Acorn Bioenergy Ltd: Construction and operation of an anaerobic digestion facility, associated infrastructure and new access road, connecting pipeline and covered digestate lagoons at Land to the north of Spring Grove Farm, Withersfield, Northwest of Haverhill, CB9 7SW

Review of Carbon Lifecycle Assessment and Development Embodied Carbon Assessment.

January 2025

Prepared by Henry Haworth – Brown & Co

Overview

This report assesses the carbon intensity information and supporting evidence of application SCC/0045/23SE *Construction and operation of an anaerobic digestion facility, associated infrastructure and new access road, connecting pipeline and covered digestate lagoons at Land to the north of Spring Grove Farm, Withersfield, Northwest of Haverhill, CB9 7SW.* This report has been divided into two sections, the assessment of the operational carbon emissions and the embedded emissions associated with the development. An assessment of the overall carbon impact of the project is made based on the combination of these two figures. No specific methodologies or standards for reporting the carbon impact of this project have been proposed by Suffolk County Council, nor have we found any specific methodologies or standards recommended within their planning policy, therefore the carbon assessments made have been assessed against appropriate industry standards used within the UK.

The proposed overall emissions contribution of the proposed development is -30,885tCO2eq per annum, this is divided into two distinct carbon saving figures, 23,883 tonnes per annum for offsetting natural gas in the grid, 7,002 tonnes from the production of the biomethane. The proposed savings from the production of biomethane are achieved using carbon capture technology utilised as part of the biomethane upgrading process.

Through this assessment we have found that the scope and methodologies proposed to be suitable. From our in-depth assessment of the calculators themselves we have proposed one change to the figure presented to account for the lack of digestate in Year 1. This would result in a change from 7,016tCO2eq to 7,839tCO2eq for emissions associated with the operational emissions of producing biomethane in Year 1 of the project.

The proposal also considers embedded Cradle to Grave (excluding operation) emissions of 7,290tonnes of carbon over the lifetime of the project, our assessment of this had no recommendations and found this to be suitable and accurate. Even with the changes proposed to the operational emissions the embedded emissions would be offset in less than 6 months of the operation of the project.

The project will clearly result in a significant reduction in carbon emissions over the course of its lifetime something that is vital for both national and international climate goals. This reduction in emissions will also align with more local targets such as Suffolk County Council's commitment to achieving "Net-Zero Suffolk" by 2030 as stated within Suffolk County Council's Corporate Environment Policy.

Carbon capture technologies such as those included as part of this project are vital to allow the UK to meet this target by creating negative carbon emissions offsetting those industries that are unable to fully decarbonise such as aviation, shipping and agriculture.

Brown & Co – Energy

Formed in 1993 Brown & Co is a leading provider of agency, professional and consultancy services across rural, commercial, residential, energy and planning. With over 300 staff across offices throughout East Anglia, the Midlands and the Yorkshire and Humber region as well as overseas, we combine a high level of specialist technical expertise with experience and local knowledge.

Based in our Lincoln Office the Brown & Co Energy team has extensive experience in delivering renewable energy projects unpinned by a strong commitment to sustainable development. Our team has over 10 years' experience in conducting carbon lifecycle assessments, ensuring that projects contribute positively to reducing carbon emissions. Our current work includes providing support on carbon lifecycle calculations to over 30 operational Anaerobic Digestion (AD) sites.

Brown & Co also work with new AD, solar and wind, guiding projects from initial feasibility studies through to planning, regulatory advice and full project management services.

This report has been prepared by Henry Haworth, Energy Manager within the Lincoln Office.

Henry Haworth BSc (Hons) MSC
Senior Associate, Agri-Business Consultancy
[redacted]

BIOGRAPHY

After graduating in 2014 Henry began working in renewable energy and planning. At the time a newly developing industry Henry's focus was on the development of new Wind Turbines and Anaerobic Digestion sites for agricultural clients.

Over the last 10 years he has developed specialist work within the AD industry providing feasibility studies for new projects, application to grant funding, specialist advice for subsidy schemes, completing planning applications and assessing the cost and sustainability of feedstocks through lifecycle carbon assessments.

Henry has ongoing contact with many operational sites providing specialist consultancy to maintain and improve existing assets and advisory service to the development of new projects on site.

Henry currently sits REA Green Gas Steering Gas Steering Group.

QUALIFICATIONS

Geography BSc (Hons)
Rural Estate and Land Management MSc
BASIS Greenhouse Gases, Carbon and Climate Change Mitigation

Henry Haworth BSc (Hons) MSC
Senior Associate, Agri-Business Consultancy
[redacted]

PLANNING

Completion of full planning, permitted development and retrospective applications for a range of AD projects. Successful in in achieving planning for varying scales of project including work organising public consultation meetings and attending committee meetings to speaking on behalf of applications.

