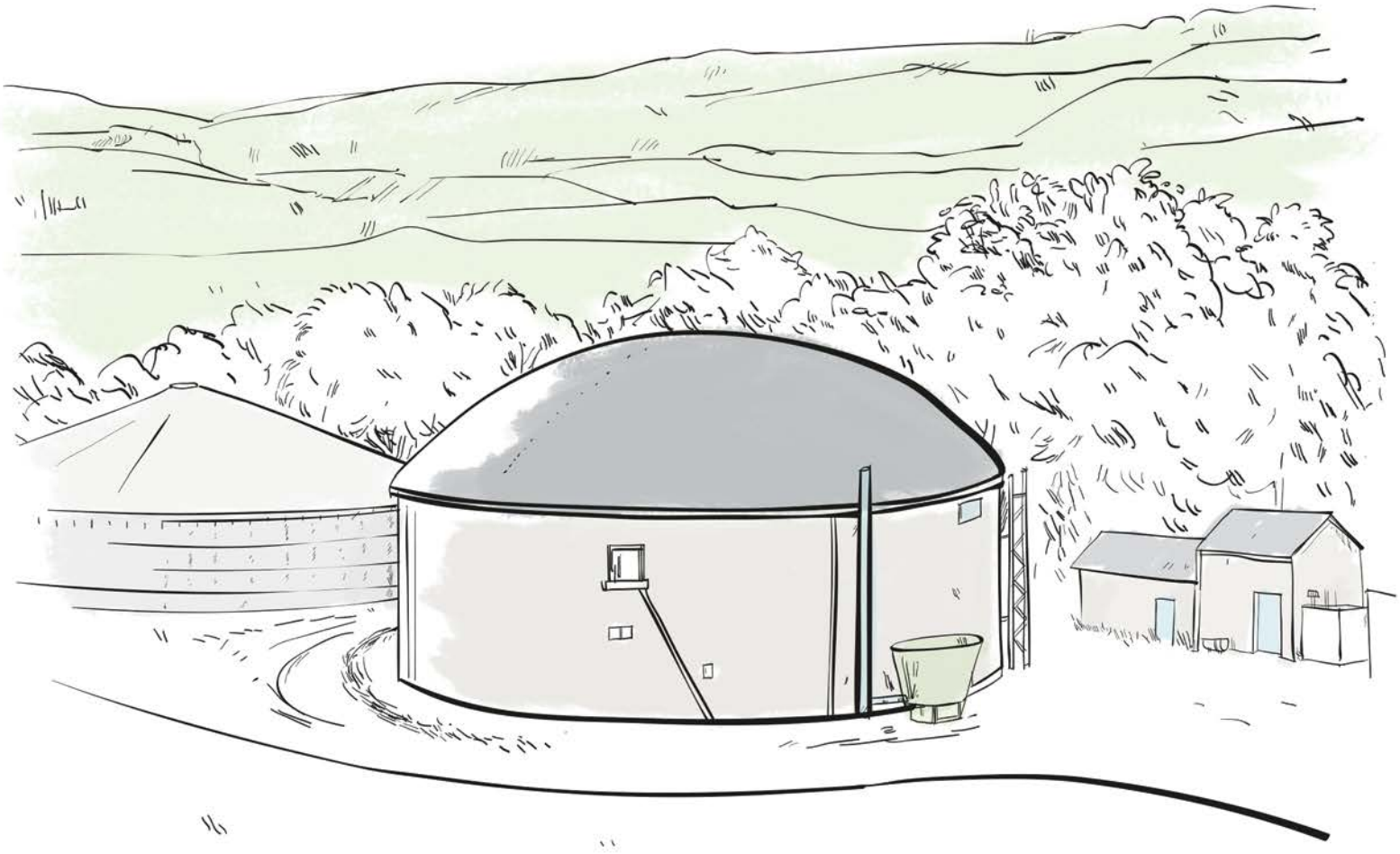
Green Investment Bank

# The UK anaerobic digestion market

A market report by the UK Green Investment Bank



# Contents

# Introduction

## The UK Green Investment Bank (GIB) began operations in November 2012. Created by the UK Government and capitalized with £3.8bn of public money, GIB's mission is to help the UK transition to a greener economy by supporting projects that are both green and commercial.

One of GIB's priority areas for investment is waste, including recycling and energy from waste. GIB published an initial report on the anaerobic digestion (AD) sector in June 2013. The report assessed the development of the AD market and the operational performance of UK facilities.

Since then the sector has continued to grow rapidly. In March 2013, the official government portal for the AD industry reported[i] 106 anaerobic digestion plants operating outside the regulated water industry. By January 2015 the corresponding figure was 167 plants – an increase of 57 per cent.

