07/02/2021

Member briefing on ongoing discussions with Government around capture and supply of bio-CO_2 from green gas plants

Background

In October 2021, in the wake of ongoing carbon dioxide (CO_2) supply issues in the UK, BEIS reached out to the REA seeking evidence on what the government could do to support the capture of CO_2 at green gas plants in the medium term, as this sector could potentially help boost resilience and security of CO_2 supplies in the UK.

We therefore put a call for evidence out to our members seeking views on the key barriers to deploying carbon capture on biomethane plants and any impactful actions that Government could take to address them. Following the call, we received valuable and extensive feedback, which we then collated into a document and submitted it to BEIS. Excerpts from that document are copied in the Annex to this update – any commercially sensitive information has been removed.

The document sets out the key potential of the biomethane sector to boost supplies of CO_2 and also highlights the key financial and market related barriers that need to be addressed. Finally, the paper also sets out our members' views on what actions the Government may take to address these barriers.

In a nutshell, the two actions from Government that would have the greatest impact, identified by members that could help roll out of CO_2 capture at green gas plants in the short to medium term were:

1) address the market perception around waste derived CO_2, and
2) provide financial support to help the business case for retrofitting or building CO_2 capture plants at biomethane plants.

The paper has been already used by different Government departments across BEIS and Defra to inform their current ongoing discussions on CO_2 shortages, diversification, and long-term supply of CO_2 to the relevant sectors.

Ongoing discussions

A cross-departmental group was formed within Defra looking at:

- the diversification and long-term supply of CO_2 for Defra sectors,
- the regulatory framework and policies for food grade CO_2 derived from waste and AD, and
- the technical requirements & chemical specification.

The REA Policy Team (Kiara Zennaro and Jenny Grant) actively joined a discussion with this group and the environmental regulator on **13th January 2022,** especially focused on bio-CO_2 from waste AD plants. The highlights from the discussion are as follows: there is

a consensus that waste derived CO_2 can be a long-term solution to help boost supplies and that there isn't an issue around its quality in a technical sense: waste derived CO_2 can meet the technical specifications. The issues are around public perception and understanding how to overcome this barrier. Defra agreed that it is important to open a dialogue with the food and drink sector and other non-food related sectors and understand what these sectors need to overcome the current perception issues. They also mentioned the possibility to focus on promoting waste-derived CO_2 as '*Sustainable*' (e.g. produced in line with circular economy principles etc.) as this could help improve these markets' acceptance of this by-product. They are keen to understand what needs to happen to enable supply of CO_2 from AD and ultimately are seeking to advise ministers.

Preliminary conversations with the Food and Beverages sector, however, would suggest that, provided there is a stringent regulation in place, this market would be likely to accept waste-derived CO_2 from AD plants. Going forward their concerns would be around scale and the security of supply. The financial barriers were also discussed, in particular the significant capital costs associated with the addition of the necessary technology for carbon capture at AD plants as well as the long-term operational running costs.

In addition to the above, on **28th January 2022** BEIS hosted a session for the Food & Drink sector focused on the opportunities for carbon capture under the newly launched phase 2 of the Industrial Energy Transformation Fund. Read here the presentation from BEIS on the eligibility of carbon capture under the IETF.

Representatives from BEIS, Defra, the EA, the AD trade associations (REA and ADBA), the Food & Drink sector (Food & Drink Federation) and the Treasury were present, along with other stakeholders. AD representatives including the REA were specifically invited along by BEIS to contribute/inform the discussion. At the meeting Tim Charters (BEIS) gave an overview of the biomethane sector in the UK and its potential to capture and supply bio-CO_2 of the right specification to the Food & Beverages market – read here the presentation from Tim Charters (BEIS). The REA re-iterated the potential of the sector, along with some of the financial barriers to capture CO_2. We also highlighted there is a gap in financial support available for deploying carbon capture on AD plants. The IETF provide capital grant to the deploying of CO_2 capture on AD plant only if the plant is installed on an industrial site (e.g. a food or drink manufacturing site). We highlighted that there are at least 70 biomethane plants currently operational in the UK that could retrofit the kit in a practical way. This could yield around 500,000 – 600,000 tonnes per annum of biogenic CO_2, boosting up our domestic supplies and protecting the sector from future shortages.

Roger Clarke from Defra expressed Defra's full support for the supply and use of bio-CO_2 in the Food & Drink sector, and our understanding is that Defra's expectation is that it meets the official specification issued by the Food Standards Agency (food grade specification).

Finally, Howard Leberman (EA) provided clarity on the regulatory framework for the supply and use of waste derived bio-CO_2 as well as the permitting requirements for installing and operating CO_2 capture technology on site. He highlighted the three key

routes available to ensure waste derived CO_2 meet End of Waste: self-assessment, End of Waste service and the Resource Framework (i.e. Quality Protocols). Howard clarified there is already a Quality Protocol for biomethane and that it wouldn't be too difficult to review its scope to include bio-CO_2, but this would be subject to funding availability (QP reviews must be funded by industry). A call for evidence would need to be issued and supported to inform a review. He also highlighted that the EA are fully supportive of the use of waste derived CO_2 from AD plants in the Food & Drink sector. Regarding permitting, if CO_2 capture kit is installed on a plant that has already an environmental permit, a variation to the permit would be required.

