LOCAL ENERGY ASSESSMENT FUND (LEAF)

Food Waste Anaerobic Digestion for Stratford upon Avon

Feasibility Study

Client - Community Energy Warwickshire (CEW)

Report authors

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EXECUTIVE SUMMARY

THE HEADLINES

Prospects for AD in the UK

- Anaerobic Digestion (AD) is considered by Defra to be "*the preferred technology for treating biodegradable waste*".
- The Coalition Agreement (2010) stated *"We will introduce measures to promote a huge increase in energy from waste through anaerobic digestion".*
- Waste Strategy 2007 for England identified food waste as "*a key priority for landfill diversion*".
- Treatment of organic waste is driven by legislation and in particular the European Landfill Directive that sets compulsory targets for a reduction in the quantity of biodegradable municipal waste being sent to landfill.
- The anaerobic digestion of organics that would otherwise go to landfill results in significant emissions reductions, through avoided generation of CH_4 in landfill, displacement of electricity and heat production from fossil fuel sources, and substitution of chemical fertilisers.
- AD is not a new technology – it has been used for many years in the UK water industry as the preferred method of treatment of sewage sludge.
- Only 70 AD commercial or farm-based AD systems are in operation in the UK – against targets of 100 commercial systems and 1000 farm based systems by 2020.
- There are very few examples in the UK where food waste is being collected and treated through a 'small scale' AD plant.

Waste collection and disposal

- The role of waste collection and disposal authorities will be crucial in any AD system proposed where domestic food waste collection and treatment is to be considered.
- The length of domestic waste collection contracts and waste disposal agreements mean that possibilities for diverting food waste from its current destinations are very limited.
- The cost of adding an additional collection service – as would be required for a source-separated domestic food waste collection – would cost a council in the region of £200k-250k.
- Composition studies carried out by the waste disposal authority have found that domestic food waste makes up only 4-6% of the green bin bio-waste collection.
- As there is no local authority commitment to collect or dispose of industrial or commercial biowaste, including food waste, much of this still ends up in landfill.

- The Coalition Government have announced £250 million of funding for council initiatives that bring back weekly domestic collections and *"add a weekly food waste (or organic waste) service to an existing fortnightly collection of residual household waste"*

- With the increased awareness of AD technology, the savings generated through renewable energy (heat and power), and the nutrient benefits from digestate, several leading in-vessel composting (IVC operators) are now turning to AD as a more economic alternative.

- When waste streams are small in volume or 'dispersed', it is not cost effective for a commercial waste operator to collect food waste at a price that smaller businesses can afford.

Food waste as AD feedstock

- Food waste represents a high energy resource i.e. it carries a high calorific value but it has the potential to produce large amounts of CO_2 and methane CH_4 (harmful greenhouse gases).

- It is estimated that every year, the UK throws away around 16 million tonnes of food and drink waste and it is thought that around half of this comes from businesses.

- The UK hospitality sector produces in excess of 400,000 tonnes of avoidable food waste and 200,000 tonnes of non-avoidable waste each year.

- Stratford upon Avon as a tourist town has more than 400 hospitality and other food waste outlets producing an estimated 4,000 - 8,000 tonnes of food waste each year.

- Successful campaigns such as the 'Love Food Hate Waste' and the 'Too Good to Waste' campaigns are clearly having an impact upon food waste behaviour – which will impact future food waste availability.

- Our survey revealed that hospitality food waste producers were positive about food waste recycling and indicated a willingness to separate food waste in their kitchens.

- Businesses in Stratford are already making efforts to generate as little food waste as possible, with incentives such as staff bonuses for reducing waste.

- Much of the food waste in Stratford upon Avon is of a 'dispersed nature' i.e. in small quantities from domestic or from the many small food outlets e.g. restaurants, cafes, hotels.

- Lack of storage space and difficulty of changing staff behaviour are given as major barriers to source segregation of food waste in the Stratford food waste survey.

Products of AD

- The ability to utilise heat produced from biogas through a Combined Heat and Power (CHP) unit on-site or locally is an important factor in AD project viability.

- Digestate resulting from the bio-digestion process is a useful replacement for chemical fertilisers and improves soil structure but it requires volume storage and access to land for spreading.

- Digestate from AD is subject to regulation and has to comply with exacting standards to be considered as a non-waste before disposal.

Site location for AD

- Whilst a number of options for siting of a community AD plant have been raised, they have not been identified nor referenced in this pre-feasibility study as considered to be premature.
- Seasonality of food waste coupled with likely urban planning and environmental restrictions point towards a farm-located co-digestion process using farm wastes and residues.
- Dairy farms provide a good co-digestion potential for food waste treatment due to the all year round availability (seasonal) of manure and slurries – and access to other feedstock sources.
- Planning and transport of materials (feedstock in, heat utilised and digestate out) are major factors when identifying suitable sites for an AD unit.
- Purpose grown energy crops e.g. ensiled forage maize were excluded from the study given the given the 'food v fuel debate' - however, energy crops grown as rotational 'break' crops significantly improve energy values to farm waste, and aid the digestion process.

Key viability factors for AD

- Access to feedstock supply and guarantees of availability i.e. contracts is crucial to any AD project, including community AD.
- The level of gate fees for accepting waste at an AD plant has a significant impact upon the commercial viability.
- Other key factors in AD viability include scale and cost of plant, collection and storage methods, environmental health and permits, planning approval, management and technical operations, and financial planning.

Financial modelling

- AD represents a complex and capital intensive process and as such, requires funding for a detailed feasibility study and business plan including risk and cost/benefit analysis.
- This study used different scenarios based upon quantities and analysis of food waste as feedstock to provide technical and financial modelling.
- Based on the financial modelling of scenarios, the Study identified the main sensitivity factors as gate fees, feedstock tonnage, transport costs, capital cost, debt ratio and energy prices.
- Community engagement, participation and investment would strengthen the financial justification for a food waste AD plant with a good chance of success in financial terms.

- There are a growing number of 'green' grant funding mechanisms and although these frequently change or become fully drawn, this is a vibrant sector.

Community AD

- The Coalition Government has recognised the importance of local community engagement through its Localism Bill and the potential of community groups to shape all our futures.
- DECC has indicated that it would like to develop clearer ideas on how to define a community energy project and there could be possible future benefits to a project in being accepted.
- Stratford and South Warwickshire in general has a strong community presence – demonstrated by the many active community groups and their activities.
- Engagement with the public and local authorities prior to submission of the planning application is important in gaining public confidence and acceptance for an AD plant.
- The potential introduction of AD systems into UK urban settings is organisationally challenging and requires community 'buy-in'.
- Currently there are no working examples of a community-owned food waste AD plant in England and Wales – although there have been a number of community AD studies carried out

Proposals

- Stratford with its particular concentration of food waste outlets, its high profile as a visitor experience and the proven determination of CEW to 'make a sustainable difference' offers a very suitable opportunity to 'test the community AD model'.
- The case for a community AD plant should take account of the wider benefits such as Social Return on Investment (SROI).
- Community groups such as CEW proposing an undertaking within the complex environment of the waste sector deserve support in terms of project development, loans and grant funding.
- CEW is well-placed to lead the engagement of specialist project management, technical and financial advisors coupled with support from organizations committed to community projects.

Main Conclusion

- It is our firm view that 'community ownership' is the key to success in this AD initiative. It will dictate the future direction of the project, raise local interest and develop social acceptance, encourage community, public and commercial partnership working, meet Government commitments to localism, and generate community investment.

GUIDELINES FOR COMMUNITY ENERGY WARWICKSHIRE

This study represents (with client agreement) a pre-feasibility and scoping exercise. The Consultants have provided CEW with information, experience and expert advice to assist them in deciding whether or not to progress a community food waste AD project. CEW are very aware that AD represents a much more complex and risky undertaking than a solar PV community investment project. Throughout our liaison with CEW directors and members, we have highlighted the many challenges involved. These are not just concerning feedstock supply, technical, financial and environmental issues. They also include the ownership and investment risks especially considering that the Stratford AD project would be a co-operative or social enterprise venture.

With such challenges and risks, it is not surprising that there are no community AD projects currently operating in England and Wales. However, as demonstrated in the text and summarised in our SWOT analysis included in the Appendices, there are clear drivers for change to waste collection and treatment – legislative, environmental, financial and social. The UK must find more effective and efficient means of collecting and treating waste in general – and food waste in particular. In fact, the term 'waste' should be replaced by 'resource'! AD is now stated as the "*the preferred technology for treating biodegradable waste*". It is an established recycling (as against disposal) technology providing a significant renewable energy source, with a clear opportunity to significantly reduce GHG emissions produced in 'competing' waste treatment / disposal processes, and with the 'bonus' of an organic fertiliser product displacing inorganic fertilisers and their associated costs and emissions.

The role of the community in waste resource management should therefore be tested – in line with the Coalition Government's commitment to The Big Society and local action. As ably expressed by other community AD feasibility studies (see Appendices) this should not be an undertaking by CEW alone. The costs and risks are simply too great. If left to the market, we can see that the development of AD will be slow - in spite of champions such as the Renewable Energy Association (REA), the Anaerobic Digestion Biogas Association (ADBA), the National Farmers Union (NFU) and the Country Landowners Association (CLA). There is potential for dispersed food waste to be collected and treated locally, and in smaller capacity AD plants whether located in urban or farm situations.

To summarise, we strongly believe and have shown through our financial modelling that there are workable and viable options applicable to small scale community AD projects. We would encourage national and local government to look carefully at this and other similar community feasibility studies with 'an open mind'. We would propose much more transparency in terms of current destinations for food waste and other digestible bio-waste – in line with our view that much of this valuable energy and fertiliser resource is still being land-filled. We would advocate closer partnership working between food waste producers, waste collection and disposal authorities, waste advisory and regulation bodies e.g. WRAP; EA – and of course enthusiastic community groups.

In conclusion, we would urge Community Energy Warwickshire to continue to take up the challenge. They have become a leading example of good community practice (as demonstrated in their short listing for the 2012 UK Community Renewable Energy Award - REA), have already established a strong organisational structure as an Industrial Provident Society, and have valuable experience in developing and managing a community investment renewable energy project. They should be supported in taking this bold initiative further.

INTRODUCTION

"AD can play an important role as a means of dealing with organic waste and avoiding, by more efficient capture and treatment, the GHG emissions that are associated with its disposal to landfill. The technology also offers other benefits, such as recovering energy, producing valuable bio-fertilisers, and using the nutrients." *Department of Energy and Climate Change 2011*[1]

The treatment of food and bio-waste through Anaerobic Digestion (AD) could be an option for towns and communities such as Stratford upon Avon where there is a prominence of hospitality and other food waste outlets. Access to the Local Energy Assessment Fund (LEAF) has provided the opportunity to study the logistics, benefits, challenges and viability of collecting food waste and treating through an AD plant for Stratford-upon-Avon.

Stratford upon Avon itself is a market-town with a population of 25,000 inhabitants. However, its numbers are swelled, especially in the summer months, with almost 4 million tourists each year. Tourism provides a major contribution to the local economy with many small businesses providing jobs and prosperity. It is serviced by the many hotels, guesthouses, restaurants, cafes and shops in the area. However, tourism brings other issues such as accessibility, affordability, traffic congestion, air pollution – and waste!

Stratford and South Warwickshire in general has a strong community presence – demonstrated by the many active community groups and their activities. People seem proud of their environment – resulting in low levels of pollution and vandalism. Some of this is due to the leadership of district, town and parish councils, their officers and elected members. Some of this is due to the presence of community groups such as Transition Towns (Stratford, Shipston) and Community Energy Warwickshire (CEW – the Client). These organisations bring together committed members of the public from a wide range of backgrounds and experience to engage and work together for the good of the environment, to improve local sustainability and to encourage local responsibility.

The Coalition Government has recognised the importance of local community engagement through its Localism Bill and the potential of community groups to shape all our futures. The launch of the £10 million Local Energy Assessment Fund competition for local community energy projects is to be welcomed.

Stratford District Council has had success in reaching and exceeding its targets for recycling, featuring high up in the local authority league tables. In terms of domestic 'green waste' material (NB containing only small amounts of food waste), much of this is diverted to in-vessel composting (IVC) treatment – working with other councils as part of the Warwickshire Waste Partnership[2]. However, with no local authority commitment to collect or dispose industrial or commercial biowaste, including food waste, much of this still ends up in landfill.

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[1] Anaerobic Digestion Strategy and Action Plan – DECC / Defra July 2011

[2] http://www.warwickshire.gov.uk/wastepartnership

CONTEXT – THE FOOD WASTE ISSUE

Waste is regarded by some as a problem and by others as an opportunity. In spite of the WRAP waste hierarchy, the various campaigns which are designed to reduce waste at source, and a wide range of general recycling programmes, there remains the issue of so-called 'residual waste'. Whilst this should refer to waste material not able to be recycled, re-used or composted, much of the waste currently sent to landfill can in fact be treated. Diversion from landfill is a priority for the UK – and is legislated under the European Union Landfill Directive. Shortage of suitable sites and the resulting harmful GHG emissions has required new strategies and solutions – and include Energy from Waste (EFW incineration), in-vessel composting (IVC) and anaerobic digestion (AD).

Food waste is produced in significant amounts from domestic, commercial and industrial sources. It is estimated that every year, the UK throws away around 16 million tonnes of food and drink waste (source: Defra 2011) and it is thought that around half of this comes from businesses. The Waste & Resources Action Programme (WRAP) highlighted the potential benefits of using commercial food waste for AD. Their report[3] published in July 2010 assessed the amount of food waste produced by the UK hospitality sector – in excess of 400,000 tonnes of avoidable food waste and 200,000 tonnes of non-avoidable waste is generated each year from businesses such as hotels, restaurants and pubs.

Food waste represents a high energy resource i.e. it usually carries a high calorific value. On the down side, it has the potential to produce large amounts of CO_2 and methane (harmful greenhouse gases). The environmental impact of this is found in the levels of CO_2 emitted per tonne of food waste as a result of land filling. Each tonne of food waste emits 1.8 tonnes of CO_2 - or 0.5 tonnes of CO_2 where landfill gas is collected and used through a Combined Heat and Power (CHP) unit.

The larger producer and retailer outlets for bio-digestible waste (e.g. vegetable residues Branston[4], food processing residues British Sugar[5] and supermarket food waste Sainsbury's[6]) can produce or aggregate sufficient quantities to justify the investment in a purpose-designed AD plant. Contractual arrangements with food waste processors are a major component for such large scale development. Much of Sainsbury's waste for example will be sent to Biffa's 'super' AD plant in Staffordshire - the biggest in the UK, processing up to 120,000 tonnes of food waste from homes and businesses every year. Such locations usually have the added benefit of on-site power and heat demand e.g. British Sugar, Wissington, thus maximising the energy outputs from the AD plant. Most also have access to land upon which the digestate can be spread – providing a valuable 'improved' natural fertiliser source (replacing the cost and environmental impact of inorganic fertilisers) and at the same time improving soil structure.

[3] The Composition of Waste Disposed of by the UK Hospitality Industry – WRAP July 2011

[4] http://ww.branston.com/news/story/minister_visits_ad_plant

[5] www.**britishsugar**bioenergy.com

[6] http://www.j-sainsbury.co.uk/media/latest-stories/2011/20111031-sainsburys-becomes-largest-retail-user-of-anaerobic-digestion

However, due to the dispersed nature and quantities of food waste from domestic or from the many small food outlets e.g. restaurants, schools, hotels etc much of this 'bio-waste' still ends up in landfill. The manufacturers' organization EEF found that the main barrier for businesses is how to deal with small waste streams that the waste management industry cannot collect and recycle affordably. Their 2011 Report[7] identifies waste storage space and labour as major issues in achieving effective segregation. It also suggests that "if waste streams are small in volume, it is unlikely to be cost effective for a waste management specialist to collect it at a price that the business can afford."

Tackling this 'dispersed food waste' issue therefore is much more challenging. There are very few examples in the UK where food waste is being collected and treated through a 'small scale' AD plant (generally categorised as plants between 20kW and 200kW electrical output capacity).

Currently there are no working examples of a food waste AD plant owned by a community group in England and Wales – although there have been a number of community AD studies carried out e.g. Share Energy in Leominster[8]. As a benchmark, we have used the experiences and 'lessons learnt' from the South Shropshire Biocycle Demonstrator Project (Ludlow)[9] with which some of our research team have been directly involved. The Ludlow AD plant does however only deal with domestic food waste, and is a joint venture between Shropshire Council and BiogenGreenfinch i.e. no community investment or involvement. The model does provide important evidence when investigating the logistic, environmental, commercial and technical case for bio-waste treatment using AD – and is included as a case study later in this report.

Community Energy Warwickshire are committed to investigating sustainable resource management – and have commissioned this scoping study to identify whether small scale AD represents a suitable local alternative (to landfill) for Stratford's food waste. CEW recognises (through their LEAF funding application) the complexity of AD – and that factors such as feedstock amounts and availability, waste contracts, scale of plant, collection and storage, transport logistics, environmental health, planning, technical operations and financial planning all have a strong influence.

This feasibility study sets out the case for and against a small-scale food waste digester in Stratford District to collect and treat waste food and other digestible waste e.g. green vegetable waste from commercial outlets in the town and district, as well as the prospect of household food waste collection. It examines possible partnerships and identifies ways forward based upon the findings of the research.

[7] http://www.eef.org.uk/manufacturingagenda/downloads/ascending-the-waste-hierarchy.pdf

[8] http://www.sharenergy.coop/wp-content/uploads/2011/07/SharenergyCaseStudyLeominsterAD.pdf

[9] Biocycle Demonstrator Report ~ Biocycle South Shropshire / Defra 2009

ANALYSIS OF REQUIREMENT

THE RESEARCH BRIEF

The Consultants have taken as guidance for this Study, the requirements laid out by CEW in the Invitation to Tender, namely:

- identification of amounts and types of food wastes produced by the hospitality sector and other businesses, including composition and quality; volumes and seasonal variations; current disposal routes and costs; possible collection methods; and ownership and contractual issues;
- siting, planning and regulatory considerations, including health and safety, transportation and controls on the use of digestate;
- potential local markets for AD products, including biogas, bio-methane, heat and digestate;
- engagement with local councillors, planners and civic groups, including a visit for interested parties to the South Shropshire bio-waste digester in Ludlow, to address possible misconceptions about urban AD.

THE RESEARCH TEAM

The Greenwatt Consortium consultants have significant experience in carrying out detailed and robust feasibility studies across a wide range of low carbon and renewable energy applications and initiatives. Our team has a particular strength in bio-energy, anaerobic digestion and waste resource management. We consider that the involvement of two of our Consortium members in the South Shropshire (Ludlow) Bio-waste Demonstrator Project has been of considerable value to the Study – enabling the Stratford upon Avon project to build directly on the first hand experience and benefit from 'lessons learnt'.