FEASIBILITY

Studies including full financial appraisals, feedstock sourcing, tendering for technology, full grid connection application and initial planning assessment. Using in depth knowledge of operational capacity from working with operation sites for over 9 years to understand site risks and finances of AD businesses.

Introduction

This report has been prepared following instruction from Acorn Bioenergy Limited on 19th December 2024. The report provides a high-level overview of the Greenhouse Gas (GHG) Methodology, supporting evidence and final carbon savings provided in support of application SCC/0045/23SE *Construction and operation of an anaerobic digestion facility, associated infrastructure and new access road, connecting pipeline and covered digestate lagoons at Land to the north of Spring Grove Farm, Withersfield, Northwest of Haverhill, CB9 7SW.*

The proposed development will be referred to as "The Development " or "Spring Grove AD" throughout this report.

The following documentation has been reviewed.

1. Spring Grove Carbon Calculation - 2025.01.06 - v8
2. Spring Grove - Carbon calculator - 2025.01.06 - v8
3. Spring Grove - Embodied Carbon - 2025.01.06 - v8
4. Planning Statementv1
5. Transport Statementv1 (1)
6. Spring Grove - Transport Movement (10.12.2024)

Documents 4 - 5 above have been supplied to Suffolk County Council as part of the original planning documentation. Acorn Bioenergy have informed us at the time of writing this report, that documents 1 – 3 have not yet been supplied directly to the council. Document 1 will be supplied as part of an additional response following a Regulation 25 request from Suffolk County Council. Documents 2, 3 & 6 provide background supporting evidence that has been utilised within the creation of the submitted documents but will not be submitted as part of the application due to containing company sensitive information.

All carbon emissions figures within this report are presented in tonnes of Carbon Dioxide equivalent (tCO2eq), this is the globally recognised figure to represent carbon emissions in, this can also be represented as carbon, tonnes of carbon or tonnes of CO_2.

This report is presented initially in two distinct sections each providing discussion, assessment and commentary on the carbon calculations presented by Acorn Bioenergy for the Spring Grove AD project. These sections comprise of 1. Operational Carbon Emissions and 2. Embedded Carbon Emissions of the Development & Construction. These will be combined in an overall assessment of the carbon impact presented within the conclusion of this report.

No information on embedded carbon emissions was submitted as part of the original planning documentation.

1. Operational Carbon Emissions

Spring Grove AD – Proposed Operational Carbon Savings

The applicant has made several proposals for the level of operational carbon emissions, the below table provides an assessment of these. These are all presented as reductions in carbon emissions as they are presented within the documentation assessed for this report.

Annual Carbon Reduction (tCO_2eq)	Document	Date
13,500	Planning Statementv1	April 2023
31,320	Planning Statementv1	April 2023
30,885	Spring Grove Carbon Calculation - 2025.01.06 - v8	December 2024

The figure of 13,500 tCO2eq represents only the carbon captured by the project. It does not account for the reduction in carbon-intensive methane emissions avoided by using a low-carbon production method like Anaerobic Digestion.

The figure of 31,320tCO2eq presented in the original planning statement was based on the information available at the time this document was created, this figure has been updated in the latest assessment as a result of more detailed information available on the project due to more updated site information and utilisation of more up to date emissions factors. It must be considered that emissions factors are updated consistently due to the development of global science and testing. This is usually dictated by information presented by the International Panel on Climate Change (IPCC) and is reflected in national standards presented by DESNZ.

The value of 30,885tCO2eq presented in the December 2024 document aligns with the results of the Carbon Calculator assessed by Brown & Co as part of this report.

The updated figure of 30,885tCO2eq presented in the latest document "Spring Grove Carbon Calculation - 2025.01.06 - v8" is the result of the utilisation of more up to date emissions factors available and up to date yield information of the feedstocks in 2024 when compared with those available in 2022, at the time the original planning documentation was prepared. There is further discussion of these updated values later in this report.

The carbon savings figure itself is made up of a combination of offsetting natural gas within the gas grid (23,883 tonnes) through the injection of low carbon renewable gas created on site and carbon savings associated with the biomethane production process (7,002 tonnes). The savings within the biomethane production process are a result of the carbon capture technology that will be installed at The Development.