The purpose of this report is therefore to review the progress of the sector since our last report, build upon the findings from the initial report, and consider further the implications for investors and operators.

Consistent with the findings from our last report – namely that new AD facilities have a risk profile better suited to equity rather than debt investment – GIB has invested equity in several new AD projects through its equity fund managers. In order to encourage liquidity in the market, GIB has also been working directly with a number of operators to explore the potential to refinance strongly performing operational assets with debt. As the sector matures, GIB has been approached by several projects that are exploring alternative financing strategies including with the use of project finance debt.

AD projects are in close alignment with GIB's green and profitable business strategy and directly contribute to GIB's transparent double bottom line. Generating renewable electricity and/or biogas reduces greenhouse gas emissions by displacing fossil fuel based sources. By diverting organic waste from landfill and producing digestate which can be used for fertiliser, anaerobic digestion contributes toward a circular economy, a concept where materials are kept in productive use, retaining a high value, and organic materials are returned to the biosphere in a sustainable way. Furthermore, Government subsidies for AD support the requirement for the UK to meet the targets for the diversion of Biodegradable Municipal Waste from landfill (UK reduction of 35 per cent of 1995 levels by 2020), as set out in the Landfill Directive.

# Key findings

## Sector developments

There continues to be significant investment in the sector with an estimated £160m invested over the last 18 months. However, there is a clear shift towards agricultural and gas to grid projects as the segregated food waste market tightens and tariff degression occurs.

## Operational performance

Average operational performance has steadily increased since our last report. On a like for like basis, operational performance for agricultural facilities in 2014 was 71 per cent (up from 63 per cent in 2013) whilst the corresponding figure was 72 per cent for source segregated food facilities (up from 67 per cent in 2013).

## Feedstock markets

The market for source segregated food waste is becoming more competitive as the rapid expansion in treatment capacity has not been matched by an increase in collection of segregated food waste. As a result, gate fees for segregated food waste are declining and operators are being forced to use a wider blend of feedstocks.

## Critical factors to project success

The fundamentals remain unchanged since our 2013 report; these being: operational reliability, competitive cost base, and understanding feedstocks and related sustainability impacts.

# Scope of this report

The focus of this report is on two broad feedstock categories:

**Source segregated food waste**
Controlled wastes produced by households, commerce, and industry.

**Agricultural**
Farm wastes, as well as purpose grown energy crops.

The 2013 report also considered the anaerobic digestion of residual waste processed as part of mechanical biological treatment facilities. However, the investment opportunity for such facilities is almost solely related to long term local authority residual waste contracts, which have now largely been procured (See GIB's July 2014 report – UK Residual Waste Market). Whilst these facilities have been included in the overall sector statistics, they have been excluded from the analysis of operational performance.

For consistency with our 2013 report, facilities in the waste water / sewage treatment sector, operated as part of the regulated water industry, have also been excluded from the report.

# Sector development

The growth in the AD sector is highlighted by the available Ofgem data, which shows a total of 161 AD facilities (excluding the regulated water industry) on the various registers as of November 2014 with an increase in installed MW capacity from 106.2 MW to 142.7 MW, an increase of 34 per cent from the 2013 report (see Table 1).

Figure 1 shows the growth in the AD sector over the last five years. The growth in AD capacity continues. As at January 2015 an estimated 30 MWe of additional capacity has been identified as currently under construction. However, over the last six months there has been a shift towards the development of smaller agricultural plants. According to recent research by NNFCC[v] the number of such facilities in development increased by a total of 70 in the six months to September 2014 while according to the same report source segregated food waste projects increased by just four.

We understand that the majority of agricultural projects have been financed by financial investors with Enterprise Investment Scheme (EIS), Venture Capital Trust (VCT) or Seed Enterprise Investment Scheme (SEIS) accreditation. However, this is likely to change after 31 March 2015 after which AD projects will cease to qualify as suitable investments for EIS, VCT and SEIS investors. The resulting gap in the financing market will have to be filled by new investors.

| Subsidy Regime | 2013 Report | | November 2014 | |
|---|---|---|---|---|
| | Number | MWe | Number | MWe |
| ROCs[ii] | 33 | 64.5 | 39 | 61.8 |
| FITS[iii] | 49 | 41.7 | 119 | 80.9 |
| RHI[iv] | 2 | N/A | 3 | N/A |
| Total | 84 | 106.2 | 161 | 142.7 |

**Table 1:** Installed capacity in the UK **Source:** Analysis of Ofgem data

Using previous DECC assumptions[vi] of a median cost of £4.4m per 1 MW of installed capacity, the increase in operational AD capacity (and in AD plants in construction, including new gas-to-grid projects) is the equivalent to an investment of circa £160m since summer 2013.