In brief, we have been able to bring together a depth of experience in the AD sector to deliver this food waste feasibility study, as follows:

- **Southampton University** – providing specialist expertise in the collection and analysis of food and bio-wastes with first-hand experience of the Ludlow BioWaste Demonstrator and many other UK and international AD projects (Prof Charles Banks; Dr Marty Climenhaga; Dr Sonia Heaven);
- **Evergreen Gas** – providing technical expertise in small and large scale farm and commercial AD systems (Michael Chesshire);
- **GeoCapita Ltd** – providing financial modelling and option analysis to evaluate the viability and economic sustainability of the selected options (Robert Woolf);
- **Greenwatt Technology** – providing waste legislation, local authority planning, AD systems knowhow, dissemination, local knowledge amongst business, local authority and community sectors and low carbon project management (Mike Woollacott; Dr Susan Juned).

KEY OBJECTIVES

The Consultants have prepared this AD Feasibility Study to achieve the following objectives:

- To identify stakeholder interest, engagement and commitment;
- To assess the levels, composition and continuity of supply of food waste and acceptable bio-waste stocks available in Stratford upon Avon and its environs from commercial, industrial, public sector and domestic sources;
- To outline the main logistical, environmental, authorisation and contractual issues related to feedstock collection, storage and disposal;
- To identify the planning, licensing and other regulatory requirements involved;
- To define the commercial issues relating to the financing and development of an AD project;
- To prepare a risk analysis that is project and site specific and lists mitigations;
- To maximise the technical, commissioning and operational experience and lessons learnt from other urban small-scale AD projects and feasibility studies e.g. Biocycle South Shropshire[10];
- To identify the key operational parameters relating to a small scale urban facility such as maintenance costs, staffing requirements, feedstock availability and consumables consumption;
- To demonstrate the commercial viability of this AD scheme, including gate fees, and its potential for achieving significant biodegradable municipal waste (BMW) diversion from landfill in Stratford District;
- To propose how best to utilise the outputs of AD – biogas, electricity, heat and digestate;
- To examine the potential for the Stratford AD Project to become a 'Centre of Excellence' for waste resource management providing a reference for other community energy groups, waste disposal authorities, policy makers and regulators;
- To examine current and likely funding streams (public and private) useful to assist the next stages towards a successful establishment of a food waste AD plant in or near Stratford upon Avon, should this initiative be pursued.

[10] Biocycle Demonstrator Report ~ Biocycle South Shropshire / Defra 2009

DELIVERABLES AND OUTCOMES

The AD Feasibility Study will provide a clear business case for Community Energy Warwickshire and other stakeholders and will base its prospects on a short, medium and long term basis. In particular, the Study will enable CEW and other partners to:

- make clear choices between AD and other food waste options – technical, economic, logistical;
- identify and clearly set out the financial basis for recommending options including appropriate financing models;
- investigate the interest and commitment from participants and beneficiaries (community, businesses and voluntary sectors) for a small scale AD plant in Stratford upon Avon;
- take full account of the opportunities afforded by the Government policies and incentive schemes such as the Feed in Tariff (FIT), the Renewable Heat Incentive Scheme (RHI), and the Renewable Obligations Certification Scheme (ROCS);
- consider a possible project implementation plan should the feasibility outcomes look promising.

POTENTIAL BENEFITS OF AD FOR STRATFORD UPON AVON

The Stratford upon Avon food waste AD proposal has the potential to satisfy several sustainability objectives under the headings of environment, community and economy. These may be summarized as follows:

- Increased capacity for the treatment of biodegradable waste diverted from landfill;
- Generation of renewable energy contributing to local targets;
- Contribution to a low carbon economy – local and national;
- Contribution to local authority recycling targets;
- Creation of jobs;
- Extending community, business and local authority awareness of the benefits of recycling, renewable energy and sustainable resource management;
- Opportunity to provide a source of bio-fertiliser for local agriculture;
- Community engagement and involvement.

DELIVERY METHODOLOGY AND PROGRAMME

CONSULTANTS APPROACH

Whilst the Consultants have been careful not to presume the outcome of such a feasibility study, we have recognised the clear commitment of Community Energy Warwickshire to investigate the viability of an AD project that meets technical, environmental, economic and social objectives. Our approach therefore has been to reflect CEW's positive stance - to provide data, feedback and proposals leading to an independent and critical analysis that builds social awareness and involvement, business engagement, environmental and economic planning, risk analysis and forward proposals for implementation. No single factor should be in a position to commit or reject – rather, a combination of issues, outcomes, commitments and costings should provide CEW and other stakeholders with the best opportunity to decide whether to progress this ambitious project – or not.

CEW indicates that '*AD technology is well understood and is widely employed internationally*' – but makes an important distinction with reference to the UK – and of course to Stratford upon Avon – in that '*the potential application of AD in UK urban settings is organisationally challenging'*. Whilst we concur with this, our study demonstrates that AD offers an efficient and sustainable solution to bio-waste – and especially food waste - much of which contains high calorific values and therefore re-usable energy. But AD is having a difficult gestation in the UK – even given the incentives offered under the Feed in Tariff or Renewable Obligation Certification Schemes – and is unlikely to meet the targets for installed AD capacity as envisaged by the National Farmers Union and included within the AD Shared Goals publication[11]. We suggest this is due to several factors, real and perceived (in no order of priority):

- Existing waste contracts
- Planning and environmental restrictions
- Feedstock supply – regularity and consistency
- Awareness of the technology and its social, economic and environmental benefits
- High capital cost
- High operating costs (revenue)
- Health and safety risks
- Transport and logistics
- Appropriate technology – type and size availability
- Environmental restrictions
- Economic use of outputs – especially heat and digestate

[11] Anaerobic Digestion Shared Goals – Defra 2009

EVIDENCE BASE

With regard to feedstock availability and access, we have used for our evidence base a wide range of local data held by Stratford District Council and Warwickshire County Council - and have added to this appropriate tables and references to official data published by DECC, WRAP, Defra, UK Statistics Authority, Chartered Institute of Waste Management, Consumer Focus and other organisations. Case studies such as the Ludlow Bio-waste digester – and other community AD feasibility studies e.g. Leominster, Youlgrave (see Appendices) - provide valuable information and have ensured that maximum gain is made from other food and bio-waste experiences and research.

We have assessed and made recommendations based on the overall national policy context, including the proposals for the revised Feed in Tariffs (FITs, Renewable Obligation Certification Scheme (ROCS) and the Renewable Heat Incentive Scheme (RHI). We have brought our experience with the current Feed in Tariff and ROC arrangements to make viability assessments.

The recommendations we have reached are consistent with local and regional studies such as the Sub-Regional Renewable Resource Assessment (April 2010), the Climate Change Adaptation Study (Feb 2011) and other relevant public sector work in relation to climate change, renewable energy generation and energy efficiency.

The role of local authorities will be crucial in any AD system proposed where domestic food waste collection and treatment is to be considered. Not only do they manage and contract domestic waste collection and disposal services but they are seen as a trusted interlocutor with households (District) and commercial (County) which will be essential to work in particular areas. We acknowledge the contribution of Stratford District Council (the Waste Collection Authority) and Warwickshire County Council (The Waste Disposal Authority) in the provision of information on waste streams and contracts. These Councils could play a pivotal role in the development and implementation of an AD project for Stratford. Indeed we would hope and actively support the growing partnership between CEW and the local council authorities.

We anticipate that this Study will help to support CEW in promoting the opportunities for AD as a community-led sustainable solution to council staff and elected council members. We propose that one method of dissemination could be to utilise the local authority dissemination model promoted by the ADEPT/Forum for the Future scenario-based programme ‘Building a Low Carbon Britain’ (2011) which recommends the following priorities for local authorities in addressing low carbon:

- Redefine the role of local government in a low-carbon economy
- Invest in low-carbon infrastructure
- Set favourable planning conditions
- Build resilience at the local level
- Prevent low-carbon social exclusion
- Foster low-carbon innovation

METHODOLOGY – WORK PACKAGES

The Greenwatt Consortium has maximized the collective expertise and resource provided by the Consultants as outlined above. The following work package schedule has been followed, and forms the basis for this Feasibility Study Report:

1. **Stakeholder Awareness, Commitment and Engagement (Leader - Mike Woollacott, Greenwatt)**

    a. Carried out a brief scoping exercise to capture initial reaction and gain early commitment to the feasibility study from CEW members and of other key stakeholders such as Stratford District Council and the Stratford business, tourism and hospitality community;
    b. Coordinated the information-gathering exercise (in conjunction with Southampton University) relating to feed stocks, including volumes and composition, current food waste management, collection and disposal methods, food waste facilities and site plans.
    c. In conjunction with CEW, coordinated the stakeholder engagement programme which included a visit to the South Shropshire Bio-waste Digester;

2. **Waste Policy, Planning and Legislation (Leader – Dr Susan Juned, Greenwatt)**

    a. Identified and confirmed the current EU and national legislation related to food and bio-waste, including any proposals in the pipeline;
    b. Defined current planning and environmental regulations applicable to Stratford upon Avon and the District, including siting, transport restrictions, pollution and digestate controls;
    c. Outlined the main logistical, environmental, authorisation and contractual issues related to feedstock collection, storage and disposal.

3. **Feedstocks Analysis and Collection Systems (Leader – Dr Marty Climenhaga, Southampton University)**

    a. Co-ordinated and supervised an audit of current and proposed bio-waste streams in and around Stratford upon Avon (with Greenwatt and CEW);
    b. Carried out a desk-based study of the feasibility of source segregated food waste treatment applicable to Stratford upon Avon, including assessment of likely yields and characteristics from domestic and commercial sources;
    c. Prepared an assessment of different types of collection schemes that could be applied ;
    d. Identified the appropriate scales of implementation of food waste digestion based on local factors including current waste management infrastructure, land base and potential for energy utilisation;

e. Carried out an assessment of the overall energy balances and net energy gains that could be achieved by separate food waste collection with AD;
f. Prepared a preliminary evaluation of improved sustainability in terms of nutrient recycling and GHG emissions abatement potentially associated with implementation of such a scheme.
g. Supported the dissemination of the results and 'lessons learnt' of the South Shropshire Bio-waste Demonstration Project and other case studies.

4. AD Technical Analysis (Leader – Prof Michael Chesshire, Southampton University, Evergreen Gas)

a. Prepared a technical analysis of different digestion schemes suited to food waste and including size, process and availability
b. Prepared an option analysis for a possible Stratford food waste digester based upon the food waste audit and assessment;
c. Identified the characteristics of a food waste bio-digester site and commented upon the various sites introduced by CEW;
d. Prepared a review of market prospects and opportunities for AD products – biogas, bio-methane, digestate;
e. Used the experience of the South Shropshire Bio-digester to prepare an outline risk analysis appropriate to Stratford and including mitigations.

5. Finance and Business Analysis (Leader – Robert Woolf, GeoCapita)

a. Reviewed the possible role(s) of Community Energy Warwickshire (CEW) within the proposed food waste bio-digestion project, as promoter, partner , manager, or investor;
b. Prepared an analysis of finance options and cost benefit for the Stratford Bio-waste AD plant;
c. Summarised the various incentive schemes that could influence the viability of the Stratford AD plant – e.g. FITs, ROCs, RHI, EIS
d. Prepared a suitable financial model(s) for the Stratford AD plant based upon the engineering and basic cost data supplied by Michael Chesshire;
e. Delivered a financial and management appraisal of the project viability to CEW and other prospective stakeholders.

6. **Project Management, Planning and Dissemination (Leader - Mike Woollacott, Greenwatt)**

   a. Prepared an outline Project Management Plan including delivery timescale and mechanisms to enable CEW and other stakeholders to progress the Stratford AD project;
   b. Ensured any recommendations are financially robust, tested for impact and are SMART (Specific, Measurable, Achievable, Realistic and Timed);
   c. Proposed methods of dissemination of the AD Feasibility Study;
   d. Provided robust project management procedures throughout to ensure that the Feasibility Study is produced on time and achieves its objectives and activities outlined above;
   e. Coordinated project launch, interim and final report and presentations, and project budget in liaison with CEW.

Activity Schedule

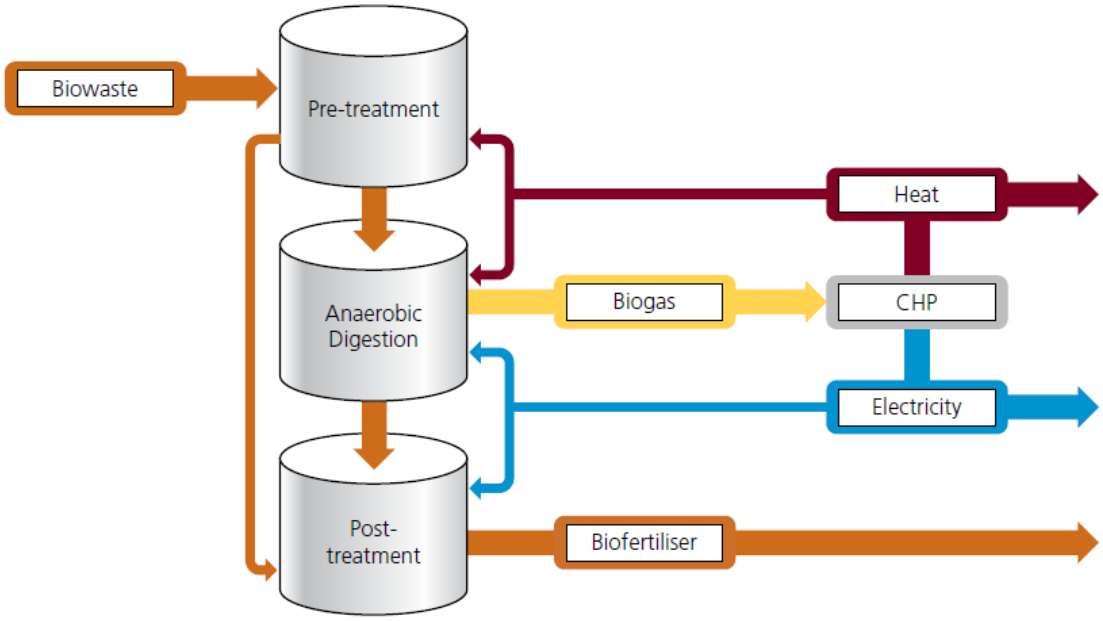
The delivery period for this LEAF-funded project was extremely tight – with just 7 weeks from mobilization to completion and presentation of final report. However, the Consultants feel that they have delivered a detailed and accurate report, covering the Work Packages within the timeframe available and as outlined below:

ACTIVITY SCHEDULE	1	2	3	4	5	6	7
1. Project Initiation, Client and Stakeholder Liaison, Case Studies, Study Visits							
2. Waste Policy, Planning and Legislation							
3. Feedstocks Analysis and Collection Systems							
4. AD Technical Analysis							
5. Finance and Business Analysis							
6. Project Management, Planning, Reporting and Dissemination							
7. Final report and presentation							

AD TECHNICAL ANALYSIS

ANAEROBIC DIGESTION – THE PROCESS

Anaerobic Digestion (AD) is a natural biological process that stabilises organic materials in the absence of oxygen. It is an enclosed, natural biological process which transforms biodegradable materials (in the absence of air) to biogas and a digestate (liquid and/or solid). The biogas produced by anaerobic digestion consists of approximately 60% methane and 40% carbon dioxide (depending on the input feedstock), and can be used as a fuel in a conventional boiler to produce hot water, or in a combined heat and power unit (CHP) to produce electricity and hot water. It can also be upgraded to liquid bio-methane for use directly as a vehicle fuel, or as methane gas for introduction to the grid. Digestate is used as an 'improved organic fertiliser' (as a result of the biodigestion process) that can be used to displace mineral fertilisers and improve soil structure.



Example of an AD plant configured to produce energy and biofertiliser from biowaste feedstock – Defra 2011

AD is not a new technology – it has been used for many years in the UK water industry as the preferred method of treatment of sewage sludge (more than 60% of sewage sludge in the UK is processed through AD) but has only recently been acknowledged by the Department for Environment Food and Rural Affairs (Defra) as "the preferred technology for treating biodegradable waste"[12]. As the UK generates over 16 million tonnes of food waste per year, AD is now being proposed as a commercially viable technology to treat this waste - producing renewable energy and usable digestate (fertilizer) whilst reducing GHG emissions from landfill.

[12] AD Waste Strategy ~ Defra 2011

Treatment of organic waste has been driven by legislation and in particular the European Landfill Directive that requires a reduction in the quantity of biodegradable municipal waste being sent to landfill. The Directive places targets on the UK for 2013 and 2020. As a consequence, costs for the disposal of waste to landfill are increasing with inflationary rises (or more) to gate fees and the Government's annual increase to the Landfill Tax of £8 per tonne of waste landfilled[13]. Known as the Landfill Tax Escalator, the current level of Landfill Tax is £56 per tonne (2011-12) increasing to £80 per tonne in 2014, with the prospect of further rises in future years.

Comparison of AD with in-vessel composting (IVC) of biowaste

It is worth highlighting in-vessel composting (IVC) as a way by which food waste and green waste is treated in aerobic conditions, through a shredding, mixing and heating process. Many councils, including several in Warwickshire operating as part of the Warwickshire Waste Partnership, have invested in IVC facilities. This has had a significant impact upon diversion of biowaste from landfill – although it must be added that such aerobic treatment actually requires energy for the process.

IVC plants have been established because the mixing of the two waste streams – green waste and food waste - requires a sufficient processing temperature to comply with UK and EU animal by-products regulations (ABPR). This means that treating the two waste streams together results in considerably higher energy and technology costs than for green waste treatment alone (the 'open windrow' method). As green waste is generally obtained in far higher quantities than food waste considerable savings can be achieved by separate collection and treatment.

With regard to greenhouse gas emissions (GHG), AD and composting both result in the emission of CO_2 but in the case of AD, renewable energy is produced. AD does therefore have GHG emissions in the form of CO_2 (the emissions from AD are from the exhaust stack of the CHP unit or equivalent) but can be demonstrated to have an overall GHG saving.

AD can be regarded as more suitable processing technology for treatment of food waste than composting as the high moisture content of food (usually about 75%) is particularly suited to the AD bio-digestion process. As food waste is also a comparatively high energy feedstock, its treatment through AD results in significant levels of energy generation (through CHP). However, food waste does require a heat treatment stage in order to comply with the animal by-products regulations (ABR). In AD this can be achieved under thermophilic conditions (57°C for 5hrs) but under mesophilic conditions (30-38°C) requires a separate treatment stage pre or post digestion.