<u>Carbon Reporting Methodology</u>

The Development will be accredited under the Non-Domestic Renewable Heat Incentive (NDRHI), having already received approval for this scheme through Acorn Bioenergy Limited. The NDRHI scheme has a required Greenhouse Gas criteria, as dictated within The Renewable Heat Incentive Scheme Regulations 2018 Schedule 3. The Development will be utilising the "Actual Value" method of calculating GHG emissions, this is the most suitable method of calculating emissions for a biomethane site due to the added complexity of the chain of custody when compared with other biomass fuelled stations, it is also a requirement of the NDRHI that all biomethane sites utilise the

"Actual Value" of reporting. The NDRHI legislation sets the standard for reporting to be in line with Part C of the Renewable Energy Directive I (RED I)[1]

In brief this focusses the reporting on the following areas:

E= total emissions from the use of the fuel;

eec= emissions from the extraction or cultivation of raw materials;

e_l= annualised emissions from carbon stock changes caused by land-use change;

e_p= emissions from processing;

e_{td}= emissions from transport and distribution;

e_u= emissions from the fuel in use;

e_{sca}= emission saving from soil carbon accumulation via improved agricultural management;

e_{ccs}= emission saving from carbon capture and geological storage;

e_{ccr}= emission saving from carbon capture and replacement; and

e_{ee}= emission saving from excess electricity from cogeneration.

For biomethane this can largely be defined in line with the below bullet points.

Emissions included in scope of RED I

- Synthetic Fertiliser production
- Fertiliser & slurry use (soil emissions)
- Seed production
- Pesticide production
- Fuel use on farm
- Fuel use for feedstock & gas transport
- Fuel use for AD site processes (ensiling, feedstock processing, feeding etc)
- Carbon stock changes in growing land
- Boiler/CHP use for AD site electricity/heat demand
- Imported electricity/heat for AD site demands
- Carbon Capture (CO_2)

Emissions excluded in scope of RED I

- Manufacture of machinery & equipment
- Production of residues (Straw)
- Production of waste (Poultry Litter, Farm Yard Manure)
- Gas transmission
- End use of biomethane
- End use of captured CO_2

Figure 1 Scope of RED I GHG reporting

[1] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance) (legislation.gov.uk)

The RED I methodology has been the industry standard for reporting carbon emissions for biomethane anaerobic digestion in the UK with 173 producers registered under the scheme (Ofgem, 2024[2]).

The replacement scheme to the NDRHI, the Green Gas Support Scheme (GGSS), came into effect on 30th November 2021. This builds upon the NDRHI and part of this is the updating of the GHG requirements. Under the GGSS the methodology of Annex V REDII is required. However, with only a single approved site (Ofgem, 2024[3]) the use of this methodology is still very much in development and therefore, not deemed suitable for calculating an appropriate value in line with existing UK biomethane sites. It must also be considered that The Development is not an applicant to the GGSS scheme and therefore for the purposes of carbon calculation methodology the RED I is suitable and appropriate.

The calculation of emissions through the offsetting of Natural Gas is defined as "avoided", "offset" or Scope 4 emissions and Acorn Bioenergy have utilised the framework defined in the World Resources Institute's (WRI) *Estimating and Reporting the Comparative Emissions Impacts of Products (2019)*[4] to establish their calculations. This is a less used method of emissions calculations due to the lack of applicability across a significant amount of industry, however we would consider the WRI and GHG Protocol (who also reference this framework) to be well recognised trustworthy sources to produce a framework of this kind. We would also consider this offsetting of Natural Gas in the UK Gas Grid with low-carbon gas a suitable area to apply this approach.

The calculation of embedded emissions is commonplace within developments and aligns with the BS EN 15978:2011 standard which is considered to be one of the recognised industry standards in reporting emissions of this kind. The detail of the scope of this standard and methodology used is outlined clearly within the document *Spring Grove Carbon Calculation - 2025.01.06 - v8*as presented by Acorn Bioenergy and reviewed as part of this report.

Offsetting Natural Gas

These emissions savings would fall under the category of "avoided emissions" also defined as Scope 4 emissions. This is defined by the GHG protocol as "reductions that happen outside of a product's lifecycle or value chain resulting from that product"[5].

The World Resources Institute (WRI)[6] have published a framework for the calculation of these "avoided emissions" which has been adopted by the GHG Protocol and published on their website.

Within this the key principles are, that in the first instance, where a company wishes to utilise a calculation for "avoided emissions" they must first account for their Scope 1, 2 and 3 emissions, something that Acorn Bioenergy Ltd have completed in detail within the rest of the documentation that is assessed as part of this report.

[2] Non-Domestic Renewable Heat Incentive (NDRHI) Quarterly Report - April to June 2024 | Ofgem
[3] Green Gas Support Scheme (GGSS): Quarterly Report - Issue 11 (ofgem.gov.uk)
[4] 18_WP_Comparative-Emissions_final.pdf
[5] Avoided emissions survey report_final draft.pdf
[6] 18_WP_Comparative-Emissions_final.pdf

The WRI framework itself is detailed and aimed more directly at company inventory reporting however it is the most up to date and widely recognised framework for this type of reporting and the principles of this can the applied to the assessment of the impacts of the proposed Development. In this case the methodology presented by Acorn Bioenergy Limited follows the relevant aspects of the framework utilising the Attributional method as laid out within the WRI document.