In addition to the above, we note that in November 2014 there were 13 AD facilities seeking accreditation under RHI with plans to inject biomethane gas into the grid. We believe this is a strong indication that many of the initial hurdles for such projects have now been overcome – with the first RHI degression for these projects recently announced.

The AD sector remains highly fragmented and currently no operator has more than five operational facilities. There is therefore scope for consolidation in the market, but one of the challenges the sector faces is that many facilities have been designed to suit project specific requirements:

- Feedstock is ideally sourced from local markets – and whilst there may be a benefit to providing a regional or national coverage, this offering is likely to appeal to only a very small number of potential customers. Most of those of any scale already have regional solutions in place.
- Digestate management requires a local solution due to transport costs.
- Technology – the wide range of technical solutions is considered to be a particular barrier. This is where the AD industry differs from other technologies such as landfill gas where engines can be readily interchanged between sites.

Notwithstanding the fragmented nature of the market, it is clear that best practice is now being shared more widely thanks to the work of ADBA, REA etc. – and this is evidenced by the clear improvements in operational performance (see Figure 2).

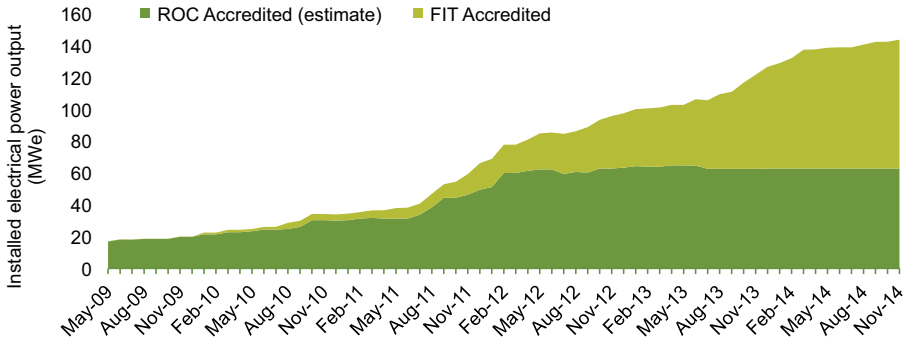



**Figure 1**: Growth in installed AD capacity in the UK
**Source**: Analysis of Ofgem,data

# Operational performance

The 2013 report considered average load factor, as the metric of operational performance, calculated by comparing reported power production eligible for support against the reported installed capacity. Whilst it is one of a number of potential measurements of operational performance – and subject to the accuracy of the information provided – it is an appropriate method to measure and compare relative performance of AD facilities. However, it is not suitable for measuring the performance of gas to grid projects and as the number of operational projects rise additional metrics may be required.

This report is based on data available in the public domain through Ofgem and third party data[vii] for facilities accredited under FIT. This wider data set allows for a more robust analysis of the market. As a result of the change in data sources, the figures from the 2013 report have been updated and restated for consistency.

Figure 2, 3 and 4 demonstrate a continued improvement in operational performance for both agricultural and source segregated food waste facilities. This suggests that the agricultural sector has seen a step change in operational performance over the last 18 months and the performance gap between source segregated food waste and agricultural facilities appears to have been all but eliminated (see Figure 4).