AD is a more capital intensive process, requires a very different management regime and can be regarded as having more health and safety issues. With the increased awareness of AD technology, the savings generated through renewable energy (heat and power), and the nutrient benefits from digestate, several leading IVC operators are now turning to AD as a more economic alternative to composting e.g. Eco Food Recycling[14] operating in the South of England.

[13] Coalition Government – Budget Report 2010

[14] Eco Food Recycling http://www.ecofoodrecycling.co.uk

ANAEROBIC DIGESTION – SYSTEM CHARACTERISTICS

> *"We will introduce measures to promote a huge increase in energy from waste through anaerobic digestion"* Coalition Agreement, 2010

The UK AD Infrastructure Report (published February 2012)[15] indicates that there are currently 214 AD plants treating in excess of 5 million tonnes of bio-digestible material and producing 170 megawatts of electricity (MWe). Of that amount, 146 are sewage sludge AD plants. Only 70 AD commercial or farm-based AD systems are in operation – a far cry from the NFU / Defra 2009 targets as set out in the AD Shared Goals Report[16] which proposes 100 commercial systems and 1000 farm based systems by 2020. Biogas – and in particular grid injected bio-methane – is regarded as an important renewable energy source able to replace the dwindling reserves of North Sea gas.

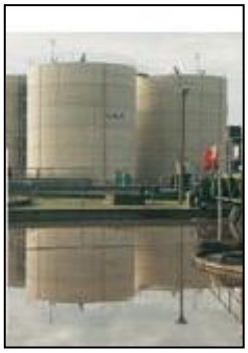
However, WRAP and NCFCC AD Infrastructure Report is upbeat:

> *"The headline figures for the AD industry provide a very positive reflection of the industry's development compared to 2005 when there were just two AD plants operating outside of the water industry in the UK."*

In the UK, AD operates in three 'mainstream' situations:

On farm AD – utilising livestock waste (cattle or pig slurries; poultry litter) which may be co-digested with energy crops such as grass or maize silage.

Commercial AD – utilising bio-waste consisting of digestible green waste or food waste produced from growers, food processors, and food retailers.



Sewage sludge AD - system used by sewage authorities for many years, operating under tight human waste regulations.

[15] WRAP and National Non-Food Crop Centre February 2012

[16] Anaerobic Digestion Shared Goals – Defra 2009

Whereas the basic bio-digestion principles are the same, the three systems have their own distinguishing features related largely to types of digester feedstock available / used:

On-farm AD

Farm-based systems are usually based around slurries (pig, cattle) with the AD providing the farmer/landowner with a secure liquid storage system that produces biogas and digestate. However, slurries have already been part-digested (by definition) and have relatively low calorific values. With such a high water content, large capacity digestion and storage tanks are required (at least equivalent to existing tank or lagoon capacity). Large amounts of liquid digestate are produced – and stored until field spreading is permitted. In an effort to increase the overall calorific value of the biogas produced, higher energy crops can be added – such as maize or grass silage, or beet. Other residues such as that derived from sugar processing, or vegetable field waste can also be added.

Very few farm-based AD systems incorporate materials imported from the food waste stream. Whilst food waste can produce biogas with a high calorific value, it comes with its own environmental and legislative requirements. Secure, vermin-free storage areas are required. A pasteurisation unit is required (pre or post digestion) to eradicate pathogens. Arrangements have to be made for transportation of feedstock into the AD plant. Odours are more of an issue affecting neighbours as a result of food waste treatment. Incorporation of imported food waste impacts upon how the resulting digestate can be used. Seasonality of supply can also be an issue – although the baseload from slurries, residues and energy crops can usually balance out the annual supply.

Commercial AD

These 'waste fed' AD plants are usually situated adjacent to or proximate to the source of the feedstock i.e. food processing factory. Alternatively they can incorporate an accessible food waste reception centre, located close to main highways enabling food waste from other outlets to be transported into a central plant e.g. supermarket chain network. Some of these larger commercial AD plants are farm-based and co-digest animal waste e.g. BiogenGreenfinch Twinwoods plant near Bedford. In all cases, the opportunity for a 'closed loop' situation where the heat and power can be utilised on-site becomes a major factor in selecting the commercial AD location.

Waste-fed AD plants are those which accept feedstock which, in whole or in part, comprises of food waste from commercial & industrial sources and/or municipal source segregated waste. There are 44 waste-fed AD plants in the UK with a processing capacity of around 3.7 million tonnes per annum and a potential to generate around 54MW of electricity. Of these, one plant injects biogas directly into the gas grid – a practice that will undoubtedly rise amongst the larger systems i.e. >1MW as refining or 'scrubbing' technology becomes more affordable – and utility companies begin to realise the importance of bio-methane as a North Sea gas replacement.

The waste-fed category has been further divided into Industrial and non-industrial facilities. These are usually defined as follow:

Waste-fed industrial **-** AD facilities which accept wastes arising from their own 'on-site' activities. They tend to have a significant throughput of material because they process high volumes of low solid effluents e.g. vegetable processing, washings etc.

Waste-fed non industrial - AD plants which accept food waste from commercial and municipal sources. They are predominantly commercial large-scale, standalone facilities. This category also often includes other integrated waste management facilities which incorporate AD as part of a range of waste management processes.

Sewage sludge AD

AD has been used as a treatment process for many years. The primary objective of a sewage works is to clean the incoming sewage or "wastewater" (>99% water) to a standard suitable for discharge into a watercourse (hence they are sometimes called 'water reclamation works'). The processes of sewage treatment produce sewage sludge as a by-product. This sewage sludge is treated through an AD process such that the resultant 'bio-solids', which can be in either liquid form or semi-solid, can be used in agriculture as a soil conditioner/fertiliser similar to digestate. Power and heat is recovered through the AD process and used on site with surplus exported where possible.

This study investigated the potential for co-digestion of sewage sludge and food waste at a local sewage works. Three major issues were identified:

- Ofwat and the use of regulated assets for commercial purposes;
- the regulations concerning the disposal of digested sewage sludge;
- sewage sludge is not a permitted input for the achievement of PAS110[17].

For these reasons, further investigation was considered to be outside the scope of this pre-feasibility study and the scenario was not included. However, further discussions with the water authority (Severn Trent) may reveal opportunities to investigate this option in more detail. This is in line with DECC's acknowledgment that:

> *"There is a clear action within this Action Plan to address and to clarify the specific regulatory issues surrounding the co-digestion of sludge and other waste materials."*[18]

[17] PAS 110:2010 ~ WRAP

[18] Anaerobic Digestion Strategy and Action Plan ~ DECC 2011

SITE CHARACTERISTICS OF A FOOD WASTE AD PLANT

It was agreed at the outset that a detailed analysis of site for a Stratford AD plant was premature, and indeed depended upon factors such as the amount and location of feedstock available, the influence of planning and environmental regulation authorities, road infrastructure, collection and transport logistics, co-digestion requirements, and proximity to heat usage from CHP. It will also be necessary to consider the operational requirements for an AD plant – and the need to facilitate operations, reduce environmental impact, gain local support and lower the risk of planning refusal or regulatory conflict.

There are various situations within or proximate to a market town environment such as Stratford upon Avon. These would include:

1. **Situation 1 - Co-location at a local sewage treatment works** – with an opportunity for co-digestion of food waste with sewage sludge. In this location, there will be environmental health restrictions and considerations. There could also be complications concerning the commercial water company's waste treatment contract and obligatory framework. On the positive side, sewage treatment companies have good experience of AD technology and their sites already have environmental permits for waste treatment. There would be an on-site demand for power and heat to assist in the existing sewage treatment process.

2. **Situation 2 - A local authority owned site** – with access and space sufficient to allow safe transportation in and out and with a demand for heat and power produced from the AD plant. This urban location has the benefits of proximity to food waste production – but on the downside will require transportation of digestate away from the plant. There would be a risk of odour and other local objections – not a strength in a community AD initiative perhaps?

3. **Situation 3 - An urban industrial or commercial site** e.g. supermarket, hospital. These sites would likely have space and access for industrial vehicles and also would be proximate to demand for heat and power. Potential for power agreements and investment partnership with industrial site owner or site tenants. As with Situation 2 above, such a site would require transportation of digestate away from the plant. There would be a risk of odour and other local objections.

4. **Situation 4 – A farm location** – preferably with dairy or pig units to provide slurry feedstock able to be co-digested with food waste, and supplying high water content substrate necessary for the AD process. In the dairy farm situation there would be some seasonality of slurry supply – unless cattle are housed all the year round (as are intensive pigs and poultry). Proximity to the town would be important – and it worthy of note that there are few dairy farms close to Stratford upon Avon! Inclusion of maize or grass silage (grown as break crops and not grown intensively as an energy crop) would add valuable energy and essential fibre to the AD process. The main issue with this location would be the ability of the farm to use or export the heat element of the CHP plant – affecting viability. Road infrastructure and transport of waste could also be a local issue.

ANALYSIS OF AD PRODUCTS

AD is not simply a method of treating bio-waste in order to reduce the impact of landfill upon greenhouse gas emissions. The process has valuable by-products derived from the anaerobic digestion process.

Biogas

Biogas is a mixture of gases with major constituents of methane (CH_4 - approximately 60% dependent upon feedstock) and carbon dioxide (CO_2 at approximately 40% content). Other gases are produced in small amounts - mainly hydrogen sulphide (H_2S) and ammonia (NH_4). The composition of the biogas also depends upon the type of AD treatment adopted e.g. thermophilic or mesophilic. The energy in biogas can be burnt as a heating fuel, used to power a gas turbine which produces electricity, or used to power a combined heat and power plant (CHP) which produces both heat and electricity. A proportion of the heat and power from the CHP e.g. 20% is fed back into the AD plant as 'parasitic' energy – with the rest available for use elsewhere onsite, to the grid (electricity) or to supply neighbouring users of heat.

CHP unit

Biogas can be 'upgraded' to pure methane, called 'bio-methane', by removing the other gases by adding a further complex and expensive technology. For this reason upgrading is only found on large AD units i.e. >1MW. This enables the bio-methane to be injected into the gas grid – under strict quality and health & safety regulations and permits. An alternative use for the bio-methane is as a transport fuel (either as liquid or compressed gas) which is being used increasingly in private and commercial vehicles. This presents an opportunity for 'closed loop' systems – where waste collection / delivery vehicles can be powered by the bio-methane.

Digestate[19]

Digestate is a nutrient-rich substance produced by AD that can be used as an organic fertiliser. It consists of left-over indigestible material and dead micro-organisms - the volume of digestate being around 90-95% of what was fed into the digester.

[19] Adapted from www.biogas-info.co.uk

By using digestate as a replacement for artificial fertilisers derived from fossil fuels (mainly natural gas), AD saves energy, cut consumption of fossil fuels and reduce the carbon footprint of agriculture. All the nitrogen, phosphorous and potassium present in the feedstock will remain in the digestate as none is present in the biogas.

Typical values for nutrients are:

- Nitrogen: 2.3 - 4.2 kg/tonne
- Phosphorous: 0.2 - 1.5 kg/tonne
- Potassium: 1.3 - 5.2 kg/tonne

However, the process of AD makes the nutrients considerably more available to plants than in raw slurry, meaning it is easier for plants to make use of the nutrients. This can be particularly valuable for land within Nitrate Vulnerable Zones (NVZ) where applications of organic nitrogen are restricted.

Digestate can be used straight from the digester, in which case it is called whole digestate and applied to grassland or arable farmland. Alternatively it can be separated in to liquor and fibre. There are some examples where the separated and dried fibre element is bagged and sold as garden fertiliser and soil improver.

FEEDSTOCK ANALYSIS AND COLLECTION SYSTEMS

This section has been lead by the Bioenergy and Organic Research Group, School of Civil Engineering and the Environment at Southampton University – Prof. Charles Banks. The research work was undertaken by Dr Marty Climenhaga – a specialist AD researcher at the University who has recently completed a project with Regenerate Biogas Inc (Toronto) working on the development of community-owned biogas plants, including resource assessment, feasibility, digestate application and funding. Dr Climenhaga was ably assisted in the Stratford Food Waste Audit by volunteers from Community Energy Warwickshire.

POSSIBLE SCENARIOS FOR STRATFORD FOOD WASTE AD PLANT

A number of possible combinations of feed stocks and scales were considered for the project, and the analysis of feedstock options focused upon the following three scenarios:

Scenario 1: Centralized digester for food waste only, potentially located on the outskirts of Stratford, with export of digestate to neighbouring farms

Likely to require the smallest digester size, with a total estimated throughput of 4,000 tonnes per year, processing a single waste stream – food waste from commercial hospitality establishments in Stratford. The plant could potentially be sited within a short distance of the town centre and the waste source. The digestate output from the plant would still need to be exported and applied as a slurry fertiliser to farmland, so local farm partners willing to take the digestate would be required. In this case, there would be associated transport and management costs for digestate 'disposal'.

Scenario 2: On-farm digester co-digesting food waste with cattle slurry, with digestate being used on-farm

This option would include the same 4,000 tonne per year hospitality food waste feedstock, but this would be taken as collected raw material directly to a farm and co-digested with an estimated 4,000 tonnes of cattle slurry from the farm. This would mean a higher throughput of material and somewhat higher biogas output, although cattle slurry is a significantly less rich feedstock for biogas production, and therefore its addition would result in only about 12% higher gas production. It does have benefits, however, in providing process stability and the siting of a digester on a farm means that the digestate can be used by the farmer directly. This avoids the need for finding a land application site and the associated transport costs.

Scenario 3: Digester located on or near a food manufacturer or producer's site, digesting food waste from the site along with food waste collected from hospitality establishments in Stratford

This option involves co-digesting the estimated 4,000 tonne per year hospitality food waste along with an additional 2,000 tonnes per year of organic waste from a food manufacturer, if one were found that were suitable and interested in partnering for a project. The plant could be sited at the food manufacturer's site, which would require transporting the hospitality food waste to the site. Land application of the digestate may be possible at the site if it were a farm-associated company e.g. vegetable grower. Otherwise a neighbouring farm able to receive and apply the digestate would again need to be found.

Table 1: The amounts of each type of waste processed under each scenario are summarised:

	Scenario 1 Central Food Waste Digester *tonnes*	**Scenario 2** On-farm digestion (co-digested) *tonnes*	**Scenario 3** Digester at Food Processing Premises (co-digested) *tonnes*
Domestic food waste (Note 2)	0	0	0
Commercial catering waste – approx 400 food premises including 80 hotels, guesthouses	4,000	4,000	4,000
Other food waste – vegetable residues, digestible green waste; food processing outlets	0	0	2,000
Manure & slurry – typical dairy herd yields	0	4,000	0
Purpose grown crops – maize, grass silage (Note 3)	0	0	0
TOTAL	4,000	8,000	6,000

Notes:

1. The above 3 scenarios represent potentially different technical and commercial models, for example, differing urban or rural locations, their respective transport costs and associated carbon footprint.

2. Our understanding is that domestic bio-waste collection and disposal has been contracted out on a long term basis (15 years) and therefore we have not included this feedstock in any of our proposals.

3. We have not included any volume of purpose grown 'energy crops' e.g. maize given the 'food v fuel debate', the wide set of unknown variables and practical issues to be dealt with. However, energy crops grown as rotational 'break' crops e.g. in Scenario 2, could add significant amounts of feed stocks at relatively high energy values.

4. We have assessed the availability of feedstock supplies as identified above based upon sampled data, local discussions and extrapolated from recent research studies. However, no commercial discussions have been entered in to at this stage.

COMPARATIVE ANALYSIS OF SCENARIOS

The advantages and disadvantages of the different scenarios are shown below in **Table 2** :

	Scenario 1: **Central Food Waste Digester**	**Scenario 2:** **On-farm digestion**	**Scenario 3:** **Food Waste Digester at Food Processor site**
Advantages	• site can be close to where waste is sourced / produced • no other AD partners required • Ludlow BioCycle offers a precedent	• no land acquisition required • digestate application at site • additional environmental benefits and GHG savings of adding cattle slurry as substrate (avoided emissions from raw manure, additional fossil fuel displacement from power generation) • for farmer, may make an on-farm AD feasible • shared investment & risks between farmer & AD proponent • potential for community tie-in: urban & rural cooperation	• no land acquisition required • additional feedstock & additional benefits in GHG savings of food processor's substrate • may make on-site AD feasible for food processor /grower • shared risks & investment between food processor & AD proponent
Dis-advantages	• requires land acquisition (although might be avoided if a Council-owned property is available) • requires separate site for digestate application e.g. farm	• transport distance for waste dependent on farm location • requires on-farm waste processing infrastructure and increased biosecurity requirements	• may require separate site for digestate • transport distance for waste dependent on food processor's location

FEEDSTOCKS ANALYSIS

Current bio-waste streams in and around Stratford

In the town of Stratford-upon-Avon and its environs, there are a number of different organic materials that could potentially provide feedstock for an anaerobic digestion (AD) plant. The following four streams were identified for study as potentially available feed stocks:

- Domestic organic waste (household food waste and garden or 'green bin' waste)
- Food waste from the commercial hospitality sector (hotels, restaurants, etc.)
- Food waste from the commercial non-hospitality sector (e.g. food processors etc.)
- Animal manures and slurries from the agricultural sector

Energy crops were discussed as a potential feedstock early in the project; however, it was decided not to include them in the scope of the study. The study specifically concerns the feasibility of a plant for anaerobic digestion of small-scale urban biowaste; the scale and short timeframe of the study made it impractical to give sufficient consideration to the inclusion of energy crops. Additionally, the use of energy crops would open a range of sustainability and food-versus-fuel issues that are best left to a study that can give adequate treatment to these issues. The option should not necessarily be discounted however - there are a number of farm-based AD situations in the UK where energy crops e.g. maize are being grown (mainly as crop rotational break crop), ensiled and co-digested in the AD plant.

Domestic Organic Waste – Current Waste Management Situation

Stratford District Council (SDC) is responsible for collection of household waste – referred to as the Waste Collection Authority. SDC supplies services to a population of 118,900 covering an area of 976 km^2; this includes the Town of Stratford-upon-Avon with its population of approximately 25,000 and approximately 10,000 residences. Currently, there is a fortnightly kerbside organics collection service[20] - the 'green wheely bin' collection.

SDC allows for food waste to be placed in the green bin. The Council also holds currently a supply of 2500 kitchen food waste caddies, which are provided free to householders upon request; thus far approximately 500-600 of the caddies have been picked up by householders.