This approach generates inventories of emissions and removals that are attributed to a given entity such as a product, in this case the Reference Product being Natural Gas within the UK Gas Grid compared with Assessed Product being the biomethane created by The Development.

The scope of the assessment has been selected as the reasonable project lifetime of 25 years. This is considered suitable and consistent with the rest of the information presented as part of this planning application.

The completion of this assessment ultimately provides a difference in the emissions produced by the reference product (Natural Gas) when compared with assessed product (Biomethane), the difference between these being the "avoided emissions" or emissions offset by this project.

The Development is proposed to save 23,883 tonnes of carbon through the offsetting of natural gas contained within the grid. This has been calculated by applying an emissions figure for Natural Gas of 212.21gCO_2eq/kWh natural gas. This has been calculated as a combination of the Scope 1 and Scope 3 emissions associated with the production of Natural Gas contained within the UK Grid. These figures have been sourced from the emissions factors presented by DESNZ (GHG Conversion factors 2024)[7]. The Scope 3 emissions value has been adjusted, as highlighted within Acorn's report, this is due to the fact that the Scope 3 emissions accounts for emissions from transportation through the UK gas grid, which the biomethane produced at The Development will still be subject to. Due to the lack of granular emissions factors presented by DESNZ in this case Acorn have adjusted the DESNZ figure utilising an emissions factor published by the European Commission. This has been well considered and the most suitable emissions factor applied based on currently available evidence. Carbon reporting is a rapidly developing area of work and therefore it is not always possible to utilise emissions factors from only a single source. In this case it may be considered that a value produced based on the European grid transmission losses may not be appropriate for this project and a more conservative approach could be taken without the consideration of the Scope 3 emissions. As part of this report we completed this more conservative assessment and this still resulted in a saving of over 680,000tCO2eq over the lifetime of the project.

In this case however we believe that the figures presented are the best available and have been correctly applied, therefore the proposal of 23,883tonnes of carbon saved through offsetting Natural Gas in the grid is appropriate.

It was noted that the calculations presented proposed an injection capacity of 10,185,248Nm^3 compared to the figure of 9,773,133Nm^3 presented in the Planning Statement. This change was queried with Acorn who confirmed that this was because of more up to date methane yield information available on the proposed feedstocks as a result of the development of the project in the time since the original application was submitted allowing for more accurate feedstock sampling to be completed.

[7] Greenhouse gas reporting: conversion factors 2023 - GOV.UK (www.gov.uk)

A full review of this methodology finds that the basis for these calculations is strong and well considered at this stage in the project. Sufficient consideration has been given to the production capability of the site, technology losses, energy content of the feedstocks through feedstock testing and with the changes proposed in our calculation above we believe that all emissions and energy factors have been taken from appropriate sources. Our conclusion from this assessment is that this should be included as reduction in emissions associated with this project.

Production Emissions & Carbon Capture – Biomethane

An additional 7,002 tonnes of carbon is proposed as a saving from the biomethane production process itself. This is calculated through a carbon lifecycle assessment of the supply chain for each feedstock, in line with the RED I requirements. This calculation is contained within *Spring Grove - Carbon calculator – 2025.01.06* This assessment identifies all the potential carbon emissions of each feedstock's production process as well as emissions associated with onsite activities. Primarily this assessment identifies multiple sources of carbon emissions, therefore leading to an overall positive carbon emission. However, The Development will also include carbon capture technology which will allow for the significant recovery of carbon that otherwise would have been emitted to atmosphere.

AD Biomethane is a technology that provides a unique opportunity to capture carbon as part of the process of upgrading biogas into biomethane, a method of capturing carbon that is significantly more energy efficient than the alternative of direct air capture.

Below is an assessment of the composition of biogas before being upgraded into biomethane.

Compound	Chemical	Range %
Methane	CH_4	50 – 75
Carbon dioxide	CO_2	25 – 50
Nitrogen	N_2	0 – 10
Hydrogen	H_2	0.01 – 5
Oxygen	O_2	0.1 – 2
Water vapour	H_2O	0 – 10
Hydrogen sulphide	H_2S	10 – 30,000 ppm
Ammonia		0.01 – 2.5 mg/m^3

Figure 2 Composition of Biogas – ADBA Practical Guide to AD *The Practical Guide to AD | ADBA | Anaerobic Digestion & Bioresources Association (adbioresources.org)*

To create biomethane, the biogas is passed through a form of "upgrading" equipment to increase the methane content to greater than 95%, allowing for injection into the gas grid or use within transportation. The upgrading process separates the CO_2 from the methane utilising technologies such as pressure swing adsorption, membrane separation or chemical absorption. The separated

CO_2 is then available to be stored and loaded onto trailers for transportation for supply to other uses.

