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FOOD WASTE COLLECTION AND TREATMENT STRATEGY

Environmental and sustainability solutions provided to

LIVERPOOL CITY REGION WASTE & RESOURCES PARTNERSHIP

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CONTENTS

EXECUTIVE SUMMARY

Context

The Environment Act 2021 introduces a requirement for all local authorities in England to provide a separate weekly collection of food waste to all households within their administrative area. The majority of authorities within the Liverpool City Region Strategic Waste Management Partnership ("the Partnership") area do not presently collect food waste with the exception of St Helen's Council. Following the 'simpler recycling' consultation response from the UK Government in October 2023, five of the six Partnership authorities now need to introduce a food waste collection service by 31st March 2026. With a wide range of variables determining how this requirement may be met across the Partnership, a strategy is required to realise the strategic goals of the Environment Act, and to deliver a best value service for Merseyside.

Project requirement

WRM, a specialist waste management consultancy with a particular specialism in food waste recycling, were appointed in April 2024 to develop a strategy for meeting the Environment Act requirement for food waste collection. The overall brief for the commission was:

> *To develop a strategic view of long-term options for optimised food waste collection and treatment and interim measures designed to offer Environment Act 2021 compliant solutions whilst transitioning to future state/operating model*.

Two central research questions were established as part of this brief which were to firstly understand what constitutes= a fully optimised food waste system for Merseyside; and then, to understand how the Partnership can transition from its current position, through interim arrangements to a future long term food waste recycling service.

This project, which was delivered between April 2024 and August 2024, included an initial project briefing paper, development and evaluation of options and quantitative modelling; all of which have informed the preparation of this report and a presentation made to Partnership Officers in July 2024.

Option identification and development

The work has identified and developed strategy options which are broadly categorised into waste collection options and waste treatment options. The waste collection aspect drew upon previous collection work commissioned by the Partnership which had established the broad parameters for food waste collection, all of which are in line with WRM expectation.

The main variable to be explored within the waste collection category is the type of fuel used in the collection fleet. This included diesel as the current fuel and therefore baseline, hydrotreated vegetable oils, and biomethane. The latter is of particular interest to the project brief as biomethane fuel can be produced by anaerobic digestion treatment of collected food wastes.

In the waste treatment category, anaerobic digestion is the established technology for recycling food waste and is also advocated as the preferred option within the Environment Act. This treatment option also benefits from fiscal incentives and the opportunity for adjacencies including carbon capture and use/storage (CCUS). With a clear technology for treating food waste, the strategy options have focused on the delivery models with options including utilisation of merchant capacity including capacity provided in the wastewater sector, and options for the Partnership to purchase and receive energy outputs back from a contractor(s). The northwest of England presently has an acute capacity shortage for merchant anaerobic digestion treatment and so options for the development of new capacity for the dedicated use of the Partnership was therefore included as an option.

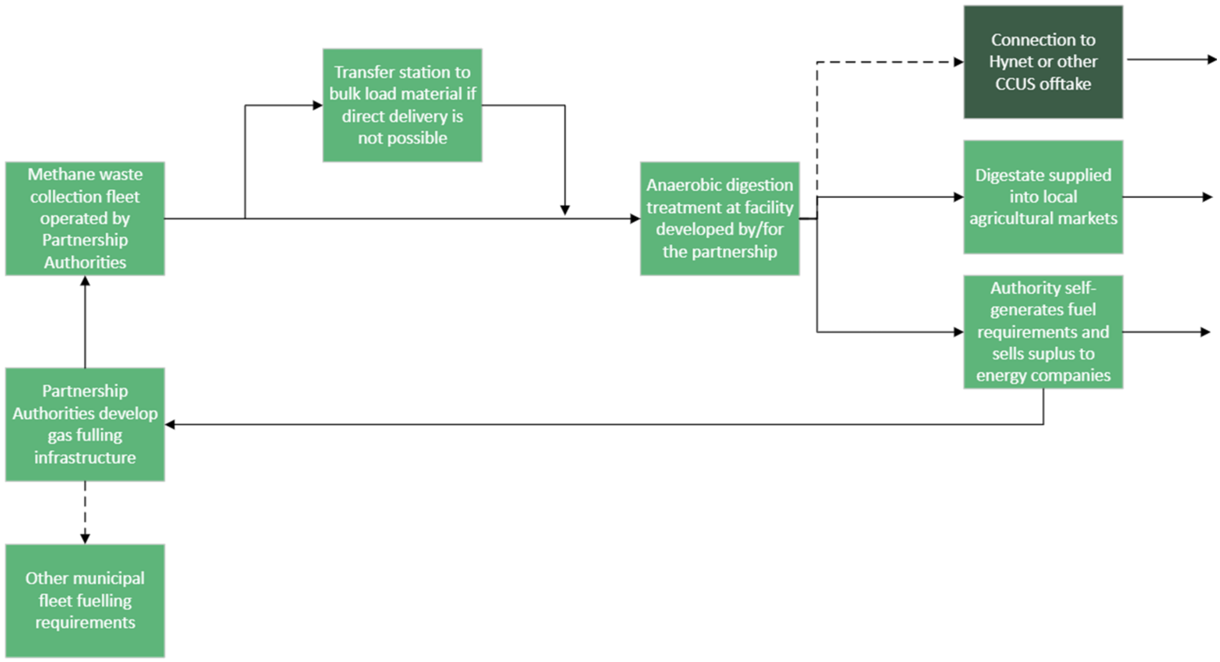
A range of variables in each option have been accommodated through the preparation of option matrices that define 3 short term and 18 long term options. A process of shortlisting was undertaken to screen out options that were undeliverable and/or unrealistic with cost and carbon modelling then applied to quantify the merits of each option. The assessment of options has also qualitative scoring using criteria that have been developed to reflect the strategic priorities of the partnership.

Conclusion and recommendations

The project has provided a structured approach to identifying the optimal food waste recycling option for the LCR Partnership. This found that option 15, which involves the development of dedicated anaerobic digestion treatment capacity within the LCR region and the use of a portion of the generated biomethane in the vehicle fleet, is the preferred option from a financial perspective, and also in all three qualitative scenarios which were developed to reflect the strategic priorities of the Partnership. A summary of how this option compares to other considered scenarios is presented overleaf.

Option	Financial		Strategic & Quality					
	Total price per tonne of food waste treated		1. Even Apportionment		2. Capacity certainty with even apportionment of other criteria		3. Local treatment capacity that delivers environmental adjacencies	
	Price (£/t)	Rank	Weighted score	Rank	Weighted score	Rank	Weighted score	Rank
1	£198.70	5	42%	8	40%	9	42%	9
3	£192.88	2	67%	3	73%	3	67%	3
4	£209.61	8	42%	8	47%	7	47%	8
7	£203.07	6	50%	6	47%	7	52%	7
9	£197.25	4	75%	2	80%	2	77%	2
10	£213.98	9	46%	7	50%	6	55%	6
14	£196.74	3	67%	3	60%	4	63%	4
15	£190.92	1	92%	1	93%	1	93%	1
17	£207.65	7	50%	5	53%	5	60%	5

The structure of the preferred long-term strategy option is illustrated below with development responsibilities for the Partnership being identified in mid-green, and the development responsibilities of the private sector being identified in dark green.



Recommended next steps

The identification of this preferred option enables a number of recommendations to be made on how the Partnership can progress to meets its Environment Act obligations. These recommendations, which are detailed in the closing section of the report, set out as a series of practical actions to progress the project, including:

- Collection vehicle and container procurement;
- Gas fuelling infrastructure feasibility and delivery;
- Confirmation of interim approach with the incumbent contractor;
- Site/land search for the development of the facility and obtaining necessary permissions and consents;
- Confirm the funding approach;
- Waste treatment contract development & procurement preparation; and,
- Registering for the Green Gas Support Scheme (GGSS)

The latter of these actions on attaining the GGSS accreditation is noted in the report as being a considerable risk and therefore priority for the preferred option, as this fiscal incentive scheme is currently due to close to new registrations in March 2028.

1.0 INTRODUCTION

1.1 Introduction to Liverpool City Region Waste Management Partnership

The Liverpool City Region Strategic Waste Management Partnership ("the Partnership") is a high-level group of representatives from Knowsley Borough Council, Liverpool City Council, Sefton Borough Council, St Helens Council and Wirral Council (the Merseyside districts), Halton Borough Council and the Merseyside Recycling and Waste Authority (MRWA). This report refers the "Partnership" and "Partnership authorities" as a collective term for the organisations commissioning this work. In using this term in a broad sense, it is recognised that there are distinct responsibilities for the MRWA as a waste disposal authority, and the other organisations as waste collection authorities.

The Partnership's purpose is to collectively address the waste management challenges in the Liverpool City Region (LCR), through the development of a Zero Waste Strategy for the City Region and provide a single voice on waste management affairs; these include implications of new waste management legislation, housing growth, the environment and climate emergency and the financial pressures on regional waste management.

1.2 The Environment Act Policy Context

The Environment Act 2021 introduces a requirement for all local authorities in England to provide a separate weekly collection of food waste to all households within their administrative area. Some 159 local authorities in England do not presently have a food waste service in place and those organisations will therefore need to introduce this new service. This includes the majority of authorities within the Partnership area with the exception of St Helen's Council who have an existing food waste service. As per the 'simpler recycling' consultation response from the UK Government issued in October 2023, this collection service needs to be in place by the 31st March 2026.

Similarly, all businesses and non-domestic premises in England (such as schools and hospitals) shall be required to have food waste recycling collection in place for the recycling of business and non-domestic premises generated food waste by 31st March 2025. This largely applies to businesses in the food service, catering, wholesale and retail sectors. Micro-firms[1] have a separate implementation date and shall be required to have a food waste collection service in place by 31st March 2027. Many waste management businesses who offer food waste collection services are preparing for non-domestic food waste collections by

[1] Micro firms are defined as businesses employing fewer than 10 members of staff and have a turnover or balance sheet of less than £1.7 million.

increasing their service offer to the commercial and industrial sectors. This includes several specialist organisations who are seeking to collect large quantities of food waste which can then be supplied into partnered anaerobic digestion facilities.

The rationale of the food waste collection requirement of the Environment Act has several dimensions. Work undertaken by Zero Waste Scotland found that the food waste fraction of the household waste stream is second only to textiles in terms of carbon intensity which makes it a high priority waste stream to maximise recycling from. This carbon intensity is, to a degree, addressed through the diversion of food waste from the residual waste stream to a recycling outlet, thereby elevating material up the waste hierarchy.

At a wider level within the waste industry, prevailing policy is seeking to disincentivise residual waste treatment practices that emit large amounts of carbon dioxide gas. This includes the UK Emissions Trading Scheme (ETS) which, from 1st January 2028, will be expanded to include Energy-from Waste facilities and incineration (without energy recovery). It should be noted that food waste, and the biogenic emissions resulting from the incineration of food waste are not included within the scope of the ETS as the tax is expected to be levied on the processing of waste that generates fossil fuel emissions only, with the point of obligation for the tax residing with the operators of the plant.

The diversion of food waste from the residual waste stream into preferred recycling outlets such as anaerobic digestion can bring a number of benefits, including the generation of clean bioenergy to displace fossil fuels, the subsequent utilisation of the energy in efficient applications, and the capture of the associated carbon emissions from the manufacture of that bioenergy. Furthermore, the recycling of food waste can support nutrient recycling with the non-gaseous outputs from treatment processes being used as an agricultural fertiliser. This has the environmental benefit of displacing carbon intensive compound fertilisers, and also contributes to other Environment Act priorities such as soils protection and health. Food waste recycling through anaerobic digestion supports the circular economy principle and aims to maximise the latent value of all materials derived from a waste treatment process.

A further dimension is the recycling rate increases and evidence from previous service launches suggests that food waste can add a 3-5 percentage point increase to an authority's recycling rate. Such a contribution is viewed by many as essential in working towards the Waste and Resources Strategy commitment to achieve a 65% municipal recycling rate by 2035, to halve residual waste generated per capita by 2041, to send less than 10% of municipal waste to landfill or incineration by 2035 and eliminating all avoidable waste by 2050.

Accessing and attaining this full range of benefits which underly the Environment Act commitment on food waste requires local authorities and their counterparts in the waste management sector to carefully consider, design and specify projects so that the full range of environmental benefits can be realised.

1.3 The project brief

Responding to the requirements of the Environment Act 2021 presents a significant change and expansion of waste services to the Partnership. As is discussed throughout this report, the requirement for the collection and recycling of household food waste necessitates the expansion of waste collection fleet, additional logistics operations, and entering into an additional major waste treatment contract. The selection of options within each of these segments of the recycling process have a variety of interdependencies and cannot be separated into discrete strategy decisions. Recognising this point, the Partnership developed this project brief which has the overarching brief:

> *To develop a strategic view of long-term options for optimised food waste collection and treatment and interim measures designed to offer Environment Act 2021 compliant solutions whilst transitioning to future state/operating model*.

The differentiation of long-term and interim strategies within this brief acknowledges that current waste recycling contracts, which are in place until May 2029, include the treatment of food waste collected by the Partnership. As a consequence of this pre-existing contract, the Partnership may be limited in specifying the waste treatment solution between collections commencing in March 2026 and the expiry of the current recycling contract in May 2029.

1.4 Project scope and objectives

To address the brief, the project has been broken down into two strategic questions which each a number of specific objectives. These include:

Q: What is a fully optimised food waste system for Merseyside; specifically,

- What approach represents absolute best practice and an optimised food waste collection & treatment system that is efficient, low carbon and circular?
- What is the context and evidence base that supports this optimised and best practice approach? This question requires a brief to be provided confirming current assumptions and advising on a number of unknowns.
- What are the cost, risks, benefits and timeline of the available approaches?

Q: How can the Partnership transition from its current position, through the interim arrangements to the future food waste recycling service; specifically,

- How should the Partnership best move towards an optimised household food waste recycling service, whilst simultaneously meeting Environment Act deadline of 1st April 2026?
- What are the costs, risks, benefits and timeline that take accounts of existing arrangements?
- How do options compare and benchmark in terms of cost, carbon, and other strategic priorities of the Partnership authorities?

To address these questions and objectives, WRM proposed and delivered a project comprising four distinct stages

1. **Project briefing**
   The project commenced with the preparation of a briefing paper which provides context to food waste collection and treatment. Topics such as energy markets and innovation which represents the optimum level of decarbonisation and environmental performance were also provided in the project briefing which has been included in this report as sections 2 to 4.

2. **Option identification and development**
   With the context provided, the project progressed to identify and describe options that can form components of a fully optimised food waste treatment solution. Such option combinations have examined key variables that will impact the Partnership's strategy including the fuel used in vehicle fleet, the location of treatment and the commercial basis upon which that treatment is provided. Identified options were presented to the Partnership in a briefing paper which forms the basis for section 5 of this report.

3. **Option evaluation**
   Combinations of options have been systematically identified through option matrices which has provided a shortlist of nine strategy options. Staregic quality evaluation criteria have then been established and weighted to provide a qualitative assessment of how well each option aligns to the Partnership's priorities. A cost and carbon model has also been developed to assess the financial and carbon performance of the shortlisted option combinations. Outputs from the evaluation were presented to the Partnership in early July 2024.

4. **Reporting and presentation**
   The presentation of option evaluation provided the opportunity for the preferred option to be identified to the Partnership. The presentation also offed the opportunity for the Partnership to ask questions of WRM as the report authors. The project then concluded shortly after the presentation with the preparation of this final project report.

1.5 About this report

This report firstly provides context on food waste collections, food waste treatment, and the energy markets associated with waste treatment. Many of the specific questions within the consultancy brief are addressed in these sections. The report then moves on to identify strategy options, evaluate those options, and present a preferred strategy option for the LCR region, thereby addressing all other questions in the brief.

WRM were appointed to deliver the project in April 2024 and work commenced on the briefing sections in May 2024. The project concluded in July 2024 with a presentation to Partnership members and the delivery of this project report. All data, prices, and statistics stated within this report pertain to this date range unless specifically stated.

This project was delivered at a time when the Partnership had engaged a variety of separate consultancy work to address other aspects of waste and recycling service reform. It should be noted that this work has focused specifically on the brief and has aligned to that other work where possible (e.g. collection round modelling work). This project has however not been able to anticipate the full range of separate strategy decisions which could potentially impact the food waste service. A decision on if and how to restrict residual waste collection would be one example of such exclusions.

2.0 REVIEW OF COLLECTION OPTIONS & INNOVATION

The first step in determining an optimised food waste recycling solution is to consider the collection options. The Environment Act requires local authorities to provide a separate, weekly and source segregated collection to households and other potential options such as in-sink maceration have not been considered. Alongside the policy obligation, other reasons for discounting the in-sink maceration approach include the cost and deliverability of a macerator in each and every home, and the ability of the current wastewater treatment system to receive, transport and treat the c.50,000 tonnes of food waste that are estimated to arise within the LCR area.

Previous consultancy work delivered to the Partnership by Frith Resource Management Ltd ("Frith") has examined a range of collection variables for food waste as part of work that addresses wider recycling consistency matters. This work determined the parameters for collection rounds which are broadly in line with WRM's expectation. Consequently, this section focuses on technical options beyond the detailed service design parameters that can deliver a circular economy solution for the Partnership.

2.1 Kerbside collection options

The collection options included in subsequent modelling work reflect the previous work delivered by Frith. For clarity, the key assumptions from that work are listed below:

- Residents are offered a 7 litre kitchen caddy and 23 litre kerbside caddy for the collection of food wastes;
- Round sizes are c.1,900 properties per vehicle per day;
- A set out rate of 45% is assumed. This reflects evidence provided by WRAP;
- A driver plus one loader is required to service each vehicle. This is a smaller crew size than the usual driver plus two loaders on most recycling collections and sensitivity analysis would help to understand any further round optimisation potential;
- A 7.5 tonne specialist food waste collection vehicle is used. This vehicle type is commonplace for household food waste collection and is suitable for tipping at transfer stations or directly at anaerobic digestion facilities; and,
- The assumed lifecycle for each vehicle is 7 years.

Additionally, WRM has included a number of additional data points required to develop the model which are benchmarked with previous local authority food waste collection projects delivered to urban and semi-urban metropolitan borough council areas. These are:

- A container replacement rate of 4% per annum;

- A yield per household that is calculated in line with the WRAP 'food waste ready reckoner' tool;
- An annual milage per collection vehicle of 13,000 miles per annum; and,
- That the collection authority provides a supply of caddy liners.

The latter point on caddy liners is a strategy and/or service decision that is frequently questioned by waste service managers and is an aspect of food waste collection that attracts a high level of debate. Evidence from existing food waste collections shows that the use of caddy liners results in higher capture and therefore recycling rates. A concern is that their use introduces inorganic contamination to the food waste stream which is ultimately spread back onto agricultural land as a fertiliser. Whilst the majority of waste anaerobic digestion plants have invested heavily in contamination removal equipment, this potential pathway for plastics to enter environment remains a key concern.

To balance the benefit and concerns of caddy liner use, WRM recommends the use of compostable liners which area starch and lactide-based derivatives of plant sources. The specification of any liners should be compliant with the European composting standard (EN13432). Liners that are sold as biodegradable, rather than compostable, are not recommended as evidence as shown those materials to be more persistent if released into the environment.

2.2 Communications on food waste

The launch of any new recycling service needs to be supported by a good level of resident communications to support resident understanding, engagement and participation. Initiatives commonly used to promote food waste recycling include a range of general advertising media as well as specific measures such as stickers on residual waste bins to advise against placing food waste in the residual waste stream. WRAP has developed a range branded, ready to use communications tools which are available to local authorities to use as part of their roll-out of food waste collections.

The modelling undertaken in this project has included a moderate-high level of spend on communications, noting their importance in attaining good levels of food waste recycling and capture. It is recommended that a communications strategy is developed by the Partnership in preparation for the March 2026 implementation date for food waste.

From a messaging perspective, the key themes to be included in any communications undertaken to residents are suggested as being;

- Facts on the environmental impact of food waste;
- Waste prevention messages and awareness of avoidable and unavoidable food waste arisings;
- How recycling of unavoidable food waste addresses these environmental impacts through the circular economy model, in particular through the production of bioenergy and biofertilizer products;
- The importance of not contaminating food waste with inorganic materials; and,
- Social impacts of food waste including the importance of redistributing surplus food which may otherwise result in food waste arisings.

2.3 Type of Collection Vehicles

The selection of a suitable waste collection vehicle significantly impacts the cost of waste collection rounds. Food waste is typically collected in very small quantities per set out in the region of 1.5kg per household per week, and for large collection round incorporating 2,000 properties per day, the payload will rarely exceed 3.5 tonnes (which could be collected over multiple tips).

For household food waste collection, the optimal vehicle therefore usually has a Gross Vehicle Weight (GVW) of 7.5 with a payload of 3 to 3.5 tonnes. Many 7.5 tonne GVW vehicles are specifically designed for kerbside food waste collection and incorporate features such as a sealed body, covered/sheeted compartment, and capacity for a service bin. WRM understand that the Frith work estimated some 70-80 vehicles would be required to service the combined fleets of the Merseyside area and this number has not been scrutinised further as part of this work, save for the option to operate a single regional fleet which is addressed in summary.

2.4 Alternative Vehicle Fuels

Beyond the service design factors discussed above, the main vehicle option that supports a circular and optimised solution for food waste recycling is the selection of vehicle fuel. This is due to the potential for anaerobic digestion to treat food waste and to produce a methane gas, a portion of which can be compressed and used as a vehicle fuel. Other power systems such as electric vehicles and, to a lesser extent hydrogen, are more novel.

Refuse Collection Vehicles (RCVs) are heavy, operate on a stop-start cycle and utilise internal/power take-off mechanisms (such as bin lifts and compactors), which all require a significant amount of fuel to operate. Alternative fuels have been proven to lower fuel costs over the vehicle’s lifetime, whilst significantly reducing greenhouse gas emissions and mitigating the environmental impact associated with poor air quality. This section provides a comparison of four available fuel types: diesel, compressed biomethane, electric and hydrotreated vegetable oil.

2.4.1 Diesel

Traditional diesel RCVs have become the most common type of waste collection vehicle for local authorities despite advances in fuel efficiency and stringent emission standards. These diesel vehicles emit large quantities of carbon dioxide and other equivalent greenhouse gases, as well as particulate matter and gases such as nitrogen oxides, that contribute to poor local air quality.

Studies have shown that the service and maintenance cost of diesel RCVs are significantly higher than those of their electric counterparts due to the greater number of moving and engine parts. This higher operational cost makes alternative fuel vehicles an attractive option for local authorities.

Diesel fuelled refuse collection vehicles are the baseline for almost all refuse collection fleets and are well understood by local authorities including the Partnership. Consequently, no further evaluation of these vehicles is provided at this stage.

2.4.2 Compressed Biomethane

Compressed natural gas (CNG) is a long-established transport fuel which is globally used in a variety of vehicle types. Biogas produced during the anaerobic digestion process can be upgraded to biomethane, by removing carbon dioxide, water vapor, and other trace gases which is chemically identical to natural gas (CH_4). When biomethane is compressed, it can be used as a transport fuel in the same way as CNG.

Biomethane powered RCVs mechanically operate in a similar way to diesel RCVs, although biomethane produces around 85-94% less carbon dioxide-equivalent emissions than diesel across its lifecycle and has a fuel duty of approximately half of diesel used for vehicle fuelling. Indeed, the full retail price of biomethane is generally lower than the duty paid on an equivalent volume of diesel fuel.

A further benefit of biomethane vehicles is a comparative reduction in nitrous oxide and particulate matter emissions which contributes to local air quality improvement objectives. Previous research has found that such reductions in nitrous oxide emissions can be as high as 90%. Additionally, biomethane that is produced and re-used locally will reduce emissions associated with fuel distribution.

During the development of options, it was identified that Liverpool City Council presently operate a fleet of c.20 CNG powered refuse collection vehicles which operate on grid gas. The aforementioned air quality benefits were cited as a key reason for their selection.

Adoption of gas-powered vehicles, whether CNG or biomethane will require procurement of a specific fleet of vehicles as the economics of converting liquid fuelled vehicles to gas powered vehicles are not viable when compared to fleet substitution/replacement. This is due to the fact that conversions requires a swap out of the chassis which is comparatively more expensive than the body and lifting/compaction units which are the other key components of a collection vehicle.

The implementation of biomethane vehicles will require gas fuelling infrastructure to be installed. The vehicle filling station can be located at the anaerobic digestion site treating food waste enabling collection vehicles to fill up when making deliveries. This is not a necessity as filling infrastructure can be installed a depot facilities providing they have a medium or intermediate pressure gas grid connection. The methane gas grid can then be used to ship gas from an AD plant treating Merseyside's food waste to the filling station location with this shipment supported by a Renewable Gas Guarantee of Origin certificate to track the gas through the grid network as described in latter sections.