Residents may dispose of their food waste in their residual waste black bin which is collected fortnightly, on alternate weeks into their green 'organics' bin. It is likely, therefore, that much of the household food waste is going into the residual waste bin (and therefore to landfill), as residents tend to dispose of food waste with their residual waste in weeks when garden waste is

[20] http://www.stratford.gov.uk/community/bin-collection-calendar.cfm

not collected[21]. This was confirmed in the Biocycle Project[22] where green waste segregation analysis showed less than 10% of the green bin contents were food waste.

Of relevance to the Stratford study, it was confirmed in discussions with SDC, and with Warwickshire County Council (the Waste Disposal Authority) that composition studies in the Warwickshire districts have found that only 4-6% of residential food waste is being collected in the green bin organics collection. The balance of the food waste was collected with the residual refuse i.e. black bag waste - and therefore is predominantly landfilled (see below for disposal routes for refuse).

According to WasteDataFlow, the government's portal for waste reporting by local authorities (www.wastedataflow.org) the total amount of household waste collected by Stratford-on-Avon District Council in 2011 was 27,689 tonnes, of which 30.5% (8,432 tonnes) of organic waste was sent for in-vessel composting (IVC). The bulk of this organic waste is garden waste, as evidenced by the waste composition results. The overall diversion rate in the district for waste in 2011, including recycling and composting, was 59.3%.

Collection and Disposal Contracts for Household Waste

Collection of household organic waste for the District of Stratford-on-Avon is contracted out to a waste services company (currently Biffa Ltd). The contract was signed in 2008 for a duration of seven years, with an option to extend for a further seven years in 2015; a total of 14 years' duration.

The processing and disposal of waste is the responsibility of Warwickshire County Council (WCC) who has also contracted with private companies for the processing and disposal of waste. The green bin organic waste is processed at an In-Vessel Composting facility near Ufton, owned by Biffa Ltd, on a contract of 15 years duration. As part of an agreement under the Warwickshire Waste Partnership, three of the district councils (including Stratford) are obligated to provide/deliver a minimum annual tonnage to the facility of 35,000 tonnes. The total organic waste delivered to the facility from collections in the County in 2011 exceeded this requirement at 39,000 tonnes.

For domestic residual refuse from Stratford-on-Avon District, two destinations for disposal exist: the Coventry and Solihull Waste Disposal Company energy-from-waste (EFW) plant in Coventry, and the Bubbenhall Wood landfill near Bubbenhall in Warwick District. The County's contract for disposal at the Bubbenhall landfill requires a minimum tonnage of 50,000 tonnes per year, an amount that decreases by 5% per year to encourage the efforts of the County and district councils to divert waste to other streams - and reduce waste generation overall).

[21] WRAP. (2009). Evaluation of the WRAP Separate Food Waste Collection Trials. http://www.wrap.org.uk/downloads/Evaluation_of_the_WRAP_FW_Collection_Trials_Update_June_2009.893aab8f.7271.pdf

[22] Biocycle Final Report ~ Defra 2009

The lengths of these domestic contracts mean that possibilities for diverting food waste from its current destinations are limited. Future legislation to ban organic waste from landfill altogether, the increasing gate fees for landfill, and changes to waste collection and treatment legislation may influence changes towards a greater recovery of food waste and other biodigestible waste. It should be noted that local authorities are not obliged to collect garden waste 'green waste' for free but do this in order to (artificially) boost their percentage recycling figures. However many local authorities are at the same time ignoring food waste which they are obliged to collect 'free of charge'.

The Coalition Government recently announced £250 million of funding for councils to support a Weekly Collection Support Scheme[23]- and encourages applications which:

> *"add a weekly food waste (or organic waste) service to an existing fortnightly collection of residual household waste, where an authority can credibly demonstrate that this represents the preference of local people. This additional service will reduce the amount of biodegradable waste sent to landfill, and reduce the amount of biodegradable food waste that has to be stored in or around the home."*

It will be interesting to see which local authorities have applied for funding under this scheme – and how this translates into increased commitment to collect food waste in particular. This may be more difficult in areas where different waste collection and waste disposal authorities operate.

Estimation of Current Quantities of Household Food Waste – Stratford Audit

To estimate the quantities of domestic organic food waste in the district and town, population census data for Stratford-on-Avon[24] was combined with waste production factors from WRAP[25] and from local authorities with separate food waste collections, including the local authorities providing waste to the Ludlow anaerobic digestion plant.

Table 3 below shows the approximate quantities of food waste estimated to be generated in the town and district, according to what factor is used to estimate household food waste generation per week.

[23] Department for Communities and Local Government - Weekly Collection Support Scheme February 2012

[24] http://www.statistics.gov.uk/ ; http://www.warwickshireobservatory.org/

[25] WRAP. (2009). Evaluation of the WRAP Separate Food Waste Collection Trials. http://www.wrap.org.uk/downloads/Evaluation_of_the_WRAP_FW_Collection_Trials_Update_June_2009.893aab8f.7271.pdf

Table 3. Estimated Household Food Waste Production

Local Authority	Population	People per household (estimated)	Number of households	Food Waste production factor kg/hh/week	Estimated Food Waste Produced tonnes/yr
Stratford-on-Avon District	118,900	2.5	47,560	1	2,473
				1.5	3,710
				2	4,946
Stratford-upon-Avon Town	25,000	2.5	10,000	1	520
				2	1,040

A meeting with the District of Stratford-upon-Avon (Senior Waste Officer) confirmed that the total amount of food waste collected in the district in 2011 was 3,320 tonnes, as determined by waste composition studies and records of the total amount of waste at 51,454 tonnes. This figure corresponds to an average household waste production factor of 1.3 kg per household per week. Assuming the same per-household food waste production rate from the Town of Stratford-upon-Avon gives the results shown in Table X2:

Table 4. Actual Household Food Waste Production

Local Authority collection area	Population	People per household (estimated)	Number of households	Food Waste Production Factor kg/hh/week	Food Waste Produced tonnes/year
Stratford-on-Avon District	118,900	2.5	47,560	1.3 (calculated)	3,320 (actual)
Stratford-upon-Avon Town	25,000	2.5	10,000	1.3 (from above)	698 (calculated)

The table shows that approximately 700 tonnes of food waste per year is currently produced by households in the town of Stratford-upon-Avon.

Estimation of Current Quantities of Commercial Hospitality Food Waste

Estimation of quantities of food waste available from the commercial hospitality sector was carried out by two methods:

i) Adaptation of the methodology used by WRAP in its 2011 report, 'The Composition of Waste Disposed of by the UK Hospitality Industry' (WRAP, 2011) combined with data based upon the numbers of hospitality establishments - pubs, restaurants, hotels and quick service restaurants (QSRs) - in Stratford and environs.

ii) An on-the-ground survey or 'audit' of businesses in the Stratford area carried out by volunteers from Community Energy Warwickshire. A questionnaire was developed for door-to-door surveying of a sub-sample of businesses, to obtain information on factors such as customer numbers and seasonal fluctuations, and to make visual observations on their waste collection facilities. This information was used to estimate annual quantities of food waste from the sampled facilities, and to extrapolate across the sector to determine total quantities potentially available in the region.

Method 1: WRAP Methodology using Waste Production Factors

To estimate the quantities of commercial waste potentially available, waste production factors were used for each type of establishment, multiplied by the number of establishments in each category. Expected waste production quantities would vary substantially depending on size of the establishment, number of meals served, logistical and supply chain arrangements (e.g. whether food is prepared fresh onsite or pre-processed in other facilities and delivered ready for final cooking), and seasonal variations. The range of potential waste production that can be expected from different types of facilities is shown in Table 5. The average waste production factors used are shown in Table 6.

Table 5. Production Factors by Business Type for Waste

Business Type	Average Total Waste per Company, based on Business Size					
	1-9 employees	10-19 employees	20-49 employees	50-99 employees	100-149 employees	250+ employees
	(tonnes/yr)	(tonnes/yr)	(tonnes/yr)	(tonnes/yr)	(tonnes/yr)	(tonnes/yr)
Hotel	11	32	40	129	152	339
Restaurant	9	38	97	18	69	251
QSR	6	18	54	112	262	375
Pub	24	61	53	108	262	375

Source: WRAP 2011: "The Composition of Waste Disposed of by the UK Hospitality Industry"; Table 18

Table 6. Median Production and Composition Factors by Business Type

Business Type	Total Waste per Company		Percentage of Food Waste in Total Waste
	Mean	Median	
	(tonnes/yr)	(tonnes/yr)	(%)
Hotel	149	66	37%
Restaurant	65	30	43%
QSR	23	12	48%
Pub	52	43	36%

Source: WRAP 2011: "The Composition of Waste Disposed of by the UK Hospitality Industry"; Tables 22 and 23

To estimate the amount of food waste from commercial hospitality establishments in Stratford, the factors shown in the table above were multiplied by the number of businesses in each category. In choosing which Total Waste factor to choose, the median was chosen rather than the mean, as this number is lower and provides a more conservative estimate.

Table 7. Median Production and Composition Factors by Business Type

Business Type	Number of Businesses in Stratford	Total Waste per Business (median)	Food Waste Percentage	Total Food Waste
		(tonnes/yr)	(%)	(tonnes/yr)
Hotels	14	66	37%	342
Restaurants	104	30	43%	1,641
QSRs	173	12	48%	996
Pubs	106	43	36%	1,342
Total	**397**			**4,321**

Author's Note: This total of approximately 4,000 tonnes pa was used for financial modelling, as explained further in this Report. This method of estimation gave a potential total ranging from 4,000-10,000 tonnes pa depending on the waste factors used and business sizes assumed. The low end of the range was chosen to avoid overestimation of the waste resource in the modelling scenarios.

Method 2: Site Visits and Face-to-Face Interviews

A small number of dedicated volunteers from Community Energy Warwickshire carried out a door-to-door survey of commercial hospitality establishments in Stratford-upon-Avon. The data collected was used to calculate estimated quantities of food waste potentially available. A copy of the survey questionnaire is attached in Appendix 4.

In addition to quantity data, the survey also provided other insights and information, described in more detail later in this section.

The survey consisted of face-to-face interviews and visual observations; it did not, however, involve sampling or weighing of waste. A survey involving quantitative sampling of waste quantities and composition would require far more extensive research involving time and resources beyond the scope of this study. Instead, standard volumes of bins and carts were used to estimate quantities based on size of containers, frequency of pickup and fullness of containers.

Interviewees were asked what size their collection containers were (from the 5 standard sizes of wheelie bins and Euro bins), how many of each, how often these were picked up, how full the container generally was at pickup and to estimate the approximate proportion of food waste (e.g. ten percent, one quarter, half, all etc). Managers and employees were generally able to answer these questions with reasonable confidence and this could be confirmed by visual observation of the bins. These were then used to calculate the weekly volume of food waste by the following formula:

> ***Weekly food waste volume = ∑(bin type by number of bins of each type) x (number of pickups per week) x (bin fullness) x (food waste proportion)***

For example, for an establishment that has one 660 litre Eurobin and two 240 litre wheelie bins that are picked up twice per week, that are generally full when collected, with about half of the bin being food waste, the calculation would be:

> ***Weekly food waste volume = [(660litre x 1)+(240 litre x 2)] x (2/wk) x 100% x 50% = 1140 litre/week***

The weekly volume of waste was then multiplied by a density factor to determine the weekly mass of waste for each business. These were then used to find annual total tonnage. A waste density of 0.3 kg/litre was used; this is somewhat conservative as food waste can have a density from 0.5-1.0 kg/litre depending on its compaction. Other materials with much lower densities, however, were mixed with food waste in the waste bins which provided the basis of the volume estimates. These would have a bulking effect in increasing the volume of the waste and filling the bins more than an equivalent mass of only food waste would. Compacted wet cardboard has a

density of 0.2 kg/litre, while plastics have a density of less than 0.1 kg/litre.[26] A conservative density factor was desired to avoid overestimation of waste quantities.

Survey method note:
It is noted that this method relies on interviewees' observation of the fullness and composition of their waste bins, which is, of course, somewhat subjective and can result in inaccuracies. However the method does not demand accurate quantification to a fine degree, but merely a range within which most respondents did not have difficulty estimating. Although it can be expected that many of the interviewees may have either overestimated or underestimated their waste amounts, it does not seem likely that *every* respondent would *overestimate* their waste, or conversely that *every* respondent would *underestimate* their waste, and more likely there would be a mix of both over- and under- estimating, which would balance out somewhat over the sample size.

The following Tables summarise the results of the Stratford Food Waste Survey.

Table 8. Door-to-Door Survey Results: Collection Provisions

Number of establishments visited	50
Number of each establishment type	Restaurant: 35 QSR: 15 Pub: 6 Hotel: 2
Number of establishments that gave waste volume estimates	35
Number of establishments with in-sink disposal systems	0
Waste Collection provision	Council: 2 Commercial collectors: 24 Not Stated: 24
Number of establishments with existing separate food waste collection (8 in total)	Commercial collectors: 6 Farmers/Staff pigs & chickens: 2

[26] [26] Density factors from the Government of Victoria's Energy and Resource Efficiency Program website, http://www.epa.vic.gov.au/bus/erep/docs/wastematerials-densities-data.pdf

The average food waste production for each establishment was also determined as both mean and median annual tonnages, waste production per employee and per meal served.

Table 9: Door-to-Door Survey Results: Food Waste Production

	Mean	Median	Maximum	Minimum
Food waste produced per establishment, tonnes per annum	19	13	103	1
Food waste produced per employee, tonnes per employee per annum	1.6	1.1	7.4	0.1
Food waste produced per meal served, kg per meal	0.5	0.3	1.7	0.02

The food waste quantities from all establishments were then summed to determine total annual tonnage from the subset, which was then scaled up for all commercial hospitality establishments to determine an overall total for the Stratford area, as shown in Table 10.

Table 10: Door-to-Door Survey Results: Overall Food Waste Quantities

Total tonnage estimated from sample, tonnes per annum	656
Number of establishments sampled	34
Total commercial hospitality establishments in Stratford	397
Total commercial hospitality food waste in Stratford, tonnes per annum	7,654

Author's note: The overall tonnage estimate of 7,654 tonnes pa from Stratford hospitality establishments is significantly higher than the Method 1 estimate developed using factors from the 2011 WRAP report. This is not as surprising as it may seem, however, as waste is difficult to measure accurately and estimates vary widely, even within studies using extensive sample sizes. For example, the possible total tonnage that could be calculated using the WRAP factors varied from 4,000-10,000 tonnes per annum, depending on the business sizes and food waste proportion assumed. The 4,000 tonne estimate was intentionally conservative, since the quantity was to be used in developing the financial model, and it was important not to overestimate the waste that may be available. Also as noted earlier, the survey methodology does rely on interviewees' judgements, which could result in overestimation.

Hospitality Industry Response to Community AD

In addition to the quantity estimation aspect, the survey provided an opportunity to gauge the opinions of Stratford's hospitality community regarding community anaerobic digestion, and the impacts or benefits that collection of food waste could have on their businesses. Of the 35 managers and employees interviewed, more than half (19 interviewees) indicated that they would be interested in more information and hearing the results of the survey. Six of these indicated that they would be willing to provide a site for a waste audit, if one were planned for the future. This indicates a very positive response and could provide a basis for further investigations, if Community Energy Warwickshire elects to pursue further steps.

It also provides an indication of the commercial community of Stratford to potentially participate in a project. Most of the respondents interviewed were positive about food waste recycling and indicated a willingness to separate food waste in their kitchens. Others, however, pointed out that they were already making efforts to generate as little food waste as possible, with incentives such as staff bonuses for reducing waste. Campaigns such as the 'Love Food Hate Waste'[27] and the 'Too Good to Waste'[28] campaigns are clearly having an impact upon food waste behaviour.

Commercial Non-Hospitality Food Waste

Stratford District Council has provided a list of food manufacturers in South Warwickshire, of which there are currently eight. None of these should be regarded as significant food processing – and food waste outlets. In addition, there are several large vegetable and horticultural grower businesses in Stratford District – some with quantities of fresh or washed green waste e.g. onion tops. Discussions with a grower consultancy in the area indicated there could be reasonable tonnages – perhaps 10,000-15,000 tonnes – of available green residues. However, of the four growers interviewed, none regarded their residues as a problem. All had arrangements with local farmers to take away their green and compost material usually on a FOC basis. Without any evidence of gate fees, it is likely that growers could demand a price for their waste, at least to cover transport, if incorporated within the AD feedstock stream. One arable farmer for example indicated that if he required poultry litter as organic fertilizer, the costs of bringing onto his farm would be £10-£15 per tonne.

The geographical locations of the food manufacturing outlets were identified using a Google map application to show their proximity to the town centre. Food waste mapping is used in collection and transport modelling. Food manufacturing and commercial green waste outlets could be included in food waste collections – and one of these might provide a suitable location for a co-digestion AD plant especially if the site has a demand for the heat provided by a combined heat and power unit (CHP) as proposed in Option 3 of the scenarios as outlined in Table 1 above.

[27] 'Love Food Hate Waste' - WRAP

[28] 'Too Good to Waste' – restaurant doggy bags - Sustainable Restaurant Association 2011

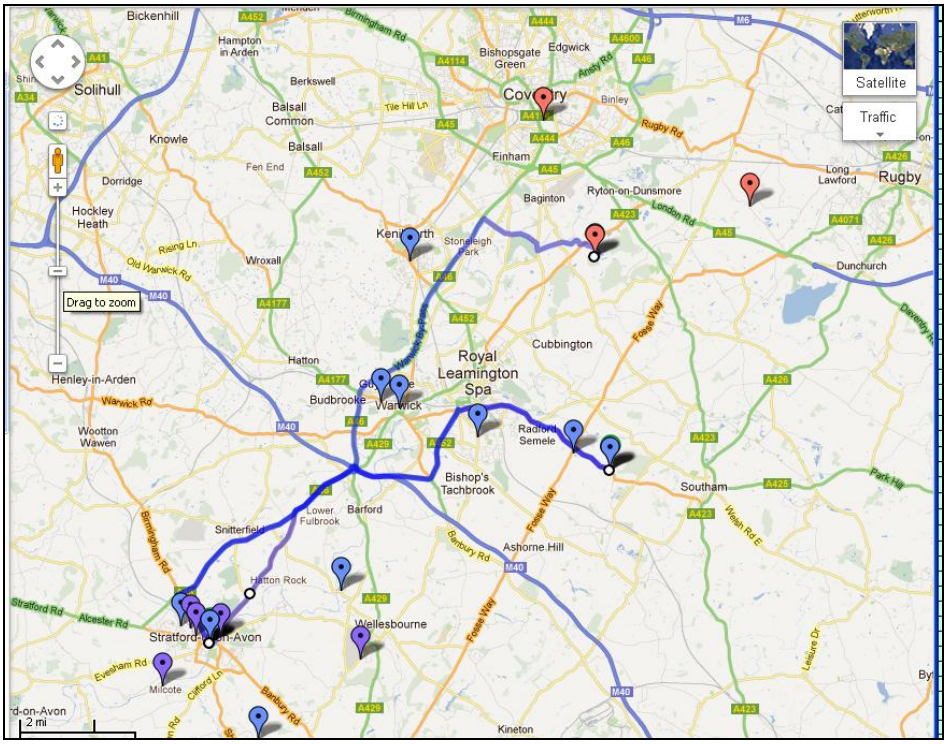


Figure 1: Screen shot of Google mapping showing locations of food processors around Stratford-upon-Avon

Estimation of Current Quantities of Agricultural Manures

As proposed under Scenario 2 above, co-digestion of food waste with agricultural waste such as cattle slurry has benefits in improved bio-digestion process stability and better biogas production than from either substrate alone. Estimation of animal manures and slurries from the agricultural sector used the methodology established in previous studies[29], and stocking rates and other supporting data from Defra.