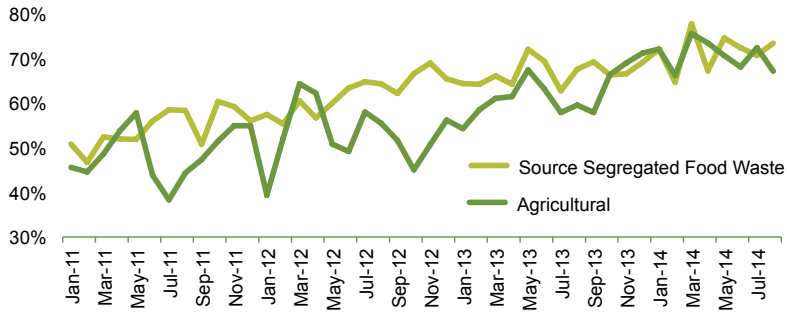



**Figure 2:** Monthly industry operational performance
**Source:** Ofgem, Tolvik Consulting

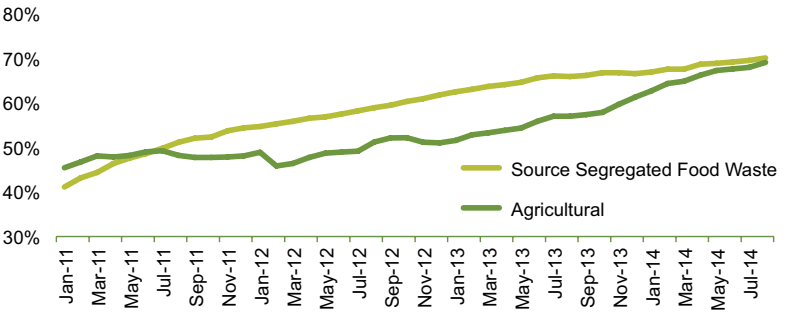



**Figure 3:** Rolling average operational performance
**Source:** Ofgem, Tolvik Consulting

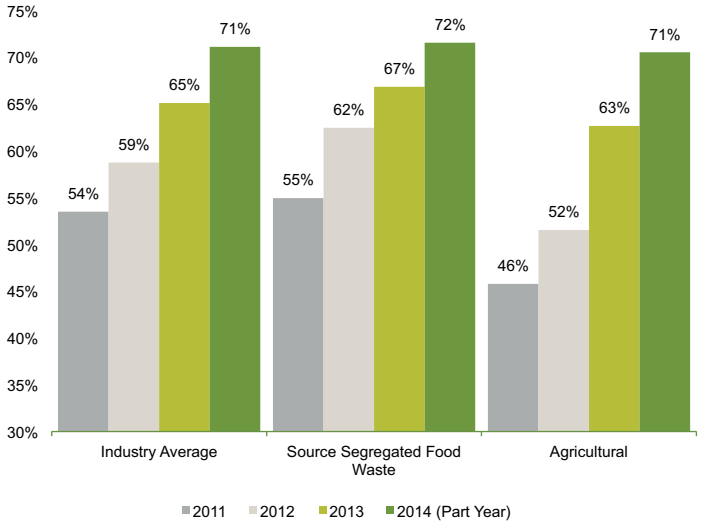



**Figure 4:** Annual operational performance by sector
**Source:** Ofgem, Tolvik Consulting

As shown in Figure 5, the average upper quartile annual load factor of all agricultural and source segregated food waste AD facilities over the last 12 months has now risen to 91 per cent, an encouraging trend when compared with 2013 report – when the figure was just 80 per cent (albeit with a much smaller sample size). This suggests that 'best in class' operations are able to deliver load factors in line with those often assumed in financial models. However, the counter argument is that three quarters of all facilities are achieving an average annual load factor below typically modelled assumptions.

Figure 6 demonstrates the operational performance across the sector measured from the month of first subsidy support. It suggests that the uncertainty in the load factor during the first 12 months of operations is higher for source segregated food waste projects when compared to agricultural projects. This is likely due to a combination of the heterogeneity of feedstock and the greater complexity of feedstock supply chains for the source segregated food waste facilities. After the first 12 months, operational performance typically stabilises.