Such a filling station could, for the Partnership, be a single large filling station as illustrated in Figure 1; or, could be a smaller filling point at each of the Partnership authorities depots as illustrated in Figure 2.

Figure 1 – Large scale bio-methane vehicle fuelling point.

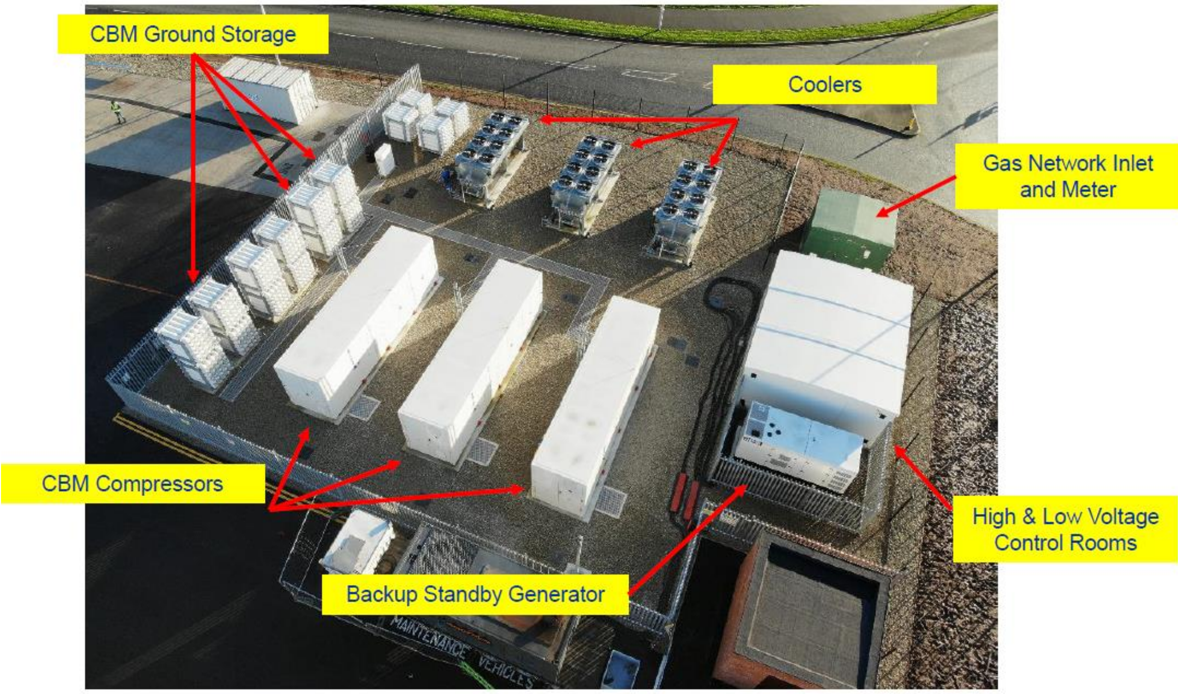


Figure 2 – depot scale biomethane filling point.

The cost of installing the smaller depot scale filling station equipment is in the region of £120,000, excluding the costs of connecting to the local gas grid which are a site-specific cost and can depend on factors such as the distance to the grid, and any encumbrances (e.g. land ownership, highway, railway, or watercourse crossings) that may escalate development costs. In one recent project, the total cost including civils work was in the region of £398,000. It is important to note that this order of cost would be incurred at each selected site for development of a filling station.

WRM does not presently have a capital cost for development of a large-scale refuelling site but has made enquiries to gather this information to support latter stages of this project.

Whilst this assessment is largely focused on the circular option for the waste collection fleet, it should be recognised that surplus biomethane that is not consumed by a filling station can go to other public sector fleet uses such as bus fuelling, and the Partnership may wish to engage with colleague in those areas to understand strategic alignment and therefore potential opportunities for biomethane fuel supply.

A further filling option for biomethane is to utilise an increasingly available network of filling stations which have arrangements with anaerobic digestion facilities for the supply of renewable gas. One recent development which could be available to the Partnership is the CNG Fuels filling station at Saturn Business Park in Knowsley (L34 9GJ) or at the St Helens filling station which is proposed by Gasrec.

<u>Implementing the biomethane option</u>

The current waste recycling contract for the Liverpool City Region with Veolia extends until 2029, and it is highly unlikely that a source of self-generated biomethane could be developed by the Partnership by this time. One challenge presented by this timescale is that the Council is obliged to commence food waste collections in March 2026 which will require the Partnership to invest in new vehicles before a potential source of biomethane becomes available. In this scenario, the baseline option would be to commence collections using diesel vehicles, although the 7–8-year lifecycle of those vehicles could then limit the option to move over to biomethane vehicles in 2029. The outcome of this situation is that the various benefits of biomethane fuel use would be lost.

A viable option for the Partnership is to procure CNG vehicles and to run those vehicles on grid methane gas in the short term (2026-2029). This would require the immediate delivery of the refuelling infrastructure and would deliver to achieve air quality savings, such as a reduction in nitrogen oxides notwithstanding the fossil origin of grid supplied gas.

Once an anaerobic digestion plant is operational and supplying a self-generated source of biomethane, the gas source can be switched to biomethane using the renewable energy guarantee of origin certificate to demonstrate the gas supply from the AD plant provider.

For a filling station to be operational in 2026, construction would need to begin imminently. Previous financial assessments conducted by WRM estimated the cost of a concrete yard area and tanker filling yard to be approximately £397,170. It is recommended to speak with the district network operator (Cadent) to conduct a capacity check at the proposed filling station locations.

2.4.3 Electric

Electric RCVs are powered by on-board batteries and offer significant environmental benefits. They produce zero tailpipe CO2e emissions and particulate matter, as well as generating considerably less noise pollution compared to diesel-powered alternatives.

Following their launch, several fleet managers raised concerns about the range of eRCV's, particularly in respect of range and payload capacity. From a performance perspective, eRCV's are now available with payloads of up to 20 tonnes per day and with a published operating duration of around 8 hours per day. It is however noted by WRM that the majority of waste collection authorities adopting eRCV's are predominantly urban, and anecdotal discussions with contacts who have trialled eRCV's has suggested their performance and associated benefits reduces in suburban and rural areas. A full charge cycle is in the region of 6-7 hours, meaning that vehicles can typically only be charged once per operational day.

The switch to electric RCVs would require a detailed study of the grid to ascertain the viability for the installation of charging infrastructure. Including analysis of the grid capacity and scoping whether the grid infrastructure around the depots is sufficient for the demand.

2.5 Hydrotreated Vegetable Oil (HVO)

HVO is a form of renewable fuel that is produced from vegetable fats and oils. Unlike regular biodiesel, hydrogen is used as a catalyst in the fuel creation process instead of methanol. This makes it a cleaner burning, environmentally friendly renewable diesel alternative, without the short shelf life of regular biodiesel.

The fuel is created by collecting cooking oil waste and processing it through a hydrogenation and isomeration process, which removes the impurities from the oil. The process breaks down existing molecules and builds them up again, leaving a final product with consistent carbon chains, but without the impurities that are common in traditional diesel and biodiesel. The result is a fuel with a chemical structure almost identical to regular diesel, therefore acting as a viable fuel replacement, but with the added benefit of a c.90% reduction in carbon dioxide emissions, and lower particulate matter and nitrous oxide emissions compared to its traditional diesel counterpart.

HVO is considered a 'drop-in-fuel'. That is, the fuel is compatible with vehicles fitted with Euro VI diesel engines, with no modifications or changes required to traditional diesel vehicles to accommodate the fuel change. Consequently, the options modelling exercise has assumed compatibility of HVO fuel with traditional diesel vehicles, resulting in no change to baseline vehicle procurement costs. For the avoidance of doubt, vehicles running on HVO operate on a liquid fuel system and cannot be converted to a gaseous fuel source such as CNG or biomethane at a later date.

Whilst the use of HVO fuel provides clear decarbonisation benefits for a vehicle fleet, its emergence as a relatively new fuel source, combined with a distinct supply chain and higher fuel cost than conventional diesel, means that the scalability of the adoption of HVO as a vehicle fuel option currently remains less common than its more traditional diesel counterpart. During the delivery of this this project it was identified that Wirral council had undertaken a trial using HVO fuels on three vehicles.

2.6 Fuel Types Comparison

Table 1 highlights the operating costs and emissions between each fuel type for a 7.5 tonne GVW food waste collection vehicle. To obtain figures for Biomethane-fuelled and electric vehicles, WRM utilised pervious work completed for other local authority waste services. The cost of a 7.5 tonne diesel vehicle was sourced from the Frith work. All fuel rates are taken from the average price paid over 2022/23. Although diesel RCVs offer the lowest capital and annual maintenance cost, HVO, electric and biomethane all have higher carbon savings, whereas diesel has no carbon saving.

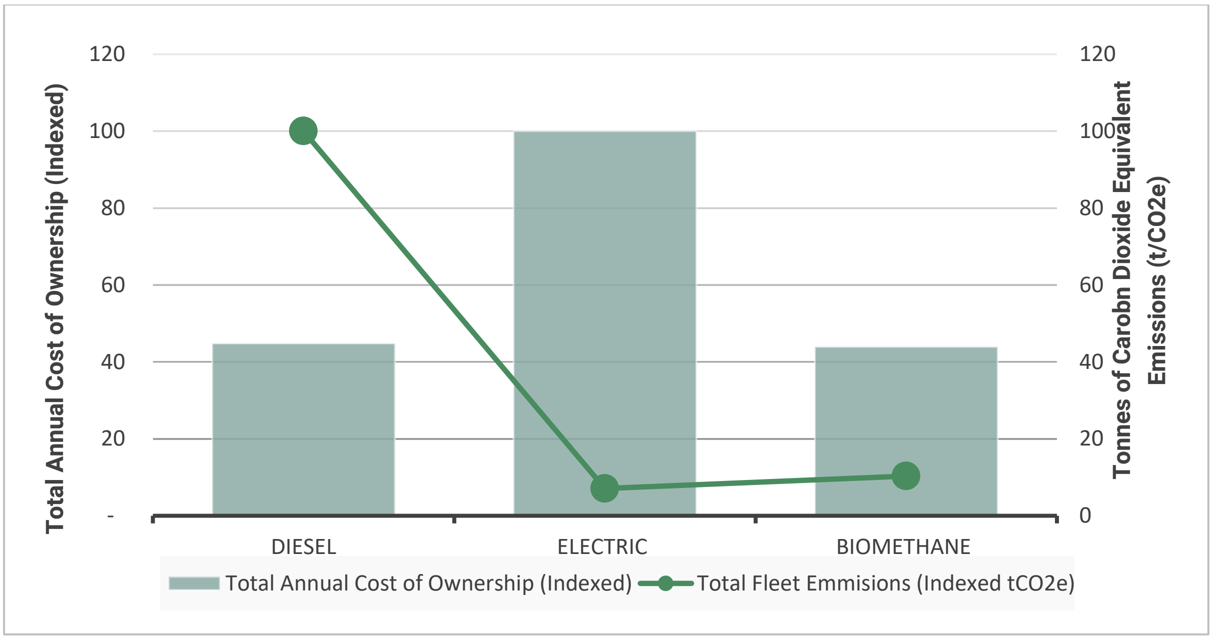
Table 1 – Fuel Type Comparisons

Fuel Type	Capital Cost (7.5t vehicle)	Operating Cost (Excluding VAT Fuel Price £)	Emissions (Kg CO2e per mile)	Annual total cost of ownership[2]
Diesel	£85,000	1.50 per litre	0.73	£20,643
Hydrotreated Vegetable Oil	£85,000	1.80 per litre	0.073	£20,643
Biomethane (RNG)	£102,000	0.65 per kg	0.09	£24,771
Electric	£145,000	0.29 per kWh	0.11	£35,214

[2] Includes apportioned capital cost over a 7-year depreciation period, plus annual vehicle servicing and repair costs.

Although diesel RCVs offer the lowest capital and annual maintenance cost, HVO, electric and biomethane all have high carbon savings, whereas diesel has no carbon saving. The relationship between the information presented in Table 1 is illustrated in Figure 3.

Figure 3 – Comparison of cost and carbon savings for diesel, electric and biomethane fuelled refuse collection vehicles.



2.7 Transfer station requirements

Depending upon the location of waste treatment, there may be a requirement for collected food waste to be bulk hauled to the anaerobic digestion facility. This operation would require the use of a waste transfer station(s).

Attention is drawn to the specific Environmental Permitting requirements for transfer stations receiving food waste. Such requirements can include:

- Appropriate containment measures for food waste;
- Odour control/management measures;
- Vermin control; and,
- Procedures to comply with the animal by-products regulations.

These requirements need to be assessed at any specific locations that the Partnership authorities propose to use so that permit variation and/or upgrade works can be undertaken. With lead times on environmental permitting currently standing at c.1 year from the point of application, it is recommended that the Partnership commences work to identify and assess the suitability of any likely waste transfer locations.

2.8 Integration of a single collection service across the whole Partnership area

One question presented by the Partnership on the collection component of the service relates to whether other governance structure could lead to an improvement in efficiency and therefore represent a more optimised collection service.

WRM has not reopened any collection round modelling work undertaken by Frith but has previously addressed this question in detail for the organic waste collection service offered within the Greater Manchester Combined Authority administrative area. That work, which was of comparable scope to this project for the Partnership examined potential areas of efficiency such as but not limited to:

- Optimised round sizes, particularly by reducing the number of 'part rounds' and removing internal administrative borders which may reduce round sizes;
- Greater sharing of fleet and resources, particularly in respect of spare vehicle provision which may have the potential to be reduced;
- Combined service management and administration functions; and,
- The use and/or development of a single depot facility which could also incorporate new biomethane filling station and/or electric vehicle charging stations.

When modelled as a single collection service, WRM found that the collection option reduces the number of vehicles required to service food waste by c.4% compared to each collection authority operating its own service. The specific reduction in service would however need to be remodelled by Frith to determine whether such a level of efficiency would apply to the Partnership authorities.

A further possible benefit of the option would be that an entire food waste recycling service could be let as an integrated collection and treatment contract across the Merseyside area, placing full control of collections and treatment within a single entity.

Whilst the option of a single collection service has several possible benefits, a number of potential challenges are also presented by the option. These include although are not limited to:

- The service management may become separate to other waste services. An example of this could be contact points for reporting missed collections which could differ from other waste and recycling services;
- There could be a disconnect in the scheduling between food waste collections and other refuse and recycling services. Such confusion on set-out days can lead to a reduction in service participation and therefore yield;
- The ability to share resources and staff across the various fleets may be constrained. This could include spare vehicles that operate across service and could also include staff who, in many authorities, frequently rotate between services to balance workloads;
- The option may limit the fuel use options if the contractor was not fully in control of depot ownership.

The listed benefits and challenges have been discussed with the Partnership, specifically in relation to the timescales and the need to have a food waste collection service in place by March 2026. This noted that other authorities looking to make and procure complex changes for this date are already at the point of releasing procurement documents in order to ensure that lead times can be accommodated. It was agreed by the Partnership that a common specification to round design and vehicle procurement could be agreed by the Partnership which is then produced and integrated into waste services at the collection authority level. WRM recommends that work on this common specification and procurement should be a priority action for the waste collection authorities within the Partnership.

3.0 PROCESS OUTPUTS: RENEWABLE ENERGY, DIGESTATE AND CARBON MARKET OVERVIEWS

Ahead of examining the waste treatment sector this review begins by outlining the role of food waste in the current energy and sustainable fuels market. This section is presented ahead of food waste treatment options as energy use often determines the selected treatment technology. This is due to the level of revenue, which is derived from energy sales, and understanding the energy market context is a pre-requisite to determining the type of waste treatment solution that the Partnership may in future specify.

3.1 Current Energy Market

Food waste is one of the most carbon intensive fractions of the wastes within the municipal waste streams, with a disproportionately high carbon emission per tonne. Energy derived from food waste contributes to the renewable energy sector by utilising organic matter that would otherwise be disposed of through energy from waste. Through anaerobic digestion and a range of adjacent technologies, food waste can be turned into a useable form of energy including electricity, heat, and transport fuels. Production of these energy outputs supports the principle of a circular economy by repurposing waste materials and to varying degrees maximising resource efficiency. Furthermore, food waste derived energy can support local energy production by enabling smaller-scale anaerobic digestion plants to be implemented closer to waste sources, reducing transportation needs and emissions.

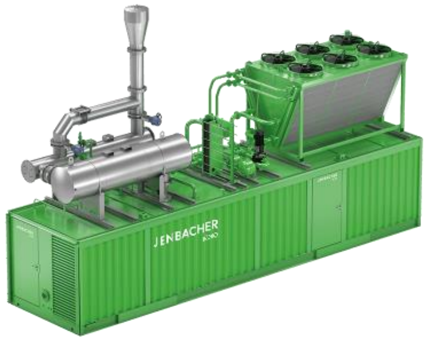
The calorific value of a fuel is a measure of how much energy is available per tonne of waste. The higher the calorific value, the greater the energy potential from the waste. Alongside calorific value, the efficiency of the energy utilisation option must also be considered. Indirect energy generation, such as burning biogas to produce steam that drives a turbine to generate electricity, is generally less efficient than direct energy export (e.g. using the gas in heating or transport applications). However, direct generation will often require energy, 'parasitic load'. The parasitic load refers to the amount of energy consumed by the system itself to operate, as opposed to the energy it produces for external use. As a result, the overall efficiency needs to be considered when determining the relative value and environmental benefits of direct and indirect energy generation.

This section now proceeds to introduce and describe the various energy outputs that could be generated from the treatment of the Partnership's household food waste.

3.2 Electricity (and heat) generation

The initial waste anaerobic digestion facilities were developed to produce electricity and heat outputs. In these systems, raw biogas from the digestion process is utilised in combined heat and power engines (CHP) which produce electricity and heat in the form of hot water. A typical CHP engine is illustrated in Figure 4.

Figure 4 – Combined heat and power engine.



CHP engines have a net electrical efficiency in the region of 40% and energy content ratio of gas produced to electricity exported reflects this efficiency rating. A further 40% is generated as heat in the form of hot water which can be used in heating applications such as industrial heating or district heating for buildings.

The high levels of adoption of CHP engines at the initial anaerobic digestion plants is attributed to several reasons. At that point in time (2009-2014) the United Kingdom has some ground to make in reaching renewable electricity generation targets. By deploying CHP engines, which are readily available and used in other industry sectors (e.g. landfill gas, large process and heavy industry sites), the production of renewable electricity was a relatively straightforward development option. Furthermore, substantial incentives were available in the form of the Feed-In Tariff, a fiscal incentive scheme which paid renewable electricity generators a unitary rate for the power they exported to grid.

There are however several reasons why electricity generation from biogas has fallen in recent years. The UK has made commendable progress towards meeting renewable power targets; hence the focus has now shifted towards incentivising the production of heating and transport fuels as discussed in subsequent sections of this report. This shift in output requirement is reflected by the termination of the Feed-in Tariff in 2019 and there are presently no financial subsidies available to anaerobic digestion plant operators in respect of renewable electricity production.

This shift in focus also reflects a more optimal use of the renewable energy created in biogas. Many waste anaerobic digesters operating with a CHP engine did not have adjacent demands for full use of the 40% heat output meaning that a large proportion of the latent energy was vented to atmosphere. This contracts with gas or vehicle fuel production which in comparison has a much higher (c.95%) energy conversion efficiency.

It should however be noted that most anaerobic digestion plants continue to operate small CHP engines are part of their operations in order to service the heat and power demands of the anaerobic digestion plant. This demand is commonly referred to as the ‘parasitic load’.

3.3 Heat and Biomethane

The heat industry represents a substantial portion of national energy demand and carbon emissions, making it a focal point for renewable energy incentives. By incentivising renewable heating fuels, the aim is to reduce reliance on fossil fuels in residential, commercial, and industrial heating applications.

Decarbonising heat presents several challenges due to the extensive infrastructure and variation of energy sources involved in heating systems. Traditionally the heat industry relies heavily on fossil fuels, particularly natural gas, which is a major contributor to greenhouse gas emissions. Presently, biomethane, which is the upgraded and purified form of biogas, is viewed as a promising renewable gas option since it can meet a wide range of demand profiles from residential heating to industrial processes without alteration to that infrastructure (e.g. boiler replacement). Current UK strategies place biomethane production through anaerobic digestion as a key decarbonisation technology, with predictions that by 2030 biomethane production could treble from 2020 levels.

The Government has previously indicated anaerobic digestion as a preferred method for treating biodegradable material, due to the benefits associated with biomethane production and its role in decarbonising the UK gas grid. Government launched the Green Gas Support Scheme (GGSS) 31st March 2021 to support the construction of new anaerobic digestion facilities. The GGSS will support this objective by providing a tariff supporting the price of biomethane injected into the gas grid at anaerobic digestion sites. This scheme follows on from the non-domestic Renewable Heat Incentive (RHI) and will pay unitary tariffs to certified producers of biomethane for a period of 15 years. The scheme is expected to help decarbonise the UK’s gas supplies by increasing the proportion of ‘green’ gas in the grid.

During peak years of production, biomethane plants incentivised by the GGSS will generate enough green gas to heat around 2 million homes.

The government recently announced their intention to extend the GGSS to 31 March 2028, a date by which a site must be injecting biomethane into the gas grid. This policy announcement provides more time for prospective applicants to register on the scheme and continue alignment between the GGSS and the introduction of municipal food waste collections. With its 15 year tariff guarantee, published and index adjusted tariffs, and the precedent of many operational examples, the Green Gas Support Scheme is now viewed as the principal incentive support scheme for waste anaerobic digestion.

3.4 Vehicle Fuel

The Renewable Transport Fuel Obligation (RTFO) launched on April 15, 2008, is one of the Government's main policies for reducing greenhouse gas emissions from transport. The RTFO achieves greenhouse gas emission savings by promoting the availability of renewable fuels for use in UK transport. Under the scheme, suppliers of eligible fuel types (petrol, diesel, gas oil or renewable fuel) in the UK must meet an annual obligation using tradeable certificates which are awarded for the supply of sustainable renewable fuel. In 2021 the renewable fuel supported by the RTFO accounted for 5.4% of the total transport fuel supplied, delivering greenhouse gas savings of 5.07 million tonnes of CO2e.

An obligated fuel supplier can obtain Renewable Transport Fuel Certificates (RTFCs) either by suppling renewable fuels or by buying them from renewable fuel suppliers. Where there is a shortfall in either of these options, the obligated supplier must obtain renewable fuel and/or certificates from third party organisations. Waste anaerobic digestion sites who are not obligated suppliers and who produce a biomethane gas which can be used as a transport fuel can sell the gas and/or certificates to those obligated suppliers. This provides a further renewable energy option alongside the GGSS.

Unlike the GGSS which provides a fixed tariff over a defined duration, the RTFO scheme is a cap and trade scheme and the value of a certificate can vary in line with supply of renewable fuels and/or demand for certificates. This makes the price received by operators looking to sell certificates less stable although has at times, resulted in a very high certificate price (e.g. where obligated vehicle fuel suppliers have a high demand for certificates). This fluctuation in value is, to a degree, reduced in circumstances where transport fuel is self-generated for use in fleets as additional benefits such as a reduction in fuel duty (by a magnitude of c.50%) can be claimed on biomethane fuels. Given this fluctuation, many operators producing vehicle fuel rely upon the GGSS as a base revenue option (where they are injecting into the gas grid to supply vehicle refuelling stations) and then switch to RTFC payments where the value of that incentive exceeds the GGSS level. This provides a beneficial uplift in the value received for gas.

An important point to note when considering biomethane as a renewable transport fuel is that the waste treatment location that generates the fuel, and the filling station for the fleet using the fuel do not need to be co-located, providing both locations are connected to the gas grid at medium or intermediate pressure levels. Where this structure can be established, Renewable Gas Guarantee Origin certificates can be used to transmit or sleeve the gas through the national gas transmission grid. This mechanism effectively mass balances the inputs at the anaerobic digestion plant and outputs at the filling station.

3.5 Hybrid gas and fuel options

A further energy utilisation option which is now increasingly being deployed is to develop anaerobic digestion facilities that have a combination of grid-gas export and vehicle fuel production. In such cases, the certainty of the green gas support scheme provides assurance on income over the term of the project and is used as the default option for gas export. This provides a platform for options which include:

- Channelling gas into vehicle fuel applications at time when the RTFC prices is higher than the GGSS in order to generate additional revenue; and/or,
- Using the GGSS as a guaranteed payment mechanism for any gas that is generated above and beyond the demands of an owner operated (i.e. Partnership) fleet.

