

Live Labs 2: Greenprint

Current Carbon Baseline for Verge Maintenance Operation for comparison with Cut-&-Collect Carbon Trials Plus Carbon Targets

West Sussex County Council & South Gloucestershire Council
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A carbon negative systems model for green infrastructure management



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1. Introduction

As referenced in the OBC, Greenprint will test a sustainable and replicable model for local authorities, transforming the role and value of the highway's green asset, and enable highways, waste, and other service functions to work together in synergy to deliver environmental, and social value benefits at insignificant cost, while reducing carbon emissions (Figure 1).

This report is a live and continuously improving document. It provides an initial operational carbon baseline as well as carbon targets going forward.

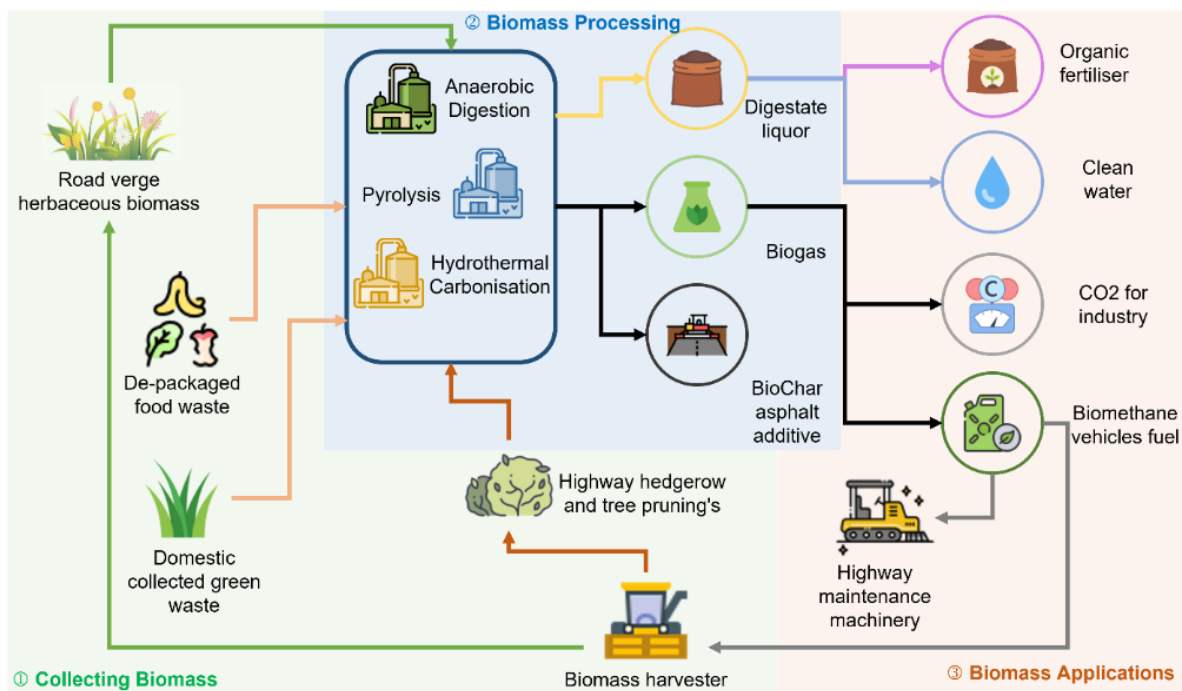
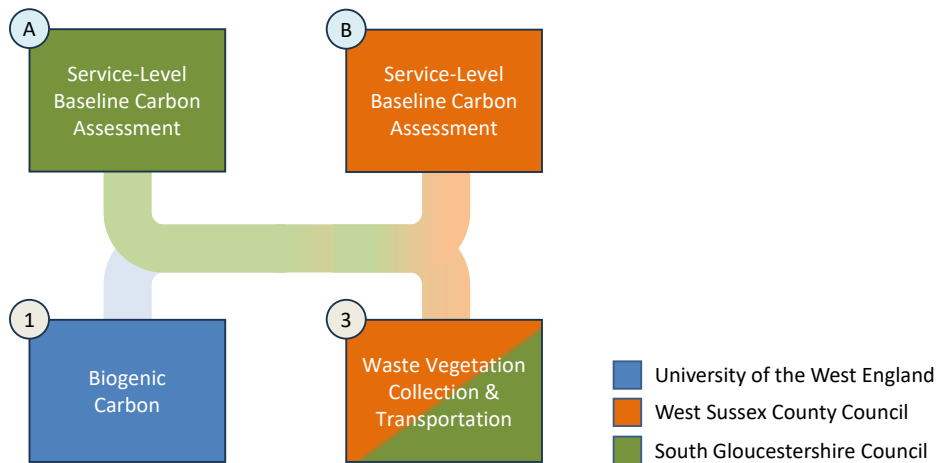


Figure 1: Greenprint Green Estate Model

The baseline carbon assessments for the Greenprint Live Labs II (LL2) project are comprised of four components. These are illustrated in Figure 2.