The calculator itself makes a thorough assessment of the available CO_2 based on the production capacity of the site at the proposed scale of The Development. A figure of 56.22% methane content is utilised, which aligns with expectations for a project of this type and there is the inclusion of suitable losses within the carbon capture process (upgraded biomethane contains 3% CO_2 that could not be removed, technology losses 7.5% of remaining CO_2).

Overall, the methodology used is thorough and allows for the capture of 14,018 tonnes of CO_2 per annum.

This accounts for all the CO_2 available for capture from the organic material fed into the digester. While this may seem a high figure, it must be considered that during the growing cycle of the feedstocks significant amounts of CO_2 are absorbed and captured through the growing cycle to then be released by the digestion process, alongside methane, to create biogas.

Once a consideration of the CO_2 inputs into the process have been made for processes such as fertiliser production and use, fuel use etc (see Figure 2) totalling 7,016tonnes CO_{2eq} in emissions, this gives a remaining carbon saving of 7,002 tonnes per annum.

The Development intends to provide the CO_2 to replace fossil fuel derived CO_2 within industry, therefore while this CO_2 will likely be released back into the atmosphere it will be offsetting CO_2 produced by carbon intensive fossil fuels and once supplied to a 3rd party should no longer be considered on The Developments carbon balance as the end use is outside of their control. This aligns with the RED I which highlights carbon capture and replacement as an area of emissions saving stating in Annex IV paragraph 15 *"Emission saving from carbon capture and replacement, e_{ccr}, shall be limited to emissions avoided through the capture of CO2 of which the carbon originates from biomass and which is used to replace fossil-derived CO2 used in commercial products and services."*

<u>Acorn Bioenergy Carbon Calculator Review</u>

The NDRHI: Sustainability Self-Reporting Guidance (version 2) 23rd November 2022 Paragraph 5.51 highlights an available tool supplied by Ofgem for the purpose of GHG calculations in line with the RED I requirement. This tool is the Solid and Gaseous Biomass Carbon Calculator (B2C2), which was commissioned by the Department of Energy and Climate Change (now the Department for Energy Security and Net Zero DESNZ). This calculator is the standard reporting tool for carbon life cycling under the NDRHI scheme, however the calculator has now not received an update since 2015 and contains some errors and default figures not in line with current carbon reporting requirements.

Paragraph 5.55 of the same guidance document states *"Alternatively, participants could create their own tool … the onus is on them to ensure – and be able to demonstrate to Ofgem - that it meets methodology as set out in the Regulations and that any in-built standard input data is appropriate"*. In this case Acorn Bioenergy have chosen to create their own tool. We have assessed the tool against the RED I methodology and our understanding of the scheme from our experience working with over 50 NDRHI applications for Anaerobic Digestion sites.

In completing this review, we assessed the following:

- Formulas used in calculation methodology

- Suitability of in-built data including referencing & Default figures used where actual operational data not yet available
- Suitability of actual data used
- Overall accuracy of the tool including risk of error

Formulas used in calculation methodology

In our comprehensive review of the carbon calculator, we found no errors within the formulas used. The calculator itself utilises a similar template to that of the B2C2, splitting the calculation into relevant sub-sections as defined by the RED I methodology (see Carbon Reporting Methodology).

Suitability of in-built data including referencing & Default figures used where actual operational data not yet available

The majority of in-built figures utilised within the calculator show a distinct update when compared with those utilised within the B2C2. Below I have highlighted some of the references used with a comment on their suitability, this is not an exhaustive list and only highlights the main reference materials used.

BioGrace II Carbon Calculator (2024) – Another Excel based tool approved by the European Commission, recognised by the International Sustainability & Carbon Certification and to RED II standard. Utilised for various carbon intensity figures, this tool is regularly updated in line with current Intergovernmental Panel on Climate Change IPCC reports and is currently the most well recognised tool for GHG reporting under RED II. The figures used were from the latest version of this calculator, updated in April 2024.

Source: UK Greenhouse Gas Inventory, 1990 to 2015. Annual report for submission under the Framework Convention on Climate Change. – While the version is historic the figures are not updated in every version. This is considered representative where used.

UK Government Department for Energy Security & Net Zero. Greenhouse gas reporting: conversion factors 2024. – Used for several emissions factors, this is the UK standard for calculating carbon emissions for businesses. This is the latest version of this document and is considered suitable for use within UK reporting and forms the standard for businesses calculating their carbon emissions within the UK.