3.6 Novel markets for biomethane

There are emerging markets for biomethane supply which includes hydrogen and sustainable aviation fuel (SAF), with demonstrator initiatives underway to promote their adoption. These options are however at early levels of technology readiness in comparison to power, heat, gas, and vehicle fuel options.

The SAF mandate, set to be implemented in 2025, introduces specific targets for the proportion of SAF in the aviation fuel mix, which suppliers and airlines need to comply with. These targets are set to progressively increase from 2025 to 2040, providing a 15-year roadmap for the industry. By 2030, at least 10% of jet fuel should be made from sustainable feedstocks. To support the development of SAF infrastructure, the government has allocated over £135 million through the Advanced Fuels Fund. This funding aims to take UK SAF plants through to completion and supports the ambition to see five plants under construction in the UK by 2025.

3.7 Carbon Capture Use or Storage

An increasingly import adjacency to vehicle fuel and gas production is the capture of carbon dioxide gas. Raw biogas produced by anaerobic digestion typically consists of 50-60% methane (CH_4) and 25-35% carbon dioxide (CO_2). As the demand for renewable energy increases, plants producing biomethane from biogas have implemented advanced technologies to capture and purify the CO_2 produced during the process. The removal of biogenic CO_2 during the biogas upgrading process in AD systems can be achieved using various separating methods, such as water scrubbing, the use of a membrane system, pressure swing absorption, or amine gas treatment.

The purified CO_2 can then be used for different applications in a variety of industries such as fire extinguishers, food and drinks, or process gases. The food and drink industry relies heavily on purified CO_2, using it to extend the shelf life of products and carbonate beverages. Such applications are referred to as carbon capture and use (CCU) options.

Beyond these applications, captured CO_2 can be directed to geological storage sites, where it is permanently stored, a process known as Carbon Capture and Underground Storage (CCS). By securely storing CO_2 and preventing it from entering the atmosphere, plants producing biomethane can further help mitigate climate change. The option to capture short rotation carbon for storage is considered to be a 'carbon removal' process with potential to generate carbon credits which could have a particularly high value. The option however remains at an early level of development which creates challenges in reliably estimating the future CCS value(s) of such carbon credits and any valuation of carbon at this time is based on known CCU values

One particular CCS project of note to the Partnership is HyNet Northwest. This is an integrated CCS and low-carbon hydrogen production project, aimed at reducing industrial carbon emissions in the North-West England and North Wales regions. The project involves upgrading and repurposing existing gas infrastructure, as well as developing new infrastructure to produce, store and distribute hydrogen, together with CCS. The development, which runs from Runcorn, through Ince Marshes, Stanlow and Ellesmere Port is scheduled to begin operating in 2025 and will initially have a carbon storage capacity of 4.5 million tonnes per year in the first phase of the project.

By 2030, the project expects to deliver approximately 10 million tonnes of carbon dioxide reduction. The captured carbon will be transported to reservoirs in Liverpool Bay via a pipeline network that combines new and existing pipelines, with the injection point located at the Point of Ayr gas terminal. This site offers significant potential for connection to the CO_2 storage pipeline, providing an optional off-take solution for captured CO_2 from an anaerobic digester treating the Partnerships food waste.

3.8 Anaerobic digestate

Anaerobic digestate is the term that refers to the food waste output from the anaerobic digestion facility following its treatment. Digestate is the majority output from an anaerobic digester, accounting for between 90-95% of process outputs by mass.

Digestate can be produced in fractions which include:

- A pumpable viscous liquid with a dry matter content of c.6%. This fraction is referred to as whole digestate; or,
- Separate fraction of digestate liquor which has a dry matter of c.1%, and a solid fibre that has a physical character resembling farmyard manure.

The production of whole or separated fractions of digestate is mutually exclusive.

Digestate is rich in nitrogen, phosphorus and potassium and is therefore used as a biofertilizer in arable and grassland agriculture. The application of digestate as a fertiliser product is, as with all fertilising products, subject to farming regulation including the Nitrate Vulnerable Zone (NVZ) regulations and Farming Rules for Water. These regulations place limits on the application rates of fertilisers based on soil and crop type, and restrictions on the timing of application in line with crop demand. The latter point on timing of application requires the operator of an anaerobic digestion plant, or its downstream supply chain, to hold at least nine months digestate storage capacity. This requirement is usually addressed by operators by arranging lagoon storage in the agricultural supply chain who receive digestate.

The application of these regulations to digestate use has, in some areas, led to concerns on the landbank that is available for the recycling of digestate to land. The Liverpool City Region does not have a large amount of agricultural land within the administrative area, although benefits from large areas of arable and grassland agriculture in the neighbouring areas of west and central lancashire, and north Cheshire. With digestate offering a lower cost and more sustainable option to manufactured fertilisers in these areas, the off-take of digestate to agriculture is not seen as a significant challenge or barrier for a facility developed in the LCR region.

To support supply into agricultural markets, all digestate produced from food wate should be produced to the PAS110 standard as detailed in paragraph 4.3.

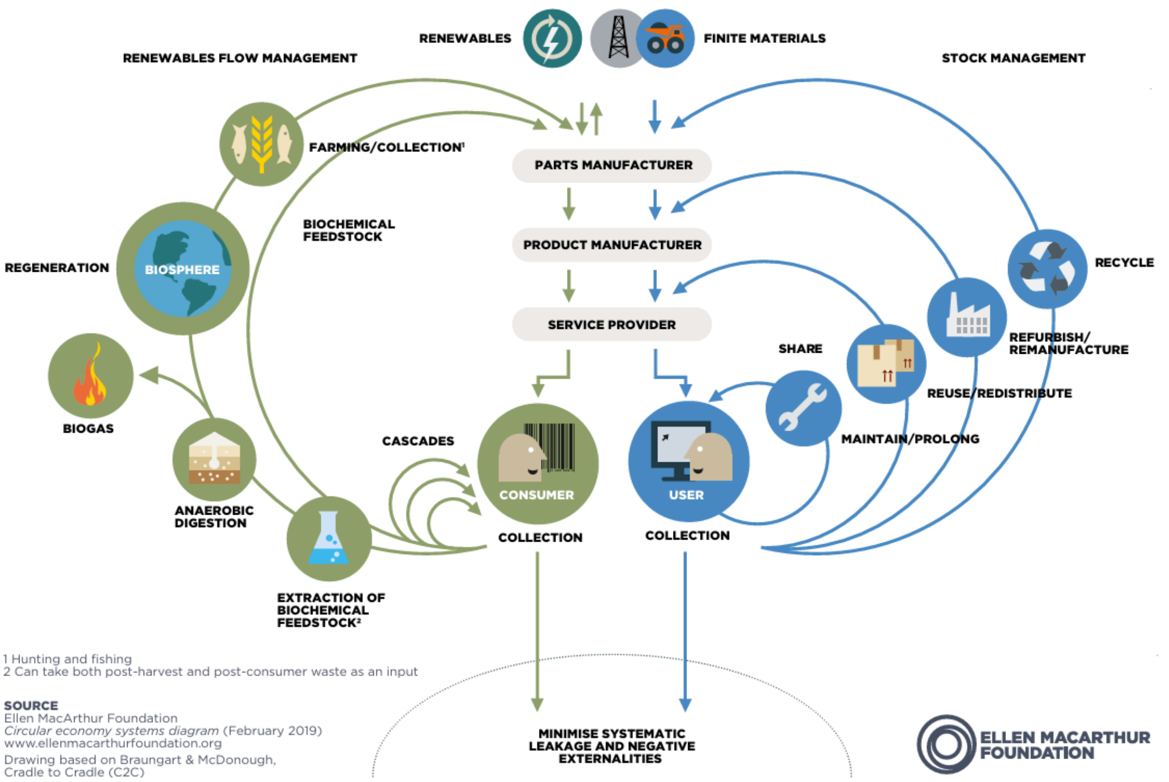
4.0 WASTE TREATMENT MARKET OVERVIEW

This section includes a review of the regulatory landscape concerning food waste management and broader policy drivers shaping the management of household food waste. A summary on the technological advancements that have emerged to enhance food waste management and the processing of secondary products. Such developments include, but are not limited to, the development of carbon capture and sequestration technologies. This section describes the technology and its variations before proceeding to look at development options for the Partnership.

4.1 Circular waste treatment solutions

Anaerobic digestion is the principal treatment technology that can be used to recycle food waste into recycled products that include biogas and biofertilizer. The Resources and Waste Strategy for England released in 2018 specifically refers to the technology as the preferred treatment option for the recycling of municipal food wastes. The concept of recycling food waste as an organic waste is specifically identified in the circular economy concept as illustrated by the Ellen Macarthur Foundation in Figure 5.

Figure 5 – Circular economy concept identifying the role of anaerobic digestion and biogas in the circular economy model



Food waste treated through anaerobic digestion provides several benefits. Firstly, the use of the process in place of residual waste treatment approaches reduces carbon emissions from the treatment of residual waste.

Additionally, the production of biogas or biomethane can be used as a low carbon fuel for power, heating or vehicle fuel. In the latter option, the opportunity to power the refuse collection vehicles, combined with the return of primary nutrients to agriculture provides a circular solution.

In residual waste treatment such as landfill or Energy from Waste (EfW), valuable nutrients are lost. Whereas recycling waste through a PAS110 accredited AD plant not only meets the DEFRA and legal definition of recycling but also returns nutrients to agriculture, forming a circular solution. The liquid portion of digestate produced through the AD process is rich in nitrogen, while the solid portion is rich in phosphorous and potassium (P&K), making it highly beneficial for use in the agriculture industry.

4.1.1 Wet Anaerobic Digestion

‘Wet’ or conventional Anaerobic digestion (Wet AD) remains the most prevalent method of anaerobic digestion in the organic waste sector. Since the government introduced the *Anaerobic Digestion strategy and Action Plan* in 2009, the number of AD plants in the UK has increased significantly.

Approximately a quarter of these plants process municipal food waste, and the technology is established and recognised as the predominant technology for food waste treatment. When passed through a pre-treatment phase, source segregated household food waste can be effectively processed to create a number of outputs, depending upon plant configuration. Outputs include power and heat from the combustions of biogas in a gas engine, biomethane, digestate in either a whole or liquid and fibre fraction, contamination that has been screened out during the waste acceptance process, and other products such as carbon dioxide.

Wet AD systems are designed to process biodegradable feedstock into a digestate pumpable substrate that typically has a consistency of less than 15% dry matter content. When processed through a pre-treatment phase, source segregated household food waste can be processed and the typical configuration of an anaerobic digestion plant capable of processing municipal food waste is as follows:

- **Reception and pre-treatment** – upon receipt at the anaerobic digestion plant, food waste feedstocks are inspected and passed through a pre-treatment line to remove physical contamination which in the municipal stream can include packaging, cutlery and non-biodegradable liners. The pre-treatment phase also monitors and controls dry matter content and dilutes as required;

Figure 6 – Food waste de-packaging line receiving food waste at an anaerobic digestion site

- **Intermediary storage and blending** – pre-treated feedstocks are then commonly held in buffer tanks which allows different types or batches of feedstock to be blended. Anaerobic digestion systems benefit from a homogenous and consistent feed which is the purpose of this process phase. The feedstock substrate is often pre-heated in this phase ahead of feeding into the digestion tanks;
- **Anaerobic digestion** - the substrate is pumped into digestion tanks (Figure 7) maintained under anaerobic conditions where it is heated and stirred to prevent suspended solids from precipitating. Four cultures of microbes break down the organic matter, firstly into amino acids, which are then respired into methane gas which rises through the substrate enabling collection at the top of the tank. The substrate has a residence ranging from around 35-75 days depending on factors such as the temperature that the tank is maintained at and the rate at which the bacteria extract the biogas from the substrate;

Figure 7 – wet anaerobic digestion tanks

- **Biogas and/or biomethane lines** – the methane rich biogas generated by the microbial activity is collected at the top of the digester, often in supported gas domes that give anaerobic digesters their characteristic appearance. A gas blower or compressor is then used to deliver the generated biogas into the gas treatment line. The raw biogas collected from the digester contains 60% methane with the remainder being a mixture of carbon dioxide, hydrogen sulphide and water vapour, and the gas treatment line seeks to remove contaminants, primarily the Hydrogen Sulphide which give the gas acidic and corrosive properties. A range of technologies and processes can be employed within this phase including water scrubbing, carbon filtration, and/or condensing. Following initial treatment, biogas can be combusted in a gas engine to produced power and heat; the latter in the form of hot water. Alternatively, the cleaned biogas can undergo further upgrading through filtration, odorant application and pressurisation to produce biomethane that meets the gas grid specification. Connecting the plant to a proximate gas grid connection then enables the bio-methane to be exported for use in place of natural sources of methane gas;

Figure 8 – Gas cleansing membranes converting raw biogas to biomethane

- **Pasteurisation** – following digestion, the liquid substrate is passed through a pasteurisation phase in which the material is held at a temperature of 70oC for a minimum of one hour. This achieves a pathogen kill for species such as Salmonella spp. and E.coli which may be present in the food waste feedstock. Following a sieve test or screen for contamination, the substrate is sent as digestate for storage;

Figure 9 – Pasteurisers treating food waste following digestion

- **Digestate processing and/or storage** – the raw substrate produced by the plant is referred to as digestate which is used as a nitrogen rich fertiliser in agriculture and field grown horticulture. Digestate may be stored at the processing site for a further residence time to collect any residual biogas, and for any further processing to take place. This can include separation of the whole digestate into a liquor and fibre fraction, although this practice is more commonplace in plants that process agricultural inputs.

Figure 10 – Digestate being separated prior to application to agricultural land.

As discussed above, the outputs from the anaerobic digestion process are, depending upon plant configuration:

- Power and heat – from the combustion of biogas in a gas engine; and/or
- Biomethane – where biogas is upgraded to gas transmission grid specification, or compressed for vehicle fuel;
- Digestate – in either a whole, or liquid and fibre fraction. Digestate produced in line with the PAS110 and Digestate Quality Protocol standard meets end of waste criteria, which means that waste regulatory controls cease to apply;
- Contamination that has been screened out during the waste acceptance process; and,
- Other products such as carbon dioxide – can be captured for use in usage or storage applications. Identifying and accessing a viable market if often a challenge with this output, and has historically been vented to atmosphere.

The annual processing capacity of anaerobic digestion systems as discussed above ranges considerably with operational plants in the UK ranging from 25,000 tonnes per annum to some 160,000 tonnes per annum.

4.1.2 Dry Anaerobic Digestion

Dry Anaerobic Digestion (Dry AD) is similar to the Wet AD process outlined above but it is designed to treat materials with a much higher solids content, typically exceeding 15% dry matter. This makes Dry AD particularly suitable for processing stackable materials, such as mixed food and garden wastes. Dry AD systems typically have a lower biogas yield per input tonne than wet AD systems, although are able to extract biogas from a wider range of feedstocks, specifically the garden waste portion of household biowaste.

Dry AD is less widely used than Wet AD, with only four plants operating in the UK, three of which on fines generated from the mechanical-biological treatment of residual municipal wastes. The low-level deployment of this specific technology within the UK often leads to the perception that dry AD is novel or innovative, despite its decade’s long operation across continental Europe.

Unlike wet AD systems, dry anaerobic digestion can operate on either a continuous feed plug-flow basis, or on a batch basis. The general process phases occurring within the dry AD process broadly follows that of the wet anaerobic digestion system.

The process outputs from dry anaerobic digestion are the same as those for wet AD. The key difference is the character of the digestate which resembles a compost rather than liquid digestate.

Reference to dry anaerobic digestion has been made here for completeness, although it is reiterated that the technology is deployed primarily for co-mingled food and garden waste collections. WRM understand that the Partnership have already discounted the option of a co-mingled food and garden waste which precludes further detailed consideration of this technology.

4.2 Regulatory Standards

The Environment Agency initially regulated waste anaerobic digestion sites in line with other waste treatment technologies although recognised the environmental risk associated with the large quantity of liquid waste storage at a single treatment site. The agency therefore began to increase regulatory standards from 2017.

Regulatory standards must be a core part of the plant specification, requiring operators to obtain detailed permits that specify operational requirements, safety measures, and environmental safeguarding policies.

All AD sites must now be developed and operated in line with CIRIA (Construction Industry Research and Information Association) engineering standards, ensuring plants operate within safe limits. Additionally, enhanced emission monitoring requirements continue to be implemented to control the environmental impact of waste processing activities.

Specific attention is drawn to the regulatory approach, recognising that any treatment solution offered to, or developed by the Partnership must fully comply with the prevailing regulatory standards. For the avoidance of doubt, such standards have been assumed when presenting subsequent facility costings.

4.3 PAS110, the digestate quality protocol, and recycling standards

The Anaerobic Digestion Quality Protocol is a set of guidelines developed to ensure that the digestate output of the AD process meet high quality standards and can be safely used in agriculture and field grown horticulture. PAS 110 and the digestate quality protocol place limits on feedstocks, operations and uses of the digestate to regulate digestate quality. A key benefit of meeting the combined standards is that any material produced under the standards attains ‘end of waste’ status and is therefore released from the requirements of the Controlled

Waste Regulations 2011. Producing a PAS110 digestate also ensures that tonnages can be attributed to the recycling rate reported by waste collection authorities in wastedataflow.

This end of waste attribute is seen as a key requirement for local authorities in claiming attribution towards their recycling rate. For digestate, which accounts for c.90% of the total digester output by mass, to meet the waste framework definition of recycling it must comply with an end of waste standard. The PAS 110 and digestate quality protocol provides a sectoral standard which therefore qualifies for local authorities attribute the food waste as in response to Q100 on the annual waste data return that local authorities submit to DEFRA (the Department for Environment, Food, & Rural Affairs). In this return, local authorities must report on various aspects of their waste management activities, including the quality and destination of the digestate produced from anaerobic digestion.

4.4 Options for securing or delivering food waste treatment capacity

Having introduced and described the anaerobic digestion treatment technology, this briefing now turns attention to how the Partnership could either secure or develop capacity for the treatment of food wastes which may result from future recycling collections services. The broad two options available to the Partnership are:

1. To use existing operational facilities on a merchant basis; or,
2. To develop, or instigate the development of new infrastructure which would be developed specifically for the capacity requirements of the Partnership (plus any headroom that might be desired).

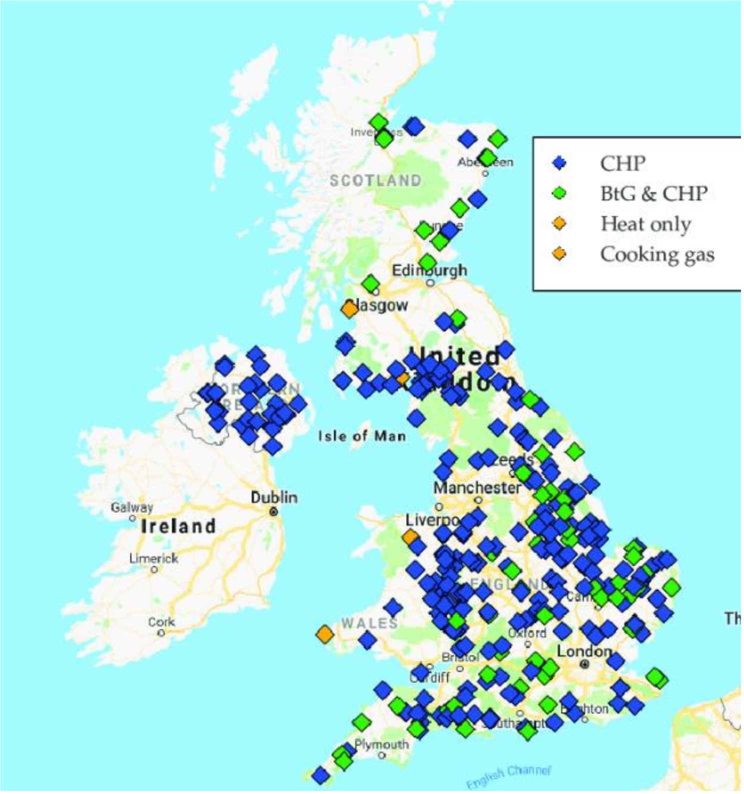
4.4.1 Merchant anaerobic digestion capacity

The expansion of household food waste collections that will be introduced provides an opportunity for existing AD capacity to be better utilised, and for additional infrastructure to be developed.

In 2022, WRM authored a report on the local authority food waste treatment sector which examined installed capacity permitted for waste management use (i.e. excluding agricultural and energy crop digestion) and the utilisation of that capacity for controlled wastes (as measured by waste return data). This report found that much of the anaerobic digestion capacity installed over the past decade is ostensibly operating below its full capacity, or at a capacity level using sub optimal feedstocks. This observation is anecdotally supported through WRM's ongoing engagement with AD operators across the sector.

Currently, the distribution of AD plants permitted to treat biowaste in England is uneven as illustrated in the deployment map compiled by the THYME (Teesside, Hull and York - Mobilising Bioeconomy Knowledge Exchange) project.

Figure 11 – Map of operational waste anaerobic digestion plants in the UK



To meet the mandatory food waste collection policy, local authorities will need accessible food waste treatment facilities within a reasonable delivery distance, and this requires consideration of existing capacity in and around each local authority area.

<u>Anaerobic digestion focus on the northwest of England</u>

The North-West of England is one of the most populated regions in the UK, with a population of just over 7.3 million residents (2020). Currently only the local authorities of Cheshire West and Chester and St Helens Metropolitan Borough Council has a source-segregated food waste collection service. Collectively these authorities are estimated to produce some 22,000 tonnes of source separated household food waste per annum.

Waste data returns show that the North-West region produced 281,000 (2022) tonnes per annum of waste which were delivered for treatment at anaerobic digestion facilities. This includes the quantity collected by two authorities (c.22,000 tonnes per annum) with source segregated collections as well as a substantial quantity of material from commercial (i.e. food service and retail) and industrial (i.e. food manufacturing) sectors. It should be noted that this excludes the food waste collected in co-mingled streams with garden waste which is prevalent in the Greater Manchester area of the region.

It is notable that over half (54%) of the waste suitable for anaerobic digestion produced in the North-West was exported to other regions of the UK for treatment. Waste return data shows that the North-West processed only 138,800 tonnes of waste which accounts for 4% of national inputs, despite the region being home to 13% of England's population. The North-West region has two anaerobic digestion facilities with a combined waste treatment capacity of 172,000 tonnes per annum. The structure and spread of the anaerobic digestion market in the North-West is limited, with approximately 95% of the installed capacity concentrated at a single site in Merseyside (Re-food at Widnes). If all local authorities within the northwest implement source segregated collection, the annual volume of household food waste is estimated to be between 96,900 and 122,900 tonnes.

The projected growth of household food waste, combined with the existing 281,00 tonnes per annum of existing organic arisings (such as commercial and industrial waste), will create a significant oversupply of feedstock for the present level of installed anaerobic digestion capacity. This issue is further emphasised by the fact that most organic waste suitable for anaerobic digestion is already exported from the region, usually to the midland area at a haulage distance of over 100 miles. Consequently, there is no readily available market for locally treating food waste generated by the Partnership. This observation is particularly emphasised by the fact that main plant, Re-food at Widnes, has limited available capacity and primarily focuses on commercial and industrial wastes.

This briefing therefore presents a clear position that relying on existing local anaerobic digestion assets to treat the Partnership's food waste is not a viable option. The conclusion does not entirely preclude the use of merchant capacity, although a decision to do so would likely result in significant haulage distance, incurring both cost and transport carbon emissions, as well as lost opportunities for some of the local circular opportunities aforementioned in this report.

Future anaerobic digestion developments in the northwest of England.

The merchant anaerobic digestion market is dynamic and a number of proposals for future developments have been brought forward to obtain town and county planning and environmental permitting consents. This includes the SUEZ facility in Darwen in Lancashire, and the Iona facility located at Crowland Street Southport.

- **Suez, Darwen.** In anticipation to the forthcoming legislative requirements, SUEZ are progressing the development of a 100,000-tonne wet AD facility to be located at the existing SUEZ Recycling and Recovery Park in Darwen. The facility is set to be located 800 metres from the M65 motorway, providing good transport links to the wider North-West region. Additionally, the site is set 450 metres from a gas grid connection, enabling the injection of AD-derived biomethane into the national distribution network. Planning permission for the facility was granted in February 2023, and is reportedly to be commissioned in April 2025. The plant will be registered to the Green Gas Support Scheme and will inject gas into the regional gas grid.