Figure 2: Baseline Carbon & Environmental Assessments



Steps 1 and 3 refer to the baseline environmental and carbon assessments in the Greenprint Carbon Assessments Map in Appendix A.

Table 1: Baseline Assessments

A & B	Service-level carbon assessments.
	This provides the service-level carbon context for the two participating authorities, West Sussex County Council (WSCC) and South Gloucestershire Council (SGC). This is a critical step in assessing the carbon benefits of the LL2 projects relative to carbon emissions of other aspects of highway's services.
1	Baseline biogenic carbon assessments.
	A key consideration of the project is the environmental impact of removing grass cuttings for use in anaerobic digestion processes and / or the production of biochar. Stage 1 Soil Biomass (Biogenic Carbon) of the Live Labs II: Greenprint Carbon Assessment Route Map focuses solely on verge-side biogenic emissions. Biogenic carbon storage and sequestration is investigated in a separate report.
3	Baseline assessment for Waste Vegetation Collection & Transportation.
	Waste vegetation, in the form of grass cutting and collection, is the only aspect of the project where a current process is being changed; from a "cut and leave" (C+L) to a "cut and collect" (C+C) process. This document provides a description of the baselining method, data points, and the carbon profiles created for the sample sites.

This document serves as an appendix to the service-level carbon assessments that were submitted in July 2024. The Biogenic baseline carbon report is submitted separately.

All the other stages of the project route map are newly designed for Greenprint and therefore do not have in-situ processes to evaluate. In these cases, carbon profiles are currently being developed for the experimental stages using similar methods and tools.



2. Assessment Framework

As outlined in the OBC, a consistent assessment framework has been developed for all stages of the Greenprint project, illustrated in Appendix A. This framework is applied at key waypoints to assess the project, with a particular emphasis on carbon. These assessments include the following high-level considerations:

- 1. Stage name.**
- 2. Process / stage description.**
- 3. Performance indicators (key metrics).**
- 4. Stage dependencies and interdependencies.**
 - a. Identifying the network of dependencies within the wider project.
- 5. Risks and barriers to implementation, assessing:**
 - a. Risk class (See Appendix B, **Error! Reference source not found.**).
 - b. Risk probability.
 - c. Impact of risk on the project and the service.
- 6. Summary of process and business changes.**
 - a. Required for experimentation and future options.
- 7. Business change costs.**
 - a. Process changes,
 - b. Staff changes (capacity and skills),
 - c. Vehicle and equipment changes,
 - d. Structural changes (infrastructure),
 - e. Procurement and contractual arrangements.
- 8. Current and projected operating costs.**
 - a. Staff and contractors.
 - b. Vehicles and plant.
 - c. Combusted fuels and energy.
- 9. Barriers to adoption and wider implementation.**
 - a. Based on the lessons learned.
- 10. Carbon profile (baseline), including carbon considerations for all GHG categories, across all lifecycle stages¹, where these apply.**
 - a. See Appendix B (Table 1).
- 11. Carbon profile (experiment and at key waypoints).**
 - a. Reassessing the metrics identified during previous assessment(s) to monitor changes, progress and shortfalls.
- 12. Collateral benefits and dis-benefits.**
 - a. High level benefits analysis, identifying the additional benefits and / or dis-benefits of the changes processes.

A sample of the assessment framework (the Excel proforma workbook) is included in Appendix C.

¹ Where these are applicable and measurable.