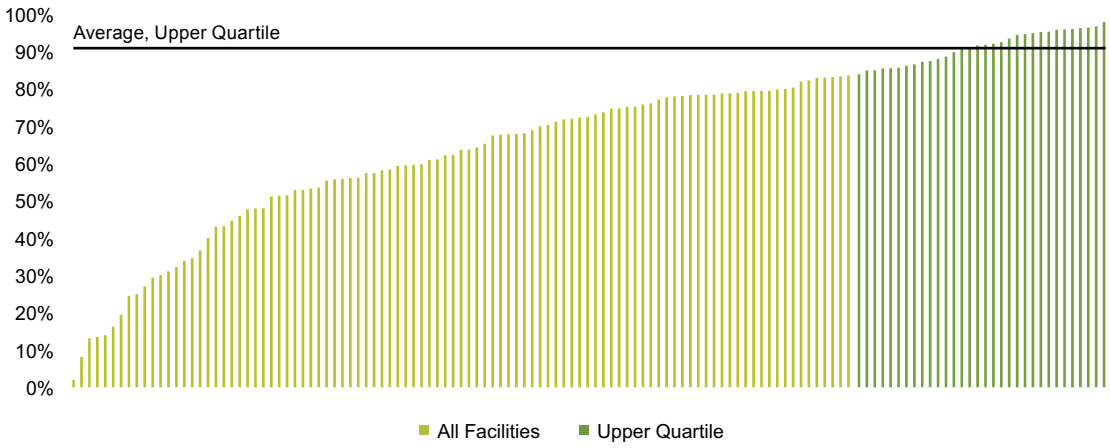



**Figure 5**: Facility by facility operational performance **Source**: Ofgem, Tolvik Consulting

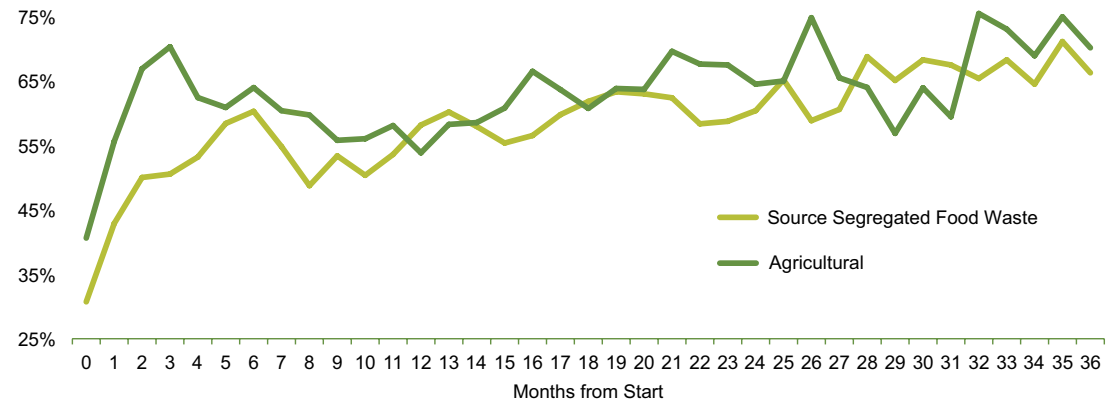



**Figure 6**: Load factors by month from start of operations **Source:** Ofgem, Tolvik Consulting

However, Figures 7 and 8 indicate AD facilities entering into operations post January 2013 demonstrate an improved ramp up profile over the first 12-18 months of operations compared to plants commissioned prior to this date. This suggests that the more recently constructed plants are benefiting from the experiences of previous AD operators and this is shown by the higher load factors from the plants constructed post January 2013.

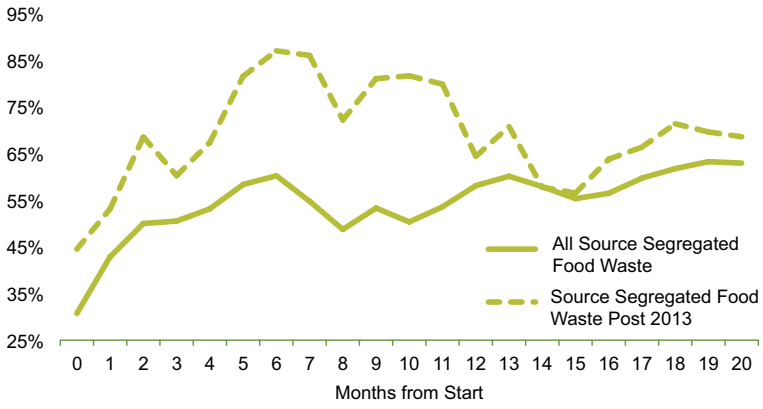



**Figure 7:** Comparison of source segregated food waste load factors during 'ramp up'

Source: Ofgem, Tolvik Consulting

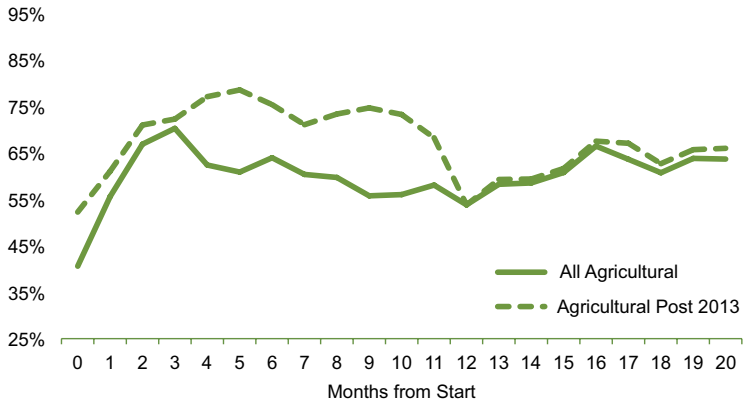



**Figure 8:** Comparison of agricultural load factors during 'ramp up'

Source: Ofgem, Tolvik Consulting

# Feedstock markets

One of the key factors influencing the development of the AD market is the availability of source segregated food waste. To ensure the sustainable development of AD capacity, there is a need to balance the rate at which food waste is collected separately from the residual waste stream thereby supporting new plants and the ongoing pressure to reduce food waste arisings at source thereby limiting the total tonnage available in the market.

However, over the last two years the expansion in AD capacity available for the treatment of source segregated food waste, estimated to be circa 1.0-1.2 million tonnes pa (Mtpa), has far exceeded the growth in food waste supply for the following reasons:

### Household food waste

Over the last 24 months the additional tonnage of food waste separately collected from households across the UK is estimated to be no more than 0.2-0.3 Mtpa. Whilst there has been steady progress in the collection of household food waste in Scotland, Wales and Northern Ireland, in the absence of a specific household food waste policy, the results in England have been relatively mixed.