- **Iona Capital, Southport:** Iona Capital have announced plans for a 80,000 tonne per annum anaerobic digestion facility at Crowland Street, Southport. The facility which has planning permission and an environmental permit and an appointed technology supplier is understood to be looking for sources of contract waste to enable the project reach financial closure which will enable the project to proceed to construction and commissioning.

Whilst these two options have been identified, it is important to note that neither has yet been constructed or commissioned which could make a decision to rely upon one or both of these sites in a business case challenging (WRM is in the process of obtaining an update on the status of these plants as part of this work). Whilst noting the current position of limited merchant assets, it should also be recognised that a pathway to 2029, at which point food waste would be released from current contractual arrangements, could enable other development options to be brought forward and commissioned, and for GGSS fiscal support to be obtained. A process of soft market testing, signalling the prospect of a sizeable food waste treatment contract, undertaken by the Partnership could help to identify such future initiatives that have not yet been publicised.

Notwithstanding that construction work is yet to commence, the development of both of these facilities would leave the Partnership with a comparatively limited level of competition in a procurement for a merchant contract unless other facilities were also developed ahead of the 2029 date. Such facilities could include merchant capacity within the wastewater sector as addressed in the following paragraphs.

4.5 Treatment in the wastewater sector

Another merchant treatment option has been discussed within the Partnership is the use of repurposed anaerobic digestion assets within the wastewater treatment sector. Anaerobic digestion is the most prevalent form of treatment for sewage sludges and the infrastructure developed at wastewater treatment sites is comparable to a food waste treatment facility. The statutory provider of sewage and wastewater treatment in the northwest of England is United Utilities PLC.

WRM are aware of proposals for the development of a food waste treatment plant at the Ellesmere Port wastewater treatment works (WwTW) although that development appears not to have been taken forward. The Partnership have recently engaged with United Utilities to understand potential opportunities for the treatment of the Partnership's food waste. This identified that techno-economic feasibility works are being undertaken at sites in St Helens and Crewe to assess how redundant assets could be re-purposed for food waste treatment. The findings of the techno-economic feasibility assessments are not due to be published until after the completion of this report. The limited details on the potential capacity in the local waste water sector at the time of writing does not materially impact the identification and development of the waste treatment options for the Partnership as the use of such capacity would be on a merchant basis. Any future opportunity to work with United Utilities at a local waste water treatment site is, for the purpose of the options assessment, viewed as being comparable to merchant options within the solid waste sector.

Despite the commonality in treatment technologies, the option of using wastewater assets for co-digestion of the Partnerships food waste faces several regulatory hurdles. These are:

1. Environmental regulatory regimes prevent the physical mixing of materials. The pathogen risk of the respective materials differs and consequently sewage sludge is not permissible in the PAS110 standard, and food waste is not permitted in the safe sludge matrix/sludge to agriculture regulations. This challenge can be overcome by designating segregated digestion lines in a sludge treatment facility; however,

2. OFWATs financial regulatory rules place limitations on the use of wastewater assets for commercial uses such as the treatment of third-party waste (e.g. Partnership Food Waste). The premise here is that assets subsidised by water bill payers cannot be used to generate commercial revenues unless the benefits of those revenues are passed back to those bill payers. To a degree, this diminishes the incentive of water companies to explore the commercial usage of available assets. One option that has been deployed by some water companies has been for the non-regulated/commercial arm of water companies to lease digestion assets from the regulated arm of the business at a market tested rate.

It is notable that where these challenges have successfully been overcome, water companies have typically focused on producing gas and/or electricity for consumption within their energy intensive water treatment and wastewater treatment processes. This could potentially limit opportunities for development of some of the circular solutions that have been described in this report.

4.6 A dedicated food waste treatment plant for Merseyside

In the absence of a merchant market, the other option is for the Partnership to develop a design, build and operate (DBO); or, a design, build, finance and operate facility that provides dedicated capacity for the Partnership requirements. Based on waste modelling undertaken by WRM using the WRAP food waste ready reckoner tool, it is estimated that the Partnership shall have a disposal requirement in the region of 49,000 tonnes per annum as presented in Table 2.

Table 2 – Projected food waste yields per collection authority

Collection Authority	Annual Tonnage Estimate (Low)	Annual Tonnage Estimate (Standard)	Annual Tonnage Estimate (High)
Halton Borough Council	2,950	3,859	4,767
Knowsley MBC	3,424	4,505	5,586
Liverpool City Council	11,486	15,113	18,740
Sefton MBC	7,354	9,357	11,361
St Helens MBC	4,363	5,681	6,998
Wirral MBC	8,092	10,427	12,761
Sub-Totals	**37,669**	**48,941**	**60,213**

High and low yield estimates have also been presented alongside the calculated requirement for c.49,000 tonnes per annum of waste treatment capacity. This range has been included to reflect factors such as service recognition, participation and set-out, all of which are influenced by the range of communication and engagement activities (as described in paragraph 2.2) which are undertaken in support of a collection service. The range may also be influenced by other waste collection factors in other material streams such as restricted residual waste collections.

When specifying waste treatment facilities for dedicated requirements, it is prudent to ensure that sufficient capacity is provided for higher levels of material capture. Additional capacity may also be incorporated for non-household municipal waste such as food waste from schools, hospitals, social care homes, and markets. Depending on the risk appetite and balance, an authority may also look to include an allowance for third party wastes such as commercial wastes that are collected by trade waste services (whether provided by Partnership Authorities or private sector service providers).

A nominal capacity of 80,000 tonnes per annum has therefore been assumed for a purpose built anaerobic digestion facility serving the Partnership needs. Such as facility would:

- Have capacity to serve the maximum household food waste forecast;
- Have surplus capacity for the additional sources of food waste that would be generated within the region; and,
- Would likely comprise two or more digestion lines working in parallel, thereby providing a level of operation contingency.

This nominal capacity will be a point for discussion with the Partnership throughout this project, although is assumed in the remaining information presented throughout this report. It is also noted that facilities of c.80,000 are commonplace in new developments that are proposed in the anaerobic digestion sector. This is due to economies of scale (e.g. building this level of capacity is not comparatively more than a c.50,000 tonne per annum plant) and the tariff bandings within the GGSS incentive scheme which, to a degree, disincentive the development of smaller scale anaerobic digestion facilities.

4.6.1 Capital and operational costs

WRM holds a range of capital costs pertaining to the preparation and construction of anaerobic digestion sites and the installation of equipment therein. The overall cost assumes that the project is delivered by an Engineering Procurement & Construction (EPC) contractor under a Design, Build Operate (DBO) model is presented in Table 3 as bring in the region of £28.6 million.

Table 3 - Capital cost estimate for constructing a dedicate Merseyside food waste treatment facility with a processing capacity of 80,000 tonnes per annum.

Cost item	Cost for 80,000 tonne per annum plant
Site/land costs	£4,040,000

Cost item	Cost for 80,000 tonne per annum plant
Procurement	£300,000
Planning, consents, and development management costs	£200,000
Digestion equipment & gas to grid unit	£12,000,000
Civils & Balance of Plant	£8,000,000
Commissioning costs	£102,000
Design Fees and Project Management	£102,000
Carbon Capture and Storage equipment installation costs	£1,650,600
Capital Cost Contingency	£2,266,900
Subtotal	**£28,661,500**

The operation of a major waste treatment facility shall also incur significant operational costs which WRM have benchmarked and present in Table 4.

Table 4 – Cost of processing estimate for constructing a dedicate Merseyside food waste treatment facility with a processing capacity of 80,000 tonnes per annum.

Cost item	Cost for 80,000 tonne per annum plant
Site Permit Annual Subsistence Fee	£12,000
Equipment Maintenance	£420,000
Operator costs Inc. cost of employment	£251,000
Mobile plant	£102,000
Mobile plant lifecycle	£132,600
Sundry Items e.g. PPE, comms, occasional expenses	£10,200
Training Costs	£5,100
Site Manager Cost to Employ	£71,400
Facility Insurance	£102,000

Cost item	Cost for 80,000 tonne per annum plant
PAS 110 inspection and laboratory testing	£10,200
ABPR visits	£2,400
Operating Contingency	£143,350
Non accepted waste disposal	£240,000
Subtotal	**£1,951,850**

It is important to note that this number does not include financing/capital write down costs which could vary significantly in accordance with different commercial delivery models. Another important observation on this number is that it does not account for any commercial agreement that could be embedded within a BDO/DBFO contract such as gainshare mechanism on energy outputs and/or third-party waste income. Including income from third party wastes received at a future facility could improve the finances set out in this report.

4.6.2 Revenues

The revenues received by a facility pertain to the sale of process outputs and renewable energy incentive schemes such as the Green Gas support scheme. Typical costs have been normalised by WRM to a per tonne basis to provide the Partnership with insight on the revenue levels per tonne that could be anticipated by the operator of a dedicated treatment facility. The calculation of revenue can be complex with different pricing rates applying to portions and/or bandings of the outputs. A base case column has therefore been included to identify which of the line items would apply to the c.49,000 tonnes of food waste that are projected by that Partnership (Table 5).

Table 5 – Revenue estimate for a typical food waste treatment facility

Revenue item	Revenue per tonne of food waste processed	Base case
Gas sales	£22	Y
Green Gas Support Scheme – Band 1	£38	Y

Green Gas Support Scheme – Band 2	£24	N/A
Green Gas Support Scheme – Band 3	£11	N/A
Digestate sales	£2	Y
Third party food waste gate fees	£10	N/A
CO2 sales – food and beverage	£2	Y

Income would typically be expected to be in the range of £63/tonne for waste delivered by the authority. Additional fees could be obtained for any third-party wastes received at the treatment facility, with the band 2 and 3 GGSS rates only being applicable if the plant achieves higher than expected biomethane yields. Third party wastes, such as additional non-household municipal wastes, or local commercial and industrial wastes cannot be guaranteed by the Partnership and have therefore been excluded from this assessment. Their inclusion could however provide a further price optimisation which could be explore through sensitivity testing at a more detailed stage of business case modelling.

4.7 Locations for a dedicated treatment facility

A suitable site for an anaerobic digestion facility is typically around 2 hectares with good access to the primary road network free from HGV constraints. Proximity to waste arisings is important to reduce the distance of waste transfer and subsequent emissions. Proximity to agricultural land for the spreading of digestate is also an important factor, and one that often trades off against the waste delivery distance.

Typically, sites are usually situated in industrial and employment areas, often on contaminated or derelict land. Where possible, sites are ideally located at least 250m from sensitive receptors to minimise their local impact and to conform with environmental permitting requirements.

4.7.1 Joint Waste Local Plan for Merseyside and Halton

This plan, which was adopted in 2013, sets out land allocations that are considered to be suitable for waste management use. The plan differentiates land by the potential type of waste management activity that could be accommodated on each site, although it does not address matters such as current use, availability, or technical factors such as the availability of gas grid and/or power grid connections.

In an option where the Partnership chooses to develop new food waste treatment capacity within the LCR area, work would be required to undertake a detailed review of the joint waste plan land allocations to shortlist and select potential locations based on commercial and technical requirements.

4.7.2 Ince Marshes

Peel Holdings are currently developing a multi-modal resource recovery park and energy from waste facility for use in connection with the recycling industry. The park is being developed on land owned by Peel at Ince Marshes located in Cheshire West and Chester, a short distance from junction 14 of the M56.

In developing the resource recovery park, the company is looking to bring together a cluster of green and renewable industries who can be co-located to drive industrial symbiosis opportunities.

Amongst the development proposals, Peel have been granted planning permission to build a Refused Derived Fuel (RDF) plant for residual waste, a plastics polymer recycling facility and also have land allocated (which still needs to be taken through the planning process) for an anaerobic digestion facility as illustrated in Figure 12.

Figure 12 – Land allocated for anaerobic digestion facility at Ince Marshes (identified in red boundary)

The site holds strategic importance due to its connection to the HyNet project outlined in section 3.7 and could be a strong option for Merseyside given its 30 minutes travelling time from Liverpool city centre (which for other parts of the city region is typically 20-40 minutes).

5.0 STRATEGY OPTIONS FOR FOOD WASTE RECYCLING IN MERSEYSIDE

Having identified available waste collection and waste treatment options, this report now moves on to address how these components can be combined to provide an overall food waste recycling service for Merseyside.

With the resident facing collection service already defined by previous project work, and anaerobic digestion confirmed in policy as the preferred waste treatment technology, the main determinants of a future strategy are the fuel used in the new food waste collection fleet, the location at which treatment is undertaken, and the commercial basis of that treatment.

5.1 Food waste collection: vehicle fuelling options

The first segment of the solution to be examined is the approach to waste collection. The Partnership recently commissioned work from fellow consultancy FRM to examine the detailed collection approach for all refuse and recycling streams in response to the requirements of the Environment Act. As part of this detailed assessment, the option identified for food waste collection comprised:

- Provision of a kitchen and kerbside caddy to residents;
- The use of 7.5 tonne refuse collection vehicles. The work established that some 70-80 vehicles would be required subject to detailed collection variables; and,
- A driver plus one loader crew configuration.

These factors, which are in line with WRM's general expectation for household food waste collections, have not been reopened as part of this work. The one factor that has been considered in further detail is the type of fuel used in these vehicles as this is material to the whole system objective. The following fuel types have been considered (please refer to section 2.0 for detailed description)

1. **Diesel**. This is the baseline fuel with the majority of Partnership fleets being diesel fuelled. A diesel fuel truck would, in most cases, be the default option presented by vehicle suppliers.
2. **Hydrotreated vegetable oil (HVO)**. This biogenic alternative to diesel can be used in Euro VI diesel vehicles as an alternative fuel. There are several examples of local authority and waste management provider fleets operating on HVO which, due to its biogenic content, produces a lower net carbon dioxide emission.

3. **Biomethane gas (and compressed natural gas)**. These vehicles utilise a compressed gas combustion line to power the vehicle chassis. As such, conversion from liquid fuels such as diesel is not viable. A gas-powered vehicle can source its fuel from either a biomethane or (fossil) grid gas source with the latter providing an important sub-option for this vehicle fuel during the first three years of food waste collection. It is noted that Liverpool City Council presently operate a fleet of c.20 gas RCV's which are fuelled from the natural gas grid. Initial calculations project that some 415,000 HGV miles per annum could be fuelled using biomethane produced from the Partnerships food waste. This quantity of fuel would support a new food waste collection service with a surplus of biomethane being available for use in other fleets, and/or for sale into the gas grid.

Electric powered vehicles have not been included within the options assessment. Despite electric RCV's being used by an increasing number of authorities, there are several reasons that have precluded their further consideration. This includes the high total cost of ownership relative to other fuel types. Furthermore, the fact that downstream waste treatment operations are disincentivised from producing electricity precludes a fully circular option from being established. Unlike HVO, which faces the same circular fuel challenge, electric RCV's cannot be readily converted from the diesel baseline.

5.2 Treatment location and haulage requirement

The location at which waste treatment is undertaken has a material impact on the delivery of options. This is due to the transfer and haulage requirements and the potential for local and social value benefits to be derived.

The market assessment presented in section 4.4.1 identifies an acute lack of merchant anaerobic digestion capacity of food wastes in the northwest of England. A number of new facilities have been proposed although are generally at early stages of development. One consequence of this market structure is that collected food disposed into a merchant contract would likely be subject to substantial haulage distances. In procurement work delivered by WRM in early 2024 to neighbouring authorities in the northwest, food waste treatment contracts have been awarded to operators as far as the West Midlands.

The options considered for the location of food waste treatment are:

1. **Within or on the curtilage of the city region.** This option reflects scenarios whereby the Partnership instigates new local capacity; or has the option of using new merchant

capacity that is brought forward. Locations for this treatment would be within direct delivery distance and/or a short transfer distance of the Partnership administrative areas; or,

2. **Inter region locations**. Reflecting scenarios where merchant capacity is used outside the LCR area.

5.3 Waste treatment: commercial basis for providing anaerobic digestion treatment

The policy context in section 1.2 describes how anaerobic digestion is identified in the Resources and Waste Strategy as the preferred treatment technology for household food wastes. All options assume the use of this technology to generate biogas and digestate outputs. The strategic variable addressed at this stage is the contracting approach through which anaerobic digestion capacity is secured.

The contracting approach is fundamental as it determines the capital requirements facing the Partnership, the control on the energy outputs including circularity options, and has a probable relationship with the location of treatment solutions as discussed in section 5.2. The treatment options considered are:

1. **Merchant capacity.** This option would see the Partnership let a contract for treatment of received food waste on a per tonne basis. Selection of output markets would be a decision for the waste treatment provider with limited guarantee of supply to the Partnership. The current availability of merchant capacity would likely see treatment take place outside the LCR area unless new infrastructure is brought forward within the northwest. All adjacencies would be at the discretion of the waste treatment provider.
2. **Merchant capacity with energy buy back.** Aa a variant of option 1, the Partnership could let a mercantile contract with clauses that require a portion of energy output to be sold back to the Partnership. Such supply could be undertaken through a grid 'sleeving' mechanism using Renewable Gas Guarantee of Origin (RGGO) certificates giving flexibility on the treatment location providing that the treatment facility is connected to the national gas transmission grid. Delivery of all other adjacencies would be at the discretion of the waste treatment provider.
3. **Build dedicated capacity for the Merseyside region.** This option sees the Partnership (specifically MRWA) investing in new waste treatment capacity which is for the dedicated use of the Partnership. The delivery of this option cold be undertaken in-house; or, through a DBO/DBFO delivery model. This option, which could also include headroom for the treatment of the region's commercial food wastes, would likely be

built within the LCR area. The facility would be eligible for renewable energy incentive payments (e.g. GGSS) providing a useful revenue source for the Partnership. The Partnership would have full control of the energy outputs providing opportunity for supply of fuel to the fleet and, potentially, other municipal fleets.

5.4 Other options

Alongside the core options of food waste treatment, are options that are adjacencies to the waste treatment process and/or enablers of an optimised circular solution. These include:

1. **Development of biomethane fuelling infrastructure.** Through depot filling stations connected to the gas grid; and,
2. **Carbon capture and use/storage equipment.** To capture carbon dioxide gas from the anaerobic digestion treatment process.

5.5 Option combinations

The options presented in sections 5.1 to 5.4 have been developed into combinations that provide a whole solution for the collection and treatment of food waste.

From a conceptual basis, a fully optimised solution is one in which the Partnership can utilise outputs from the waste treatment service to support food waste collection operations; and potentially, other waste fleet and municipal vehicle fuelling requirements.

In developing options that work towards this fully circular solution, the current contractual arrangements need to be considered. WRM understands that MRWA is presently entered into a contract with a waste management provider (Veolia) for treatment of recyclable materials until 2029. The scope of this contract includes any collected household food waste. This contract effectively determines the initial treatment (and therefore location) option for the first three years of food waste collection (i.e. from March 2026 until 2029), with longer term strategy options then being implemented from 2029 onwards.

Options identification matrices have therefore been established to consider the short-term options available to the Partnership in years 1-3 (Table 6) and in the longer term from year 3 onwards (Table 7). In identifying the option combinations, the matrices also discount options where there is rationale for doing so. Discounted options are identified in grey shading with specific barriers highlighted in red along with a brief description of why an option has been discounted. It is also noted that the development of these matrices involved consultation with colleagues from the Partnership team.

Table 6 – Strategy combination matrix (years 1-3)

Years 1-3 (During current Veolia Contract)									
	Collection			Delivery		Treatment			
Option	Current Fuel Mix	HVO	Grid gas (CNG)	Direct/local transfer	Inter region transfer	Merchant	Merchant with Energy Buy Back	Development of dedicated capacity	Comments
0.1									Procuring diesel vehicles could limit transfer to some long-term options.
0.2									Would also require diesel vehicle procurement. This could limit long term gas options for collection fleet.
0.3									Gas vehicles are purchased and operate on grid gas (e.g. similar to current Liverpool fleet) until biomethane source is available post 2029

Table 7 – Strategy combination matrix (year 3 onwards)

Year 3 onwards (Long term strategy options)									
	Collection			Delivery		Treatment			
Option	Current Fuel Mix	HVO	Biomethane	Direct/local transfer	Inter region transfer	Merchant	Merchant with Energy Buy Back	Development of dedicated capacity	Comments
1									
2									No requirement for vehicle fuel buy back as anaerobic digestion cannot supply diesel
3									
4									
5									No requirement for vehicle fuel buy back as anaerobic digestion cannot supply diesel
6									Unlikely that Partnership would build out of LCR area (NB: periphery of LCR would be local transfer)
7									

Year 3 onwards (Long term strategy options)									
	Collection			Delivery		Treatment			
Option	Current Fuel Mix	HVO	Biomethane	Direct/local transfer	Inter region transfer	Merchant	Merchant with Energy Buy Back	Development of dedicated capacity	Comments
8									No requirement for vehicle fuel buy back as anaerobic digestion cannot supply HVO
9									
10									
11									No requirement for vehicle fuel buy back as anaerobic digestion cannot supply HVO
12									Unlikely that Partnership would build out of LCR area. (NB: periphery of LCR would be local transfer)
13									No source of biomethane available for buy back in a merchant only structure
14									

Year 3 onwards (Long term strategy options)									
	Collection			Delivery		Treatment			
Option	Current Fuel Mix	HVO	Biomethane	Direct/local transfer	Inter region transfer	Merchant	Merchant with Energy Buy Back	Development of dedicated capacity	Comments
15									
16									No source of biomethane available for buy back in a merchant only structure
17									
18									Unlikely that Partnership would build out of LCR area (NB: periphery of LCR would be local transfer)

The option matrices presented in Table 6 and Table 7 provide a comprehensive approach to identifying combinations of options and also enable an initial down selection of options where it is clear that there are barriers to an option proceeding. This structured process has shown that all short term (year 1-3) options are feasible and that the initial longlist of 18 options has been reduced down to a shortlist of 9 options. Reasons for discounting long term options are stated within Table 7 , and can generally be summarised as:

- The Partnership being highly unlikely to invest in dedicated treatment capacity out of the LCR region and its immediate periphery. It should be noted that immediately adjacent areas such as the Ince Marshes site described in 4.7.2 have, as a result of their potential to offer Social Value to the LCR Region, been included within the LCR region options.
- There being no requirement for vehicle fuel buy back by the Partnership where biomethane is not used; or,
- There being no source of biomethane available for the Partnership to use as a vehicle fuel in merchant only treatment options.

The discounting of several long terms option combinations provides a shortlist which has been taken forward to a detailed level of option evaluation (Table 8).

Table 8 – Shortlist of long-term strategy option combinations

Option	Collection fuel	Treatment Location	Provision of capacity
1	Diesel	LCR Region	Merchant
3	Diesel	LCR Region	New build dedicated capacity
4	Diesel	Inter-regional transfer	Merchant
7	HVO	LCR Region	Merchant
9	HVO	LCR Region	New build dedicated capacity
10	HVO	Inter-regional transfer	Merchant
14	Biomethane	LCR Region	Merchant with biomethane fuel buy back
15	Biomethane	LCR Region	New build dedicated capacity

Option	Collection fuel	Treatment Location	Provision of capacity
17	Biomethane	Inter-regional transfer	Merchant with biomethane fuel buy back

6.0 STRATEGY OPTION EVALUATION

The shortlisted strategy options listed in Table 8 have been evaluated from strategic quality and financial perspectives to identify a preferred option combination that best aligns with the Partnership's priorities. This section details the approach and outcome from the application of the selected evaluation criteria.

6.1 General identification of option merits

Prior to any formal option evaluation taking place, the project made a general assessment of the merits, advantages and benefits of each component option, along with drawbacks, disadvantages and risks. The purpose of this initial assessment was to provide a context against which option combinations could be scored and weighted.

Appendix A sets out the review of option merits which was presented to the Partnership for review and comment as part of the option development phase of the project. In presenting this view of option merits, WRM note that the assessment is provided from a generic and independent perspective and that the listed points may not be exhaustive; particularly in respect of some of the specialist perspectives that may exist across the waste collection and treatment value chain. It is however a point of reference which has been used in the scoring and weighting of option combinations in subsequent paragraphs of this section.

6.2 Short term option evaluation

Work on the evaluation initially sought to address the short term (years 1-3) options presented in Table 6. This matrix confirmed that all options are deliverable and that the commercial basis for, and location of waste treatment are effectively fixed by the current Veolia contract.

The variable differentiating each option is therefore the fuel type used in the food waste collection service. Waste collection vehicles have a generally accepted lifespan of 7 years upon which most local authority fleets are replaced for new vehicles. The balance of the fuel use within the collection vehicles therefore lies in the fuel use options within the long rather than short term options.