3. Vegetation Collection & Transportation (Stage 3)

Currently, most Local Highways Authorities (LHAs), including WSCC and SGC, operate C+L grass cutting processes. The Greenprint project explores the implementation of C+C processes in South Gloucestershire and West Sussex to provide feedstock for the two LL2 experiments:

1. **The production of electricity and organic fertiliser from anaerobic digestion (AD), and,**
2. **The production of biochar for long-term carbon sequestration and as a construction material – delivered from HTC and/or pyrolysis.**

3.1. Trial Sites Selection

The trial sites for C+C chosen by WSCC and SGC were selected based on the following criteria:

1. **Sites diversity (to ensure a representative sample).**
2. **Site accessibility (for the purposes of sampling and observation).**
3. **Historical site data availability (grass cutting).**
4. **Partner(s) engagement and willingness to support the LL2 project.**
5. **Grass cutting sequences alignment with the LL2 project timings.**

Grass cutting is highly variable in terms of cost and carbon emissions generated. This is due to changeable weather and ecological conditions that impact the difficulty of mowing and the speed of grass growth. With this in mind, baseline sites were selected due to their proximity to experimental sites. They have also been chosen for their similar features in terms of terrain and size, providing greater accuracy when comparing sites. Moreover, collecting data from both baseline and experimental sites at the same time of year yields a more accurate comparison between C+L and C+C processes.

The baseline sites selected represent areas that meet this criterion, providing greater assurance when comparing across the year.

To best demonstrate the carbon baseline compared with the experimental sites, six have been selected:

1. **SGC:**
 - a. Doddington – Baseline Measurement
 - b. Yate – Experimental Measurement
2. **WSCC:**
 - a. Worthing – Baseline Measurement
 - b. Aldwick, Bersted & Pagham (grouped for practical reasons) – Experimental Measurement

All data for all sites has been normalised for a standard unit of 1,000 m² of grass cutting. This ensures greater accuracy in comparing across the various sites.

3.2. Data Collection

The methodology for the collection of data for both the C+L and C+C profiles was agreed jointly between WSCC and SGC. Operatives carrying out verge maintenance activities were required to record key data sets that would be used to feed into the FHRG model. This data was captured during operational days and subsequently input into a central spreadsheet.

- Mileages, labour hours and fuel consumption were recorded at the start and end of each operational day.
- Some assumptions were applied in relation to the operational use of trimmers - as the precise 'trigger time' for this item of plant was not known.
- Dedicated gangs were tasked with recording the data in real time, to ensure a consistent approach and eradicate the possibility of capturing data not related to the activities under study.
- Regular feedback at the end of each cut day, along with weekly project meetings were used to sense check and monitor progress with data collection and quality assurance purposes.
- Both councils employ a nominated project team member to input all data to ensure a consistent approach.

4. Baseline Carbon Profiles: Cut & Leave (C+L)

Using data collected from the C+L processes for the trial sites, the following baseline carbon profiles have been developed:

4.1. C+L Baseline Site: Worthing (WSCC)

- **Site Area: 246,150 m²**
- **Sample Size: 5 cuts over 12 months.**
- **Total Sample Size: 1,230,750 m²**
-

Table 2: Worthing Baseline Carbon Profile (Per 1,000m²)

ID	Category	Description	Unit Of Measure	Per 1000 m ²	Emission Factor	Total kgCO ₂ e	Cost Per UoM (£)	Data Confidence
1	Combusted Fuels	Diesel for Plant Transportation	litres	0.7434	3.2856	2.4427	£ 0.96	Medium-High
2	Services	Resource Days (Staff & Contractors)	operative.day	0.1219	2.3360	0.2847	£ 15.84	Medium-High
3	Combusted Fuels	Diesel for Mowers	litres	1.8282	2.9517	5.3961	£ 2.52	Medium-High
4	Combusted Fuels	Petrol for Strimmers	litres	0.2275	2.9517	0.6715	£ 0.29	Medium
5	Combusted Fuels	Strimmer 2-Stroke Oil	litres	0.0046	3.1443	0.0143	£ 0.02	Medium-Low
Totals Per 1000 m²						8.8093	£ 19.64	

4.2. C+L Baseline Site: Doddington (SGC)

- **Site Area: 254,010 m²**
- **Sample Size: 9 cuts over 12 months.**
- **Total Sample Size: 2,286,090 m²**

Table 3: Doddington Baseline Carbon Profile (Per 1,000m²)

ID	Category	Description	Unit Of Measure	Emission Factor	Total kgCO ₂ e	Cost Per UoM (£)	Data Confidence
1	Combusted Fuels	Diesel for Plant Transportation (Class III LGV)	miles	3.2856	0.8537	£ -	Medium-High
2	Services	Resource Days (Staff & Contractors)	operative.day	2.3360	0.1517	£ 10.26	Medium-High
3	Combusted Fuels	Diesel for Mowers	litres	3.2856	2.8289	£ 1.21	Medium-High
4	Electricity	Energy for Strimmers (Rechargeable Battery Packs)	kWh	0.2749	0.0143	£ -	Medium
Totals Per 1000 m²					3.8486	£ 11.48	



5. Target Carbon Profiles

Carbon profiles have been developed to assess the costs, operational performance changes, and carbon impacts of the proposed changes required for C+C. These are detailed below.