### Hospitality

Recycling rates including food waste used in composting recently reported by WRAP are up 7 per cent to 54 per cent[viii] showing good progress. However, with this including food waste used in composting sector contributing only circa 0.8 Mtpa of food waste arisings, such an improvement will generate only a modest additional supply of food waste for AD facilities.

### Retail & supply chain

The Courtauld Commitment[ix] is improving performance, both in terms of reducing waste volumes and increasing recycling rates, but this is a relatively small sector. It has recently been reported[x] that with the seven largest supermarkets generate only 0.2 Mtpa of food waste out of a sector total of around 0.4 Mtpa.

### Food manufacturing

Competitive pressure means that very little food waste is landfilled. Much of the food waste arising in the sector is currently spread on land, converted to animal feed or sent to sewer. The key to the ongoing success of the AD sector is that it is able to successfully market the superior environmental performance of AD projects against these alternatives to encourage waste producers to direct their food waste to AD. However, the nature of the competing outlets for this food waste and its relative homogeneity means that it is likely to attract lower gate fees than food waste from other sources.

Using various sources and focusing only on source segregated food waste AD facilities, as at the end of 2014, the headline capacity of operational source segregated food waste AD facilities in the UK was estimated to be 2.6 Mtpa, with an increase in capacity of around 1.2 Mtpa over the past 2 years. The figure is an estimate as a number of facilities do not solely process food waste, and capacities of individual facilities vary with feedstock and residence time. It is also estimated that there is a further 0.5 Mtpa of AD capacity currently either in construction or for which funding is understood to be in place.

In October 2014, the NNFCC[xi] indicated that food waste AD projects 'under development' had a total capacity of 5.7 Mtpa. Taken together with continuing degression in tariffs, the limited availability of feedstock will affect the commercial feasibility of projects and can be expected to restrict the number of projects proceeding to construction.

Figure 9 below sets out the projected headline capacity and the "adjusted capacity" assuming 85 per cent availability of currently operating food waste AD plants. It assumes further modest improvement in the volume of household food waste collected and incremental improvement from other sources but no 'step change' in collection.

The net effect of this supply / capacity balance is that gate fees for food waste have fallen over the last few years. Whilst the 2014 WRAP gate fee report[xii] indicated that local authorities were paying on average £40/t, the reported gate fee range was £19/t- £63/t. It is understood that gate fees for household food waste for new contracts have fallen to around £20/t. This trend has been confirmed by respondents to DECC during the recent consultation process for RHI degression where gate fees for unpackaged food waste were reported to average around £15/t[xiii].

Source segregation of household waste is prevalent in Scotland, Wales and Northern Ireland, but remains piecemeal in England. If these conditions persist then it is likely that there is currently sufficient AD capacity at a national level to treat current volumes of separately-collected food waste given the number of plants in operation and construction.

While there is limited room for growth in food waste AD, the agricultural AD market remains attractive. There has recently been particularly significant growth in this sector – as evidenced by the FIT degression. This is because developers have turned their attention to farm AD opportunities where the feedstock risks are perceived as more manageable with the potential for longer duration feedstock contracts alongside the increased homogeneity in fuel composition. These advantages coupled with the potential for the local landowner (farmer) to act as a long term owner of the AD facility and off-taker of the digestate and heat have provided additional incentives for investors to focus attention on the agricultural waste subsector of the AD market.