Of greater importance is perhaps the risk that selection of a collection vehicle fuel in the short term could constrain or limit the delivery of some longer-term strategy option combinations. An example of this would be the specification of a diesel or HVO fuelled food waste collection fleet which could create challenges in subsequent delivery of a biomethane option. Specific challenges could include replacement of fleet ahead of its scheduled lifecycle replacement dates, integration with fuelling infrastructure, or the ability of the Partnership to offer a substantive biomethane off-take from the commencement of a waste treatment contract.

Given the relative weighting of the short-term options and the risk that longer term strategy options could be constrained through short term option selection, this work has set aside the short-term options to enable focus on the long-term strategy options, recognising that the solution deployed in years 1-3 of food waste collections will in fact be determined by the selected long term strategy option combination.

6.3 Evaluation of strategic and qualitative considerations

The project commenced with an evaluation of the strategic and qualitative considerations in advance of and separate to the financial evaluation which is presented in Section 6.4. This approach ensured that the scoring and weighting of quality options was carried out without any undue influence from the financial position of each option combination.

Initial assessment of option merits

Evaluation has first considered the strategic and qualitative merits of each option which have been assessed against the priorities of the Partnership. Eight strategic and quality criteria were proposed by WRM to the Partnership to reflect factors such as the importance of capacity certainty, deliverability and reliability of options, social value, and the benefits of the fully optimised circular food waste recycling service being examined in this work. Table 9 presents the quality criteria along with the broad measurement and details of how each criterion relates to the Partnership.

Table 9 – Strategic & quality evaluation criteria

Strategic & Quality Criterion	Criterion measurement	Details
Proximity principle and perception of treatment location	Proximity to Central Liverpool (as a reference point)	Options may have a difference in the haulage distance to the location at which waste treatment is undertaken. The proximity principles direct for waste to be treated as close to its arising as possible. Cost and carbon emissions (included in other evaluation criteria) will increase with haulage distances. There may also be an adverse/negative public perception associated with exporting waste for treatment outside the city-region, or northwest region.

Strategic & Quality Criterion	Criterion measurement	Details
Security of capacity /offtake	Long term security and stability of off-take	At c.45,000 tonnes per annum, the Partnership has a substantial disposal requirement. The limited level of competition in the northwest, combined with other authorities requiring treatment capacity from March 2026 could see concerns on the long-term availability/stability of food waste treatment capacity for Merseyside.
Local long-term infrastructure for Merseyside	Delivery of social value benefits for Merseyside	The development of local infrastructure can provide a range of (non-capacity certainty) benefits. This includes a range of social value objectives and the ability for the Partnership to specify the outputs and to respond to and capitalise upon future innovations.
Delivery of adjacencies	Delivery of a fully optimised and circular solution for the region's food waste	The ability of the authority to specify outputs varies in each option. Some options provide a greater level of certainty that the fully optimised circular solution desired by the Partnership will be delivered.
Integration with regional sustainability objectives	Delivery of strategy and integration with other initiatives	The ability of each option to contribute to wider Merseyside sustainability objectives varies with some options having potential to contribute towards the wider decarbonisation of the Partnership authorities' operations. Options also vary in their ability to integrate with other regional initiatives such as Hynet.

Strategic & Quality Criterion	Criterion measurement	Details
Delivery certainty	The level of friction in delivering the option	Some options can be delivered with certainty, whereas others will require varying levels of procurement, construction and commissioning. More complex pathways that have interdependencies can diminish the certainty that the targeted solution will be delivered.
Carbon balance	Ability to maximise carbon savings	The level of carbon savings attained by/attributed to the Partnership authorities will vary in each option
Capital cost requirement across Partnership	The ability of the Partnership to meet the capital spend requirements	Some options will require substantial upfront spend to develop new infrastructure and/or purchase new vehicles. The budget availability or funding approach for each option will vary

Prior to being taken forward, the criteria proposed by were discussed and tested with Partnership representatives to ensure their alignment to the collective strategic outlook. As part of these discussions, it was noted that potential criteria such as recycling rate impact could be applied to the options, although are determined by variables not considered in this work. In the case of recycling rate impact, such variables might include resident communications undertaken in support of a service launch, and other waste collection approaches such as restricting residual waste collections.

Option scoring

A scoring approach was developed for the application of the strategic and quality criteria presented in Table 9 to the strategy option combinations listed in Table 8. This used a simple 1-3 scoring system with a score of zero also being included for a number of criterion where a score of 1 might not be applicable (e.g. for criteria with potential for no benefit whatsoever, or for criteria which might have been not applicable). The 1-3 scoring system was calibrated against a 1-5 and 1-10 scoring system to check and confirm that the use of a limited range of scores allowed for sufficient distinction of the option combinations, Appendix B provides a full breakdown of the available scores and a guide for allocating scores against each strategic and quality criterion.

The application of the scoring guide to the option combinations listed in Table 8 was then undertaken by WRM. This provided an independent perspective based on the waste strategy, procurement and service and infrastructure experience of the delivery team.

Scoring of carbon balance as a strategic and quality criterion

In seven of the criteria, the application of scores was based on qualitative assessment, although for carbon, reference was made to the quantitative model which provides a comparison of the carbon impacts of each option combination. This model applies input data from a range of service variable to greenhouse gas reporting factors published by the Department for Energy Security and Net Zero (DESNZ), specifically:

- For the collection options – the carbon emissions from the combustion of different fuel sources. The model developed by WRM takes into account the annual mileage for each waste collection vehicle, fuel economy rates, and the different carbon emission profiles for the various fuel sources;
- For the haulage options – the carbon emissions associated with transfer and haulage within or outside the region. With limited visibility on fuel sources, it has been assumed that all bulk haulage vehicles operate on diesel fuel as the specification of this fleet may fall outside the Partnership's remit. Further carbon savings could therefore be attained if a fuel such as HVO or biomethane were to be used to support bulk haulage.
- For the waste treatment option – the carbon emissions associated with the waste treatment process have been accounted for along with the carbon benefits of bioenergy production and the use of digestate in place of manufactured fertilisers.

A breakdown of the carbon profile for the collection, haulage and treatment components of each option combination are presented in Table 10. This data formed the reference point in the comparative scoring of carbon emissions within the quality criterion for carbon balance.

Table 10 – Summary of option carbon emissions calculated by option project model

	Collection tCO2e/annum	Haulage tCO2e/annum	Treatment tCO2e/annum	Total Carbon Position	Ranking
Option 1	713,553	86,840	-15,837,151	-15,036,758	7
Option 3	713,553	86,840	-15,837,151	-15,036,758	7
Option 4	713,553	423,866	-15,837,151	-14,699,732	9
Option 7	71,355	86,840	-15,837,151	-15,678,955	1
Option 9	71,355	86,840	-15,837,151	-15,678,955	1
Option 10	71,355	423,866	-15,837,151	-15,341,930	5
Option 14	85,626	86,840	-15,837,151	-15,664,684	3
Option 15	85,626	86,840	-15,837,151	-15,664,684	3
Option 17	85,626	423,866	-15,837,151	-15,327,659	6

The carbon balance presented in Table 10 illustrates the anticipated difference in emissions between diesel vehicles and HVO or biomethane vehicles; and separately, the difference in carbon emissions associated with the haulage to proximate and inter-regional waste treatment locations. The carbon balance also shows that the waste treatment segment of the value chain provides a significant carbon benefit. This carbon benefit derives from several factors such [as the diversion of material from the residual waste stream, the producing of a short cycle carbon fuel that displaces fossil sources of methane gas, and the production of digestate as a biofertilser which is used in place of carbon intensive mineral and compound fertiliser products]. Collectively, these benefits significantly outweigh any carbon emissions incurred within the waste treatment process (e.g. the energy required to operate the treatment process).

Strategic and quality allocated scores

The scoring approach described in the preceding paragraphs has then been applied to the shortlisted option combinations set out in Table 8. The raw scores allocated to each option are presented in Table 11.

Table 11 – Allocated scores for strategy option combinations

Option	1	3	4	7	9	10	14	15	17
Proximity principle and perception of treatment location	2	3	1	2	3	1	2	3	1
Security of capacity /offtake	1	3	2	1	3	2	1	3	2

Option	1	3	4	7	9	10	14	15	17
Local long-term infrastructure for Merseyside	2	3	0	2	3	0	2	3	0
Delivery of adjacencies	1	1	1	1	1	1	2	3	2
Integration with regional sustainability objectives	1	1	0	1	1	0	2	3	1
Delivery certainty	2	1	3	2	1	3	2	1	2
Carbon balance	1	1	1	3	3	3	3	3	3
Capital cost requirement across Partnership	0	3	2	0	3	1	2	3	1
Sub-total	**10**	**16**	**10**	**12**	**18**	**11**	**16**	**22**	**12**

Option weighting

In allocating scores to the option combinations, it is recognised that not all evaluation criteria are of equal importance to the Partnership. Indeed, it is reasonable to expect differences in perceived importance amongst member authorities within the Partnership depending upon their segment of the value chain (e.g. waste collection or waste disposal).

To address this observation, weightings have been applied to the scores presented in Table 11 to reflect the priorities of the Partnership members across the evaluation criteria. An initial even allocation of 12.5% per criterion was selected as a starting point and each member of the Partnership was invited to express their perceived importance; either through the return of adjusted percentages, or through a general ranking and narrative which could be converted by WRM to a percentage. This process resulted in agreement on three variants of weightings which are:

1. A neutral weighting with all criteria being weighted evenly;
2. A capacity certainty weighting whereby substantial weight (c.30%) is allocated to the certainty of long term capacity provided by each option. Discussions with Partnership representatives cited the acute lack of merchant capacity within the LCR area and wider northwest region as a reason for this scenario; and,
3. A weighting placing elevated importance on the delivery of environmental adjacencies and social value alongside capacity certainty. This weighting reflects the desire of the Partnership to explore the fully optimised, circular food waste treatment option that is addressed in this options assessment study.

Table 12 – Weightings (including three agreed variants) applied to the scoring of strategy option combinations.

Theme	Criterion	Even Apportionment	Capacity certainty recognised as a key risk	Delivery of secure capacity delivering environmental adjacencies
Proximity principle and perception of treatment location	Proximity to Central Liverpool (as a reference point)	12.50%	10.00%	15.00%
Security of capacity /offtake	Long term security and stability of off-take	12.50%	30.00%	25.00%
Local long-term infrastructure for Merseyside	Delivery of social value benefits for Merseyside	12.50%	10.00%	5.00%
Delivery of adjacencies	Delivery of a fully optimised and circular solution for the region's food waste	12.50%	10.00%	20.00%
Integration with regional sustainability objectives	Delivery of strategy and integration with other initiatives	12.50%	10.00%	5.00%
Delivery certainty	The level of friction in delivering the option	12.50%	10.00%	10.00%
Carbon balance	Ability to maximise carbon savings	12.50%	10.00%	15.00%
Capital cost requirement across Partnership	The ability of the Partnership to meet the capital spend requirements	12.50%	10.00%	5.00%
	Sub-total	**100%**	**100%**	**100%**

The weightings set out in Table 12 have then been applied to the raw scores in Table 11 to provide weighted scores for each of the nine shortlisted strategy options. Appendix C details the weighted scores for each and every criterion, which are summarised for each of the three weighting variants in Table 13.

Table 13 – Summary of weighted scores for each weighting variant

Weighting	1. Even apportionment		2. Capacity certainty with even apportionment of other criteria		3. Local treatment capacity that delivers environmental adjacencies	
Option	Weighted score	Rank	Weighted score	Rank	Weighted score	Rank
1	42%	8	40%	9	42%	9
3	67%	3	73%	3	67%	3
4	42%	8	47%	7	47%	8
7	50%	6	47%	7	52%	7
9	75%	2	80%	2	77%	2
10	46%	7	50%	6	55%	6
14	67%	3	60%	4	63%	4
15	92%	1	93%	1	93%	1
17	50%	5	53%	5	60%	5

The analysis presented in Table 13 identifies a number of strategy options that consistently perform well against the strategic and quality criteria that have been established for the Partnership.

Option 15, which involves the adoption of a biomethane fleet, and the development of dedicated capacity (on a DBO/DBFO basis) within the LCR region, performs consistently well across all variants of the criterion weightings. This is perhaps not surprising noting that this option represents the fully optimised, circular option for treating the Partnership's food waste which is being addressed by this project. In addition to providing capacity certainty within the region, the option offers a range of strategic benefits including application of the proximity principle, contribution to region decarbonisation initiative (with potential to integrate into CCU/S), local social value benefits, and the delivery of a long-term asset for use by the Partnership authorities.

Options 3 and 9, which involve the development of a dedicated treatment plant within Merseyside also perform well consistently well across the weighting variants. The benefits of these options generally reflect the merits of option 15, specifically in relation to capacity certainty through a dedicated asset, social value delivery, and the proximity principle. These options however do not reflect the fully optimised solution due to the use of diesel or HVO fuel in the collection fleet.

Option 14, comprising a biomethane fleet with local merchant treatment with vehicle fuel buy back, also performs consistently above average for the same reasons as options 3 and 9. The limited control of the Partnership in areas such as social value, and potential limitations on regional sustainability initiatives (e.g. Hynet) which cannot be guaranteed at this stage are reasons that may result in a lower strategic quality score for option 14.

6.4 Evaluation of the financial position of each strategic option

Each strategy option taken forward for modelling has been modelled on a whole service cost basis. The model comprises collection costs associated with a dedicated food waste round design, launch costs for the rollout of such a service, annual operational costs to maintain the collection service, costs associated with the transfer of collected material to a treatment end destination and the carbon impact of the collection and treatment of the material.

To allow for a direct evaluation of each option against each other, the model has calculated each option on a whole life cost per tonne basis, with the calculation steps set presented throughout this section of the report.

Integrated collection and treatment model

Baseline values for collection and treatment have been assembled and input into a financial and carbon model which underpins this project report which enables a direct comparison of the whole option cost and carbon performance to be directly evaluated.

Baseline costs for collection, treatment and carbon performance are provided through a series of model input sheets as listed below. It should be noted that model input data is inputted/calculated for all six authorities that form the Partnership.

Food Waste Round Design (Appendix D): Sets out the modelled parameters for a food waste collection round for each of the Partnership Authorities. The food waste round design sheet includes the following data for all six Partnership authorities:

- Property numbers and apportionment based on 2023 census data (e.g. Balance of houses vs HMO properties);
- The in-property (7-litre) and external food waste caddies (23-litre) to be provided to households as part of the service;
- The collection frequency of the material (weekly);
- The assumed pass rate for each collection vehicle, and the number of rounds each vehicle will complete per week;
- The number of days the collection round is in service per week (5);

- The number of vehicles required to service the collection rounds on a weekly basis;
- The assumed set out rate of containers at the kerbside, and the quantum of material expected to be collected from participating households annually;
- The estimated quantity of material collected per vehicle per collection round;
- The financing assumptions taken for the fleet of vehicles to be purchased for use in the service;
- The anticipated annual mileage of each collection vehicle, the fuel economy of each collection vehicle, and the resulting fuel consumed by each collection vehicle. This has been modelled for diesel, HVO and Biomethane vehicles.

Food Waste Launch Costs (Appendix E): Sets out the costs associated with the launch of a food waste collection service for each of the Partnership Authorities. The sheet includes the following data:

- Round design costs, comprising the purchase of round routing software and route planning, plus staff costs for a team of co-ordinators and supervision on the ground to support container and service delivery and troubleshooting.
- Costs to publicise and promote the rollout of the food waste collection service, which comprises a promotional campaign to launch the service, and an ongoing publicity campaign to maintain participation.
- Costs associated with the provision of in-property caddies and external containers to households and multi-occupancy dwellings.

Collection Round Costs (Appendix F): Sets out the price inputs used to calculate the launch and annual operational costs of a food waste collection service, which comprises the following:

- Input prices for round design costs.
- Input prices for publicity and promotion, both for the launch of the service and its ongoing annual operation.
- The cost of supplying replacement containers to households and multi-occupancy dwellings, expressed as a figure per household.
- The cost to the authority of supplying liners to residents. Expressed as a figure per household per year.
- Capital costs associated with the procurement of diesel, HVO and Biomethane vehicles.
- Fuel costs associated with the operation of collection vehicles to service collection rounds. Expressed as a £/litre, or £/kg figure, depending on the fuel type.

- Assumed costs associated with the annual repair and service of collection vehicles, expressed as a cost per annum.
- Costs associated with staff employed to deliver the collection services. Includes staffing costs for vehicle drivers, loaders and an annual allowance for PPE provision.

Food Waste Op Costs (Appendix G) (Diesel, HVO and Biomethane): Sets out the costs associated with the annual operation of a collection service using a diesel, HVO and Biomethane collection vehicle fleet, comprising the following factors:

- Caddy replacement costs (assumed 4%).
- Provision of liners (assumption of 2 liners provided per week to households).
- An annualised cost for the procurement of Diesel, HVO and Biomethane vehicles.
- Staffing costs for vehicle drivers, loaders and an annual allowance for PPE provision

Transfer Delivery Tonnages (Appendix H): Sets out the waste apportionment and growth figures for food waste arisings across the six authorities

Transfer Distances and Costs (Appendix I): Sets out the costs associated with the handing and transfer of food waste arisings across various haulage distances. The key variable in this sheet is local/LCR region transfer vs interregional transfer.

Anaerobic Digestion Base Values (Appendix J): Sets out the inputted base revenues, capital expenditure (CAPEX), operational expenditure (OPEX) and overheads/fixed costs associated with the construction, operation and maintenance of a wet anaerobic digestion system with an annual operating capacity of 80,000 tonnes per annum. This value has been assumed to accommodate the c.50,000 tonnes of food waste that are estimated to arise from the Partnership authorities, as well as headroom for other local waste sources. The selection of this capacity also reflects the level of capacity that is commonly developed from a economy of scale perspective.

Treatment Option Definition (**Appendix K)**: Allows for the coding of different treatment options, or combinations of different treatment options, including the adjustment of specific variables required to develop the scenarios to which each option pertains..

The Treatment Option Definition Sheet directly links to the treatment output sheets, summarised below:

- **Wet AD – Mercantile (Appendix L):** Sets out the costs of processing to the Authority should the household food waste arisings generated in the LCR region be treated through mercantile capacity.
- **Wet AD – Authority Site (Appendix M)**: A discounted cash flow model linked to the options involving the construction of an anaerobic digestion plant. The model includes anticipated revenues derived from the sale of process outputs and CAPEX and OPEX (fixed and variable) costs associated with the construction and operation of an anaerobic digestion asset. The application of the project's net margin, divided by the annual tonnage results in the calculation of the anticipated gate fee.

Carbon Data Input sheets – Carbon calculations associated with the collection, transfer and treatment collected food waste, and the measured carbon impact of haulage and spreading of natural digestate. (**Appendix N, O, P and Q**).

Model Assumptions

Listed below are a number of general key assumptions that have been taken into account with respect to the construction of the financial model:

- The modelled technology is wet Anaerobic Digestion.
- The start year of the project is set at 2029, consistent with the expiry timeline of the WRM Contract that the LCR has with Veolia. This start year is also after the closure of the GGSS scheme meaning that revenues from that incentive scheme would be available from the service commencement date.
- The baseline project term is set at a 15-year payback period. A reason for this is the alignment with the GGSS tariff duration, from which a proportion of revenues are expected to be received over the project term. A project duration of 15 years also allows for a balance between short term value for money offerings; allowing the Partnership to enjoy the economy of scale advantages associated with new build infrastructure generated over time, whilst simultaneously providing an opportunity for adaption to potential future market developments/innovations. It should be noted that any facility constructed would have a design life greater than 25 years and will serve as a long-term asset for the Merseyside region.
- Year 1 tonnage is based on the WRAP IMD estimation approach which stands at 49,789 tonnes. The model assumes a 2% municipal waste growth factor year on year. Third party tonnages derived from commercial or other non-domestic sources (such as schools or hospitals) have not been included within the baseline model but are a key sensitivity which could potentially reduce the effective gate fee payable for household waste collected by the Partnership.

- The model assumes a 45% material capture rate for food waste, in line with the Firth report.
- New build dedicated capacity shall be financed by the Partnership, due to local authority access to lower borrowing rates. This is set for modelling purposes at 3.5% in line with WRM's previous experience.
- Baseline revenues associated with the processing of food waste through each new build dedicated capacity option are set out in Table 5 of this report. This excludes third-party gate fees, due to the absence of any third-party waste being processed under a baseline scenario.
- "Inter-regional transfer" represents the movement of material out of the North West England region into neighbouring areas centred around the Midlands and Warwickshire regions. The transfer distance (from a central postcode within the LCR Region – L3 0BE) has been set at 98 miles for modelling purposes. If capacity were not available at plants in this area, this distance could increase although any increase in carbon emissions would be minor in comparison to the carbon impact of the initial haulage distance (e.g. the assumed 98 miles) and the carbon benefits of the biomethane associated with the treatment of the food waste.

Costs and revenues

Costs associated with vehicle procurement and annual servicing and maintenance arrangements are set out in section 2.6. Capital and operational costs and revenues associated with the construction, management and operation of a purpose-built facility are set out in sections 4.6.1 and 4.6.2 respectively. All costs used to inform the financial model have been sourced from a combination of engagement with industry suppliers/representatives, obtained from similar WRM reference projects, and/or anecdotal evidence from some twenty years of experience within the waste management industry.

Financial Assessment Option Summary

The summary of the financial assessment for each of the modelled options is shown in Table 14 which summarises key cost categories from the financial model.

Table 14 - Financial summary of modelled options

Option	1	3	4	7	9	10	14	15	17
Launch Cost (£m)	7,307,179	7,307,179	7,307,179	7,307,179	7,307,179	7,307,179	7,307,179	7,307,179	7,307,179
Contract Collection Cost (£m)	135,785,588	135,785,588	135,785,588	139,546,429	139,546,429	139,546,429	134,094,822	134,094,822	134,094,822
Contract Transfer Cost (£m)	10,770,716	10,770,716	20,164,442	10,770,716	10,770,716	20,164,442	10,770,716	10,770,716	20,164,442
Contract Treatment Cost (£m)	17,220,351	12,213,129	17,220,351	17,220,351	12,213,129	17,220,351	17,220,351	12,213,129	17,220,351
Treatment cost (£/tonne)	20.00	14.18	20.00	20.00	14.18	20.00	20.00	14.18	20.00
Total Contract Cost (£m)	163,776,655	158,769,433	173,170,381	167,537,496	162,530,274	176,931,223	162,085,889	157,078,667	171,479,616
Contract Cost Ranking	**5**	**2**	**8**	**6**	**4**	**9**	**3**	**1**	**7**

The approach to launching a source-segregated food waste collection service with the ambition of driving resident engagement and maximising recycling rates is assumed to be the same in all options, and therefore launch costs for a food waste collection service are estimated to be £7,307,179.

The cost differential in collection costs observed across the modelled options can be attributed to the fuel used in the vehicles used to service the collection rounds. Options in which a biomethane vehicle is used to service the collection rounds demonstrates the lowest collection cost, approximately £1,690,000 (or 1.25%) cheaper than the diesel collection vehicle, which ranks second on collection. As demonstrated in section 2.6, a 7.5 tonne food waste collection vehicle using biomethane as its fuel source is approximately £17,000 more expensive than its traditional diesel counterpart. However, the lower fuel price and fuel economy difference to a diesel-fuelled vehicle results in the lowest collection cost, when the whole life vehicle cost is taken into account.

The difference in the transfer cost observed amongst modelled options is attributed to the location by which waste arisings are transferred to for treatment. Modelling demonstrates a cost increase of over 60% when material is transferred out of the Partnership area and northwest. This statistic is important noting the acute lack of anaerobic digestion capacity within the northwest of England.

Differences in contract treatment costs are attributed to the delivery model by which each option is executed. Where a new build dedicated capacity option has been modelled, an assumption has been taken that the Partnership would receive and benefit from the revenues associated with the operation of an Authority owned asset, which includes GGSS tariff payments, revenue generated from the sale of upgraded biomethane to the collection authorities, digestate sales and the sale of captured carbon to applicable markets. The discounted cashflow model has calculated a price per tonne of £14.18 over the assumed 15-year project term when these revenues are taken into account.

In options where merchant capacity is utilised, the gate fee has been set at £20/tonne. This is representative of the merchant market, based on WRM's recent local procurement experience. The c.£6/tonne difference observed between the merchant capacity gate fee and the new build anaerobic digestion facility option is attributed to the higher borrowing rates associated with private investment (set at a typical 8.5% within the model), and investor return that is expected to be generated on renewable energy projects of this nature.