The above list highlights only the main reference material used to highlight the suitability and detail used in the creation of this calculator. A review of all the reference material was undertaken by Brown & Co and it was found that the sources used were suitable in all instances. All sources of data are suitably up to date to be considered accurate and appropriate for current industry reporting.

Suitability of actual data used

At this stage the level of actual data is limited as The Development has not yet been able to finalise all contracts with suppliers. The data used within the calculator is consistent with the feedstock supply information contained within the Planning Statement (April 2023).

Overall accuracy of the tool including risk of error

From the assessment we have completed we believe that the calculator produced by Acorn Bioenergy is fit for purpose providing a calculator well suited to this development and one that aligns with the RED I methodology.

The main areas of risk have been identified as:

Potential for human error. Due to the calculator being created specifically for Acorn Bioenergy, it will be unique to this site and therefore is susceptible to user error. This risk can be lessened through suitable training for staff using the calculator and regular internal auditing of the tool to ensure no errors have been made. It has been noted that at this stage the tool has only been used internally by members of staff who have created the tool within Acorn Bioenergy as well as having had 3rd party reviews by industry experts including Synertree, E4Environment and NNFCC (who assisted with the creation of the B2C2 for DEFRA), all of whom have confirmed it's suitability. The calculator has also been assessed as part of this report and found to be in line with the requirements of the RED I.

Input data. As with any calculators of this nature the results are only as good as the input data. As we have completed a full review of all the input data we believe that this risk is currently low. Once operational, careful management procedures should be implemented to ensure data collected is accurate and additional checks and audits are completed on 3rd party suppliers to maintain this. It must be noted that there is likely to be some change to the carbon emissions figure once actual data is input, however data used up to this point is suitable for a project of this stage.

It should be noted that due to the inclusion of digestate as the primary source of Nitrogen fertiliser for the Silage, Grass and Maize crop that the calculator and carbon saving figures supplied will be appropriate only from Year 2 onwards as there will not be any digestate available within Year 1. The total annual emissions from production of the feedstocks has been stated as 7,016tCO2eq, however if it is considered that these crops would be grown utilising synthetic fertilisers in Year 1 (due to the lack of available digestate) then the Year 1 emissions would equate to 7,839tCO2eq, an increase of 823tCO2eq over the 25 year project lifetime.

Conclusions of Operational Carbon Emissions Assessment

The information presented by Acorn Bioenergy Ltd in relation to the operational carbon emissions of the Spring Grove AD aligns with the RED I methodology which is suitable, not only as this is the requirement of the site for the scheme which it has accreditation but also as this has become the industry standard for biomethane in the UK due to the development of 173 sites under the NDRHI.

The calculator used appears to have no errors and has had due diligence completed by several well-established experts within this industry. Our review concluded that the calculator used is appropriate and accurate.

Through this assessment of operational emissions we have identified one area where these calculations could benefit from a small change to provide increased accuracy to the final figures. A consideration that digestate will not be available in the first year of production due to the lack of available digestate from the site, therefore that synthetic fertilisers should be considered to provide the required nutrients from crop growth in Year 1. The impact of these changes are presented in the table below.

	Acorn Calculator (tCO2eq)		Brown & Co Conservative Assessment (tCO2eq)		Difference (tCO2eq)
Savings					
Annual Carbon Emissions from Offsetting of Natural Gas	- 23,883		- 23,883		-
Annual Carbon Capture	- 14,018		- 14,018		-
Emissions					
Year 1: Carbon Emissions from Biomethane Production	7,016		7,839		- 823
Years 2 - 25: Carbon Emissions from Biomethane Production	7,016		7,016		-
Annual Totals					
Year 1 Carbon Emissions	- 30,885		- 30,062		- 823
Years 2 - 25 Carbon Emissions	- 30,885		- 30,885		-
Project Lifetime Totals					
Carbon Emissions	- 772,125		- 771,302		- 823

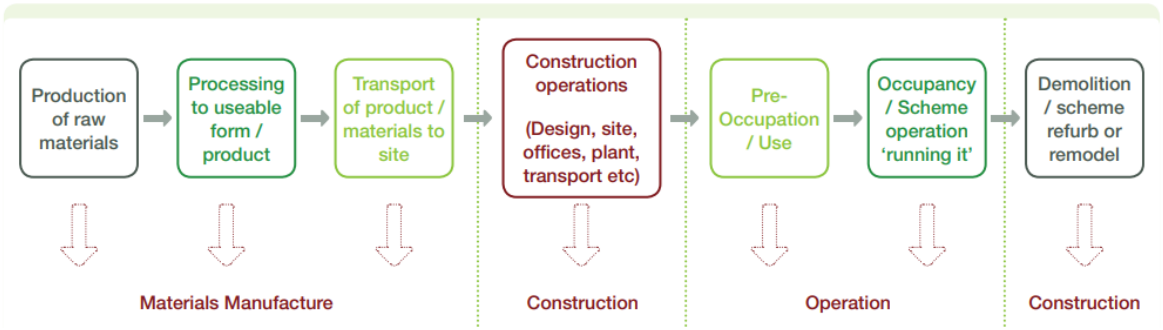
This reassessment shows an increase of 825tCO2eq over the lifetime of the project, this equates to an increase of approximately 0.11% in emissions when compared to the figures presented by Acorn Bioenergy.