According to Defra agricultural census figures[30], in 2007 Warwickshire had the following:

- 114 farms with less than 10 cows (total 282 animals)
- 12 farms with between 10 and 30 dairy cows (total 168 animals)
- 39 farms with between 70 and 100 dairy cows (total 3173 animals)
- 36 farms with between 100 and 200 dairy cows (total 5231 animals)
- 2-4 farms with over 200 dairy cows (at least 400 animals)

[29] Banks, C. J., Salter, A. M., Heaven, S., & Riley, K. (2011). Energetic and environmental benefits of co-digestion of food waste and cattle slurry: A preliminary assessment. *Resources, Conservation and Recycling*, *56*(1), 71-79.

[30] http://www.defra.gov.uk/evidence/statistics/foodfarm/landuselivestock/junesurvey/county-size.htm

There were a total of 10044 milking head on 224 farms. Each fully mature dairy cow produces 19.4 tonnes of excreta per year[31]. For other cattle in the dairy (calves, heifers etc.) a factor of 11.6 tonnes per year is used.

Table 11. Total Quantities of Cattle Slurry from Dairy Farms in Warwickshire

Size Category	Number of Farms	Dairy Cows	Manure Factor	Annual Production
		head	t/hd	tonne/yr
1-10 head	114	282	19.4	5,471
10-30 head	12	168	19.4	3,259
30-70 head	21	790	19.4	15,326
70-100 head	39	3,173	19.4	61,556
100-200 head	36	5,231	19.4	101,481
over 200 head	2	400	19.4	7,760
Total	224	10,044		194,854

These figures are based only on the number of milking head – actual production varies according to the numbers of other cattle and livestock, and the percentage of time that they are housed indoors.

Table 12 below shows a typical calculation for a single farm, which is more useful for siting of an individual AD plant.

Dairy Cows	Other Cattle	Dairy Cow Manure Factor	Other Cattle Manure Factor	Annual Production
head	head	tonnes/head	tonnes/head	tonnes/year
145	129	19.4	11.6	4,309

[31] Banks, C. J., Salter, A. M., Heaven, S., & Riley, K. (2011). Energetic and environmental benefits of co-digestion of food waste and cattle slurry: A preliminary assessment. *Resources, Conservation and Recycling*, *56*(1), 71-79.

As shown, a medium-sized dairy farm with 145 milking head could expect to produce approximately 4,300 tonnes per year of cattle slurry; however the amount that can actually be collected depends on how much time the cattle spend indoors. On some farms, cattle are housed for the whole year, whereas for others, the cattle may only be in the barns during the winter months, and during the summer months the manure would be deposited on the field while the cows grazed. Dairy farms are good candidates for AD since even cattle that graze would return to the barns for milking and thus provide manure every day of the year.

Summary – Feedstock Analysis

This feedstock assessment determined the overall waste quantities that could serve as potential feedstock for a community AD plant. These estimates have been fed into subsequent selection of options for digestion and technical system selection. They have been used extensively in the scenario development and financial modelling carried out in this Study.

FOOD WASTE COLLECTION OPTIONS

The options for collection of bio-digestible waste for an AD plant depend on the type and sources of waste being considered on the plant. For collection of domestic waste, a detailed collection model with possible routes dependent on distances between houses and between transfer station and processing location is necessary.

In this study, however, domestic waste was not part of the detailed scenario analysis, due to the length of the District Council's current collection contract and the unlikelihood of being able to introduce a new domestic food waste collection service. We were informed that the cost of adding an additional collection service – as would be required for a source-separated food waste collection – would cost the Council in the region of £200k-250k. It should be noted, however, that were funds available to introduce such a service, a food waste collection system could be modelled for collection of the approximately 3,300 tonnes of domestic food waste in the district.

The three AD scenarios chosen for this study (highlighted above) all require collection of food waste from commercial hospitality establishments in Stratford. Scenario 1 has commercial food waste as the sole feedstock, while the on-farm and food processing site options also include cattle slurry and on-site food or digestible green waste 'residues', respectively. Neither of these two other waste streams requires collection and transport, as both are produced on-site, and would therefore require only local transport within the site.

For the collection of commercial food waste, a collection system calculation was made in Table 13:

Table 13. Collection Vehicle Requirements for Servicing Commercial Establishments in Stratford

Annual food waste quantity	4000 tpa
Number of collection points (businesses)	397
Food waste production per point	27 kg/day
Number of days' waste accumulation	7 days (weekly)
Amount of waste per collection point	192 kg
Refuse Capacity of Collection Vehicle (RCV) (7.5 tonne lorry)	3.58 tonnes
Number of points to fill RCV	18
Number of rounds needed to service all points	22
Number of days in collection work week	5
Number of rounds per collection day	5

The number of times that the food waste collection vehicle could fill up, make the trip to the AD plant, and return to the collection area for the next round would depend on the distance of the AD plant from the collection area. Most likely a single vehicle would be unable to complete five collection rounds in one workday. If split between two to three vehicles, however, five collection rounds per day could be feasible, depending on the plant's location. This also provides cover for vehicle downtime for maintenance and repair.

A 7.5 tonne vehicle was chosen as the Refuse Collection Vehicle (RCV) for this analysis – this is a small refuse lorry. A larger vehicle would be able to collect more waste in fewer round trips. However, the vehicle access requirements of collecting waste from the back alleys and narrow streets restricts the size of the lorry that could be used. Therefore, a small refuse lorry was considered as a suitable balance point for the trade-off between capacity and manoeuvrability. If Community Energy Warwickshire elects to proceed with further steps, more detailed vehicle selection and collection modelling could be undertaken.

CARBON SAVINGS FROM AD

The anaerobic digestion of organics that would otherwise go to landfill results in significant emissions reductions, through avoided generation of methane and ammonia in landfill, displacement of electricity and heat production from fossil fuel sources, and substitution of chemical fertilisers.

A carbon balance model has been developed by the University of Southampton which allows us to quantify emissions savings, by comparing to avoided energy and material inputs resulting from diversion of food waste from landfill, and use of digestate in place of chemical fertilisers. The carbon savings are shown in Table 14, with each component briefly outlined below.

Abatement of fugitive methane from landfill

The methane that could be generated annually from each waste input stream was estimated for each option. Estimates are based on a biogas methane percentage of 60%. The emissions avoided are equivalent to the methane emissions that would result from land filling of the same amount of waste (this is the current situation for most of Stratford's general refuse) in a landfill without gas recovery and with equal degradation of the organic matter. With landfill gas recovery or in situ oxidation of methane, the figures shown would be reduced.

Fossil fuel electricity generation displacement

Carbon dioxide savings based on the potential electrical output of the plant, after correction for the energy needed to meet its own power requirement, are compared to the amount of CO_2 that would be produced in generation of the same amount of electricity by the current grid (estimated at 712kg CO_2 equivalent per kWh ~ after Chesshire). For comparison a grid rolling average 1990-2006 conversion factor from Defra[32] was used; this encompasses the current grid generation sources including fossil fuels, nuclear and renewables. Assessment in the Table below has been based upon electricity generated from natural gas which is 0.1125 kg CO_2e/MJ = 405 g/kWh[33]

Fossil fuel heat generation displacement

If the heat generated by the plant can be utilised, there would be significant greenhouse gas savings, which are quantified in comparison to heat produced from natural gas. This is also corrected for the plant's own heat requirements. Assessment in the Table below has been based on displacing natural gas at 0.0571 kgCO_2e/MJ = 205 g/kWh[34]

[32] Dept of Environment and Rural Affairs. Guidelines to Defra ' s GHG Conversion Factors. *Power*. 2008;(April):1-15. Available at: http://archive.defra.gov.uk/environment/business/reporting/pdf/ghg-cf-guidelines-annexes2008.pdf.

[33] (DECC 2010, *Digest of United Kingdom Energy Statistics 2010*)

[34] AEA, 2010 *Guidelines to DEFRA/DECC GHG conversion factors for company reporting*

Transport emissions savings

Transport of waste to the processing plant, and transport of digestate from the plant to the land application site, has emissions due to the diesel fuel used in the transport of materials. For each scenario, total transport emissions were compared to the emissions from transporting the equivalent amount of waste to the Bubbenhall Wood landfill site, a distance of 19 miles from the centre of Stratford. The in-vessel composting site at Ufton Hill is 2 miles closer - however non-separated food waste in the general waste would likely be going to the landfill rather than composting.

Displacement of chemical fertiliser use

Mineral nitrogen fertiliser depends on fossil fuel for its manufacture. Each tonne of food waste digestate contains about 6kg of nitrogen as well as other valuable plant nutrients; it is estimated that each tonne of nitrogen produced results in the emission of at least 3 tonnes of CO_2 using a factor of 7.01 kg CO_2e / kgN[35]. Such nutrients would otherwise be wasted in landfill. As indicated below, the amount of nitrogen that could be supplied by digestate application to soil was calculated for each scenario, along with the corresponding emissions offset for the energy required to produce the equivalent amount in fertiliser.

Ammonia oxidation

The amount of ammonia that would be generated through degradation in landfill was estimated based on typical organic nitrogen content for the input wastes. Under current regulations, the ammonia produced would have to be oxidised before discharge to the environment, which has a power requirement of approximately 1 kWh/kg of oxygen[36].

Table X below shows the overall greenhouse gas (GHG) savings for each scenario, expressed as tonnes of carbon dioxide equivalent (CO_2 equiv). The scenarios show carbon savings of approximately 7,000 - 10,000 tonnes CO_2 equivalent per year, depending on the amounts of waste processed and transport distances for waste and digestate.

[35] Mortimer, Elsayed & Evans, 2010, *Environmental Assessment Tool for Biomaterials,* NFCC

[36] Banks CJ, Arnold R, Heaven S, Chesshire M, Lewis L. Biocycle anaerobic digester: performance and benefits. *Proceedings of the ICE - Waste and Resource Management*. 2011;164(3):141-150. http://www.icevirtuallibrary.com/content/article/10.1680/warm.2011.164.3.141. Accessed March 27, 2012.

Table 14. Greenhouse Gas Emissions Savings from Potential Scenarios

	Scenario 1 Central Food Waste Digester		**Scenario 2** On-farm Digestion		**Scenario 3** Digester at Food Processing Premises	
	Avoided emissions pa	**CO_2 equivalent pa**	**Avoided emissions pa**	**CO_2 equivalent pa**	**Avoided emissions pa**	**CO_2 equivalent pa**
Methane generation avoided by non-land filling of waste	378,000 m^3 CH_4	5,666t CO_2	378,000 m^3 CH_4	5,666t CO_2	567,000 m^3 CH_4	8,500t CO_2
Fossil fuel displacement by electricity generation	1177 MWh	532t CO_2	1335 MWh	603t CO_2	1756 MWh	794t CO2
Fossil fuel displacement by heat generation	1139 MWh	335t CO_2	1001 MWh	295t CO_2	934 MWh	276t CO_2
Nitrogen fertiliser avoided by digestate application	32t Nitrogen	227t CO_2	53t Nitrogen	370t CO_2	49t Nitrogen	341t CO_2
Transport emissions comparison to landfill (based on daily round trips to/from Bubbenhall or AD site)	101.5 miles daily to landfill 17.4 miles to AD plant	84t CO_2	101.5 miles daily to landfill 13.5 miles to AD plant	88t CO_2	101.5 miles daily to landfill 23.1 miles to AD plant	78t CO_2
Ammonia generation in landfill leachate – avoided energy demand for oxidation	48 tonnes NH_4^+	35t CO_2	55 tonnes NH_4^+	41t CO_2	72 tonnes NH_4^+	53t CO_2
GHG mitigation treating annual housed animal slurry through AD				238 t CO2e [37]		
Total CO_2 equivalent		**6,797**		**7,301**		**9,963**

[37] Based on IPCC methods (using an emission factor of 19% methane emitted from slurry)

FINANCE AND MANAGEMENT APPRAISAL FOR STRATFORD COMMUNITY AD

This section represents a considerable amount of work largely through the development of financial modelling to suit the Stratford AD proposal. In essence, and agreed by CEW at the outset, our financial appraisal has represented an important scoping and pre-feasibility stage in an effort to determine the project viability in economic terms. As CEW are at a very early stage in their project assessment and without firm decisions on the special purpose vehicle (SPV), the partners and stakeholders, the food waste contracts, the funding preferences, the possible site locations etc, this Study focuses upon 'the possible' – using a scenario basis for analysis and recommendation.

OPTIONS FOR STRATFORD FOODWASTE AD

The Study identified the possible options for a Community AD plant for Stratford based on feedstock availability. It also set out the relative advantages and disadvantages of each of the scenarios considered. A domestic food waste option has not been included in any of our proposals due to the current long-term contractual arrangements in place. Also, purpose grown energy cropping for farm AD have been left out of the analysis – due to the 'food or fuel' issues and also the wide set of unknown variables and practical issues to be dealt with. The three scenarios selected represent potentially different technical and commercial models, for example, differing urban or rural locations, transport costs and associated carbon footprint. As this is a pre-feasibility study, we have not assessed any specific sites but focused upon size and scale economics based upon estimated feed stock availability.

We have prepared a financial model which can be flexed to offer changes to the volumes and related costs for the three selected scenarios of feed stocks and AD plant location as follows:

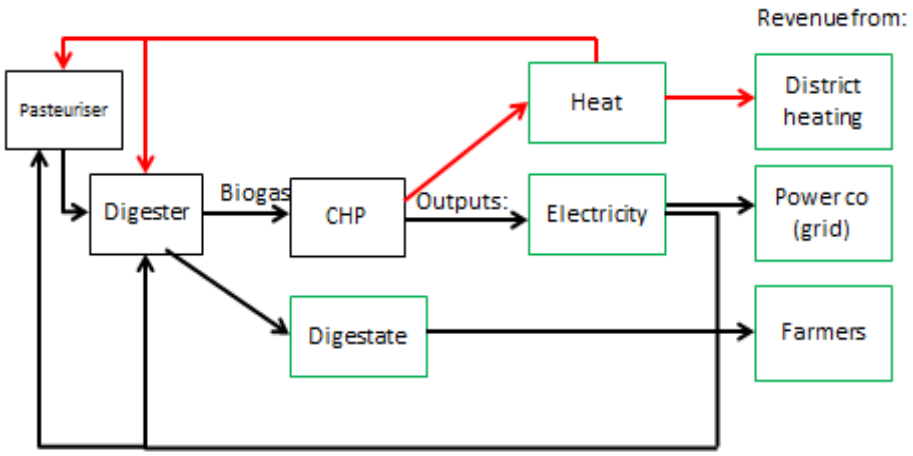
	Option 1 Central Food Waste Digester *tonnes*	**Option 2** On-farm digestion (co-digested) *tonnes*	**Option 3** Digester at Food Processing Premises (co-digested) *tonnes*
Commercial catering waste – approx 400 food premises including 80 hotels, guesthouses	4,000	4,000	4,000
Other food waste – vegetable residues, digestible green waste; food processing outlets	0	0	2,000
Manure & slurry – typical dairy herd yields	0	4,000	0
TOTAL	**4,000**	**8,000**	**6,000**

FINANCIAL APPRAISAL

Our financial model is based on the following:

- Inputs of volumes of feed stocks, capital costs of an appropriately sized AD plant, operating costs and revenues from a Combined Heat and Power (CHP) unit.
- Subsidies from FITs, LECs and RHI included on current or proposed (consultation in progress) tariffs.
- Financial return is expressed as an Internal Rate of Return (IRR) for a 20 year life project computed on pre-tax cash flow available to investors. *Author's note: IRR has been used as it is widely regarded as the best single measurement of return (although not the only measurement) to equity providers for long term projects because early cash returned is weighted more heavily than later cash returns through discounting.*
- An assumption has been made as to part funding of a project with external debt finance.
- One class of equity has been modelled but we recognise that more than one class is contemplated with possible different return criteria for different stakeholders i.e. community investment, as compared to corporate or institutional equity.
- The model includes allowances for planning and grid connection costs.
- Site acquisition costs not included.
- Tax has not been included as selection of a particular investment vehicle cannot be predicted at this stage.

Figure 2 – AD process flow diagram upon which outputs from the AD plant have been modelled



Author's note: The above flow diagram is representative – but acknowledges that this is one of several operational layout possible and currently in operation.

CASHFLOW

The base case cash flow is attached as Appendix 2. Detailed analysis (as spreadsheet) has been supplied to CEW under separate cover. The cash flow attached is for Scenario 2 i.e. on-farm digestion which includes manure and slurry as additional feed stock to commercial food waste. This is likely to be a more straightforward proposal than Scenario 3 which has a source of additional feed stock e.g. green vegetable residues or other food waste being sited at or near commercial food processing premises but with no access to livestock manure or slurry. Scenario 3 is likely to offer a higher financial return but with more complex commercial negotiations to be concluded.

In Scenario 2, payback of equity is achieved in about 11.5 years and the IRR is 9.3%. If equity were to be split between commercial providers and the community it would be possible to adopt a structure which could give commercial investors a higher return required to attract them to invest and a lower return which would remain attractive to community investors, particularly with the potential to enhance their returns through using Enterprise Investment Scheme (EIS)[38] benefits. Such financing options can be modelled when specific site data is available together with current information on grants and incentives.