Financial Analysis – Cost per Tonne Basis

Baseline food waste tonnages upon which the project report findings are based are set out in in the Transfer Delivery Tonnages tab of the integrated model. The base model assumes some 860,000 tonnes of food waste arisings generated from the Partnership region shall be sent for treatment via Anaerobic Digestion over the project period. Table 15 below provides a summary on a cost per tonne basis for each modelled option.

Table 15 - Financial performance of each modelled option expressed on a cost per tonne basis

Option	1	3	4	7	9	10	14	15	17
Launch Costs (£ per tonne)	8	8	8	8	8	8	8	8	8
Collection Cost (£ per tonne)	158	158	158	162	162	162	156	156	156
Transfer Cost (£ per tonne)	13	13	23	13	13	23	13	13	13
Treatment Cost (£ per tonne)	20	14	20	20	14	20	20	14	20
Total Option Cost (£ per tonne)	198.70	192.88	209.61	203.07	197.25	213.98	196.74	190.92	207.65
Cost per Tonne Ranking	**5**	**2**	**8**	**6**	**4**	**9**	**3**	**1**	**7**

As anticipated, the results of the calculations performed to inform Table 15 mirror those presented in Table 14. Option 15 (biomethane fuelled collection fleet with Authority-built asset within the LCR region) demonstrates the lowest option cost per tonne, almost £2 per tonne cheaper than the second-ranked option, option 3 (Diesel fuelled collection fleet with Authority-built asset within the LCR region) and c.£5.80 cheaper than the third-ranked option, option 14 (biomethane fuelled collection fleet with merchant capacity within the LCR region, with biomethane buy back).

6.5 Combined strategic quality and financial assessment

Having evaluated strategic quality and financial criteria independently, the assessment now proceeds to bring together all evaluation criteria into a single assessment. The weighted quality scores (for each variant) presented in Table 13 have been brought together with the total cost per tonne for each option presented in Table 15. A summary presenting this combination of financial and strategic quality criteria is set out in Table 16 as an overall evaluation of strategy options for the project.

Table 16 – Summary of overall (financial and weighted strategic & quality) evaluation

	Financial		Strategic & Quality					
	Total price per tonne of food waste treated		1. Even Apportionment		2. Capacity certainty with even apportionment of other criteria		3. Local treatment capacity that delivers environmental adjacencies	
Option	Price (£/t)	Rank	Weighted score	Rank	Weighted score	Rank	Weighted score	Rank
1	£198.70	5	42%	8	40%	9	42%	9
3	£192.88	2	67%	3	73%	3	67%	3
4	£209.61	8	42%	8	47%	7	47%	8
7	£203.07	6	50%	6	47%	7	52%	7
9	£197.25	4	75%	2	80%	2	77%	2
10	£213.98	9	46%	7	50%	6	55%	6
14	£196.74	3	67%	3	60%	4	63%	4
15	£190.92	1	92%	1	93%	1	93%	1
17	£207.65	7	50%	5	53%	5	60%	5

This combined strategic and quality assessment provides a preferred option that leads the options rankings on both financial criteria, and in a variety of sensitivity tested strategic quality criteria.

Option 15 which involves the development of dedicated anaerobic digestion treatment capacity within the LCR region and the use of a portion of the generated biomethane in the vehicle fleet, is therefore the recommended option to be taken forward from this option evaluation and assessment. As discussed throughout section 6.3, the application of lower borrowing rates available to local authorities and the control and pass through of biomethane revenues results in this option representing the lowest price. At the same time, the option offers many strategic and quality benefits including capacity security, local social value benefits, and potential for the maximum level of decarbonisation opportunities. In making these concluding remarks, it is noted that option 15 constitutes the fully optimised and circular food waste recycling service that the Partnership set out to investigate through this work.

The combined evaluation summary presented in Table 16 also identifies a number of other options that performs consistently well. Noting these options at this stage may be helpful to the Partnership as they could provide reserve options in the event that the preferred option or part thereof were to be undeliverable for an unanticipated reason. Options 3 and 9 both involve the construction of a dedicated treatment facility on a DBO/DBFO basis albeit with diesel and HVO fuels respectively used in the collection fleet. Such options could provide fallbacks in circumstances where the circular vehicle fuel is not deliverable, with the diesel use in option 2 providing a price driven alternative, and the HVO fuel use in option 9 maintaining the decarbonisation priority.

Option 14 is also notable as it is similar in most aspects to option 15, albeit with the treatment capacity being developed by the waste sector on a merchant basis with sale of vehicle fuel back to the Authority. Whilst some of the financial value is lost as a consequence of the merchant structure, many of the local social value benefits would continue to be delivered; albeit with less certainty that all adjacency opportunities would be developed by the operator. Option 14 could therefore provide a useful contingency option to the preferred option in any circumstances where procurement of dedicated capacity falls through, or in circumstances where a variety of local merchant treatment options are quickly brought forward and become available. Indeed, WRM have recent public sector procurement experience with Cheshire East Council where a DBFO solution and merchant option for the same technical solution were run alongside each other with selection between the final tenders for each lot being at the absolute discretion of the Authority. Such an approach enabled flexibility on the selected development approach right up to the point of final evaluation and identification of preferred bidder.

A final important note on the preferred option and reserve options is that compliance is attained with the Environment Act 2021 requirements for household food waste in all options following the legislated March 2026 implementation date.

7.0 CONCLUSION AND RECCOMENDATIONS

This section concludes the project by reflecting on the key findings of the work as well as setting out recommended actions that the Partnership can take to progress the preferred strategy option.

7.1 A structured approach to strategy development

The project has provided a structured approach to identifying the optimal food waste recycling option for the LCR Partnership.

This commenced with a briefing which has contextualised and informed each segment of the food waste recycling chain. Through the provision of this briefing at an early stage of the project, colleagues across the Partnership authorities have been able to confirm their understanding of the 'known' evidence base and have also been able to understand previously 'unknown' matters which are material to a future food waste strategy decision. By providing the evidence base in sections 2 to 4 of this report, the project has levelized the understanding of Partnership colleagues as a collective decision on the strategy option is taken and progressed.

The project has provided a systematic approach to option identification and down selection. This has balanced the baseline merchant or off-take type structures that have prevailed to date with, a spectrum of option combinations up to and including a fully optimised and circular solution for collecting and treating household food waste.

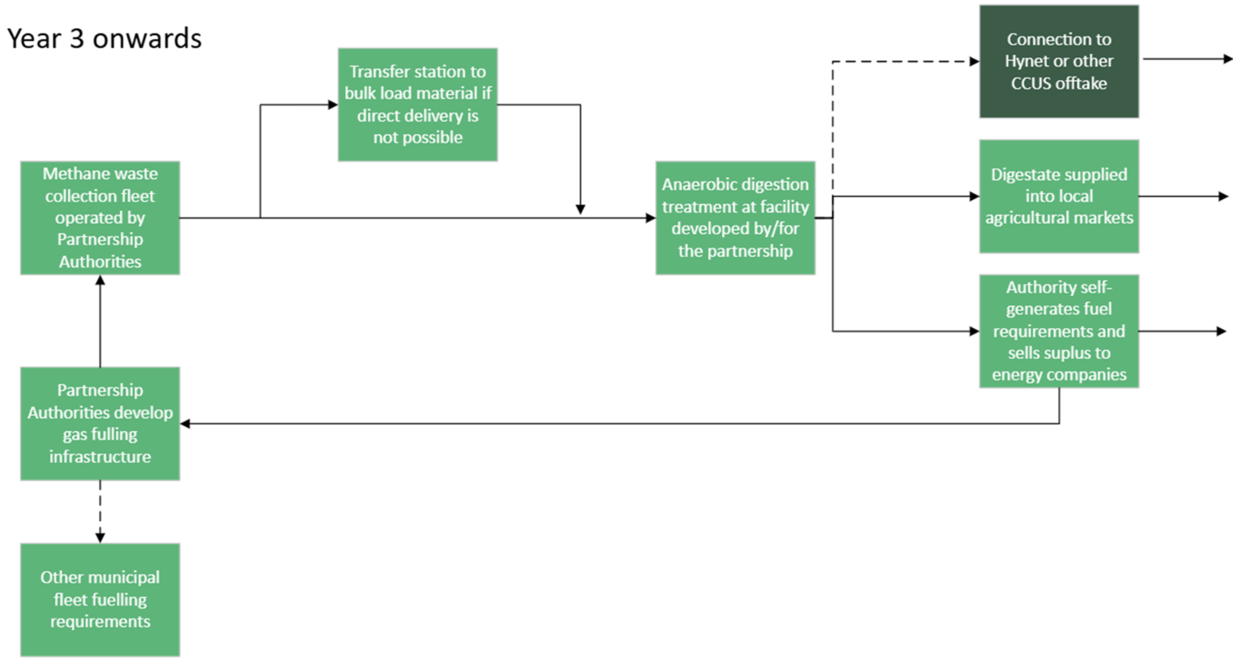
A framework for down-selection and evaluation of the option shortlist has reflected strategic priorities of the Partnership authorities from a qualitative perspective. Market insight and a range of financial benchmarks has enabled financial modelling to be undertaken at a more detailed level than initially included in the project scope. Furthermore, Partnership colleagues have been engaged in the development of the option evaluation framework to give a level of agency in this consultancy delivered options assessment. Collectively, this evaluation approach offers a good level of assurance to those in the governance and approvals process whose decisions may rely on this report.

As a consequence of the delivery approach for this project, it is concluded that this report provides the Partnership with a robust basis from which to consider, approve, and then progress and develop the preferred food waste strategy option.

7.2 Key conclusion – identification of a preferred strategy option

The concluding remarks of section 6.5 identifies option 15 which involves the development of dedicated anaerobic digestion treatment capacity within the LCR region and the use of a portion of the generated biomethane in the vehicle fleet, as the preferred option. The structure of the preferred long-term strategy option is illustrated in Figure 13 with development responsibilities for the Partnership being identified in mid-green, and the development responsibilities of the private sector being identified in dark green.

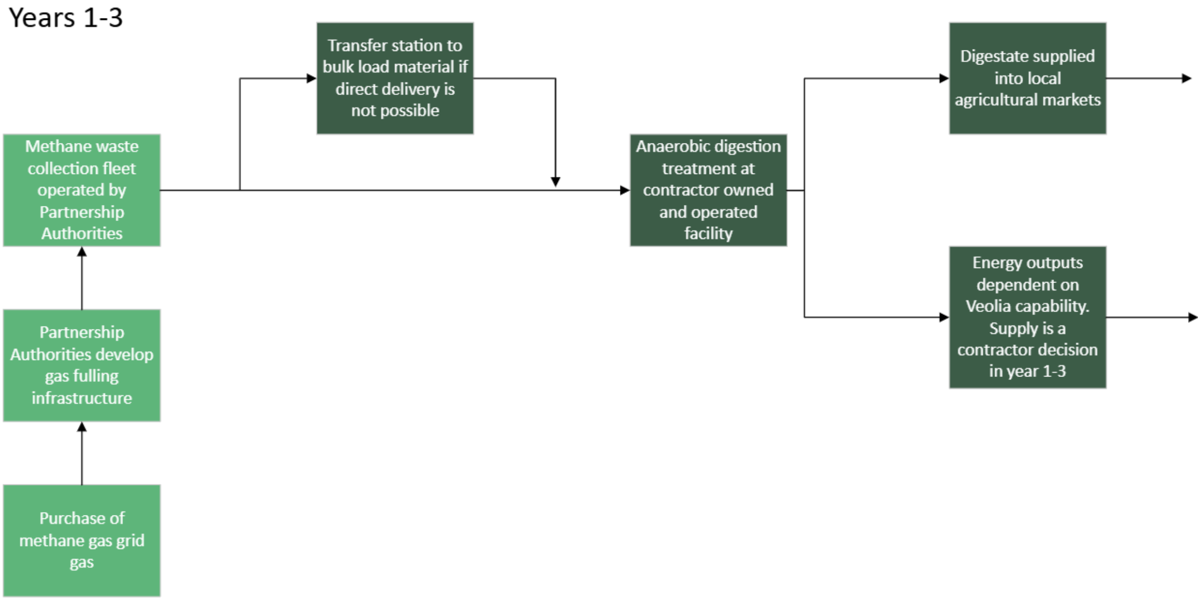
Figure 13 - Flow chart representation of preferred long term strategy option



Paragraph 6.2 described how the selection of short-term options is actually determined by the identification of the long-term strategy option. A key risk that was identified in that section was the potential for a short-term option to preclude or limit some of the longer-term options.

With the preferred long-term strategy option now identified, the project can return to the short-term options which provide a solution for the three years following implementation of food waste collections in March 2026. Option 0.3, comprising the use of (fossil) grid gas in CNG fuelled vehicles with merchant treatment of food waste being arranged through the incumbent recycling provider (Veolia) is the best fit option to enable the longer-term delivery of Option 15. Whilst grid gas does little to immediately decarbonise waste collections, the use of that fuel provides immediate air quality benefits and also lays down the infrastructure and fleet to enable the use of biomethane fuel when available. An illustration of this short term option is provided in Figure 14 overleaf.

Figure 14 – Flow chart representation of preferred short term strategy option



7.3 Recommendations to progress and develop the preferred strategy option

Reflecting on the preferred options illustrated in Figure 13 and Figure 14 along with the commentary provided throughout this report enables a number of recommendations to be made on how the Partnership can progress with the development of the preferred strategy option. Table 17 identifies key work packages that are now required. A brief description of each requirement and an indicative timescale are also set out to provide an outline programme for delivery.

Table 17 – Recommended actions to progress and develop the preferred option

Work Package / Action	Timescale	Summary of required Activity
Collection vehicle and container procurement	2024	The Partnership agreed to procure the service in line with a common specification which shall then be delivered by each collection authority. Work is therefore required to confirm that common specification in line with the advice of the collection assessment provided by Frith Resource Management. This workstream can also address container procurement and staff recruitment to enable timely implementation of the service in March 2026. WRM are

Work Package / Action	Timescale	Summary of required Activity
		aware the vehicle leads times are reported to be in the region of one year from the point of ordering and this action should be a priority within the programme.
Gas fuelling infrastructure feasibility and delivery	2024	The short- and long-term options have recommended the use of gas-powered vehicles. In the short term, these vehicles will be fuelled by grid gas and work is required to determine the optimal fuelling strategy for these vehicles. This could include the installation of fuelling equipment at depots as has been assumed in the options assessment in which case site specific engineering feasibility assessments will be required. This work packaged could simultaneously examine options to install refilling infrastructure at a transfer station; or, for the fleets to use the increasing network of open access filling stations as described in paragraph 2.4.2.
Confirmation of approach with incumbent contractor	2024	The short-term option relies on the incumbent recycling contractor, Veolia, to provide an off-take for collected food wastes between March 2026 and May 2029. Prior to the service commencing, it is recommended that dialogue on the preparedness for deliveries of contract food waste are held to confirm that the short-term option is fully deliverable.
Site/land search	2024	The long-term strategy option has recommended the development of dedicated waste treatment capacity for the Partnership tonnages. A site within, or on the periphery of the LCR area will therefore be required. Whilst some prospective candidates for delivering a facility may have land options, other may look towards the authority to provide a (reference) site as part of a procurement process; particularly in a contract structure where the anaerobic digestion facility is a reverting asset.

Work Package / Action	Timescale	Summary of required Activity
		It is therefore recommended that a priority action for 2024 is for the Partnership, and specifically MWRA to commence a site search. This can include specific sites identified in this report such as the Peel Holdings site at Ince Marshes, as well as other land allocations identified in the Joint Waste Local Plan for Merseyside.
Funding approach	2024	This report has identified that the development of an anaerobic digester to treat the regions food waste will require an investment of c.£28.5m (Table 3). A DBFO contract structure may provide the best value procurement option for the authority due to lower prudential borrowing rates, and a workstream is therefore suggested to examine how this capital funding requirement may be met and arranged. This workstream may also examine other funding requirements associated with the service and the balance of funding commitments and promises offered by central government in implementing the simpler recycling reforms.
Waste treatment contract development & procurement preparation	2024 - 2025	Delivery of the preferred option (or any of the options identified as potential reserves) will necessitate the development and procurement of a major waste treatment contract. A key workstream to follow on from the above listed activity is to prepare the structure and procurement of this contract through more detailed and focused scoping work. Such work could include: • Soft market testing (suggested in 2024-2025) to understand and confirm the capabilities and capacities of the market to deliver the preferred strategy option. This process would also enable a market perception of risk to be identified along with potential optimisations

Work Package / Action	Timescale	Summary of required Activity
		(e.g. the level of third-party waste acceptance that could improve best value; • Development of a contract risk allocation log to identify and record broad areas of risk that the Partnership can/cannot accept; • Stakeholder analysis to ensure that all required stakeholders are identified and engaged in an appropriate manner; • Specification of core requirements for delivery of the required works and/or services in a contract principles paper which would provide the detailed business case for proceeding to develop and publicise the procurement documentation. As this proposed work progresses, it is recommended that the Partnership monitors the merchant anaerobic digestion market across the northwest for any new developments which (1) increase competition within the market, and therefore, (2) could lead to a legitimate check and challenge on the preferred strategy option.
Permissions & consents	2025 (Partnership) 2026 (provider)	A key limitation and risk of delivering the preferred strategy option is the closure of the Green Gas Support Scheme in March 2028. Any new build facility that is predicated on the economics set out in this report therefore needs to be built and commissioned by this date. A key variable in meeting this timescale could be the time required to obtain planning permission and an environmental permit. To de-risk the attainment of the GGSS date, and also to potentially simplify the procurement of the treatment solution, applications for permissions and consents should commence t the earliest opportunity.

Work Package / Action	Timescale	Summary of required Activity
		If the Partnership is able to identify and offer a development site, then this activity could occur as early as 2025, whereas a provider led site is unlikely to commence with applications until a waste treatment contract has been entered into. A nominal date of 2026 is identified for this scenario.
Resident communications	Early 2026	This report has in paragraph 2.2 emphasised the importance of effective communications in implementing a successful food waste service. The need for a concerted and high-profile publicity campaign is therefore noted within this programme.
Build & commission	2026-27 (Partnership planning) 2027-28 (provider planning)	The build of an anaerobic digestion facility from receiving planning permission to entering into commissioning tests will take between 12-18 months. Two timescales are provided for this works period depending upon when planning permission id received.
GGSS closure	2028	March 2028 is noted as a key date due to the closure of the Green Gas Support Scheme. Any new build facility that is predicated on the economics set out in this report therefore needs to be built and commissioned by this date.
Service transition	2029	The term of the current recycling contract expires and the long-term strategy option presented in this report is fully implemented.

APPENDIX A – CONSIDERATION OF OPTION MERITS, BENEFITS, ADVANTAGES, DRAWBACKS, LIMITATIONS AND DISADVANTAGES

	Merits, benefits and advantages	Drawbacks, limitations and disadvantages
Diesel	Fuelling infrastructure presently in place	Prospective prohibition of diesel/petrol vehicles?
	Familiarity with diesel vehicles as the baseline	Carbon emissions and air quality impacts from fossil fuel combustion
	Lower purchase cost than gas fuelled alternatives	Potentially limits future use of self-generated biomethane due to misalignment of vehicle lifecycle and 2029 transition date
HVO	Carbon emission reduction and air quality benefit	Long term supply of HVO is uncertain as a comparatively novel fuel source.
	Flexibility of conversion to diesel fuel if required as a contingency	Reliant on a developing supply chain which presently has limited capacity.
	Fuelling infrastructure fundamentally in place	The LCR Partnership is at the end of the value chain and could encounter upstream competition from segments who control feedstock materials.
	Precedent for fuel well demonstrated in local authority and commercial fleets	Competition for fuel from other users is likely impact on pricing
	Lower purchase cost than gas fuelled alternatives	
Biomethane	Operationally, vehicles are identical to diesel baseline	Capital cost of developing new depot or centralised refuelling infrastructure

	Merits, benefits and advantages	Drawbacks, limitations and disadvantages
	Significant air quality and carbon reductions compared to diesel vehicles	Deliverability of new refuelling infrastructure by March 2026 may be challenging
	Ability to utilise self-generated fuel in a fully circular and optimised option	Higher purchase cost of vehicles
	Can operated on CNG as an alternative/contingency	
	Current fuel duty is 50% (fixed for 3 years) of the fossil fuel comparators providing large operational incentive	
	Precedent for fuel well demonstrated in both local authority (including Liverpool City Council) and commercial fleets	
In region treatment	Accords with proximity principle reducing transfer carbon emissions and cost	Presently acute capacity shortage within the northwest region which limits the immediate delivery
	Opportunity for direct refuelling	Likely to require a level of involvement from the Partnership to instigate or directly deliver new treatment capacity
	Social value benefits attributed to LCR region	
	Infrastructure development provides capacity for other organic wastes arising in the region (e.g. commercial and industrial wastes)	

	Merits, benefits and advantages	Drawbacks, limitations and disadvantages
	Can be instigated in the merchant by an anchor contract if not developed by the Partnership.	
Inter-region treatment	Excess of available capacity provides opportunity for short term low gate fee	Latent energy value lost from region
	Gas grid enables circular supply of biomethane back to authority	Loss of social value from treatment within region (whether delivered in merchant or Partnership facility
		Current available capacity likely to be in midlands, resulting in a significant haulage distance with associated carbon and cost impacts
Merchant	Appetite amongst investors and operators to develop a facility in the region where an anchor contract is available.	Procurement risk of contracting with entity that has not yet delivered a facility.
	Delivery of facility may be more expedient that a dedicated facility	Utilisation of energy outputs will likely be at the discretion of the operator, with no guarantee on supply to the Partnership.
	A number of potential options have already been identified. This includes potential United Utilities sites.	
	Negates capital cost for Partnership	

	Merits, benefits and advantages	Drawbacks, limitations and disadvantages
Merchant with energy buy-back	Option provide circularity with a reduced capital spend requirement and delivery risk on the Partnership.	No additional commercial benefit to Partnership through biomethane buy back as operators have a range of competing sectors to sell energy outputs into.
	High level of investor and operator interest to develop a new facility in the region where a anchor contract is available.	
Develop dedicated capacity	Full range of sustainability benefits can be specified by the Partnership	High level of capital spend elevates risk to Partnership
	Social value benefits delivered within the LCR area	Timescales may be challenging for current round of Green Gas Support Scheme payments if procurement does not commence immediately
	Opportunity to integrate with other regional sustainability initiatives (e.g. hynet, wider fleet decarbonisation)	Site identification and acquisition presents a key programme and deliverability risk
	Dedicated capacity provides capacity certainty	Planning and environmental permits present programme and deliverability risk
	Likely high level of interest to deliver works and services contract	

APPENDIX B – STRATEGIC & QUALITY CRITERIA INCLUDING SCORING GUIDE

Criterion	Measure	Consideration	Score
Proximity principle and perception of treatment location	Proximity to Central Liverpool (as a reference point)	Options may have a difference in the haulage distance to the location at which waste treatment is undertaken. The proximity principles direct for waste to be treated as close to its arising as possible. Cost and carbon emissions (included in other evaluation criteria) will increase with haulage distances. There may also be an adverse/negative public perception associated with exporting waste for treatment outside the city-region, or northwest region.	3= Local treatment within LCR 2= Treatment on periphery of LCR 1= Treatment outside Northwest
Security of capacity /offtake	Long term security and stability of off-take	At c.45,000 tonnes per annum, the Partnership has a substantial disposal requirement. The limited level of competition in the northwest, combined with other authorities requiring treatment capacity from March 2026 could see concerns on the long-term availability/stability of food waste treatment capacity for Merseyside.	3= Capacity guaranteed over a long-term period 2= Capacity guaranteed for medium term period 1= Short term capacity guarantee; or, likelihood of future capacity concerns after an initial short term period.

Criterion	Measure	Consideration	Score
Local long-term infrastructure for Merseyside	Delivery of social value benefits for Merseyside	The development of local infrastructure can provide a range of (non-capacity certainty) benefits. This includes a range of social value objectives and the ability for the Partnership to specify the outputs and to respond to and capitalise upon future innovations.	3= Full realisation of a range of social value benefits within LCR 2= Some realisation of a range of social value benefits within LCR 1= Limited realisation of a range of social value benefits within LCR 0= No realisation of a range of social value benefits within LCR
Delivery of adjacencies	Delivery of a fully optimised and circular solution for the region's food waste	The ability of the authority to specify outputs varies in each option. Some options provide a greater level of certainty that the fully optimised circular solution desired by the Partnership will be delivered.	3= Delivery of CCU/S, high value gas utilisation, and decarbonisation of collection fleet (potentially with wider fleet decarbonisation) 2= Delivery of two of CCU/S, high value gas utilisation, and decarbonisation of collection fleet. 1= Delivery of one of CCU/S, high value gas utilisation, and decarbonisation of collection fleet.