Concerns around scale and security of supply from the biomethane sector were raised by the Food & Drink sector at the meeting. A representative of this sector, in particular, said that they were concerned that the volumes of CO_2 produced at biomethane sites would be insufficient and they also highlighted constraints associated with limited space availability for CO_2 capture equipment and storage at most sites. To inform future discussions it would be good to understand how we can reassure these stakeholders on these specific issues.

Following the discussion on 28th, BEIS has been in touch to highlight that different teams at BEIS "are working closely together to bring together some of this information and ensure it gets heard across the department. Whilst the scope of the IETF is unlikely to be revised in the short-term, I really welcome any further feedback you have for us. If we can support any of your members with their applications, please let me know."

Next steps

BEIS are now looking at whether a further session with the major CO2 marketing companies would also be helpful. This would be more of a get-to-know-you session to make connections and to ensure that the CO_2 sector are fully aware of the opportunity for the AD sector and how to engage with plants. BEIS has asked REA and ADBA to provide an overview of the sector and the CO_2 opportunity, before letting the CO_2 companies talk (at a general level) about their key factors when looking at supply opportunities.

Regarding the potential financial support from Government to help with deploying carbon capture at AD plants, that looks unlikely in the short term as the Government is probably waiting to see how the market is responding to the CO_2 crisis, and whether the value of CO_2 increases to a point that justifies the investment without the need for a policy intervention.

Even if Government does not introduce a financial mechanism, these discussions are delivering positive publicity for the biomethane sector in the UK and hopefully some of the identified market barriers will be overcome as a result of these ongoing discussions. We will continue to keep our members updated. If you require any clarification, please contact us.

Appendix 1

Please note this paper was issued in October 2021 and some of the contents may have changed since then.

REA member feedback on CO_2 capture from biomethane plants

In the wake of ongoing carbon dioxide (CO_2) supply issues in the UK BEIS reached out to the REA seeking evidence on what the government can do to support CO_2 capture at green gas plants in the medium term, as this sector could potentially help boost resilience and security of CO_2 supplies in the UK. The following is based on feedback from the REA's members and other key players in this market.

Contents

1. State of art of carbon capture at biomethane plants in the UK

Most CO_2 supplied in the UK is currently produced as a by-product of fertiliser manufacturing processes.

It is our understanding that around 50% of CO_2 is currently supplied by two CF Fertilisers' ammonia manufacturing plants - Ince (in Cheshire, Airliquide's CO_2 plant at the back of the fertiliser plant) and Billingham (on Teesside). Roughly another 45% is supplied by the fertiliser plant in Rotherham owned by Nippon (formerly Yara). The remaining supplies are represented by biogenic CO_2 (bio-CO_2) from bioenergy plants.

It is worth noticing that Nippon used to run a bioethanol plant in Wilton (Ensus) producing CO_2 as a by-product, but the plant shut down in 2018 although we understand this plant is re-starting production.

The UK CO_2 industry has relied heavily on these sources for domestic CO_2 supply. However, due to issues such as increasing energy costs, and aging production assets, the ammonia industry in the UK has become extremely volatile, with numerous long-term shutdowns due to economic and mechanical reasons.

There are currently around 11 biomethane plants in the UK capturing around 80 to 90,000 tonnes of CO_2 per annum (most of which are crop-based plants, with a few plants also taking animal manures/slurries).

The CO_2 from these biomethane plants is largely supplied to the food and beverage (F&B) sector, mostly via third-party supply companies such as Airliquide and BioCarbonics (a business more recently set up that supplies 'green CO_2' from biomethane plants).

In order to be supplied to F&B sector, the CO_2 must be 'food-grade' (i.e. very high quality spec). The two key specifications for 'food-grade' CO_2 are: the standard issued by EIGA, and the one issued by ISBT. We understand these two are broadly aligned, requiring analysis for over 20 different contaminants, and both specifications allow CO_2 from AD plants to be used. The EIGA specification explicitly states that greater care should be used when sourcing CO_2 from waste-based plants (see relevant excerpt in Appendix 1) but there are not specific restrictions on the use of CO_2 derived from waste-based AD plants. Comprehensive testing and stringent quality control procedures will be undertaken to comply with both specifications.

The technology to capture CO_2 from biomethane plants already exists in the UK, it is proven and commercially available and can be practically retrofitted on most biomethane plants. See Appendix 2 for further information about technology available. In addition to the 11 plants that are already capturing CO_2, there are another 70 operational plants that could easily retrofit carbon capture (if financially viable). The remainder of plants that are currently operational use water wash for biogas upgrade: for these plants retrofitting carbon capture is more challenging as the waste CO_2 is full of air that is used to flush out the CO_2 from the water (in other words, CO_2 levels are too diluted and it's difficult to get a good quantity). CO_2 capture generally works better on plants that have membrane separation.