SENSITIVITY ANALYSIS

We have performed a sensitivity analysis on key variables and show in the table below (extracted from the detailed cash flow) the changed Internal Rate of Return (IRR) which results. Each change is considered individually from the base case:

Table 15. Sensitivity analysis summary

	Base case	Gate fee receivable reduced from £40 to £35 for catering & other food waste	Annual tonnage of commercial waste reduced by 10%	Increase in transport cost from £8 to £10	Increase debt from 40% to 50%	Digestate application income increased from £0 to £2 and cost decreased to £0	Capex increased by £200k
Option 1	5.0%	3.3%	1.6%	2.2%	4.6%	6.4%	3.4%
Option 2	9.3%	7.7%	6.2%	6.8%	9.3%	10.7%	7.4%
Option 3	10.9%	9.0%	9.3%	6.8%	11.2%	12.6%	9.2%

The above sensitivities from base case (each measured individually *over the full 20 year project life*) show that a reduction in gate fees of £5 per tonne (12.5%), a reduction annual tonnage of 10% or an increase in transport costs of £2 per mile (25%) would have significant effects on returns to shareholders and affect viability from an external funders perspective. It is also worth noting that we have assumed that electricity sales can be achieved for 20 years as they represent about 14% of income (in addition to the FIT income). However, we believe our base case itself is conservative and there are potential upsides to be considered at a business planning phase which could offset or reverse the downside sensitivities modelled above or indeed any other chnages that become apparent during project planning.

38 An Introduction to the Enterprise Investment Scheme (EIS) *WWW.HMRC.GOV.UK/EIS*

STRATFORD COMMUNITY AD – FINANCE OPTIONS AND COST BENEFIT ANALYSIS

Introduction

These notes and the table below set out financial structures with benefits and costs associated with each. It should be noted that:

- The scale and timing of any project is unclear and therefore benefits and costs could change with new legislation
- Grants may assist with project development but are unlikely to affect overall finance options
- FITs/RHI etc will apply to any finance option if the parameters are met by the project.

Table 16 below sets out the various finance options appropriate to a project in which the community can engage. It does not address any particular social enterprise vehicle which might be adopted as this is likely to depend on the finance option selected.

Ref	Finance Options	Benefits	Costs	Notes
1	All finance from community	1. Positive stakeholder ownership. 2. Relatively low level of returns required 3. EIS/SEIS attractions for investors	Possible complexity of administration with high numbers of small investors	A major challenge would be to achieve required level of investment.
2	Finance from community + private equity (PE)	1. Straightforward structure at community level 2. Community component reduces level of returns required compared to PE alone	1. More complex structure as it includes two finance vehicles 2. Return requirements of PE	Community investment can provide small and increasing capital sums which can be scaled over time as results are proven to those investors
3	As (2) + debt finance	1. Mitigates return requirements of PE 2. More easily replicable model because of scale of finance which can be raised.	1. Raising debt finance is not cost effective for small projects 2. In the current market, bank debt to be refinanced after 7-10 years	Bank funding may be subject to suitable heat/power off-take contracts to assure loan repayments

Ref	Finance Options	Benefits	Costs	Notes
4	Finance from community + Council	1. Potential gift of land; 2. Public sector support and Councils can borrow prudentially at attractive rates long term.	Complexity of Council processes for legal support etc.	Issue is use of land if considered provided below Open Market Value (OMV). Situations vary locally.
5	Finance from community + corporate equity from company or companies in related sectors	1. In house corporate expertise in project development and project mgt; 2. Strength and scale of a corporate investor.	1. Return requirements of corporate; 2. Complexity of corporate process and admin.	A major engineering business or power supplier might be interested to invest for the wider market potential/access to green power.
6	Finance from community + renewables fund	1. Ethical investor alongside community; 2. Green Investment Bank.		Some very experienced investors in the market.
7	Finance from community + corporate equity + farming equity	1. Links a potential feed stock provider and user into project; 2. Robust if more complex structure as it engages more stakeholders.	Potential complexity and cost from different classes of equity.	Farm investor may have land available but limited cash for investment.
8	Phased buy in to equity from community + additional equity from PE/corporate or other parties.	1. Community acquires larger stake over time; 2. Suitable where community has limited initial capital but can commit more over agreed time period - including reinvestment of returns.	Potential complexity and cost from different classes of equity and option clause definition.	Founding shareholders have to agree option mechanism and community buy-in price formula.

Author's Funding Note:
Apart from finance option (1) above, all other options would require external funding. As there are no project specific details available, a financing plan has not been drawn up and funders have not been approached. However, there are a variety of institutions and banks targeting social enterprises e.g. Triodos Bank http://www.triodos.co.uk - and a viable project should attract funding. Our financial modelling and cash flow forecast will provide CEW with the necessary tools to address applications.

STOP PRESS - It is worthy of note that The Big Society Bank will launched on April 4th – with £600 million of loan and equity funding for community-based projects and operating on a 'revolving fund' basis. CEW should look closely at this Government-led initiative to see how it might offer finance for a Stratford community AD project. Announcement of the launch of the Big Society Bank can be found at http://www.guardian.co.uk/society/2012/apr/04/david-cameron-big-society-fund

FINANCE INCENTIVE SCHEMES FOR AD

Introduction

The table below sets out potential incentives and subsidies that might be applicable to a food waste bio-digestion project. The notes which follow set out possible financial assistance from currently available initiatives whose availability and criteria may change over time. Eligibility for particular support can only be confirmed at the time a project is commissioned,

DECC has indicated that it would like to develop clearer ideas on how to define a community energy project and there could be possible future benefits to a project in being accepted as such. Indeed, in the extract below from the Anaerobic Digestion (AD) Framework Document published by DECC in 2011[39], community-based AD is considered to be a "key area to be addressed":

Work stream	***What do we need to do?***	***What will this achieve?***
2c - Can we build on and work with community scale AD projects?	*Work with existing vanguard projects that have a strong link to local communities.* *Links to 2a - How can we ensure that the benefits of using AD are understood and shared by everyone?*	*AD can be operated at a range of scales. To date, our industry remains at the medium to large scale and is run mainly by single commercial operators. If we are to exploit the full range of resource and potential that exists for AD, we need to see a greater diversification in its use to community and farm-scale, with benefits being delivered to a wider cross-section of society.*

Author's Note: The structure of any project, the chosen legal entity and participants are not known and therefore the notes below set out the general position on energy and general investment incentives as at March 2012

[39] Developing an Anaerobic Digestion Framework – Defra November 2010

Table 17. Renewable Energy Incentives applicable to AD

Incentive	How applied	Tariff (2011-12) (AD projects)	Term/ indexation	Notes
Feed In Tariff (FIT)	Electricity generated	Generation tariffs proposed (wef from Oct 2012) are: • 14.7p/kWh for schemes of less than 250kW • 13.7p/kWh for schemes 250 - 500kW • 9.0p/kWh for schemes 500 – 5,000kW • Export tariff of 3.1p/kWh assumed continues to apply to this technology.	20 years indexed (RPI)	• The government is consulting on tariffs for non-PV technologies • Tariff proposals under consideration by government suggest a 5% real terms reduction in baseline tariffs from April 2014. • A Power Purchase Agreement (PPA) with a power supply company is likely to offer a higher income than 3p/kWh for export electricity.
Renewable Heat Incentive (RHI)	Heat generated	• 6.8p/kWh for schemes of less than 200kW • No limitations on receiving RHI for renewable heat where CHP installations are receiving FITs	20 years indexed (RPI)	• Payments calculated by reference to metered amount of eligible renewable heat generated. • For CHP systems supplying heat to premises located on different sites, metering is also required at the point of usage to ensure that payments are not made for heat that is wasted.
Renewable Obligation Certificates (ROCs)	Electricity generated NB For AD, this is double ROC	• 8.4p/kWh at Feb 2012 auction (double ROC)	Pricing is market driven	• ROC and electricity prices are both variable and can be volatile at times. • A project cannot claim both ROCs and FITs
LEC (Levy Exemption Cert)	Clean electricity generated	• 0.45p/kWh was the approx 2011 value as a component of electricity price. • Value determined by ref to Climate Change Levy, which is set by government.		• Not tradable

RENEWABLE ENERGY PROJECT DEVELOPMENT ASSISTANCE

WRAP - Anaerobic Digestion Loan Fund

The Anaerobic Digestion Loan Fund (ADLF) is a £10M fund designed to support the development of new AD capacity in England in conjunction with investment from the private sector. The fund aims to support 300,000 tonnes of annual capacity to divert food waste from landfill by 2015.

Fundamentally, lending will be based on the business demonstrating that they have applied for commercial funding, which either has been declined or offered on terms which question the overall viability of the investment project. WRAP would not support a business that is able to self-finance an investment programme and equally WRAP would only provide a loan on a viable project. The IRR specified in any application will be subject to due diligence.

Surprisingly, given the objective is designed to support the development of new AD capacity, one of the lending criteria is P&L accounts for the last 3 years of trading. This would need to be clarified with WRAP.

A number of factors will be considered when assessing loan risk including the nature of the project being undertaken, the financial security of the borrower and the value of the assets to be used as collateral. Loans considered low risk can expect to be priced at the lower end of the range of interest margin and projects carrying a higher degree of risk at the upper end. The determined rate will apply for the period of the loan.

The Co-operative Community Energy Challenge ('the Challenge')

An AD project as envisaged by Community Energy Warwickshire and the basis of this Feasibility Study appears to fit closely with the objectives of the Challenge.

We agree with the three project needs identified in the Challenge Guidance Notes - time, money and expertise. We offer the following comments:

- A project mentor offering 24 days is an innovative idea and the mentor will need to be a specialist in AD, planning issues, transport and feed stock sourcing to be effective. As a mentor, the person will be relying on others to actually take the necessary actions to develop the project.
- The offer to meet £10,000 of development costs is welcome and ideally would meet general costs associated with travel to meetings, and business planning (e.g. financial modelling costs). At this development phase, we would expect legal and technical costs to be of less a priority than the general business planning costs.
- The Guidance Notes state that further support may be available from The Co-operative Enterprise Hub and/or The Co-operative Bank to assist with grid connection; legal/contractual advice; planning issues and consents; Power Purchase Agreements; and technical advice on correct plant and equipment.

Clearly, CEW will require professional support and inputs in order to submit a full bid to The Co-operative Group. We trust that this Feasibility Study and the planning, technical and financial expertise used will provide CEW with a good foundation for an application to the Cooperative Challenge. Establishing a successful and viable Community AD Scheme is a complex challenge. However, with our significant experience in bidding for energy projects, with project finance and with technical knowhow, the Greenwatt Consortium suggest that the many issues raised in this Study can be resolved. Stratford with its particular concentration of food waste outlets, its high profile as a visitor experience and the proven determination of CEW to 'make a sustainable difference' offers a very interesting opportunity to 'test the community AD model'.

http://www.co-operative.coop/energychallenge

Community Generation Fund

In February 2012, FSE Group (FSE) and lead partner National Energy Foundation (NEF) announced that the Community Generation Fund is open for applications. The Fund aims to provide support at both pre-planning development and post-planning construction stages, to community energy generation projects that can achieve technical & financial viability, community inclusion and social impact.

The Fund will finance up to 75% of pre-planning development costs, via open-ended bridging loans which will be repayable only if planning consent is achieved successfully ("Development Loans") and finance for up to 75% of post-planning construction costs, via term loans with flexible repayment arrangements ("Construction Loans"). However, funding will be directed towards communities falling within the top 50% of deprived locations, as measured by latest Indices of Deprivation. An initial £1.25million has been made available for this initiative via Big Society Investment Fund and Esmée Fairbairn Foundation.

http://thefsegroup.com/funding/social-funds/community-generation-fund

General business assistance schemes

There appear to be 2 possibly relevant schemes at present introduced by Government Departments which may be relevant to an AD project:

Seed Enterprise Investment Scheme (SEIS) - to be introduced with effect from April 2012 (subject to consultation and possible amendment) and is an improved version of the EIS for small companies which are less than two years old and which carry on a genuine new trade. Income tax relief at 50%. It remains the position that EIS better suits commercial enterprises rather social enterprises as one benefit is tax free capital gain on exit. http://www.hmrc.gov.uk/seedeis/index.htm

National Loan Guarantee Scheme – allows banks to lend directly to smaller businesses at a lower cost than would otherwise be the case. UK businesses with a turnover of up to £50m will be eligible to benefit from the scheme. Banks apply for Government guarantees against the borrowing within a 2 year window for a fee. They can use the guarantee to raise funds at a lower cost. It is expected that the scheme could lead to a reduction in the cost of business loans of up to 1 percentage point. http://www.hm-treasury.gov.uk/nlgs.htm

WIDER SOCIETY COSTS AND BENEFITS

Our work at this feasibility stage has focused on the costs and benefits from various proposals as to feed-stocks, biogas utilisation and revenue. Renewable energy projects have a variety and mixture of reasons for investigation and development. Financial return on investment is not the only criterion upon which project decisions are made. In projects which involve the community, social and environmental issues can be powerful drivers.

To fully examine proposals for an AD plant in the wider context of Social Return on Investment (SROI), it would be necessary to map and review current arrangements for bio-waste disposal. Such a study could include details of approaches taken by the public and private sectors to deal with waste disposal.

Investigation could include the various categories of waste and the direct costs associated with disposal together with the indirect costs arising from, for example, ground contamination. We refer earlier in this Report pp 40-43 to the quantification of the carbon footprint of current disposal arrangements and an assessment of the potential for carbon savings. It would also be possible to construct scenarios for the fossil fuel savings arising from AD heat and electricity generation.

A wider economic view of possible outcomes from the installation of a local food waste AD plant should include 'businesses created' (supply chain) and 'jobs created' – these could be modelled and costed once the scale and scope of the community AD project are decided upon.

A review would also be conducted to assess the impact of other changes which become apparent during the study including further indirect environmental impacts and regional/national/EU changes to legislation.

MANAGEMENT APPRAISAL AND RISK ASSESSMENT

A project of this nature would require several distinct management stages:

- Project development: identifying site(s); early community engagement.
- Business planning: confirming feed stock and revenue streams and contractual proposals; planning application and consent; plant design, funding plan; operational management requirements.
- Achieving financial close: carry out due diligence; project documentation; shareholder agreements and any loan documentation; formation of legal entity; permitting; issuing construction tender and selection of contractor.
- Construction phase management.
- Operational management: day to day operations, financial management, shareholder and funder management information, community communications, marketing (for additional feed stocks, further AD plant opportunities).

The above outline project stages highlight the complexities that may be encountered in what should regarded by a community group as a major project undertaking – operating in the complex environment of the bio-waste sector. It is useful that CEW already has a successful track record gained from raising share capital, establishing working partnerships and managing the implementation of two local PV projects. Our client discussions with CEW demonstrated their awareness of the level of planning and pre-contract work that is required to structure a project of this nature with an indicative capital cost in excess of £2m. CEW is in a good position to lead the engagement of specialist project and financial advisors to deal with each of the above stages. It has already gained the support of organizations committed to community projects e.g. Carbon Leapfrog www.carbonleapfrog.org

However it is clear that should CEW decide to proceed further with the community AD initiative, a team of external specialists will be required especially in areas of site planning, waste contracts, environmental permits, food waste logistics and analysis, technical systems, energy management, financial modelling and stakeholder engagement.

PROJECT RISKS

In the course of our work we have built up a picture of the main project risks and these are summarised below:

Risk	Explanation	Mitigation	Notes
Site acquisition	Finding a suitable and available site	Secure with an option to minimise cost	
Planning	May require consent on a rural site or change of use on an urban site	Early discussion with planners before submitting application	
Community opposition for urban plant	Perhaps due to perceptions as to toxicity, community does not support an AD plant	Communications programme setting out green benefits and plant controls	Would limit community investment
Funding shortfalls	1. Corporate/Institutional equity investment not attracted to the project. 2. Loan funding not available	1. Community investment likely to accept returns below market. 2. Increasing array of 'green' funding options 3. Long term revenue contracts to assure lenders of repayment	
Revenue	Heat and electricity sales are required to underpin viability	Long term contracts with good credit risk parties	Indexation of prices may be possible
Transport	Cost of transport sensitive to distance, no of pick up points, load volumes, no of journeys per week/month	Siting of AD plant – see 3 scenarios considered	
Feed stock	Reliable supply in volume of feed stock is required and at/ close to current Gate fees	Size the plant according to indicative offers from producers of food waste	
Digestate	Cost of disposal of digestate is higher than expected	Site digester close to users	
Technology	Performance of AD plant not as expected	Performance criteria set out in contract	Supported by appropriate warranties
Maintenance	Higher level of scheduled maintenance or breakdowns of Plant than predicted	Long term maintenance contract with fixed price for guaranteed level of availability	

CONCLUSIONS FOLLOWING FINANCIAL APPRAISAL

1. Our view is that whilst all 3 scenarios could be viable, **Option 2 - on-farm co-digestion** is likely to be the most straightforward to deliver commercially.

2. Viability will be determined by feedstock availabilities, gate and collection fees and a range of site-specific issues particularly in relation to transport distances.

3. There are a growing number of 'green' grant funding mechanisms and although these frequently change or become fully drawn this is a vibrant sector.

4. Community engagement, participation and investment would strengthen the financial justification for a food waste AD plant with a good chance of success in financial terms.

COMMUNITY AD ~ ANALYSIS OF ROLES OF COMMUNITY ENERGY WARWICKSHIRE

BACKGROUND AND STATUS OF COMMUNITY ENERGY WARWICKSHIRE

- Community Energy Warwickshire (CEW) is an Industrial provident Society (IPS) formed in late 2010.
- The objectives of CEW are to support individuals and communities in energy efficiency and energy, demand reduction and to undertake as principal clean energy projects.
- CEW has currently no employed staff – all the directors and other participants are unpaid volunteers.
- CEW's directors (currently seven) and members have between them extensive experience in renewable energy, the UK electricity industry, business and project management.

CEW ACTIVITY AND INVESTMENT RECORD

- CEW has completed two solar PV projects working in partnership with South Warwickshire NHS Foundation Trust raising private investment through a share offer a combined capital cost of £100k
- The development of these 2 solar PV projects required CEW to undertake the following:
    - detailed investment appraisal of project
    - negotiations with South Warwickshire NHS Foundation Trust for use of hospital roofs, leading to signing of Memorandum of Understanding and agreement of template roof space lease
    - selection of solar PV installer by competitive tender
    - registration of CEW for VAT and Corporation Tax and successful application to HMRC for advance assurance that shares are eligible for Enterprise Investment Scheme (EIS) tax relief
    - drafting of business plan and share offer documents and accompanying internal due diligence and independent external review
- CEW has organised and delivered energy efficiency fairs in six local communities during 2012

SUMMARY OF ROLES FOR CEW IN AN AD PROJECT

Based on the above track record and skills and experience of its founder members the following roles appear to be appropriate for CEW in an AD project:

- Input into site selection in South Warwickshire subsequent development of planning application;
- Communications programme and management of a PR campaign engaging the community and other possible partners and stakeholders;
- Encouraging local and national community investment through share offer;

- Drafting of share offer documents to raise equity from the community;
- Administration of share registration/changes;
- Participation at board level in a project company set up to design, build, finance and operate an AD project;
- Marketing of project to attract additional feed stock especially to gain community buy-in;
- Management of an education and dissemination programme.