5.1. C+C Trial Sites: Aldwick, Bersted & Pagham (WSCC)

- **Site Area: 191,235 m²**
- **Sample Size: 5 cuts over 12 months.**
- **Total Sample Size: 764,940 m²**

Table 4: WSCC, Aldwick, Bersted & Pagham: Target Carbon Profile (Per 1,000m²)

ID	Category	Description	Unit Of Measure	Per 1000 m ²	Emission Factor	Total kgCO ₂ e	Cost Per UoM (£)	Data Confidence
1	Combusted Fuels	Diesel for Plant & Recyclate Transportation	miles	3.9899	3.2856	13.1092	£ 5.15	High
2	Services	Resource Days (Staff & Contractors)	operative.day	0.2249	2.3360	0.5253	£ 30.85	High
3	Combusted Fuels	Diesel for Mowers	litres	3.4480	2.9517	10.1773	£ 4.76	High
4	Combusted Fuels	Petrol for Strimmers	litres	0.4471	2.9517	1.3197	£ 0.62	High
5	Combusted Fuels	Strimmer 2-Stroke Oil	litres	0.0056	3.1443	0.0175	£ 0.02	Medium
Totals Per 1000 m²						25.1489	£ 41.40	

5.2. C+C Trial Sites: Yate (SGC)

- **Site Area: 128,629 m²**
- **Sample Size: 4 cuts over 12 months.**
- **Total Sample Size: 514,516 m²**

Table 5: SGC: Yate: Target Carbon Profile (Per 1,000m²)

ID	Category	Description	Unit Of Measure	Emission Factor	Total kgCO ₂ e	Cost Per UoM (£)	Data Confidence
1	Combusted Fuels	Diesel for Plant Transportation (Class III LGV)	litres	3.2856	1.9091	£ 0.81	High
2	Services	Resource Days (Staff & Contractors)	operative.day	2.3360	0.4631	£ 41.58	High
3	Combusted Fuels	Diesel for Mowers	litres	3.2856	5.7630	£ 2.46	High
5	Electricity	Energy for Strimmers (Rechargeable Battery Packs)	kWh	0.2749	0.0436	£ -	Medium
Totals Per 1000 m²					8.1788	£ 44.84	

5.3. Caveats

There is a high degree of variability in the rate of grass growth between years and seasons. Therefore, whilst the baseline provides an accurate reflection of carbon and cost incurred for the year 2024, it should be taken into consideration that this is not directly representative of future years.



6. Scaled Baseline and Experimental Profile Figures

6.1. SGC & WSCC Baseline Figures:

To scale the figures above, the subsequent tables highlight the total carbon impact of SGC and WSCC’s C+L baseline operations over total area of grass maintained by each council.

Table 6: Scaled Operational (C+L) Baseline Figures

	Ha	1000m ²	kgCO ₂ e / 1000m ²	Total kgCO ₂ e
SGC	473	4739	3.8	18008
WSCC	400	4000	8.8	35200

6.2. SGC & WSCC Cut and Collect Experimental Profile Figures:

Likewise, the below table scales up the carbon impact of the Greenprint (C+C) approach to grass maintenance to represent emissions over the entirety of grass area maintained by SGC and WSCC.

Table 7: Scaled C+C Carbon Profile Figures

	Ha	1000m ²	kgCO ₂ e / 1000m ²	Total kgCO ₂ e
SGC	473	4739	8.2	38386
WSCC	400	4000	25.1	100400

7. Assumptions made when scaling baseline

It is important to note the caveats and limitations in relation to figures presented in scaling baseline and experimental profile figures.

Baseline data was collected from defined patches within each council area at a single point in the year. This data was scaled up to estimate emissions figures for the rest of the council’s grass cutting operations. However, it is important to note, across each local authority area, there is variability in sites, soil fertility and terrain as well as seasonal variations in weather, impacting grass growth rates. All of which could have an impact on time taken to cut grass, the volume of grass arisings collected, machinery capabilities, fuel consumption and the amount of labour associated with delivering the service. Baselining data will continue to be collected into Year 3 of the project to build a mean and level out potential variations.