2. Embedded Carbon Emissions of the Development & Construction

Scope of Reporting

A figure for the Embedded Carbon Emissions was not presented as part of the original planning application due to the lack of a requirement within Suffolk County Council's planning policy requiring this to be assessed. The Council have not provided any specific standard for which to make this assessment therefore in this case Acorn Bioenergy Ltd have utilised the BS EN 15978:2011 standard. This is a well-used and appropriate European Standard developed in 2011 and is recognised by the British Standards Institution, it has also been adopted by the Royal Institute of Chartered Surveyors (RICs). Although published 13 years ago it must be considered that the lifecycle of a building project will not have changed significantly since this time. As highlighted by Acorn Bioenergy within their assessment this is a widely used standard for reporting embedded emissions in built structures in the UK.

An alternative to the BS EN 15978: 2011 could be the GHG Protocol, the world's most widely used standard for GHG reporting. The scope of this standard aligns with the BS EN 15978: 2011 however provides less detailed breakdown of scope of reporting (as presented in Spring Grove Carbon Calculation - 2025.01.06 - v8), see below.



The assessment presented by Acorn has correctly excluded the "Use Stage" from the assessment as this is already covered by the assessment completed under the RED I assessment as already discussed within this report.

Stage D of the BS EN 15978: 2011 has been excluded from the assessment, this aligns with the principle of Cradle to Grave which the European Environment Agency define as "from the time natural resources are extracted from the ground and processed through each subsequent stage of manufacturing, transportation, product use, and ultimately, disposal". [8]

Emissions Assessment: Cradle to Gate

The first stage of assessment has been undertaken utilising actual figures relevant to the project, the materials list within Figure 3 of the report produced by Acorn Bioenergy is thorough and includes all items expected to be included in a project of this kind. We are unable to provide analysis on the quantity of each material stated as this falls outside our area of expertise, third party evidence or comparison with another project of a similar scale would be an appropriate way to verify this. As this project is not yet built the contingency of 20% for additional emissions to account for any material changes and onsite vehicles during the construction stage is considered more than appropriate, a suitable comparison has been used to justify this further. The planned development should not deviate far from the current design due to the stipulations of the planning permission (if granted) and advanced stage that the project is currently at in terms of design. It must also be considered that vehicle movements will contribute a very small amount to the overall emissions in this project.

The assessment of the embedded carbon presented in Figure 3 utilises the UK Government GHG Conversion Factors for Company Reporting 2024, this database is designed for use for the Streamlined Energy and Carbon (SECR) regulations. The databased states "the scope of the factors

[8] cradle to grave — European Environment Agency (europa.eu)

is defined such that it is relevant to Streamlined Energy and Carbon Reporting (SECR) regulations. The factors may also be used for other purposes, but users do this at their own risk.".

In this circumstance although the calculation is not for the SECR this database is the most readily available for providing a wide range of up-to-date emissions factors that has been recognised by the UK government. Other databases are available through various international organisations however it is considered that the database utilised is suitable for purpose and is used through the report for consistency as well as having been used for some factors within the RED I calculator produced by Acorn Bioenergy.

A review of data within Figure 3 of Acorn's assessment finds that the factors used are appropriate for the materials stated and where needed appropriate conversion factors have been used to ensure the correct unit of measurement has been used. These sources have been provided and reviewed.

The figure of 6,917tonnes of CO_{2eq} appears appropriate based on the data presented and the sources used to validate it. This is expected to be the primary source of emissions associated with the construction and decommissioning of the project due to the emissions associated with the production of raw materials, the figure calculated reflects this. It must be noted that Acorn have opted to utilise the 'Primary material production' factor, this ensures that they are accounting for the full production lifecycle of the products used.

Emissions Assessment: End of Life

As identified by the assessment and quoted BSRIA source stated there is no single recognised methodology for the end of life of a development. The difficulty of assessing this stage is increased in relation to this project as Anaerobic Digestion is a relatively new technology therefore there will be limited instances of decommissioning of this type of development.

