant to change. We have observed that the recommendation by Plantlife to reduce verge cuts to two per year is not being implemented yet. At the same time, we need deal with the political risk and evaluate local communities' attitudes towards changes in verge management in supporting core sector challenges like decarbonisation and biodiversity. This will require a clear communication message ahead explaining that reducing verge cuts reduces CO2 emissions and supports biodiversity.

12. Year 3 Plan/Outlook

In Year 3, the project will reach its conclusion, integrating all the processes analysed and developed across various work packages into a single, optimised system. Life Cycle Assessment (LCA) and Techno-Economic Analysis (TEA) will be conducted to assess the viability of the Greenprint.

This phase will mark the completion of all initial Business Case deliverables and the peak of project expenditures as we consolidate all processes. If deemed viable, the outcome will be a comprehensive Business Case supporting the transition from current practices to a fully integrated Greenprint system—enabling biomass conversion and achieving a significant reduction in CO_2

emissions. It will be the year all the engagement and collaboration initiatives will ramp up and Greenprint should see direct application in local authorities interested.

Summary of Year 3 Plan

WP1: Carbon Model Development

- The carbon model will calculate carbon savings from various options considered in WP2 and WP3, reporting results in terms of CO2 reductions and economic benefits.
- The carbon model process will also be shared at the national level (FHRG).

WP2: Cut & Collect Operations and Logistics

- **Expansion of Operations**: We will extend Cut & Collect activities to a neighbouring local authority, East Sussex. The collected biomass will be used for biochar production and road deployment.
- **Rural Operations**: A large-scale Cut & Collect operation will be conducted, preceded by a full litter survey and the introduction of new technology, such as robotic litter collectors.
- **Logistics & Business Case Development**: We will evaluate storage options, depot conversion, use of skips and tractors, and the transport of other biomass sources to develop a comprehensive business case with concrete sites and data.
- **Reducing Verge Cutting Strategy**: Based on work from Years 1 and 2 (including the Plantlife verge management guide and engagement strategies), we will produce a long-term implementation plan.
- **Year 3 other Focus Areas:**
    - **Seasonal Growth Assessment & Data Validation**: Refining data from Years 1 and 2 to optimise cutting schedules.
    - **Efficiency Improvements**: Implementing lessons from Year 2 to improve cutting processes, machinery performance, and staff operations.
    - **Scaling Up Cut & Collect Practices**: Evaluating long-term feasibility and efficiency of large-scale rural operations.
    - **Litter Management**: Exploring and trialling litter removal solutions alongside verge cutting.
    - **Machinery Development & Alternative Fuels**: Testing cutting equipment modifications and using Hydrotreated Vegetable Oil (HVO) as an alternative fuel.
    - **Arisings Utilisation & Biochar Production**: Collecting sufficient biomass for biochar road trials and other applications.
    - **Cost & Logistics Modelling**: Developing a full-scale costing model to support the transition to Business as Usual (BAU).
    - **Final Reporting & Documentation**: Compiling results into a technical report and the Greenprint How-To Guide for future sustainable verge management practices.

WP3: Biochar Production & Scaling

- **Field Trials & Scaling Up**: Expanding biochar production for road deployment and other uses.
- **CAGE Project Participation**: Contributing to new bio-energy developments.
- **BC Model Support**: Conducting Life Cycle Assessment (LCA) and Techno-Economic Analysis (TEA) for Greenprint.
- **Biochar Road Binder & Materials Development and Deployment:**This project investigates the use of biochar as a partial fine aggregate/filler replacement in asphalt mixtures through laboratory testing and road trials.

WP7: Greenprint & Complementary Reports

- Final documentation and reporting to support long-term implementation and policy recommendations.

13. Lessons Learned

Every project presents its own blend of challenges, opportunities, and valuable insights. Converting these into practical lessons learned is a crucial practice for Greenprint that greatly enhances the project success and the potential for others to implement it in their own authorities. A key goal for Greenprint is to be open and transparent with the sector to ensure they can learn and feel safe to take on new innovations.