It is our firm view that 'community ownership' is the key to success in this AD initiative. It will dictate the future direction of the project, raise local interest and develop social acceptance, encourage community, public and commercial partnership working, meet Government commitments to localism, and generate community investment. **In short, we advise that whilst strategic and financial partnerships will be essential, CEW should 'keep hold' of the ownership, overall management and direction of the project!**

OTHER ROLES IN AN AD PROJECT CURRENTLY OUTSIDE THE SCOPE/CURRENT CAPACITY OF CEW

To be able to position CEW as 'project owners', it is useful to consider the areas where it does not currently have resource capacity, experience or skill sets. These areas may include:

- Detailed technical planning of an AD project (sizing of AD plant, feed stock logistics, permitting etc);
- Preparation of a planning application with EIA documentation;
- Project investment appraisal;
- Raising equity and debt funding from the market, and negotiation of loan financing documentation with lenders;
- Waste contract negotiations and management;
- Project management of groundworks, services, grid connection (if required), construction of AD plant and certifying payments to contractor;
- Operational management of AD plant;
- Commercial management and marketing of project.

WASTE POLICY PLANNING, LEGISLATION AND GUIDANCE

This briefing is not intended to be a detailed report of all the legislation covering food waste collection and anaerobic digestion but is a guide to a community organisation on what to consider and who to go to for more information.

LOCAL AUTHORITIES, HOUSEHOLD AND BUSINESS FOOD WASTE COLLECTIONS

Household Waste

The Household Waste Recycling Act 2003 provides that *"where English waste collection authorities have a general duty to collect waste they shall ensure, except in some circumstances, that by 31 December 2010 they collect at least two types of recyclable waste together or individually separated from the rest of the household waste"*.

The Act placed no restriction on the type of organisation undertaking the collections. Collections can be by any agency that satisfies the Waste Collection Authority (WCA) that it can do the job and comply with the regulations.

The Act deemed that community recycling groups, charity and voluntary organization, the local authority itself, public and private companies or any combination of these are all acceptable 'waste collectors'.

Business Waste

All businesses have a legal duty to make contractual arrangements for waste to be collected by a licensed private waste management company or their local authority commercial waste service. Local Authorities are allowed, by law, to recover reasonable costs for the collection and disposal of trade waste under the Environmental Protection Act 1990.

LEGISLATION SPECIFICALLY FOR THE COLLECTION OF FOOD WASTE

Reducing biological waste (such as food waste) is a key objective of national and European policy and legislation**.** *Waste Strategy 2007 for England* identified food waste as "a key priority for landfill diversion". Local authorities who do not divert such materials from landfill face financial penalties.

FACTORS INFLUENCING HOUSEHOLD AND BUSINESS WASTE COLLECTIONS

WRAP has produced detailed information on the collection of food waste from households[40]. The WRAP website has more details: www.wrap.org.uk.

In 2011, WRAP commissioned a further report on household and small business waste collections[41]. They found that:

- Increasing numbers of local authorities across the UK are providing food waste collections to households in their area.
- Most large commercial producers of food waste arrange to have their food waste collected separately for recovery by private sector providers.
- Many schools and small businesses are not offered a food waste collection service, and their unsorted waste is sent for disposal even where the food element is a significant proportion of the waste stream and could be recycled.
- Across England, Scotland and Wales, there were only some 20-25 organisations offering separate food waste collections to small businesses (including a few social enterprises, some private contractors and, mainly, local authorities), at the time of research carried out for WRAP in 2009 -2010.

Key factors encouraging the provision of business food waste collection services were found to be:

- The landfill tax escalator, which is set to continue increasing annually by £8 per tonne to reach £80 per tonne in 2014. When added to a gate fee landfill becomes an expensive waste disposal option
- The increasing awareness and sensitivity of businesses to their waste management bills
- A desire on the part of many local authorities to improve service provision to local businesses and schools to allow for greater recycling.

Landfill Tax

The disposal of waste to landfill is taxed in a way that is intended to help the UK meet the goals of the EU landfill directive. An escalated increase is intended to encourage the development of recycling infrastructure by making landfill disposal more expensive as an option.

[40] Food waste collection guidance, WRAP, July 2009

[41] Collecting food waste from small businesses and schools WRAP, February 2011

THE BUSINESS RECYCLING AND WASTE SERVICES COMMITMENT

In 2011, DEFRA and WRAP announced a new Business Recycling and Waste Services Commitment to bring together smaller businesses that need recycling services with local councils and agencies offering help. This built on the work of the former BREW Centre for Local Authorities.

The Commitment is intended to help increase recycling rates and tackle the issues that smaller businesses face in getting access to waste services, The Commitment lists 12 principles of best practice that local authorities can use to tailor services to local businesses.

Businesses are responsible for disposing of their own waste and recycling. Usually this involves paying the local authority or another provider to collect their rubbish. Almost half of councils across the country already offer local businesses a recycling service.

GOVERNMENT SUPPORT FOR ANAEROBIC DIGESTION

The Government committed itself to substantially increasing energy from waste through Anaerobic Digestion (AD) in the Coalition Agreement and has confirmed this stance in the Anaerobic Digestion Strategy and Action Plan[42].

As part of the action plan the Government funded the National Non-Food Crop Centre (NNFCC) to provide an AD portal as the key hub and tool for information dissemination on anaerobic digestion and first point of contact for information on AD for local authorities, businesses, farmers and the wider public.

More details are available at: www.biogas-info.co.uk.

LEGISLATION COVERING ANAEROBIC DIGESTION

EU Legislation:

The EU legislation relevant to Anaerobic Digestion is Article 4 of the revised Waste Framework Directive[43] which came into force in September 2011. The Framework requires a 5-step waste hierarchy to be applied in waste management legislation and policy namely in priority order: prevention, preparing for re-use, recycling, other recovery and disposal.

Article 4(2) makes provision for specified waste streams to differ from the waste hierarchy, where justified by positive life-cycle assessment analysis. For certain organic waste, such as food waste, the use of AD to treat the waste is considered 'to be a better overall environmental outcome than recycling such waste, taking into account the local economic and environmental considerations'[44].

[42] www.defra.gov.uk

[43] Directive 2008/98/EC.

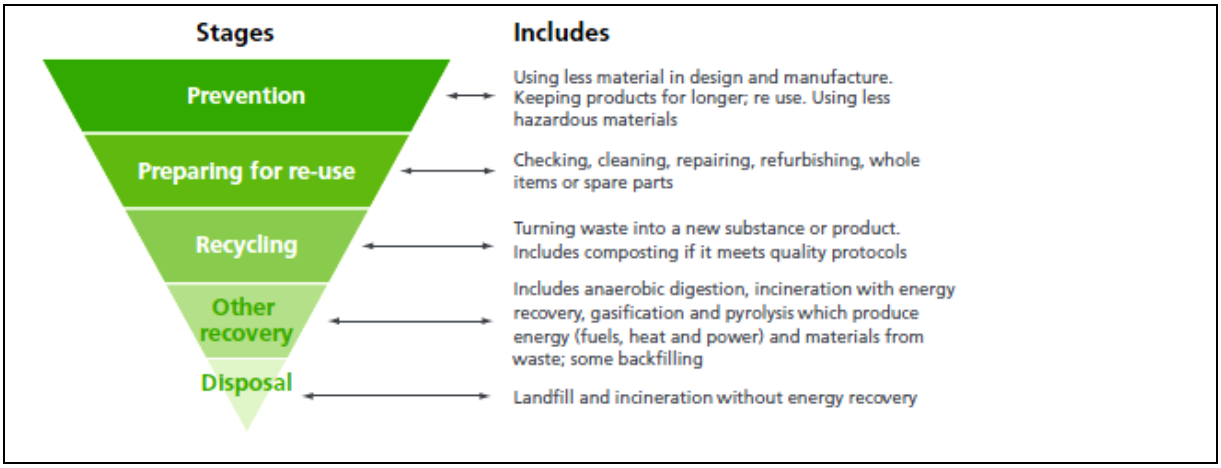
[44] Anaerobic Digestion Strategy and Action Plan DECC/DEFRA 2011

Further information on the practical application of the waste hierarchy and the circumstances in which departures from the hierarchy are justified for specified waste streams has been published by DEFRA[45].

AD is considered to have a role in meeting the UK Climate Change Act 2008 targets for greenhouse gas emissions, the EU renewable energy targets, and the EU Landfill Directive targets.

UK Legislation:

UK legislation follows the five-step waste hierarchy:



Source: DEFRA/DECC AD Strategy and Action Plan

Author's note: Representatives in the AD industry have successfully argued that AD with its renewable energy potential, fertilizer replacement and reduced CO_2 emissions deserves to be included in the Recycling category i.e. placed higher in the hierarchy.

Animal By-Products Regulations

All food waste collections, handling and processing must be compliant with the Animal By-Products Regulations (ABPR). This is to maintain bio-security and prevent transfer of disease. The EU Animal By-Products Regulation (EC1774/2002) legislation permits the treatment of low-risk (Category 3) animal by-products such as domestic and commercial kitchen wastes in approved composting or biogas plants.

Full details of the ABPR are available on the Defra website:
www.defra.gov.uk/publications/2011/12/01/pb13688-animal-by-products-controls-111130/

Planning:

Most AD plant proposals would normally be expected to go through a planning process. Contact the local planning authority (in this case Stratford on Avon District Council) for advice. The Planning Portal is the UK Government's online planning and building control resource. More details can be found at www.planningportal.gov.uk

[45] http://www.defra.gov.uk/environment/economy/waste/eu-framework-directive/

Permits:

Plants that use waste as feedstock require a permit. This is to prevent harm to health and the environment. AD plants need to comply with waste permitting requirements as well as authorisation, if appropriate, under the Animal By-Products Regulations (ABPR) as above. Permits are applied for through the Environment Agency.

Exemptions:

Exemptions are available for lower risk activities where registration can be with the Environment Agency online. Two specific waste exemptions for small scale anaerobic digestion operations are T24 which covers treatment of manures and slurries at premises used for agriculture and T25 which covers the treatment of a wider range of materials including food waste. However it should be noted that these exemptions are for AD plant with less than 50 tonnes of waste on site and any one time, including the digester capacity itself. As such and based upon our scenarios and the amounts of waste envisaged, these exemptions will not apply to the Stratford Community AD proposal.

PAS 110 and Quality Protocol:

The digestate is the residue from AD at the end of the process. It is also subject to regulation and has to comply with a Standard to be considered as a non-waste before disposal. The digestate has to comply with the British Standards Institute (BSI) Publicly Available Standard (called PAS 110) for digestate[46]. Digestates from the anaerobic digestion of waste (or a mixture of waste and non-waste) which have not been treated to the standard remain a waste and applicable waste and waste management controls will apply to their handling, transport and application.

The Quality Protocol provides an industry specification against which producers can verify that anaerobic digestion materials are of consistent quality and fit for purpose. Quality outputs include the whole digestate, the separated fibre fraction and the separated liquor. If the criteria in the Quality Protocol are met (including certification to PAS110), quality outputs from anaerobic digestion will normally be regarded as fully recovered. This means that in those circumstances the use of the fully recovered material may not require an authorisation.

The Environment Agency www.environment-agency.gov.uk has published guidance on the permitting process, the Quality Protocol and PAS 110. A list of bio-waste types suitable for AD can be found in Appendix B of the Environment Agency's Quality Protocol for Anaerobic Digestate. The Anaerobic Digestate Quality Protocol was published in England and Wales in 2009 and updated in July 2010. WRAP also provides detailed information on the Quality Protocol and PAS110.

For detailed information and advice on permits, exemptions and PAS110 contact the Environment Agency. The Midlands Regional office is located at:

Midlands Regional Office, Sapphire East, 550 Streetsbrook Road, Solihull, West Midlands, B91 1QT Tel: 0370 8506506

[46] The British Standards Institute Publicly Available Specification for digestate

STAKEHOLDER ENGAGEMENT

Whilst at such an early stage of project development – in fact currently at pre-feasibility stage – it was considered premature to engage with specific stakeholders, although some awareness will have filtered down as a result of the food waste audit and through other investigatory meetings. If CEW plan to proceed with this challenging yet exciting initiative, the importance of public engagement and approval cannot be underestimated - as indicated in the Biocycle Final Report[47],

> *"It is clear that engagement and communication with the public has been a key tool for risk management throughout the project and will continue to be important in the future."*

DOMESTIC

Homes can produce significant amounts of food waste over the year with reports of up to 30% of all food purchased being wasted[48]. Whilst some of this is home-composted along with other green waste, much of the domestic food waste ends up in the general recycling or green waste bins. However, collection of 'source separated' food waste brings its own logistical problems and costs especially considering the small amounts per household. This was evident in the South Shropshire case study – and any development at Stratford should take full account of these findings. Our study has investigated this through sample data and through local authority interviews, and has used case studies of other community AD studies as reference. Currently, unless changes brought about by waste legislation are introduced and implemented, the costs of introducing a separate domestic food waste collection service are prohibitive to the Council. However, this may change – and therefore CEW could have an important role in raising awareness amongst householders about the need to reduce food waste in the first instance, and to understand the benefits of home composting or divert food waste to IVC and in the future a possible local AD treatment plant.

COUNCILS

The Feasibility Study has interacted closely with the local councils (Stratford on Avon District Council, and Warwickshire County Council in particular) to ensure that the Study takes full account of the contractual and waste obligation issues and to canvas reaction to source segregated food waste collections and treatment through AD – and the possibility of community involvement at an investment and management stage. Even given the likelihood of food waste coming from commercial sources, communication with and possible association with the waste collection and disposal authorities – and in particular with the Warwickshire Waste Partnership – would seem a very sensible approach. Again, the South Shropshire Biocycle project confirmed this:

> *"The project had full cross party support within the District Council and that assisted in the positive engagement with the public"*

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[47] Biocycle South Shropshire Ltd ~ Final Report Defra 2009

[48] WRAP Food Waste Report 2008

BUSINESSES

We regard to the business community and hospitality sector in particular in and around Stratford upon Avon as central to the successful implementation of a community AD project – should the environmental and economic case be accepted. These, including the many restaurants, hotels and food retail outlets in the town would be the main providers of feedstock, in the form of raw, processed and cooked food waste (subject to animal by-product ABP regulations). However it should be recognised that the main issues of engagement with this group will be to demonstrate economic benefit (to justify behaviour change and segregation at source) as well as providing solutions in the form of minimal storage areas and ease of collection. Our study has highlighted the several legislative requirements that businesses will need to address now and in the future. A campaign to raise awareness as to the prospective benefits that a local business food waste collection system could provide will be essential should the community initiative go ahead.

ORGANISATIONS

Finally, many other organisations e.g. schools[49], hospitals, universities, community centres, care homes produce significant amounts of food waste. Our study has not focused specific attention upon this sector, although examples were included within the sample food waste audit. It is a feedstock source that requires more examination and data collection. As importantly, this group especially educational establishments, offers a good prospect for awareness raising – including the importance of reducing food wastage in the first instance of course!

SUMMARY

Most if not all of these potential feedstock producers, processors and waste managers will need to be informed, educated as to the benefits and issues of AD, and committed if the Stratford community food waste project is to be successful. Failure to get over this barrier will mean that medium to long term food waste stocks will not be guaranteed and project sustainability will be at risk.

[49] "Food Waste in Schools" WRAP January 2011

APPENDICES

APPENDIX 1 – SWOT ANALYSIS

STRENGTHS	WEAKNESSES
1. CEW experience , brand and track record 2. Consortium understanding of community funding schemes 3. Community investor interest or 'appetite' helps business case 4. CEW enthusiasm and commitment 5. Legal community structure established (IPS) 6. Good partner experience to date (SWNHT)	1. No AD experience 2. Stakeholder interest not assessed 3. CEW may be seen as inexperienced to commercial organisations 4. CEW lack of complex commercial and project management expertise 5. No guarantee of investor interest in AD 6. Investors may not understand benefits and risks of AD 7. Domestic waste under long term contracts
OPPORTUNITIES	**THREATS**
1. Govt commitment to divert food waste from landfill 2. Govt and commercial commitment to AD as 'preferred treatment of food waste' 3. Landfill tax escalator to encourage diversion 4. 4000 tonnes commercial food waste in SoA 5. 2500 tonnes household food waste potential in SoA town (only 4% currently diverted) 6. Value of power and heat from AD (v IVC) 7. Value of digestate as improved organic fertiliser and soil conditioner 8. Reduced CO2 and CH4 (methane)emissions 9. Short existing contracts (1yr) for commercial waste 10. Likely commitment from hospitality sector 11. Local supermarkets could be persuaded to support food waste stream to boost green, local credentials 12. Dispersed food waste in small quantities – low interest to large waste collectors 13. Support councils to reduce landfill costs 14. Interest from prospective local partners – farms, university (additional feed stocks) 15. Option for co-digestion - food processor site 16. Development of smaller AD plants – Evergreen; Methanogen; Muckbuster 17. Potential for national demonstrator and 'centre of excellence' for small scale food waste treatment (attracting grants?) 18. Financial modelling indicates good IRR for investors 19. Investor appetite for green projects supported by government incentives 20. Cooperative investor (lower return) expectation increases viability	1. Cannot secure contracts of feedstock supply in line with 20 year investment plan 2. Competing demand for food waste – 'competitive bidding' by contractors? 3. Dispersed food waste – expensive to collect 4. Councils not convinced of cost/benefit of AD or already committed capex to IVC 5. Local authorities fail to support commercial waste collection 6. Possible conflict (in waste supply) with IVC 7. No perceived benefit for council to add another household collection @ c£250k 8. Public perception and resistance to waste collection, transport and AD locations and activities 9. Changes to Govt / EU waste legislation 10. Govt incentives (FIT; RHI; ROC) change for the worse e.g. solar PV 11. Govt change may impact upon medium (>10 year) strategy and support for AD 12. Food waste regulations and litigation risk 13. Campaigns such as 'Love Food Hate Waste' / 'Doggy Bag' reduce food waste availability. 14. Other community AD studies have not proceeded e.g. Leominster [RW: why not??] 15. Difficulty of finding suitable site 16. Transport restrictions (food waste, digestate; ABR) 17. Planning restrictions for AD siting 18. AD location may be unable to utilise heat (from CHP) affecting plant viability 19. AD technical and H&S risks 20. AD viability subject to sensitivities of gate fees, transport, debt costs etc 21. Corporate/institutional equity investment not attracted to the project.