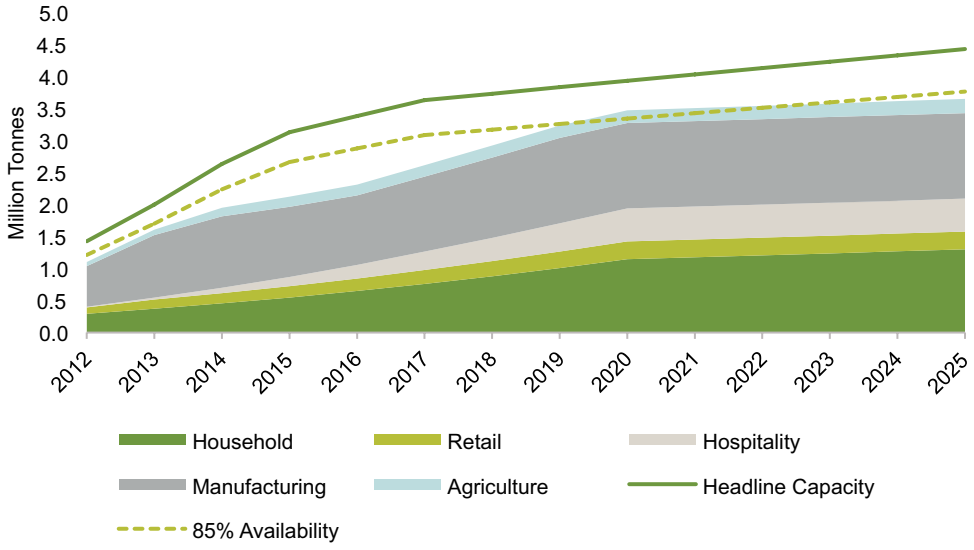



**Figure 9**: AD food waste supply vs. capacity balance **Source**: Tolvik

# Critical factors to project success

From analysis of the data and discussions with industry, GIB has identified the following macro factors to compete in the market and deliver an upper quartile operational and financial performance:

- **Operational reliability** – the consistent ability to source feedstock competitively, achieve high plant availability, maintain a culture of continuous maintenance and improvement, retain adequate storage capacity, and have appropriate contingency arrangements.
- **Competitive cost base** – both in terms of capital cost and operating costs, the key drivers include plant efficiency, appropriate digestate disposal arrangements, strong relationships with technology and EPC providers, and competitive energy sales arrangements.
- **Understanding feedstocks** – to competitively secure an optimal biology including biogas yields, retention times, reject rates, sustainability etc.

# Sector outlook and GIB activity

The degression of feed-in tariffs will continue to make the economic feasibility of AD projects more challenging. At the same time, the changes in the tax regulations for EIS, VCT and SEIS investors means that these investors are going to withdraw from making new AD investments. In the meanwhile, the improving operational performance of the sector and the possible opportunity for consolidation in the sector may help attract new investors to the market.

For equity investment in new AD facilities, GIB will continue to make any investments through its nominated waste fund managers, Foresight and Greensphere, who have made a combined total of five equity investments in the AD sector – two in Northern Ireland and three in Great Britain.

GIB is ready to lend project finance debt to projects which demonstrate the following criteria:

- Project sponsors with a track record of developing, constructing and operating AD facilities, including a proven ability to:
  - secure all necessary permits and consents;
  - secure strategic site locations and build strong relationships with key industry participants;
  - negotiate commercially advantageous feedstock, digestate management and offtake (PPAs, heat if applicable) arrangements;
  - deliver capital projects on time and budget (via a multi-contracting or EPC approach); and
  - deliver projects that achieve industry leading operating availability.
- Project or portfolio of projects:
  - expected to be cash-flow positive within 12 – 18 months on a run-rate basis;
  - meet GIB's sustainability criteria, including strict requirements around the proportion and sustainability of dedicated energy crops; and
  - with adequate pipeline of further investments.

# Further information

## Glossary

| Defined term | Meaning |
|---|---|
| AD | Anaerobic digestion |
| Biogas | Mixture of gases produced by anaerobic digestion |
| CHP | Combined heat and power |
| DECC | Department of Energy and Climate Change |
| DEFRA | Department of Environment, Food and Rural Affairs |
| Digestate | Nutrient rich material left following anaerobic digestion |
| Feedstock | Any renewable material that can be used directly as a fuel or converted into another form of fuel or energy |
| FIT | Feed In Tariff |
| GIB | UK Green Investment Bank |
| kWh | Kilowatt hour |
| Mt | Million tonnes |
| MW | Megawatt 1 MW = 1000 kW |
| MWe | Megawatt of electrical power |
| PPA | Power purchase agreement: A contract between an electricity generator and a power purchaser |
| Residual waste | Waste which is left after recycling, composting etc |
| RHI | Renewable Heat Incentive |
| ROC | Renewable Obligation Certificate |
| Waste water | Effluent which it is the legal obligation of the regulated water industry to process |

## Understanding AD

AD is not a new technology, and has been widely applied in the UK for the treatment of sewage sludge for over 100 years. However, only recently has it been used in the UK for treating other waste and purpose-grown crops in order to generate renewable energy and divert waste from landfill.

AD is a natural process in which micro-organisms break down organic matter or biowaste (such as food waste, slurry, crop residues, etc.), in the absence of oxygen, into biogas (a mixture of carbon dioxide and methane) and digestate/biofertiliser. AD is used for industrial or domestic purposes to manage waste and/or to release energy. The biogas can be used in a number of ways: directly in engines for combined heat and power (CHP); burned to produce heat; or can be cleaned to become bio-methane and used in the same manner as natural gas, including as a vehicle fuel. The digestate/biofertiliser, which is made from the left over indigestible material and dead micro-organisms, contains valuable plant nutrients such as nitrogen and potassium, and can be used as a renewable fertiliser or soil conditioner.