1. Coordination Efforts with Diverse Stakeholders and Specialists:

Recognising the need for intricate coordination efforts among various stakeholders and specialists.

Developing effective communication and coordination strategies to streamline interface management between workstreams.

2. Adapting to Innovative Approaches / Addressing Resistance to Change

Acknowledging the challenges in departing from traditional approaches for innovative projects is very hard for people who deliver BAU to implement reduced-cut trials. They have a tendency to overthink the political backlash and freeze. Similarly, it is difficult for budget-conscious staff to undertake meaningful trials that have some risk, even for the purpose of demonstrating failure with the intention of improvement.

3. Long-Term Planning and Impact Assessment:

Acknowledging the need for long-term planning and impact assessment, especially in projects with delayed manifestations of benefits.

Developing strategies to capture and monitor comprehensive benefits over an extended period.

Understanding the importance of project duration in capturing ecological shifts and gradual changes in soil fertility.

4. Keep focus on the core deliverables:

This project covers various specialised skills and processes, often completely new or yet to be defined, that need to work together as a system. The risk of losing focus on what is 'in scope' is much higher than usual for projects, and the project manager needs to be very vigilant and keep reminding the stakeholders of their boundaries.

5. Workforce Planning and Recruitment:

Streamlining hiring processes, offering competitive wages, and investing in training programs improve staff retention and adaptability to new equipment.

6. Reducing Equipment Downtime:

Preventive maintenance strategies and adequate spare parts inventory are critical to minimising disruptions. Collaborating with manufacturers can also improve machinery reliability.

7 Enhancing Data Collection and Accuracy:

Standardised data entry protocols and automated validation tools enhance data consistency. Assigning a dedicated data officer improves reliability.

8 Optimising Biomass Processing:

Anaerobic digestion trials revealed challenges in processing grass mixed with food waste. Alternative approaches, including additional storage infrastructure, need exploration.

9 **Community Engagement and Transparency**:

Public involvement increases project acceptance. Publishing schedules and maintaining transparency fosters trust and participation

14. Conclusion

The Year 2 progress report highlights the significant advancements made across the Greenprint project despite facing procurement delays initially, operational constraints, and the complexities of implementing innovative approaches. The project has successfully scaled up cut-and-collect operations, refined carbon modelling methodologies, and advanced biomass processing trials, laying the groundwork for long-term sustainable management of green estate infrastructure.

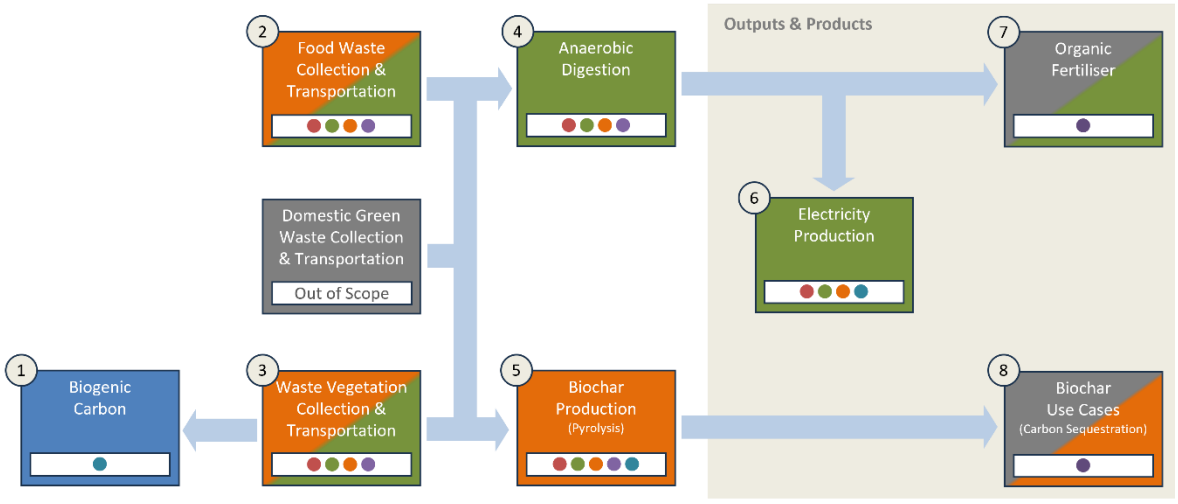
These achievements demonstrate the project's resilience and the effectiveness of proactive project management in adapting to challenges. Collaboration between local authorities, industry partners, and research institutions has been instrumental in ensuring continued progress. The lessons learned from trials and stakeholder engagement efforts will be crucial in refining methodologies and informing best practices for future applications in the final Greenprint document.