Criterion	Measure	Consideration	Score
Integration with regional sustainability objectives	Delivery of strategy and integration with other initiatives	The ability of each option to contribute to wider Merseyside sustainability objectives varies with some options having potential to contribute towards the wider decarbonisation of the Partnership authorities' operations. Options also vary in their ability to integrate with other regional initiatives such as Hynet.	3= Option fully integrates with regional objectives with opportunity to support wider LCR objectives and also integrate with third party initiatives (e.g. hint) 2= Some delivery of sustainability objectives in the LCR region. 1= Limited delivery of sustainability objectives in the LCR region. 0= No Some delivery of sustainability objectives in the LCR region; or, the sustainability benefits are attributed to a location outside of LCR.
Delivery certainty	The level of friction in delivering the option	Some options can be delivered with certainty, whereas others will require varying levels of procurement, construction and commissioning. More complex pathways that have interdependencies can diminish the certainty that the targeted solution will be delivered.	3= A high level of confidence that the option can be implemented /delivered with its programme. The delivery programme is clear with limited opportunity for detrimental scope/cost impacts. 2= A medium level of confidence that the option can be implemented /delivered with its programme. The delivery programme is clear with limited opportunity for detrimental scope/cost impacts. 1= Option is complex with potential for the programme to feature unanticipated scope changes which may result in delay or cost increases. The level of management and administration time incurred by LCR is significant in this option.

Criterion	Measure	Consideration	Score
Carbon balance	Ability to maximise carbon savings	The level of carbon savings attained by/attributed to the Partnership authorities will vary in each option	3 = High level of comparative carbon savings (as quantified by cost model) 2= Medium level of comparative carbon savings (as quantified by cost model) 1 = Low level of comparative carbon savings (as quantified by cost model)
Capital cost requirement across Partnership	The ability of the Partnership to meet the capital spend requirements	Some options will require substantial upfront spend to develop new infrastructure and/or purchase new vehicles. The budget availability or funding approach for each option will vary	3= Option presents an upfront capital spend requirement that is challenging for the Partnership to meet. 2= Option presents an upfront capital spend requirement that is manageable for the Partnership. 1= Option presents an upfront capital spend requirement that is not problematic for the Partnership. 0= Option has no upfront capital spend requirement.

APPENDIX C – WEIGHTED OPTION SCORES

Applied weighting:	Capacity certainty risk with even apportionment								
Option	**1**	**3**	**4**	**7**	**9**	**10**	**14**	**15**	**17**
Proximity principle and perception of treatment location	6.7%	10.0%	3.3%	7%	10%	3%	7%	10%	3%
Security of capacity /offtake	10.0%	30.0%	20.0%	10%	30%	20%	10%	30%	20%
Local long-term infrastructure for Merseyside	6.7%	10.0%	0.0%	7%	10%	0%	7%	10%	0%
Delivery of adjacencies	3.3%	3.3%	3.3%	3%	3%	3%	7%	10%	7%
Integration with regional sustainability objectives	3.3%	3.3%	0.0%	3%	3%	0%	7%	10%	3%
Delivery certainty	6.7%	3.3%	10.0%	7%	3%	10%	7%	3%	7%
Carbon balance	3.3%	3.3%	3.3%	10%	10%	10%	10%	10%	10%
Capital cost requirement across Partnership	0.0%	10.0%	6.7%	0%	10%	3%	7%	10%	3%
Sub-totals	**40%**	**73%**	**47%**	**47%**	**80%**	**50%**	**60%**	**93%**	**53%**

Applied weighting:	Capacity certainty recognised as a key risk (with even apportionment of other factors)								
Option	**1**	**3**	**4**	**7**	**9**	**10**	**14**	**15**	**17**
Proximity principle and perception of treatment location	6.7%	10.0%	3.3%	7%	10%	3%	7%	10%	3%
Security of capacity /offtake	10.0%	30.0%	20.0%	10%	30%	20%	10%	30%	20%
Local long-term infrastructure for Merseyside	6.7%	10.0%	0.0%	7%	10%	0%	7%	10%	0%
Delivery of adjacencies	3.3%	3.3%	3.3%	3%	3%	3%	7%	10%	7%
Integration with regional sustainability objectives	3.3%	3.3%	0.0%	3%	3%	0%	7%	10%	3%
Delivery certainty	6.7%	3.3%	10.0%	7%	3%	10%	7%	3%	7%
Carbon balance	3.3%	3.3%	3.3%	10%	10%	10%	10%	10%	10%
Capital cost requirement across Partnership	0.0%	10.0%	6.7%	0%	10%	3%	7%	10%	3%
Sub-totals	**40%**	**73%**	**47%**	**47%**	**80%**	**50%**	**60%**	**93%**	**53%**

Applied weighting:	Delivery of secure and local treatment capacity that delivers environmental adjacencies								
Option	**1**	**3**	**4**	**7**	**9**	**10**	**14**	**15**	**17**
Proximity principle and perception of treatment location	10.0%	15.0%	5.0%	10%	15%	5%	10%	15%	5%
Security of capacity /offtake	8.3%	25.0%	16.7%	8%	25%	17%	8%	25%	17%
Local long-term infrastructure for Merseyside	3.3%	5.0%	0.0%	3%	5%	0%	3%	5%	0%
Delivery of adjacencies	6.7%	6.7%	6.7%	7%	7%	7%	13%	20%	13%
Integration with regional sustainability objectives	1.7%	1.7%	0.0%	2%	2%	0%	3%	5%	2%
Delivery certainty	6.7%	3.3%	10.0%	7%	3%	10%	7%	3%	7%
Carbon balance	5.0%	5.0%	5.0%	15%	15%	15%	15%	15%	15%
Capital cost requirement across Partnership	0.0%	5.0%	3.3%	0%	5%	2%	3%	5%	2%
Sub-totals	**42%**	**67%**	**47%**	**52%**	**77%**	**55%**	**63%**	**93%**	**60%**

APPENDIX D – FOOD WASTE ROUND DESIGN MODEL INPUTS

	Unit	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	Report Notes / Assumptions
Number of properties	Nr	58,890	70,700	238,860	130,370	85,640	151,300	Property apportionment and alignment with ONS data for 2023
Food Waste Recycling Scheme Coverage								
Food only (Houses)	Nr	53,001	62,499	179,145	103,775	77,419	136,170	612,008
Multi-Occupancy		5,889	8,201	59,715	26,595	8,221	15,130	Balance taken from Frith Report
Food Waste Container Offered								
Food Waste Container Offered	Litres	23	23	23	23	23	23	
In-property container provided	Litres	7	7	7	7	7	7	
Mutil-Occupancy	Litres	7	7	7	7	7	7	
Container replacement requirement	%	4%	4%	4%	4%	4%	4%	Assumed 4% for all authorities
Liner provided	Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Assumption that 2 liners will be provided per week (as per Frith Report)
Food Waste Collection Frequency								
Food only	Frequency	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	All authorities are mandated to provide a weekly food waste collection.
Multi-occupancy	Frequency	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	
Vehicle Pass Rate								
Houses	Nr	1900	1900	1900	1900	1900	1900	Pass rate assumption of 1,900 as a balance between Frith Report Pass Rates and previous food waste estimation exercise from Liverpool (Round assumption of 3,100 properties). Similar demography to Manchester region.
Multi Occupancy	Nr	2250	2250	2250	2250	2250	2250	WRAP assumption of 2,600 properties applied.
Round Numbers (Routes per week)								
Food only	Nr	28	33	94	55	41	72	
Multi-occupancy	Nr	3	4	27	12	4	7	
Total	Nr	31	37	121	66	44	78	
Working Days per Week	Nr	5	5	5	5	5	5	Assumed 5 on a weekly food waste collection
Vehicles required								
Food only	Nr	5.6	6.6	18.9	10.9	8.1	14.3	Spare vehicles excluded - to be provided by wider fleet.
Multi-occupancy	Nr	0.5	0.7	5.3	2.4	0.7	1.3	
Total	Nr	7.0	8.0	25.0	14.0	9.0	16.0	0.0
Crew Configuration								
Driver	Nr	1	1	1	1	1	1	
Loader	Nr	1	1	1	1	1	1	
Shift Multiplier	%	100%	100%	100%	100%	100%	100%	
Staff Inputs								
Drivers	Nr	7	8	25	14	9	16	
Loaders	Nr	7	8	25	14	9	16	

	Unit	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	Report Notes / Assumptions
Container Presentation & Weight								
Set-out rate	%	45%	45%	45%	45%	45%	45%	Assumed set out rate of minimum of 45% in line with WRAP targets. Also value stated in Frith Report.
Containers collected per week	Nr	26,501	31,815	107,487	58,667	38,538	68,085	
Yield per household	kg/hh/wk	1.27	1.25	1.25	1.40	1.29	1.34	Yields per household figures derived from Local Authority Market Report data.
Yield per MO		1.27	1.25	1.25	1.40	1.29	1.34	
Average Weekly Yield (House)	tonnes	67	78	224	145	100	182	
MO Average Weekly Yield	tonnes	7	10	75	37	11	20	
Average Annual Yield	tonnes	3,889	4,596	15,526	9,491	5,745	10,543	Approx. 900 tonnes uplift from figure outlined in the presentation from Wednesday 12th June
Average presented container weight	kg	2.5	2.5	2.1	2.5	2.6	2.7	
Round Payload								
Food only	tonnes per day	2.17	2.10	1.78	2.12	2.22	2.29	
Multi-occupancy	tonnes per day	2.57	2.49	2.11	2.51	2.62	2.71	
Round Totals		*4.74*	*4.59*	*3.89*	*4.62*	*4.84*	*5.00*	
Vehicle Selection								
Food only	GVW	7.5	7.5	7.5	7.5	7.5	7.5	
Multi-occupancy	GVW	7.5	7.5	7.5	7.5	7.5	7.5	
Vehicle Payload Check								
Food only	Tonnes	3.3	3.3	3.3	3.3	3.3	3.3	
Multi-occupancy	Tonnes	3.3	3.3	3.3	3.3	3.3	3.3	
Fleet Financing Assumption	Years	7	7	7	7	7	7	In line with existing fleet replacement cycles reported by waste collection authorities
Mileage per Vehicle - Diesel								
Food only	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Multi-occupancy	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Mileage per Vehicle - HVO								
Food only	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Multi-occupancy	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Mileage per Vehicle - Biomethane								
Food only	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Multi-occupancy	Miles/annum	13,000	13,000	13,000	13,000	13,000	13,000	
Vehicle Fuel Economy - Diesel								
Food only	Miles per gallon	16	16	16	16	16	16	
Multi-occupancy	Miles per gallon	16	16	16	16	16	16	
Vehicle Fuel Economy - HVO								
Food only	Miles per gallon	12	12	12	12	12	12	
Multi-occupancy	Miles per gallon	12	12	12	12	12	12	
Vehicle Fuel Economy - Biomethane								
Food only	Miles per kg	5	5	5	5	5	5	
Multi-occupancy	Miles per kg	5	5	5	5	5	5	
Fuel Consumed - Diesel								
Food only	Litres	20,607	24,300	69,652	40,348	30,101	52,943	
Multi-occupancy	Litres	1,933	2,693	19,606	8,732	2,699	4,968	
Total	Litres	22,540	26,992	89,258	49,080	32,800	57,911	
Fuel Consumed - HVO								
Food only	Litres	27,476	32,400	92,869	53,797	40,134	70,591	
Multi-occupancy	Litres	2,578	3,590	26,141	11,643	3,599	6,623	
Totals	Litres	30,054	35,990	119,010	65,440	43,733	77,214	
Fuel Consumed - Biomethane								
Food only	Litres	14,524	17,126	49,090	28,437	21,215	37,314	
Multi-occupancy	Litres	1,363	1,898	13,818	6,154	1,902	3,501	
Totals	Litres	15,886	19,024	62,908	34,591	23,117	40,815	

APPENDIX E - FOOD WASTE LAUNCH MODEL INPUTS

	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	LCR Partnership Region Wide
Round Design Costs	£ 200,000	£ 200,000	£ 200,000	£ 200,000	£ 200,000	£ 200,000	£ 1,200,000
Publicity and Promotion	£ 164,833	£ 197,889	£ 668,569	£ 364,906	£ 239,706	£ 423,489	£ 2,059,392
Container Deployment							
Food only (Houses)	*£ 243,805*	*£ 287,494*	*£ 824,067*	*£ 477,363*	*£ 356,125*	*£ 626,382*	£ 2,815,236
Multi-Occupancy	*£ 406*	*£ 566*	*£ 4,118*	*£ 1,834*	*£ 567*	*£ 1,043*	£ 8,535
In-Property Caddy	*£ 106,002*	*£ 124,998*	*£ 358,290*	*£ 207,549*	*£ 154,837*	*£ 272,340*	£ 1,224,016
Container Total	£ 350,213	£ 413,058	£ 1,186,475	£ 686,746	£ 511,529	£ 899,765	£ 4,047,787
TOTAL LAUNCH COST	**£ 715,046**	**£ 810,947**	**£ 2,055,044**	**£ 1,251,652**	**£ 951,236**	**£ 1,523,254**	**£ 7,307,179**

APPENDIX F - COLLECTION ROUND COSTS MODEL INPUTS

Item	Unit	Notes		Cost £ (Excl VAT)
Diesel				
Round Design Costs	£			200,000
Publicity and Promotion				
Launch	£/hh			2.80
Ongoing annual	£/hh			1.50
Waste Containers (Litres)				
7 Litre	£/bin			2.00
23 Litre	£/bin			4.60
Food Waste Liners	£/hh/yr			1.93
Vehicle Capital Costs		Inflationary Factor		
7.5 Tonne	£/vehicle	1.02		85,000
Vehicle Fuel			diesel rate	
Diesel cost per L	£/Litre		1.5	1.50
7.5 Tonne		mpg	Fuel duty	0.05795
	£/mile	16	1.50	0.43
Vehicle Repair & Service	% of CAPEX per Annum			10%
7.5 Tonne	% of Vehicle cost			8,500.00
Staffing Costs				
Driver	£/person/yr			27,534
Loader	£/person/yr			24,054
PPE Provision	£/person/yr			500

Item	Unit	Notes		Cost £ (Excl VAT)
Hydrotreated Vegetable Oil				
Round Design Costs	£			200,000
Publicity and Promotion				
Launch	£/hh			2.80
Ongoing annual	£/hh			1.50
Waste Containers (Litres)				
7 Litre	£/bin			2.00
23 Litre	£/bin			4.60
Food Waste Liners	£/hh/yr			1.93
Vehicle Capital Costs		Inflationary Factor		
7.5 Tonne	£/vehicle	1.02		85,000
Vehicle Fuel		mpg	HVO rate	
HVO cost per L	£/Litre			1.80
7.5 Tonne	£/mile	16	1.50	0.43
Vehicle Repair & Service	% of CAPEX per Annum			10%
7.5 Tonne	% of Vehicle cost			8,500.00
Staffing Costs				
Driver	£/person/yr			27,534
Loader	£/person/yr			24,054
PPE Provision	£/person/yr			500

Item	Unit	Notes		Cost £ (Excl VAT)
Biomethane				
Round Design Costs	£			200,000
Publicity and Promotion				
Launch	£/hh			2.80
Ongoing annual	£/hh			1.50
Waste Containers (Litres)				
7 Litre	£/bin			2.00
23 Litre	£/bin			4.60
Food Waste Liners	£/hh/yr			1.93
Vehicle Capital Costs		Cost Uplift	Diesel Equivalent	
7.5 Tonne	£/vehicle	28,000	85,000	102,000
		On diesel equivalent		
Vehicle Fuel		mpg diesel equivalent	BioM rate	
BioM cost per L	£/kg			0.6500
7.5 Tonne				
Vehicle Repair & Service	% of CAPEX per Annum			8%
7.5 Tonne	% of Vehicle cost			8,160.00
Staffing Costs				
Driver	£/person/yr			27,534
Loader	£/person/yr			24,054
PPE Provision	£/person/yr			500

APPENDIX G - FOOD WASTE OPERATIONS COSTS

Diesel	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	LCR Wide
Container Replacement							
Houses	£ 9,752	£ 11,500	£ 32,963	£ 19,095	£ 14,245	£ 25,055	£ 112,609
Multi-occupancy	£ 471	£ 656	£ 4,777	£ 2,128	£ 658	£ 1,210	£ 9,900
Total	£ 10,223	£ 12,156	£ 37,740	£ 21,222	£ 14,903	£ 26,266	£ 122,510
Liner Provision							
Liners (All service segments)	£ 227,315	£ 272,902	£ 922,000	£ 503,228	£ 330,570	£ 584,018	£ 2,840,034
Vehicle Procurement (Annualised Cost)							
Houses	£ 67,746	£ 79,886	£ 228,982	£ 132,644	£ 98,956	£ 174,052	£ 782,266
Multi-occupancy	£ 6,356	£ 8,852	£ 64,454	£ 28,706	£ 8,874	£ 16,331	£ 133,574
Total	£ 74,102	£ 88,738	£ 293,437	£ 161,350	£ 107,830	£ 190,383	£ 915,839
Staffing Costs							
Drivers	£ 192,738	£ 220,272	£ 688,350	£ 385,476	£ 247,806	£ 440,544	£ 2,175,186
Loader	£ 168,378	£ 192,432	£ 601,350	£ 336,756	£ 216,486	£ 384,864	£ 1,900,266
PPE Replacement	£ 3,507	£ 4,008	£ 12,525	£ 7,014	£ 4,509	£ 8,016	£ 39,579
Total	£ 364,623	£ 416,712	£ 1,302,225	£ 729,246	£ 468,801	£ 833,424	£ 4,115,031
Fuel Costs (Diesel)							
Houses	£ 30,910	£ 36,450	£ 104,478	£ 60,522	£ 45,151	£ 79,415	£ 356,925
Multi-occupancy	£ 2,900	£ 4,039	£ 29,409	£ 13,098	£ 4,049	£ 7,451	£ 60,946
Total	£ 33,811	£ 40,489	£ 133,887	£ 73,620	£ 49,200	£ 86,866	£ 417,871
Vehicle Repair & Service							
Houses	£ 47,422	£ 55,920	£ 160,288	£ 92,851	£ 69,269	£ 121,836	£ 547,586
Multi-occupancy	£ 4,449	£ 6,196	£ 45,118	£ 20,094	£ 6,212	£ 11,432	£ 93,502
Total	£ 51,871	£ 62,116	£ 205,406	£ 112,945	£ 75,481	£ 133,268	£ 641,088
TOTAL ANNUAL OPERATIONAL COST	**£ 761,946**	**£ 893,113**	**£ 2,894,693**	**£ 1,601,611**	**£ 1,046,785**	**£ 1,854,224**	**£ 9,052,373**

HVO	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	LCR Wide
Container Replacement							
Houses	£ 9,752	£ 11,500	£ 32,963	£ 19,095	£ 14,245	£ 25,055	£ 112,609
Multi-occupancy	£ 471	£ 656	£ 4,777	£ 2,128	£ 658	£ 1,210	£ 9,900
Total	£ 10,223	£ 12,156	£ 37,740	£ 21,222	£ 14,903	£ 26,266	£ 122,510
Liner Provision							
Liners (All service segments)	£ 227,315	£ 272,902	£ 922,000	£ 503,228	£ 330,570	£ 584,018	£ 2,840,034
Vehicle Procurement (Annualised Cost)							
Houses	£ 67,746	£ 79,886	£ 228,982	£ 132,644	£ 98,956	£ 174,052	£ 782,266
Multi-occupancy	£ 6,356	£ 8,852	£ 64,454	£ 28,706	£ 8,874	£ 16,331	£ 133,574
Total	£ 74,102	£ 88,738	£ 293,437	£ 161,350	£ 107,830	£ 190,383	£ 915,839
Staffing Costs							
Drivers	£ 192,738	£ 220,272	£ 688,350	£ 385,476	£ 247,806	£ 440,544	£ 2,175,186
Loader	£ 168,378	£ 192,432	£ 601,350	£ 336,756	£ 216,486	£ 384,864	£ 1,900,266
PPE Replacement	£ 3,507	£ 4,008	£ 12,525	£ 7,014	£ 4,509	£ 8,016	£ 39,579
Total	£ 364,623	£ 416,712	£ 1,302,225	£ 729,246	£ 468,801	£ 833,424	£ 4,115,031
Fuel Costs (HVO)							
Houses	£ 49,457	£ 58,319	£ 167,165	£ 96,835	£ 72,241	£ 127,064	£ 571,081
Multi-occupancy	£ 4,640	£ 6,462	£ 47,054	£ 20,957	£ 6,478	£ 11,922	£ 97,513
Total	£ 54,097	£ 64,782	£ 214,219	£ 117,791	£ 78,720	£ 138,986	£ 668,594
Vehicle Repair & Service							
Houses	£ 47,422	£ 55,920	£ 160,288	£ 92,851	£ 69,269	£ 121,836	£ 547,586
Multi-occupancy	£ 4,449	£ 6,196	£ 45,118	£ 20,094	£ 6,212	£ 11,432	£ 93,502
Total	£ 51,871	£ 62,116	£ 205,406	£ 112,945	£ 75,481	£ 133,268	£ 641,088
TOTAL ANNUAL OPERATIONAL COST	**£ 782,232**	**£ 917,406**	**£ 2,975,025**	**£ 1,645,783**	**£ 1,076,305**	**£ 1,906,344**	**£ 9,303,095**

Biomethane	Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	LCR Wide
Container Replacement							
Houses	£ 9,752	£ 11,500	£ 32,963	£ 19,095	£ 14,245	£ 25,055	£ 112,609
Multi-occupancy	£ 471	£ 656	£ 4,777	£ 2,128	£ 658	£ 1,210	£ 9,900
Total	£ 10,223	£ 12,156	£ 37,740	£ 21,222	£ 14,903	£ 26,266	£ 122,510
Liner Provision							
Liners (All service segments)	£ 227,315	£ 272,902	£ 922,000	£ 503,228	£ 330,570	£ 584,018	£ 2,840,034
Vehicle Procurement (Annualised Cost)							
Houses	£ 67,746	£ 79,886	£ 228,982	£ 132,644	£ 98,956	£ 174,052	£ 782,266
Multi-occupancy	£ 6,356	£ 8,852	£ 64,454	£ 28,706	£ 8,874	£ 16,331	£ 133,574
Total	£ 74,102	£ 88,738	£ 293,437	£ 161,350	£ 107,830	£ 190,383	£ 915,839
Staffing Costs							
Drivers	£ 192,738	£ 220,272	£ 688,350	£ 385,476	£ 247,806	£ 440,544	£ 2,175,186
Loader	£ 168,378	£ 192,432	£ 601,350	£ 336,756	£ 216,486	£ 384,864	£ 1,900,266
PPE Replacement	£ 3,507	£ 4,008	£ 12,525	£ 7,014	£ 4,509	£ 8,016	£ 39,579
Total	£ 364,623	£ 416,712	£ 1,302,225	£ 729,246	£ 468,801	£ 833,424	£ 4,115,031
Fuel Costs (HVO)							
Houses	£ 49,457	£ 58,319	£ 167,165	£ 96,835	£ 72,241	£ 127,064	£ 571,081
Multi-occupancy	£ 4,640	£ 6,462	£ 47,054	£ 20,957	£ 6,478	£ 11,922	£ 97,513
Total	£ 54,097	£ 64,782	£ 214,219	£ 117,791	£ 78,720	£ 138,986	£ 668,594
Vehicle Repair & Service							
Houses	£ 47,422	£ 55,920	£ 160,288	£ 92,851	£ 69,269	£ 121,836	£ 547,586
Multi-occupancy	£ 4,449	£ 6,196	£ 45,118	£ 20,094	£ 6,212	£ 11,432	£ 93,502
Total	£ 51,871	£ 62,116	£ 205,406	£ 112,945	£ 75,481	£ 133,268	£ 641,088
TOTAL ANNUAL OPERATIONAL COST	**£ 782,232**	**£ 917,406**	**£ 2,975,025**	**£ 1,645,783**	**£ 1,076,305**	**£ 1,906,344**	**£ 9,303,095**