Emissions Assessment: Deconstruction/demolition

Due to the lack of available specific data on this stage of the process, the assessment has utilised *Carbon Emission Reduction Evaluation of End-of-Life Buildings Based on Multiple Recycling Strategies*[9] Journal of Cleaner Production. A review of available resource on this found very little clear and useable figures were available outside of that proposed within the report. It must also be considered that emissions associated with the demolition are largely associated with the energy used in demolition equipment, which is likely to be minimal. In this instance Acorn have utilised actual data on the site area and utilised the figures stated within the available literature stated above to provide a figure of 255tCO2eq. This is deemed an appropriate method and relies on best available actual site data in line with the current proposed development.

Emissions Assessment: Transport

Emissions factors figures have been used from the DESNZ published figures within '2024 Government Gas Conversion Factors for company reporting'. These are the best available and

[9] (PDF) Carbon Emission Reduction Evaluation of End-of-Life Buildings Based on Multiple Recycling Strategies (researchgate.net)

most appropriate figures to be used for this calculation. This has been combined with the best available data for construction material based on the proposed building materials. This has produced a figure of 117.97tCO2eq which we believe to be appropriate for a site of this type.

Emissions Assessment: Disposal

Acorn has set out a clear intent to recycle the materials used, the justification set out is sound and appropriate. As is stated within the assessment the recycling of materials allows for the ability to reduce emissions. In this instance the assessment has not considered this reduction but instead opted to utilise a figure of 0tCO2eq, we therefore consider this to be a very conservative estimate of emissions at this stage.

Conclusion of Embedded Carbon Emissions of the Development & Construction

Overall, the assessment of the embedded emissions has selected a robust scope of carbon emission calculation for those emissions outside of the scope of the operation of the site (RED I methodology). The use of BS EN 15978: 2011 is considered appropriate for the assessment of 'Cradle to Grave' carbon emissions of the development.

All calculations are presented clearly and evidenced by suitable and up to date sources. The final figure of 7,290 tonnes CO2eq is considered appropriate based on the approach that we have assessed as part of this report.

The End-of-Life emissions are considered to be the weakest part of the calculation, however this is due to the lack of suitable standards or datasets available that currently support this aspect of the project lifetime. It must be considered that this is likely to amount to a small contribution to the overall project, as highlighted by the Department for Business Innovation and Skills 2010 report.

Conclusions

From the analysis completed of the information supplied by Acorn Bioenergy Limited we are happy with the scope, methodology and findings presented within their assessment of the carbon impacts of this project.

We have highlighted the consideration that digestate would not be available within the first year of operation and therefore an additional 823 tonnes of carbon emissions should be accounted for to allow for the use of synthetic fertilisers within the production of feedstocks in Year 1 of operation.

Below is presented an updated assessment of Acorn's emissions figures and the figures calculated with the proposed changes in this report. This also includes the embedded emissions calculated by Acorn Bioenergy Ltd and found to be appropriate through the assessment completed in this report.

	Acorn Calculator (tCO2eq)		Brown & Co Assessment (tCO2eq)		Difference (tCO2eq)
Savings					
Annual Carbon Emissions from Offsetting of Natural Gas	- 23,883		- 23,883		-
Annual Carbon Capture	- 14,018		- 14,018		-
Emissions					
Year 1: Carbon Emissions from Biomethane Production	7,016		7,839		- 823
Years 2 - 25: Carbon Emissions from Biomethane Production	7,016		7,016		-
Annual Totals					
Year 1 Carbon Emissions	- 30,885		- 30,062		- 823
Years 2 - 25 Carbon Emissions	- 30,885		- 30,885		-
Project Lifetime Totals					
Carbon Emissions	- 772,125		- 771,302		- 823
Development & Construction - Cradle to Grave					
Embedded emissions (over 25 years)	7,290		7,290		-
Project Lifetime Totals - including embedded emissions	- 764,835		- 764,012		- 823

The difference of 823tCO2eq between the calculation completed by Acorn Bioenergy and the assessment completed within this report is considered negligible when considering the significant carbon saving the project will provide over its proposed 25-year lifetime.

The figures presented by Acorn Bioenergy are suitable and backed by strong and well justified evidence. The project will clearly result in a significant reduction in carbon emissions over the course of its lifetime something that is vital for both national and international climate goals. This reduction in emissions will also align with more local targets such as Suffolk County Council's commitment to achieving "Net-Zero Suffolk" by 2030 as stated within Suffolk County Council's Corporate Environment Policy [10].

The biomethane carbon capture process that will be implemented by this project is a vital technology in the UK's progression to legally binding Net Zero 2050 target. Carbon capture technologies are vital to allow the UK to meet this target by creating negative carbon emissions offsetting those industries that are unable to fully decarbonise such as aviation, shipping and agriculture.

[10] environment-policy.doc