As the project moves into Year 3, the focus will shift toward consolidating findings, optimising operational efficiencies, and validating the feasibility of biomass innovations through a road deployment trial. Key priorities include scaling up biochar production for road trials, expanding anaerobic digestion applications, integrating refined carbon accounting practices, collaborating with LL2 projects and other local authorities and producing the Greenprint. These efforts will be essential in translating project insights into scalable, real-world solutions that can drive sustainable transformation across the UK’s local authority green estate management practices.

In conclusion, while challenges remain, the project is on track to successfully achieve its objectives within the original budget. Through ongoing collaboration, knowledge sharing, and innovation, Greenprint is well-positioned to make a lasting impact on sustainable verge management and contribute meaningfully to the broader decarbonisation agenda. However, the Business Model we develop for the full-scale application of Greenprint in WSCC and SGC should validate its theoretical framework and highlight the economic viability of a business-as-usual (BAU) solution.

Appendix A: WP1_Carbon Route

Live Labs II: Carbon Assessment Route Map (West Sussex & South Gloucestershire) v11.3



- **People** (Commuting, Home Working & Business Travel*)
- **Premises & Sites** (Combusted Fuels / Energy Use*)
- **Vehicles & Plant** (Embodied Carbon & Fuels / Energy Use*)
- **Purchased Products & Services** (Business Change, Future Operations & Transportation As A Service*)
- **Carbon Offsetting & Sequestration** (Including Energy To Grid*)

*Additional, Live Labs II specific, above baseline.

- Global Process
- Out Of Scope
- West Sussex
- South Gloucestershire

Appendix B: WP2_WBS

LL2_GREENPRINT_SPRINTS PLANNING

URBAN MOVEMENTS AND SPACES ENGINEERING MANAGEMENT

TASK NAME	PROJECT MANAGER	START DATE	END DATE	OVERALL PROGRESS	PROJECT DELIVERABLE	Core deliverables 2.A and 5
WP2 Intermediary Deliveries Y1	JCC			0%	SCOPE STATEMENT	"Review and restructure the operation for Highway verge management with the view to Whole Life Cycle management including: Regime, technologies, and processes" - "Improve bio-diversity and reduce carbon"