These scaled figures assume that identical mowing equipment will be used across all sites, fuel consumption rates remain consistent across different terrains and soil conditions, efficiency and



productivity of the workforce is maintained across all sites, and transportation mileage between mowing locations and depots are similar. However, this may not be wholly representative of reality when C+C operations are scaled.

8. Conclusion

In conclusion, Greenprint continues to progress ambitious carbon reduction goals and ensures carbon is at the heart of every decision. Baseline figures outlined in this document suggest that operational carbon emissions associated with the Greenprint C+C approach are greater than baseline C+L emissions. However, this data is representative of only one stage in the project route map (Stage 3, Appendix A) and should be considered holistically alongside other stages of the route map as the project progresses. For example, potential emissions savings could be achieved from biogenic carbon, fugitive emissions, AD and Pyrolysis/HTC processes and possible reduction in grass cutting frequency as soil fertility is reduced.

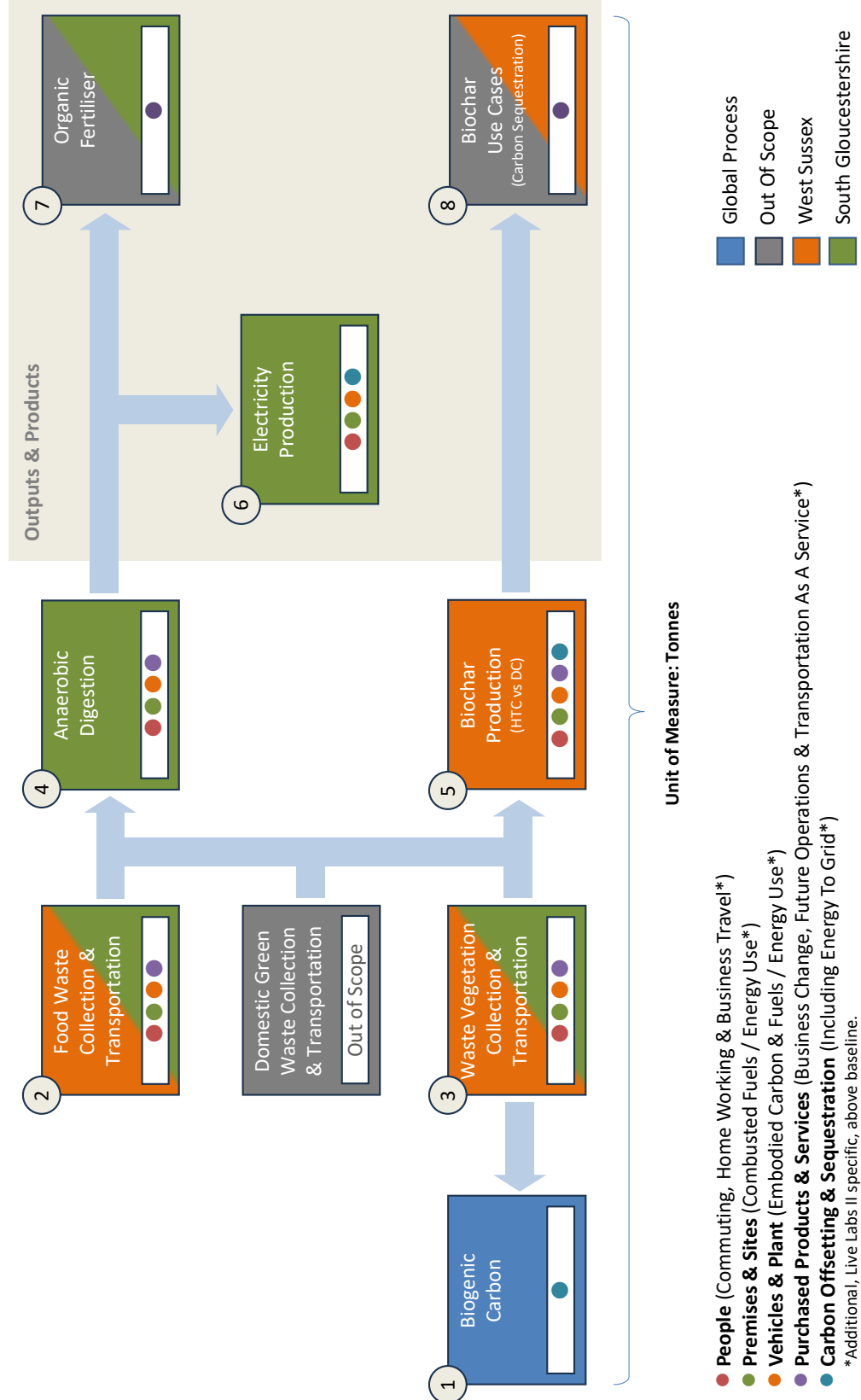
Figures presented in this document are indicative and are likely to be revised as greater confidence around operational data is achieved. Therefore, this live document is subject to continuous development over the life of the Greenprint project.