APPENDIX H - TRANSFER DELIVERY TONNAGES MODEL INPUTS

Waste Growth	100%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%
Project Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Contract Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Halton MBC	3,889	3,967	4,046	4,127	4,210	4,294	4,380	4,467	4,557	4,648	4,741	4,836	4,932	5,031	5,132	5,234	5,339	5,446	5,555	5,666
Knowsley MBC	4,596	4,687	4,781	4,877	4,974	5,074	5,175	5,279	5,384	5,492	5,602	5,714	5,828	5,945	6,064	6,185	6,309	6,435	6,564	6,695
Liverpool CC	15,526	15,836	16,153	16,476	16,806	17,142	17,485	17,834	18,191	18,555	18,926	19,305	19,691	20,084	20,486	20,896	21,314	21,740	22,175	22,618
Sefton MBC	9,491	9,681	9,874	10,072	10,273	10,479	10,688	10,902	11,120	11,343	11,569	11,801	12,037	12,278	12,523	12,774	13,029	13,290	13,555	13,827
St. Helens MBC	5,745	5,860	5,977	6,096	6,218	6,343	6,470	6,599	6,731	6,865	7,003	7,143	7,286	7,431	7,580	7,732	7,886	8,044	8,205	8,369
Wirral MBC	10,543	10,753	10,969	11,188	11,412	11,640	11,873	12,110	12,352	12,599	12,851	13,108	13,371	13,638	13,911	14,189	14,473	14,762	15,057	15,359
Totals	49,789	50,785	51,800	52,836	53,893	54,971	56,070	57,192	58,335	59,502	60,692	61,906	63,144	64,407	65,695	67,009	68,349	69,716	71,111	72,533

APPENDIX I - TRANSFER DISTANCES AND COSTS MODEL INPUTS

Partnership Region	Reference Postcode	Wet Anaerobic Digestion		
		LCR Partnership Area (Average)	Northwest England (Average)	Out of Region (Average)
Halton MBC	L3 0BE	15	40	104
Knowsley MBC		22	40	104
Liverpool CC		22	40	104
Sefton MBC		22	40	104
St. Helens MBC		22	40	104
Wirral MBC		22	40	104

Assumed Haulage Costs Upper haulage distance (miles)	£/tonne
0	£0.00
10	£6.00
20	£7.00
30	£8.00
50	£9.50
75	£14.00
100	£15.75
125	£20.50
150	£25.00

APPENDIX J - ANAEROBIC DIGESTION BASE VALUES MODEL INPUTS

	Base Value		Base Unit per Tonne	
Revenues				
Gas Sales	£	-	£	21.56
RHI	Not used		£	-
Digestate Sales	£	-	£	1.50
Third Party Gate Fees			£	15.00
Green Gas Support Scheme - Band 1	£	-	£	37.58
Green Gas Support Scheme - Band 2	£	-	£	24.07
Green Gas Support Scheme - Band 3	£	-	£	10.61
CO2 Sales - Food and Beverage	£	-	£	2.17
Capital Cost				
Site/Land lease costs	£	4,040,000		
Procurement	£	300,000		
Planning, consents and development management cos	£	200,000		
Digestion equipment & gas to grid unit	£	12,000,000		
Civils & Balance of Plant	£	8,000,000		
Commissioning costs	£	102,000		
Design Fees and Project Management	£	102,000		
Capital Cost Contingency	£	2,266,900		
Refuelling Station Costs				
CCUS Installation Costs	€	1,965,000.00		
Operational Costs				
Cost of Processing/Variable Costs				
Contamination disposal (at 5%)	£	120.00	£	6.00
Gas Parasitic Load (10% for power and heat)	£	-	£	2.16
Consumables (Water, Ferric dosing etc.)	£	-	£	0.50
Digestate Removal (m3)	£	-	£	6.00
Overheads/Fixed Costs				
Site Permit Annual Subsistence Fee	£	12,000.00		
Equipment Maintenance	£	420,000		
Operator costs Inc. cost of employment	£	251,000		
Mobile plant	£	102,000		
Mobile plant lifecycle	£	132,600		
Sundry Items [e.g. PPE, comms, occasional expenses]	£	10,200		
Training Costs	£	5,100		
Site Manager Cost to Employ	£	71,400		
Facility Insurance	£	102,000		
PAS 110 inspection and laboratory testing	£	10,200		
ABPR visits	£	2,400		
Business Rates	£	449,600		
Operating Contingency	£	143,350.00		

APPENDIX K – TREATMENT OPTION DEFINITION SHEET FROM MODEL

	Wet Anaerobic Digestion Authority Site	Wet Anaerobic Digestion New Site	Wet Anaerobic Digestion Merchant Site
TREATMENT OPTION DEFINITION - Refer to technology specific base value sheet to review facility CAPEX, OPEX, and benchmarked/assumed plant capacity			
Rounded LCR requirement (tonnes per annum)	80,000	80,000	80,000
Plant capacity (tonnes per annum)	80,000	80,000	N/A
Number of plants (Nr)	1	1	N/A
Treatment plant location	LCR Partnership Area	LCR Partnership Area	Out of Region
Project Duration (Years)	15	15	15
Capital Write-down (Years)	15	15	N/A
Funding (Public / Private)	Public	Private	N/A
Contractor Operated (Y/N)	Yes	Yes	Yes
Contractor Margin (%)	10%	10%	N/A
Third Party Waste Input (Y/N)	No	No	N/A
Third Party Waste Input Start Date	2029		
Utilisation of 3rd Party Capacity (%)	0%	0%	N/A
Treatment OPTION DEFINITION - Refer to technology specific base value sheets to review facility CAPEX, OPEX, and benchmarked/assu			
KEY TREATMENT SENSITIVITIES - the below list adjusts items regarded as key variables in the forward outlook			
Wet AD Merchant Gate Fee	0	0	20
FOREX on imported kit (adjustment to current £:€ rate)	1.00	1.00	1.00
BASELINE ADJUSTMENT FACTORS - the below list allows scenario specific adjustment of all other cost model input values			
Revenues			
Gas Sales	95%	95%	95%
Digestate Sales	100%	100%	100%
Third Party Gate Fees	0%	0%	100%
Green Gas Support Scheme - Band 1	100%	100%	100%
Green Gas Support Scheme - Band 2	100%	100%	100%
Green Gas Support Scheme - Band 3	100%	100%	100%
CO2 Sales - Food and Beverage	100%	100%	0%
Capital Cost			
Site/Land lease costs	100%	100%	N/A
Procurement	100%	100%	100%
Planning, consents and development management costs	100%	100%	100%
Wet AD Digestion equipment	100%	100%	100%
Wet AD Civils & Balance of Plant	100%	100%	100%
Commissioning costs	100%	100%	100%
Design Fees and Project Management	100%	100%	100%
Capital Cost Contingency	100%	100%	100%
CCUS Technology Utilisation	100%	100%	0%
Operational Costs			
Cost of Processing/Variable Costs			
Contamination disposal	100%	100%	100%
Gas Parasitic Load	100%	100%	100%
Wet AD Consumables (Water, Ferric dosing etc.)	100%	100%	100%
Mobile plant fuel	100%	100%	N/A
Digestate Removal (m3)	100%	100%	100%
Overheads/Fixed Costs			
Site Permit Annual Subsistence Fee	100%	100%	100%
Equipment Maintenance	100%	100%	100%
Operator costs Inc. cost of employment	100%	100%	100%
Mobile plant lease	100%	100%	100%
Mobile Plant Lifecycle	100%	100%	100%
Sundry Items [e.g. PPE, comms, occasional expenses]	100%	100%	100%
Training Costs	100%	100%	100%
Site Manager Cost to Employ	100%	100%	100%
Facility Insurance	100%	100%	100%
PAS 110 inspection and laboratory testing	100%	100%	100%
ABPR (Monthly Visits)	100%	100%	100%
Business Rates	0%	0%	0%
Operating Contingency	100%	100%	100%
Recyclable Pet Bedding	100%	100%	100%
SPV Fee & Contractor Margin	100%	100%	100%
Cost of finance	100%	100%	100%

APPENDIX L – WET AD MERCANTILE MODEL

Item	Base Unit per Tonne										
		Project Year	1	2	3	4	5	6	7	8	9	10
		Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		LCR Tonnage	49,789	50,785	51,800	52,836	53,893	54,971	56,070	57,192	58,335	59,502
		Third party input tonnage										
		Annual input	49,789	50,785	51,800	52,836	53,893	54,971	56,070	57,192	58,335	59,502
Gate Fee	**£ 20.00**		£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00
Cost of Processing			£ 995,775	£ 1,015,690	£ 1,036,004	£ 1,056,724	£ 1,077,859	£ 1,099,416	£ 1,121,404	£ 1,143,832	£ 1,166,709	£ 1,190,043

Item										
Project Year	11	12	13	14	15	16	17	18	19	20
Year	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
LCR Tonnage	60,692	61,906	63,144	64,407	65,695	67,009	68,349	69,716	71,111	72,533
Third party input tonnage										
Annual input	60,692	61,906	63,144	64,407	65,695	67,009	68,349	69,716	71,111	72,533
Gate Fee	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00	£ 20.00
Cost of Processing	£ 1,213,844	£ 1,238,121	£ 1,262,883	£ 1,288,141	£ 1,313,904	£ 1,340,182	£ 1,366,986	£ 1,394,325	£ 1,422,212	£ 1,450,656

APPENDIX M - WET AD AUTHORITY SITE MODEL

				Project Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
				Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
				LCR Tonnage	49,789	50,785	51,800	52,836	53,893	54,971	56,070	57,192	58,335	59,502	60,692	61,906	63,144	64,407	65,695	67,009	68,349	69,716	71,111	72,533
				Third party Input Tonnage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Annual input	49,789	50,785	51,800	52,836	53,893	54,971	56,070	57,192	58,335	59,502	60,692	61,906	63,144	64,407	65,695	67,009	68,349	69,716	71,111	72,533
Item	**Base Value**	**Base Unit per Tonne**	**Scenario Adjustment**	**Scenario Adjustment**																				
Revenues																								
Gas Sales		£ 21.56		95%	£ 1,019,773	£ 1,040,169	£ 1,060,972	£ 1,082,191	£ 1,103,835	£ 1,125,912	£ 1,148,430	£ 1,171,399	£ 1,194,827	£ 1,218,723	£ 1,243,098	£ 1,267,960	£ 1,293,319	£ 1,319,185	£ 1,345,569	£ 1,372,480	£ 1,399,930	£ 1,427,929	£ 1,456,487	£ 1,485,617
Digestate Sales		£ 1.50		100%	£ 74,683	£ 76,177	£ 77,700	£ 79,254	£ 80,839	£ 82,456	£ 84,105	£ 85,787	£ 87,503	£ 89,253	£ 91,038	£ 92,859	£ 94,716	£ 96,611	£ 98,543	£ 100,514	£ 102,524	£ 104,574	£ 106,666	£ 108,799
Third Party Gate Fees		£ 15.00		0%	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Green Gas Support Scheme - Band 1		£ 37.58		100%	£ 1,871,061	£ 1,908,482	£ 1,946,652	£ 1,985,585	£ 2,025,297	£ 2,065,803	£ 2,107,119	£ 2,149,261	£ 2,192,246	£ 2,236,091	£ 2,280,813	£ 2,326,429	£ 2,372,958	£ 2,420,417	£ 2,468,825	£ 2,518,202	£ 2,568,566	£ -	£ -	£ -
Green Gas Support Scheme - Band 2		£ 24.07		100%	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Green Gas Support Scheme - Band 3		£ 10.61		100%	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
CO2 Sales - Food and Beverage		£ 2.17		100%	£ 107,793	£ 109,948	£ 112,147	£ 114,390	£ 116,678	£ 119,012	£ 121,392	£ 123,820	£ 126,296	£ 128,822	£ 131,399	£ 134,027	£ 136,707	£ 139,441	£ 142,230	£ 145,075	£ 147,976	£ 150,936	£ 153,954	£ 157,034
Annual Revenue					*£ 3,073,310*	*£ 3,134,776*	*£ 3,197,472*	*£ 3,261,421*	*£ 3,326,650*	*£ 3,393,183*	*£ 3,461,046*	*£ 3,530,267*	*£ 3,600,872*	*£ 3,672,890*	*£ 3,746,348*	*£ 3,821,275*	*£ 3,897,700*	*£ 3,975,654*	*£ 4,055,167*	*£ 4,136,271*	*£ 4,218,996*	*£ 1,683,439*	*£ 1,717,107*	*£ 1,751,450*
Capital Cost																								
Site/Land lease costs	£ 4,040,000			100%	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ 269,333	£ -	£ -	£ -	£ -	£ -
Procurement	£ 300,000			100%	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ 20,000	£ -	£ -	£ -	£ -	£ -
Planning, consents and development management costs	£ 200,000			100%	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ 13,333	£ -	£ -	£ -	£ -	£ -
Digestion equipment & gas to grid unit	£ 12,000,000			100%	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ 800,000	£ -	£ -	£ -	£ -	£ -
Civils & Balance of Plant	£ 8,000,000			100%	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ 533,333	£ -	£ -	£ -	£ -	£ -
Commissioning costs	£ 102,000			100%	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ -	£ -	£ -	£ -	£ -
Design Fees and Project Management	£ 102,000			100%	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ 6,800	£ -	£ -	£ -	£ -	£ -
Capital Cost Contingency	£ 2,266,900			100%	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ 151,127	£ -	£ -	£ -	£ -	£ -
CCUS Installation Costs	£ 1,650,600			100%	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ 110,040	£ -	£ -	£ -	£ -	£ -
Capital Subtotal	*£ 28,661,500*																							
Annual Capital Repayment					*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ 1,910,767*	*£ -*	*£ -*	*£ -*	*£ -*	*£ -*
Finance Outstanding					*£ 26,750,733*	*£ 24,839,967*	*£ 22,929,200*	*£ 21,018,433*	*£ 19,107,667*	*£ 17,196,900*	*£ 15,286,133*	*£ 13,375,367*	*£ 11,464,600*	*£ 9,553,833*	*£ 7,643,067*	*£ 5,732,300*	*£ 3,821,533*	*£ 1,910,767*	*-£ 0*	*-£ 0*	*-£ 0*	*-£ 0*	*-£ 0*	*-£ 0*
																			£ -	£ -	£ -	£ -	£ -	£ 0
Operational Costs																								
Cost of Processing/Variable Costs																								
Contamination disposal (at 5%)		£ 6.00		100%	£ 298,732	£ 304,707	£ 310,801	£ 317,017	£ 323,358	£ 329,825	£ 336,421	£ 343,150	£ 350,013	£ 357,013	£ 364,153	£ 371,436	£ 378,865	£ 386,442	£ 394,171	£ 402,055	£ 410,096	£ 418,298	£ 426,664	£ 435,197
Gas Parasitic Load (10% for power and heat)		£ 2.16		100%	£ 107,345	£ 109,491	£ 111,681	£ 113,915	£ 116,193	£ 118,517	£ 120,887	£ 123,305	£ 125,771	£ 128,287	£ 130,852	£ 133,469	£ 136,139	£ 138,862	£ 141,639	£ 144,472	£ 147,361	£ 150,308	£ 153,314	£ 156,381
Consumables (Water, Ferric dosing etc.)		£ 0.50		100%	£ 24,894	£ 25,392	£ 25,900	£ 26,418	£ 26,946	£ 27,485	£ 28,035	£ 28,596	£ 29,168	£ 29,751	£ 30,346	£ 30,953	£ 31,572	£ 32,204	£ 32,848	£ 33,505	£ 34,175	£ 34,858	£ 35,555	£ 36,266
Digestate Removal (m3)		£ 6.00		100%	£ 298,732	£ 304,707	£ 310,801	£ 317,017	£ 323,358	£ 329,825	£ 336,421	£ 343,150	£ 350,013	£ 357,013	£ 364,153	£ 371,436	£ 378,865	£ 386,442	£ 394,171	£ 402,055	£ 410,096	£ 418,298	£ 426,664	£ 435,197
Variable cost Sub-total					*£ 729,704*	*£ 744,298*	*£ 759,184*	*£ 774,368*	*£ 789,855*	*£ 805,652*	*£ 821,765*	*£ 838,200*	*£ 854,964*	*£ 872,064*	*£ 889,505*	*£ 907,295*	*£ 925,441*	*£ 943,950*	*£ 962,829*	*£ 982,085*	*£ 1,001,727*	*£ 1,021,762*	*£ 1,042,197*	*£ 1,063,041*
Gross Margin					*£ 2,343,606*	*£ 2,390,478*	*£ 2,438,288*	*£ 2,487,054*	*£ 2,536,795*	*£ 2,587,531*	*£ 2,639,281*	*£ 2,692,067*	*£ 2,745,908*	*£ 2,800,826*	*£ 2,856,843*	*£ 2,913,980*	*£ 2,972,259*	*£ 3,031,704*	*£ 3,092,338*	*£ 3,154,185*	*£ 3,217,269*	*£ 661,677*	*£ 674,911*	*£ 688,409*
Overheads/Fixed Costs																								
Site Permit Annual Subsistence Fee	£ 12,000			100%	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000	£ 12,000
Equipment Maintenance	£ 420,000			100%	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000	£ 420,000
Operator costs Inc. cost of employment	£ 251,000			100%	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000	£ 251,000
Mobile plant	£ 102,000			100%	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000
Mobile plant lifecycle	£ 132,600			100%	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600	£ 132,600
Sundry Items [e.g. PPE, comms, occasional expenses]	£ 10,200			100%	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200
Training Costs	£ 5,100			100%	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100	£ 5,100
Site Manager Cost to Employ	£ 71,400			100%	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400	£ 71,400
Facility Insurance	£ 102,000			100%	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000	£ 102,000
PAS 110 inspection and laboratory testing	£ 10,200			100%	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200	£ 10,200
ABPR visits	£ 2,400			100%	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400	£ 2,400
Business Rates	£ -			0%	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Operating Contingency	£ 143,350			100%	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350	£ 143,350
Recyclable pet bedding disposal (non acceptance)	£ 240,000			100%	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000	£ 240,000
SPV Fee & Contractor Margin				100%	£ 401,012	£ 402,471	£ 403,960	£ 405,478	£ 407,027	£ 408,607	£ 410,218	£ 411,862	£ 413,538	£ 415,248	£ 416,992	£ 418,771	£ 420,586	£ 422,437	£ 424,325	£ 235,174	£ 237,138	£ 239,141	£ 241,185	£ 243,269
Cost of finance				100%	£ 936,276	£ 869,399	£ 802,522	£ 735,645	£ 668,768	£ 601,892	£ 535,015	£ 468,138	£ 401,261	£ 334,384	£ 267,507	£ 200,631	£ 133,754	£ 66,877	-£ 0	-£ 0	-£ 0	-£ 0	-£ 0	-£ 0
Annual Fixed Cost Sub-total					*£ 1,903,262*	*£ 1,904,721*	*£ 1,906,210*	*£ 1,907,728*	*£ 1,909,277*	*£ 1,910,857*	*£ 1,912,468*	*£ 1,914,112*	*£ 1,915,788*	*£ 1,917,498*	*£ 1,919,242*	*£ 1,921,021*	*£ 1,922,836*	*£ 1,924,687*	*£ 1,926,575*	*£ 1,737,424*	*£ 1,739,388*	*£ 1,741,391*	*£ 1,743,435*	*£ 1,745,519*
Net Margin	*-£ 17,159,530*				**-£ 1,470,423**	**-£ 1,425,010**	**-£ 1,378,689**	**-£ 1,331,442**	**-£ 1,283,249**	**-£ 1,234,093**	**-£ 1,183,954**	**-£ 1,132,812**	**-£ 1,080,647**	**-£ 1,027,438**	**-£ 973,166**	**-£ 917,808**	**-£ 861,343**	**-£ 803,749**	**-£ 745,003**	**£ 1,416,762**	**£ 1,477,881**	**-£ 1,079,714**	**-£ 1,068,524**	**-£ 1,057,110**
Unitary Charge OR Gate Fee	**£ 14.18**				£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18	£ 14.18
Adjusted Net Margin (sense check this value = 0)	*-£ 0*				-£ 764,192.67	-£ 704,655.35	-£ 643,927.29	-£ 581,984.67	-£ 518,803.20	-£ 454,358.10	-£ 388,624.09	-£ 321,575.41	-£ 253,185.75	-£ 183,428.30	-£ 112,275.69	-£ 39,700.04	£ 34,327.12	£ 109,834.83	£ 186,852.70	£ 2,367,254.25	£ 2,447,383.64	-£ 90,821.65	-£ 59,853.78	-£ 28,266.56

APPENDICES N-Q – CARBON EVALUATION MODEL INPUTS

Waste collection

Diesel		Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	Totals
Emission		Source Segregated Food Waste Collection						
CO_2e	Households	52,782	62,241	178,406	103,346	77,099	135,608	
	Mutli-occupancy	4,952	6,897	50,218	22,366	6,914	12,724	
	CO_2e Totals	57,735	69,138	228,624	125,712	84,013	148,332	713,553
CO2	Households	57,317	67,588	193,732	112,225	83,723	147,258	
	Mutli-occupancy	5,378	7,489	54,532	24,287	7,508	13,817	
	CO_2 Totals	62,695	75,077	248,264	136,512	91,230	161,075	774,853
CH_4	Households	13	15	44	25	19	33	
	Mutli-occupancy	1	2	12	6	2	3	
	CH_4 Totals	14	17	56	31	21	37	176
NOx	Households	620	732	2,097	1,215	906	1,594	
	Mutli-occupancy	58	81	590	263	81	150	
	NOx Totals	679	813	2,687	1,478	988	1,744	8,388

Hydrotreated Vegetable Oil		Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	Totals
Emission		Source Segregated Food Waste Collection						
CO_2e	Households	5,278	6,224	17,841	10,335	7,710	13,561	
	Mutli-occupancy	495	690	5,022	2,237	691	1,272	
	CO_2e Totals	5,773	6,914	22,862	12,571	8,401	14,833	71,355
CO2	Households	5,732	6,759	19,373	11,222	8,372	14,726	
	Mutli-occupancy	538	749	5,453	2,429	751	1,382	
	CO_2 Totals	6,269	7,508	24,826	13,651	9,123	16,107	77,485
CH_4	Households	1.30	1.53	4.39	2.54	1.90	3.34	
	Mutli-occupancy	0.12	0.17	1.24	0.55	0.17	0.31	
	CH_4 Totals	1.42	1.70	5.63	3.10	2.07	3.65	18
NOx	Households	186	219	629	364	272	478	
	Mutli-occupancy	17	24	177	79	24	45	
	NOx Totals	204	244	806	443	296	523	2,516

Biomethane		Halton	Knowlsey	Liverpool	Sefton	St Helens	Wirral	Totals
Emission		Source Segregated Food Waste Collection						
CO_2e	Households	6,334	7,469	21,409	12,402	9,252	16,273	
	Mutli-occupancy	594	828	6,026	2,684	830	1,527	
	CO_2e Totals	6,928	8,297	27,435	15,085	10,082	17,800	85,626
CO2	Households	5,644	6,656	19,078	11,051	8,245	14,501	
	Mutli-occupancy	538	749	5,453	2,429	751	1,382	
	CO_2 Totals	6,182	7,405	24,531	13,480	8,995	15,883	76,476
CH_4	Households	153.76	181.31	519.71	301.06	224.60	395.04	
	Mutli-occupancy	0.12	0.17	1.24	0.55	0.17	0.31	
	CH_4 Totals	153.88	181.48	520.95	301.61	224.77	395.35	1,778
NOx	Households	38	45	129	75	56	98	
	Mutli-occupancy	4	5	36	16	5	9	
	NOx Totals	42	50	166	91	61	108	518

Waste transfer

CO2 Equivalent	Wet Anaerobic Digestion			
kg CO2e/mile	**No Transfer**	**LCR Partnership Area**	**Northwest England**	**Out of Region**
Halton MBC	0.000	23.521	62.410	162.531
Knowsley MBC	0.000	34.498	62.723	163.080
Liverpool CC	0.000	103.493	188.170	489.241
Sefton MBC	0.000	68.996	125.446	326.161
St. Helens MBC	0.000	34.498	62.723	163.080
Wirral MBC	0.000	68.996	125.446	326.161
Totals per day	0	334	627	1,630
Totals per year	**0**	**86,840**	**162,999**	**423,866**

Digestate dispatch

CO2 Equivalent	Wet Anaerobic Digestion			
kg CO2e/mile	**No Transfer**	**LCR Partnership Area**	**Northwest England**	**Out of Region**
Halton MBC	0	3,545	9,405	24,494
Knowsley MBC	0	6,143	11,169	29,041
Liverpool CC	0	20,755	37,736	98,114
Sefton MBC	0	12,687	23,068	59,977
St. Helens MBC	0	7,679	13,963	36,303
Wirral MBC	0	14,093	25,624	66,622
Totals per year	**0**	**64,903**	**120,965**	**314,550**

Waste treatment

Factor	Wet Anaerobic Digestion
	Food Waste
Anaerobic digestion carbon emissions	9
Biomethane production (Wet AD)	-99
Liquid digestate fertiliser off-set	-186
Total Carbon balance from waste treatment and fertiliser off-setting per tonne	**-275.90**