At Risk?	TASK NAME	FEATURE TYPE	RESPONSIBLE	STORY POINTS	START DATE	END DATE	DURATION in days	STATUS	PRIORITY	ON TARGET	COMMENTS
	Develop a Strategy for Reduced Cut Regime										
No	Read and Understand Plantlite "Managing Grassland Road Verges" document		WSCC HWS		01/05/2024	05/05/2024	5	Complete	Medium	No	Can be used as reference in the strategy but must be agreed with Michele and Politicians before
No	Seek and analyse return of experience from other counties in reducing and changing verge management		WSCC HWS / Steve Hill		01/05/2024	05/05/2024	5	Complete	Medium	No	there is a wide range of experiements by other local authorities. The link tpo the summary (non exhaustive) is here
No	Analyse SNDP and Paint-pierce Hurst experiments and draw conclusions		WSCC HWS		10/05/2024	15/05/2024	6	Complete	Medium	No	No change in the soil and biodiversity observed probably because the experiment needs to extend longer. Contractor needs to extrapolate information regarding carbon footprint
No	Engage with Grasstex (contractor)and seek their experience and support)		WSCC HWS		01/05/2024	15/05/2024	15	Complete	Low	Yes	Grasstex are now fully onboard
Yes	Class the parishes as red/amber/green in term of support for reduced cut regime		WSCC HWS / Steve Hill		20/04/2024	31/05/2024	42	In Progress	High	No	
No	Identify sites with high biodiversity, and adjusting harvesting schedules to match, linking to local plans for Green Infrastructure and local nature recovery plans.		WSCC HWS / Steve Hill / WSCC Ecologist		20/04/2024	31/05/2024	42	Complete	Medium	No	
No	Develop a long term Change in Cut Regime Strategy for Rural and Urban with a variety of options, and including: the proposed number of Cuts, starting size for Y2, proposed expansion strategy, trials, etc....		WSCC HWS		15/04/2024	31/05/2024	47	Complete	High	No	**Y1 INTER MEDIARY DELIVERABLE 1** (use Draft LL2 GREENPRINT 2_REDUCED CUT STRATEGY OUTLINE STRUCTURE) This strategy aims to bring long-term changes in cutting operations with THE FOCUS IS ON CARBON REDUCTION. the immediate objective is to support Y2 scaling up the Cut & Collect regime in areas chosen with the Grasstex. Grasstex will seek areas to trials representative of the county's various topography and other constraints, so as to make Y2 less bias for testing machinery and processes/logistic
No	Develop a "Change of Mind " strategy		Steve Hill		01/11/2023	30/09/2024	335	Complete	High	Yes	**Y1 INTER MEDIARY DELIVERABLE 2** (use Draft 2 Community Engagement Outline)
Yes	Get the Change in Cut Regime + Change of Mind strategies endorsed by SRO and Political		WSCC HWS		01/10/2024	01/12/2024	62	In Progress	High	No	
No	Implement Change of Mind Strategy (See Steve Hill document for further details)		Steve Hill		01/01/2025	31/12/2025	365	Needs Review	Medium	Yes	This should start in areas agreed with Grasstex for Y2 with consideration to the
	Cut & Collect Processes and Logistic										
No	Baseline and analyse the current mowing processes (Whole Life Cycle) for Urban and Rural areas		WSCC HWS /GRASSTEX		01/11/2023	31/05/2024	213	Complete	High		
No	Collect and analyse the Y1 and Y2 data from the operational Cut & Collect team		WSCC HWS /GRASSTEX		01/11/2023	31/10/2024	366	Complete	High		
No	Compare costs and carbon footprint against conventional grass cutting operations		WSCC HWS /GRASSTEX		01/11/2023	30/11/2024	396	Complete	Medium		
No	Draft options of the various possible scenarios for optimising the processes for Cut & Collect (whole Life Cycle) broken into comparable and observable parts for monitoring and evaluation ease. For Rural and Urban areas		WSCC HWS /GRASSTEX		01/11/2023	31/05/2024	213	Complete	High		
No	Define criterias and ranks options according to feasibility.		WSCC HWS /GRASSTEX		15/12/2023	15/06/2024	184	Complete	Medium		
No	Agree with Client which Proces optimisation options should be tested in Y2 and Y3		WSCC HWS /GRASSTEX					Complete	Medium		
Yes	Define trials' protocols and data to be recorded and monitored during the trials		WSCC HWS /GRASSTEX		15/12/2023	15/02/2024	63	Complete	High		**Y1 INTER MEDIARY DELIVERABLE 3** (use Cut & Collect Technology and Logistic Experiments Plan)