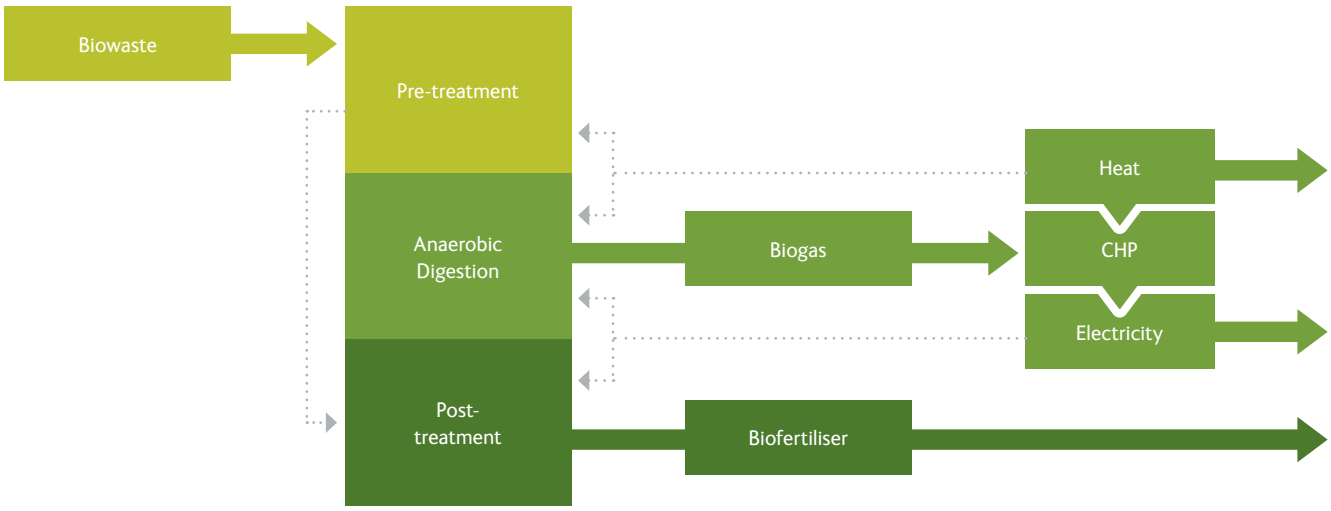



**Figure 10**: Anaerobic digestion process **Source:** DEFRA and DECC

# Contacts

### GIB team

For further information on GIB's activities in the AD sector please contact one of the following:

Chris Holmes, Managing Director
chris.holmes@greeninvestmentbank.com
0330 123 3041

Amit Rama, Director
amit.rama@greeninvestmentbank.com
0330 123 3043

Dominic Noel-Johnson, Vice President
dominic.noel-johnson@greeninvestmentbank.com
0330 123 3028

Brendan Carolan, Senior Associate
brendan.carolan@greeninvestmentbank.com
0330 123 3046

### GIB's nominated fund managers

www.foresightgroup.eu
www.greenspherecapital.com

# References


[i] www.biogas-info.co.uk

[ii] Data refers to the number of AD facilities that claimed ROCs in August 2014. It does not include accredited facilities that were not recorded in the Ofgem dataset in August 2014 nor three ROC accredited facilities (two sugar production facilities and a paper mill) which and account for 128 MWe of installed capacity.

[iii] https://www.gov.uk/government/statistics/monthly-small-scale-renewable-deployment

[iv] https://www.gov.uk/government/statistics/rhi-and-rhpp-deployment-data-november-2014

[v] http://www.mrw.co.uk/news/ad-schemes-on-target-to-deal-with-growth-in-feedstock/8661469.article

[vi] DECC – Review of the generation costs and deployment potential of renewable electricity technologies in the UK Study Report, October 2011

[vii] http://www.variablepitch.co.uk/

[viii] http://www.wrap.org.uk/content/hospitality-and-food-service-agreement-progress-note

[ix] http://www.wrap.org.uk/content/what-is-courtauld

[x] http://www.brc.org.uk/brc_news_detail.asp?id=2751

[xi] NNFCC: Anaerobic Digestion Deployment in the United Kingdom – Update – October 2014

[xii] http://www.wrap.org.uk/content/wrap-gate-fees-report-2014-0

[xiii] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384202/Biomethane_Tariff_Review_-_Government_Response_-_December_2014.pdf

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**Headquarters**
Atria One, Level 7
144 Morrison Street
Edinburgh EH3 8EX

Tel: +44 (0)330 123 2167

**London office**
21-24 Millbank Tower
Millbank
London SW1P 4QP

Tel: +44 (0)330 123 3021

**Find out more**
Email: enquiries@greeninvestmentbank.com
LinkedIn: Green Investment Bank

**greeninvestmentbank.com**

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