9. Appendix

9.1. Appendix A: Greenprint Assessments Map

Version 11.3





9.2. Appendix B: Emissions Source Classifications

Table 6: Emission Source Classifications

Emission Source	In Scope
Combusted fuels (including diesel, petrol, gaseous fuels, biofuels).	Yes
Fugitive emissions (for decomposing vegetation and AD plant).	Yes
Heating and cooling (scope 2 emissions, where applicable).	Yes
Electricity (scope 2, where not sourced from the AD plant).	Yes
Services (scope 3, from supply chain partners).	Yes
Materials (where applicable).	TBD
Travel (staff and contractor commuting and business travel).	Yes
Transportation (of materials, plant, recyclates and waste).	Yes
Waste (to landfill or incineration).	No
Traffic (out-of-scope for this project).	No
Sold goods and services (in scope for stages 7 and 8).	TBD
Investments (out-of-scope for this project).	No
Leases and franchises (out-of-scope for this project).	No
End of life (out-of-scope for this project).	No
Water (use and sewerage).	Yes
Other emissions sources.	TBD

9.3. Appendix C: Sample Stage Proforma

Figure 3: Excel Proforma Workbook v4.5

Stage Name									
Example Stage: Vegetation Waste Collection & Transportation									
Stage Description									
This is an example of a completed profile.									
Key Stage Dependencies & Interdependencies									
1	Collection & Distribution Vehicles								
2	Collection & Distribution Staff								
3	Additional Staff Training								
4	Increased Waste Storage Facilities (Depot)								
5	Vehicle Upgrades (Vegetation Capture & Storage)								
Key Stage Risks									
Description	Class	Probability	Impact						
1 Vehicle Capacity	Business Change	Medium	Medium-High						
2 Reduction in Cuts / Collections Per Day (Process Throughput)	Timescales Escalation	Medium-High	High						
3 Safety Impact of New Equipment	Health & Safety	Medium-Low	High						
Collateral Benefits & Disbenefits									
Description	Class	Scale							
1 Increased Cost of Operations (Dis-Benefit)	Reduce Costs	Strongly Negative							
2 Variability Of Yield (Based On Seasons / Weather, Dis-Benefit)	Increase Efficiency	Strongly Negative							
3 Variability Of Feedstock Quality (Dis-Benefit)	Increase Effectiveness	Negative							
4 Process Efficiency (Dis-Benefit)	Increase Efficiency	Unknown							
5 Market Value of Feedstock (Dis-Benefit)	Increase Revenues	Unknown							
6 Cost of Equipment / Vehicle Changes	Reduce Costs	Negative							
7 Impact on Biodiversity (Dis-Benefits)	Other	Unknown							
Carbon & Cost Analysis (Baseline, Where Applicable)									
Per 500m2									
Category	Description	Unit Of Measure (UoM)	Quantity	UoM Adjustment	Emission Factor	Total kgCO2e	Cost Per UoM (£)	Confidence	
1	Transportation	Fuel for Vehicles (Waste Collection)	litres	48	1	0.3460	16.6080	£ 1.44	Medium-High
2	Combusted Fuels	Fuel for Plant	litres	16	1	0.2884	4.6144	£ 1.36	Medium-High
3	Services	Vehicle Crew (*2)	operative.day	1	2	1.7700	3.5400	£ 96.60	High
Carbon & Cost Analysis (Experiment)									
Category	Description	Unit Of Measure (UoM)	Quantity	UoM Adjustment	Emission Factor	Total kgCO2e	Cost Per UoM (£)	Confidence	
1	Transportation	Fuel for Vehicles (Waste Collection)	litres	71	1	0.3460	24.5660	£ 1.44	Medium-High
2	Combusted Fuels	Fuel for Plant	litres	30	1	0.2884	8.6520	£ 1.36	Medium-High
3	Transportation	Fuel for Transport From Depot to Processing	litres	11	1	0.6574	7.2314	£ 1.44	Medium-High
4	Services	Vehicle Crew (*2)	operative.day	2	1	1.7700	3.5400	£ 96.60	High