No	Liaise with Steve Hill and define which areas to implement trial Y2		WSCC HWS /GRASSTEX		15/12/2023	03/01/1900	-45271	Complete	High		
No	Investigate AD or composting options for the cuttings in Y2 and Y3		WSCC HWS /GRASSTEX		15/01/2024	31/05/2024	138	Complete	Medium		
No	Implement trials Y2 in areas where the Change of Mind strategy and communication has been ongoing		WSCC HWS /GRASSTEX		01/04/2024	30/10/2024	213	Complete	Low		
	Cut & Collect Technology										
No	Gather lessons learned during Y1 machinery increased usage		WSCC HWS /GRASSTEX		01/11/2023	31/10/2023	0	Complete	High		
No	Investigate / Evaluate cutting and transporting types of equipment on the market with the view for Y2 expansion (Urban and Rural)		WSCC HWS /GRASSTEX		01/11/2023	31/12/2023	61	Complete	High		
Yes	Test a range of technologies for cutting, collecting and transporting verge biomass that would be suitable for Y2 increased operation and changes of processes		WSCC HWS /GRASSTEX		01/04/2023	30/10/2023	213	Complete	High		
Yes	Define and agree which equipments (lawn mower and others) will be purchased in Y2 according to the processes to be trialed and commercial preferences		WSCC HWS /GRASSTEX		01/12/2023	31/12/2023	31	Complete	High		**Y1 INTER MEDIARY DELIVERABLE 4** (use WSCC Rural Cuts_Inventory and preselection of machineries documents)
Yes	Establish procurement route and cost estimate for equipment -		WSCC HWS /GRASSTEX		01/12/2023	31/12/2023	31	Complete	High		
Yes	Order equipments for delivery in March 24 at the latest's. Renew lease/purchase vehicles for crew one in preparation for year 2		WSCC HWS /GRASSTEX		15/01/2024	15/01/2024	1	Complete	High		**Y1 INTER MEDIARY DELIVERABLE 5**
Yes	Convert Depot for new Cut & Collect operation		WSCC HWS /GRASSTEX		01/02/2024	31/03/2024	60	Complete	Medium		
No	Set up and train second team of operators		WSCC HWS /GRASSTEX		01/03/2024	30/03/2024	30	Complete	Low		
	Verge Litter Analysis and Management										
Yes	Consider the impact of verge litter and how to remove it: current processes for collection, technologies for removal and separation, designation as waste stream, implications for licensing and transport, and downstream processing.		SGC HWS		01/02/2024	31/05/2024	121	Overdue	High	Deadline Passed	
	Bio-diversity Optimisation - Support WP5 Trials										
No	Check Plantlite shortlist of sites and agree with them and Steve Hill the final sites		WSCC HWS / GRASSTEX / Plantlite / Steve Hill		01/11/2023	31/12/2023	61	Complete	High		
No	Engage with Parishes and Implement Change of Mind Strategy (See Steve Hill document for further details)		Steve Hill / WSCC HWS		31/01/2024	30/10/2024	274	Complete	High		
No	Undertake highways Stat research		WSCC HWS		01/12/2023	31/01/2024	62	Complete	High		**Y1 INTER MEDIARY DELIVERABLE 6**
No	Provide support for Plantlite to setup samples collection on highways		WSCC HWS		31/01/2024	25/02/2024	26	Complete	Medium		
No	Provide support to Plantlite to mark and protect trials perimeters		WSCC HWS		25/02/2024	30/10/2024	249	Complete	Low		
	Co2 monitoring WP1										
Yes	Provide support to WP1 in providing all data related to carbon impact for the current operation for Baseline		WSCC HWS		01/12/2023	31/01/2024	62	Complete	High		**Y1 INTER MEDIARY DELIVERABLE 7**
No	Provide support to WP1 in providing all data related to carbon impact for trialed and tested restructured operation for Cut & Collect		WSCC HWS		01/04/2024	30/11/2024	244	Complete	Low		
	Produce Y1 report for WP2										
Yes	Draft report Structure		JCC		01/11/2023	05/11/2023	5	Complete	High		
Yes	Produce WP2 report for Y2		WSCC HWS / GRASSTEX / Steve		01/12/2023	15/02/2024	77	Complete	Medium		**Y1 INTER MEDIARY DELIVERABLE 8** (use WP2 Year 1 Report (structure))
Yes	Correlate report with SGC		AMEY		01/12/2023	28/02/2024	90	Complete	Medium		
Yes	Integrate report in Y2 Greenprint Project Whole Life Cyle		AMEY		01/03/2024	30/03/2024	30	Complete	Low		

Appendix C: Photos

Several members of the team in West Sussex viewing the demo of some new equipment.


Kubota

The team visit the Ricardo Plant


ISEKI
SF450
ISEKI