APPENDIX 2 – CASH FLOW SUMMARY

Base case cash flow for a 20 year project – **Option 2: on-farm co-digestion** (most likely scenario)

	Years																				
£000 pa		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues																						
Gate fees			160	158	157	155	154	152	151	149	148	146	145	143	142	140	139	138	136	135	134	132
Electricity sales			67	69	72	75	78	81	84	88	91	95	99	103	107	111	116	120	125	130	135	141
Heat			8	8	8	8	9	9	9	10	10	11	11	12	12	12	13	14	14	15	15	16
Digestate			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incentives																						
FITS			218	225	231	238	245	253	260	268	276	284	293	302	311	320	330	340	350	360	371	382
FITs export			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROCS			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LECS			7	7	7	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12
RHI			17	18	18	19	19	20	20	21	22	22	23	24	24	25	26	27	27	28	29	30
Total Revenues			476	485	494	503	513	523	534	544	556	568	580	593	606	619	634	648	664	679	696	713
Opex			(250)	(257)	(265)	(273)	(331)	(290)	(298)	(307)	(316)	(426)	(336)	(346)	(356)	(367)	(478)	(389)	(401)	(413)	(425)	(438)
Loan repayment			(112)	(112)	(112)	(112)	(112)	(112)	(112)	(112)	(112)	(112)	(112)	(112)	0	0	0	0	0	0	0	0
Free cash flow before tax			115	116	117	119	70	122	124	126	128	30	132	135	250	253	156	259	263	267	271	275
Net cash flow to equity		(1,252)	115	116	117	119	70	122	124	126	128	30	132	135	250	253	156	259	263	267	271	275
IRR:	9.3%																					

APPENDIX 3 – CASE STUDIES

1. SOUTH SHROPSHIRE BIOWASTE FACILITY, LUDLOW

The South Shropshire Biowaste Demonstrator Facility 'Biocycle' in Ludlow was initiated as a local AD solution to bio-waste and was built with government funding as part of the New Technologies Demonstrator Programme (Defra).

This project was co-funded by the Council, DEFRA and Advantage West Midlands in order to *'arm key decision makers with the facts and realities of implementing new technologies and empowering them to make informed decisions*'.

The plant is the first of its kind in the UK to process source-separated municipal kitchen waste into biogas and a bio-fertiliser. It is a demonstration plant, so it is designed to be a research and development facility rather than a commercial plant. The site aims to showcase the technology, prove its reliability and educate people by monitoring the process and publicising the technology.

Furthermore the plant is helping to keep 5,000 tonnes of food waste out of landfill every year. It also uses the methane gas created to generate over 1.5 million kWh of 'green' electricity. The site is entirely self sufficient in power and even exports some of this to the national grid. The site is part owned by Shropshire Council and is operated day to day by BiogenGreenfinch.

The Biocycle project provides important experience and 'lessons learnt' to the Stratford upon Avon AD proposal. Whilst there are clear differences in terms of location (rural), population, socio-economic grouping, business, tourism, hospitality density and feedstock availability, nevertheless there are many transferrable issues and outcomes. Members of CEW were able to visit the Ludlow plant as part of the LEAF-funded feasibility study and discuss with the Council and the operators the main opportunities and challenges.

The Ludlow Biocycle Report [50] lists some of the main 'key points to consider':

- Engagement with the public prior to submission of the planning application proved beneficial in terms of gaining public confidence and acceptance for the plant;
- The fact that the Local Authority was a partner helped engender public confidence;
- The site selection is important and should ideally be away from sensitive receptors and close to markets for feedstock and outputs;
- Designers (of AD plant) should consider the employment of proven technology that is fit for purpose and can be easily adapted to cater for a wide range of feed stocks if required;
- The design and efficiency of the AD process is inextricably linked with the type of feedstock expected;
- It is important to define from the outset the acceptable levels of contamination and dry matter within the feedstock;
- The composition and quality of the feedstock will determine the biogas generation and the quality of the digestate;
- The feedstock gate fee should reflect the difficulty of treatment in terms of sorting, shredding and further processing;
- Changes in feedstock can have environmental impacts such as increased odour generation;
- The markets for the digestate will determine the type of post-digestion treatment equipment required;
- The likely end market for the outputs and the criteria which need to be met should be considered from the start of the project;
- Discussions with the power purchasers should occur as early as possible to identify the level of loading that can be exported from the proposed site;
- A source separated food waste collection scheme from households and businesses yielded a far less contaminated feedstock;
- A good food collection scheme depends on raising awareness.

[50] Biocycle South Shropshire Ltd ~ Final Report Defra 2009

2. LEOMINSTER (LEAD) FEASIBILITY STUDY

Project LeAD was started in 2008 by two individuals who both had the same idea about community-owned AD and who came together with Towards Transition Leominster to form a steering group. The original aim was to build a 20,000 tonne a year plant on the Leominster Enterprise Park that would deal with animal slurries and commercial food waste. In 2008 when the first work began on the project there was excitement about the proposed Feed-In Tariffs (FIT) and the stability they could bring to the finances of an AD facility. The 2007 Waste Strategy had highlighted AD as a win-win technology, and subsequent work from the NFU suggested that 1000 new farm AD facilities could be built by 2020. The AD industry seemed on the cusp of large-scale expansion.

Project LeAD (Leominster AD) initially decided to pursue AD as a project, as opposed to any other renewable technology, because of the rural nature of Herefordshire. The aim was to develop a community renewables project that could support the local economy and act as a catalyst for other new ventures. Herefordshire has a successful agricultural sector and a vibrant small food producer economy. Community AD could support both of these by providing a local and cost-effective route for waste from both industries. In addition, the close relationship with local farmers and food producers could be promoted to remind locals about the things they can buy that are produced locally. The by-product of AD - digestate - is a valuable alternative to commercial fertiliser and could help lower farmers' costs.

A decision to procure a full technical feasibility study was taken in January 2010 and Project LeAD was officially 'launched' at a public meeting later that month. In March 2010 Project LeAD made an application for funding to the LEADER Programme, a source of European funding to assist the development of rural areas and part of the Rural Development Programme for England (RDPE). Some of the costs, such as planning, were not eligible for support under RDPE rules so LeAD would be reliant on several other funding streams to proceed.

Sharenergy worked with LeAD by supporting the feasibility study, funding planning advice, sourcing alternative funding and helping their deliberations over which legal structure best suited them. LeAD was also being supported by Community First from the Co-operative Enterprise Hub.

The network of individuals, organisations and communities investigating AD in the Marches area were brought together and Marches Anaerobic Digester CIC (Community Interest Company) was incorporated on the 18th October 2010. The objects of Marches Anaerobic Digester CIC are to carry on activities that benefit the community and in particular, to determine whether there is scope for a community owned AD plant within the Marches, that can be sufficiently viable to make it suitable for investment in, and ownership by, the community.

A large amount of work had to be carried out on the assumption that the FIT would be sufficient to make the project viable but lower than expected final tariffs were announced. For this and other organisational reasons it has not been possible to develop the LeAD project as yet.

All parties have learned how complex an AD development is; the pitfalls and essential stages have been exposed such that many others can benefit from the experience and knowledge propagated by Sharenergy and LeAD. "Community Anaerobic Digestion: The Stages and Barriers to Success" draws heavily on work funded by Sharenergy who have shared their knowledge via various Government consultations to help inform the development of more appropriate policy to encourage viable community AD projects. *(Extracted from Share Energy Case Study 1 March 2011 with thanks)*

3. ISSUES AND CHALLENGES OF AD (SHARENERGY)

Discussion notes from CEW meeting with Sharenergy – based on LeAD and Clee Hill experience.

With thanks to Eithne George, Director

Feedstock Supply and Contract

- Complicated waste collection and disposal system exists
- Uncertainty of guaranteed feedstock availability
- Commercial food waste – what is the cost margin of collection?
- Length of commercial contracts (short term) is a big issue – difficult to plan and guarantee returns e.g. Coop supermarkets have 1 year contract
- Food waste from factories – much of low calorific value (e.g. washings) and not identified as problem
- Waste industry highly competitive – can they work with / alongside community groups?
- Waste collector as partner – unlikely to interest large contractors but more likely with small collectors
- Interest of waste collector in source separation? Will legislation bring about change?
- What will be the future value of waste and gate fees – and impact upon viability?
- AD is competing for food waste with collection and delivery contracts into EfW and IVC compost units e.g. Cwm Harry, Newport
- No evidence of local authority involvement in waste collection or disposal contracts for small businesses
- Future availability of glycerol to boost energy output for AD e.g. Kemble Farms, Cirencester?
- Can we expect food waste to be banned from landfill soon – then large quantities available for AD.

Scale and size of investment of AD plant

- Main support is for large centralised AD plants e.g. Biffa 120,000 tonnes; 6MW capacity regional AD at Cannock, Staffs
- Is the technology available to make 250-500kW AD plants – suitable for community projects - viable?
- Leominster proposal was for a 500kW, 40,000 tonnes digester at a cost of c£3m inc pasteuriser - funding planned to be sourced 50% (£1.5m) loan equity and 50% (£1.5m) share capital

- AD is much higher risk than other renewable energy projects - even community investors expect return of 8-10%
- 'Investability' – directly related to length and certainty of waste contracts established by community group

Farm-based AD

- Farm animal wastes have low calorific value, but have land for digestate 'disposal' and can assist with meeting nitrate vulnerable zone (NVZ) tight restrictions e.g. 6 months storage; spreading times etc
- Is slurry or FYM really a problem for livestock farmers – and therefore what is their incentive for AD?
- With costs of production at c£30 / tonne is it worth ensiling maize or grass silage for AD?
- Public reaction to replacing food crops with energy crops?

Planning

- Sites for AD have not met resistance from planning authority
- Good site needs good road access; proximity of heat use (e.g. swimming pool / leisure centre); storage facility
- Look for farm-located co-digester proximate to heat demand e.g. industrial estate, leisure development

AD Outputs

- Finding a customer for heat is crucial – but risk of 'single client' user
- Importance of price fix contract for heat output
- Look for on-farm uses for heat e.g. wood drying wood; horticulture – options limited
- Gas to grid injection – very costly and only suited to large AD systems
- Digestate – not all good news – high water content and therefore volume – storage requirement

Community lobbying for AD – Government support needed to:

- Open up access to contracts
- Stop FW to landfill
- Provide fair market place

4. SUSTAINABLE YOULGRAVE FEASIBILITY STUDY, DERBYSHIRE

Sustainable Youlgrave (SY) www.sustainableyoulgrave.org is a volunteer, community-led group and initiative which has the objective of reducing the impact on the environment of the community's activities, and for their benefit. SY is investigating all feasible sources of renewable energy (RE) as well as improvements to household energy and water efficiency, transport and the local economy to take us if possible to carbon neutral and a sustainable future.

In 2009 a full feasibility study was carried out into the appropriateness and viability of setting up and running one or more AD plants for farmers in the Bradford Valley (near Bakewell) of the Peak District, with the aims of generating biogas or electricity and heat for use or sale, and the production of safe farm digestates to displace artificial fertilisers presently in use. The Feasibility Study Report and Toolbox (*How to*) report was produced for the use of other communities & farmers groups to assess their own AD opportunities themselves.

The Youlgrave Study was focussed largely upon a farmer cooperation model, based on the 'hub and spoke' method designed by Southampton University which allows for aggregation of bio-wastes enabling more viable processing units. Three AD units were proposed – at least one of which would accept domestic/commercial food waste. There is some relevance therefore to the Stratford initiative although there are significant differences too – not least in the rural context of the Bradford Valley, the objectives of the 'rural community' i.e. SY, and the differing amounts of high energy food waste available to both projects.

Those main barriers revealed by the 2009-10 study and considered relevant to the Stratford-upon-Avon situation are summarised as follows:

Waste operator resistance

- Lack of interest from local waste management transport companies to supply local food waste to AD – food waste producer pays for landfill cost;
- Existing commercial producers of food waste would have to pay more for specific source-separation bin quantities compared to their existing general waste bin charges;
- Waste collection market is fiercely competitive – no enthusiasm for alternative system due to current low profit margins and current low landfill charges (but rising!).

Collection authority resistance

- Unwillingness from waste collection authority to get involved in a food waste (and digestible biowaste) source-separation scheme due to existing domestic contracts with waste management companies;
- Potential income loss of landfill or aerobic composting gate fee reimbursements from existing national government recycling targets if waste diverted to AD.

Waste authority resistance

- National policy is for cost-effective, macro-waste treatment in massive incineration, large scale AD or aerobic (IVC) treatment plants to replace landfill, strategically located across the county, served by large waste transporters, and ignoring the inherent transport pollution and traffic impact;
- County policy and strategy affected by policy changes and delays resulting from county and national political elections.

Planning

- Planning authority (Peak District National Park Authority) not in favour of co-digestion of off-farm waste (food waste or sewage sludge);
- Concern about the increase in traffic to service AD plants in the area;
- Planning authority favour only small-scale, on-farm (and largely non-viable) AD plants.

Sewage Sludge (as co-digestion feedstock)

- Low interest from water treatment company (Severn Trent);
- Farmer resistance – fear of disease and heavy metals getting through into the digestate.

Access to project development funding

- Significant funding required (up to perhaps £300K) between feasibility and successful development of proposed AD plants;
- Expert services in design and planning approval required;
- Many funding sources are unwilling to advance finance of development stage due to high risk of rejection.

Sustainable Youlgrave conclusions (selected as relevant to Stratford community AD):

- Communities such as SY are responding to the government's wish to 'substantially increase energy from waste through AD' and their commitment 'towards a Zero Waste economy';

- There is a lack clear lack of 'joined-up thinking' – collection and disposal authorities; waste contractors etc;

- Waste policy in England and Wales should follow the 'proximity principle' – essentially that all waste must be managed (irrespective of method) as close to the source of its production as possible;

- If the government wishes to optimise viable energy generation from renewables, then AD co-digestion should be encouraged wherever environmentally feasible from micro to macro development, on and off-farm and elsewhere;

- Waste management companies and local authorities should be instructed to make some of their waste available to small as well as macro AD schemes;

- Local authorities should be instructed to take part in pilot schemes with local communities to explore greater waste source-separation and the use of the organic fractions in local AD plants on or off-farm;

- UK Government should fund strategically-sited demonstration AD plants co-digesting food waste and sewage sludge on-farms around UK to overcome their suspicions and fears;

- Increased funding and availability of loans for farms, landowners and community groups to facilitate the design and development of 'local' AD projects and meet UK and NFU targets by 2020.

With acknowledgement to Brian Mallalieu Sustainable Youlgrave February 2012

APPENDIX 4 - STRATFORD-UPON-AVON HOSPITALITY FOOD WASTE SURVEY

Business Information: Answer questions in box BEFORE speaking to the interviewee, if possible. Confirm or fill in missing info at end of interview if they haven't lost patience ;)

Date: _____

Surveyor:_____

Business Name: _____

Business Address: _____

Business Type: *hotel* *pub* *restaurant* *quick-service restaurant (QSR)*

<table>
<tr><th>Restaurant</th><th>Pub</th><th colspan="2">Quick-Service</th><th>Hotel</th></tr>
<tr><td>European (specify)</td><td rowspan="4"></td><td>Fish & chips</td><td>Burger</td><td rowspan="2">Star / diamond rating:</td></tr>
<tr><td>South Asian (specify)</td><td>Ethnic</td><td>Chicken</td></tr>
<tr><td>Asia-Pacific (specify)</td><td>Café</td><td>Mobile</td><td rowspan="2">No. of Rooms</td></tr>
<tr><td>Other</td><td colspan="2">Retail (e.g. Bakery)</td></tr>
</table>

Food services provided (*check all that apply*):

Breakfast / Morning Coffee / Lunch / Afternoon Tea / Dinner / Snacks / Takeaway

1. Is the business part of a chain? *Yes/No* Name of chain/group _____

2. Daily/weekly Opening Hours _____

3. **Number of Seats** in the establishment (can count tables, then x by seats per table) _____

General Questions - Fill in with the interviewee:

1. How many employees work here? _____ (*# of full time /# of part time*)

2. Are you open all weeks of the year? If not, when are you closed?

[For following question on number of meals & season - give flexibility in answers, & may be helpful to prompt them – e.g. 'more or less than 20? Ok, more than 50? etc. – and if they prefer to estimate as no. of tables per hour etc. you can use that, then estimate from average table size. Does not *have to use the exact ranges given below]*

3. About how many meals a day do you serve during your high season? Low / mid seasons?

High (dates)	*1-25*	*26-50*	*51-100*	*101-150*	*150-200*	*250-300*
Low (dates)	*1-25*	*26-50*	*51-100*	*101-150*	*150-200*	*250-300*
Mid (dates	*1-25*	*26-50*	*51-100*	*101-150*	*150-200*	*250-300*

Waste Questions

If they are happy to continue talking at this point, continue with these questions & ask to take a look at the waste bins out back

1. Do you have **food waste** recycling or separate collection of food waste?

[If yes, answer the box below, try to get as detailed as possible answers; if no continue]

Yes:

Who takes your food waste?

Where does it go? *(e.g. composting or other)*

Are there separate bins for food waste in the kitchen or other spots?

What size bin is it collected in & how many?

How often is it collected?

How full is it when collected? *(% estimate)*

No: *(questions below for general waste)*

1. Is there a food waste disposal unit in the kitchen (e.g. grinder)? *Yes/No*

If yes, how much is it used? *(% estimate)*

2. Who has responsibility for waste management at this business? _____(*position)*

3. Do you pay for your waste collection? *Yes/No*

4. What company collects your waste? (*name likely on bin, e.g. Biffa, Greenstar, Grundon, Fortress, Environmental Connections, Veolia, Verdant*)

5. What size container is collected, and how many of each?

2-wheeled bin			**4-wheeled bin**		**Skip (with compactor)**	**Skip (without compactor)**	**Sacks**	**Other**
120 L	240 L	360 L	660 L	1100 L				

6. How often is the waste collected?

7. Are the containers usually full when collected? (*estimate how full*)

8. How much of the container would you estimate to be **food waste** (e.g. half, most, very little, all -or estimate percent below - can estimate a figure rather than range if possible)

0-25%	**25-50%**	**50-75%**	**75-100%**

Closing Questions

[*For those that seem really interested – if they're interested take contact info; if not just name & position]*

9. Would you like to hear more about the study and its results when it's done?

10. We can get a more accurate picture if actual waste quantities are available. Would you be able to provide your actual waste records? (or give a contact at your business for that?)

11. As part of a later study, we may carry out free (and anonymous) waste audits – would you be potentially interested?

Interviewee Name & Job Title: Contact Number/Email *(if desired)*

Thank You for your Time!

in association with

Contact details:

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