The food and beverage sector in the UK, however, has been very strict regarding the sources of CO_2 allowed and does not currently accept any waste and sewage derived CO_2. Some companies like Coca Cola in the UK have in some cases adopted even a stricter approach, rejecting all CO_2 from AD plants. This is purely an issue associated with perception as we are aware CO_2 from waste fed AD plants is being used in the F&B sector in countries such as Italy.

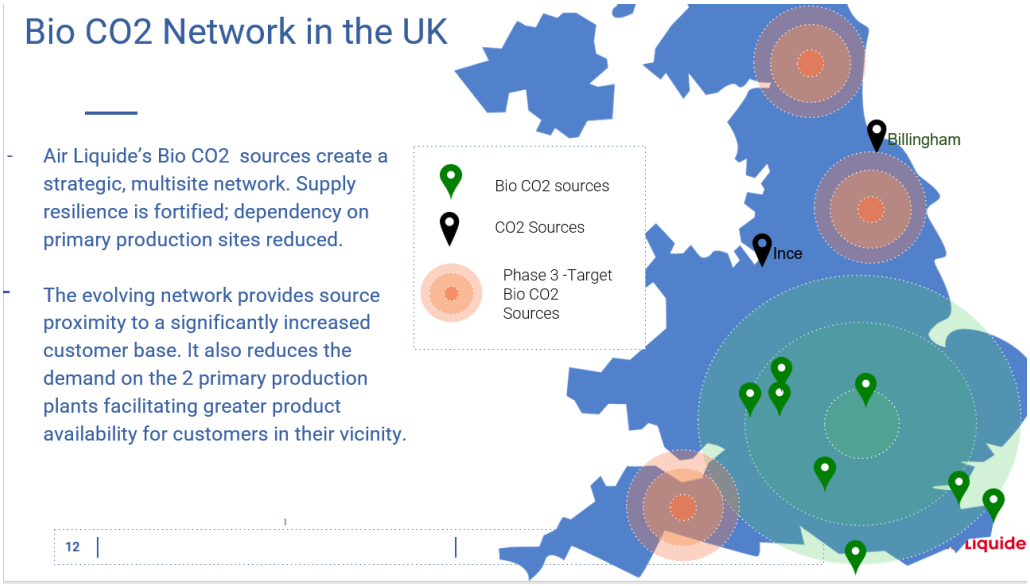
Key benefits and potential of carbon capture at green gas plants

All biomethane plants have a stream of CO_2 that is easy to capture and compress / liquify. Roughly a 40,000,000 kWh/annum plant could make around 7,300 – 8,000 tonnes / annum of CO_2 that could be captured and permanently sequestered or used in the food and beverage or other industrial sectors (estimate from industry). In addition to the plants that are already capturing CO_2, another 70 could retrofit the kit in a practical way. **This could yield around 500,000 – 600,000 tonnes per annum of biogenic CO_2, boosting up our domestic supplies and protecting the sector from future shortages.** There are also other plants being developed under the RHI and more plants will be developed under the future Green Gas Support scheme, which could result in even larger volumes of CO_2 available in the future.

Given that most CO_2 is supplied from the three centralised large fertiliser plants highlighted above, the gas is currently transported for long distances to the point of

use. CO_2 from biomethane plants has the advantage that it is produced in a decentralised way. A network of decentralised biomethane plants in the UK capturing the CO_2 would drastically **reduce travelling distances** to the point of use compared to the existing centralised approach (as illustrated in the picture below from AirLiquide).

It would also provide a **more diversified source** than current UK supplies and therefore **increase security and reduce vulnerability** (e.g. if an AD plant shuts down, there would be many other AD plants that can supply this by-product). The picture below shows Airliquide's Bio-CO_2 network in the UK.



Finally, companies like CF Fertilisers are using fossil gas in their manufacturing process without carbon capture and storage. In the future they may need to switch to carbon free gases (e.g. renewable hydrogen) or deploy CCS to minimise their costs under the Emission Trading Scheme. When this happens, **these plants will no longer produce and supply any CO_2**, so the UK will need to have other sources of CO_2 to meet this gas demand in the future.

2. Key barriers to deploying carbon capture on biomethane plants and green CO_2 market

The information below was identified by the REA's members as the key barriers to deploy carbon capture on biomethane plants.

Market perception

The perception issue around waste derived CO_2 has been mentioned by most members as one of the key barriers that need to be overcome. There is lack of acceptance by the market of any CO_2 that is derived from wastes (e.g. food wastes and sewage sludges).

There is clearly a mismatch between market rejection of waste derived CO_2, and Government policy (Defra's waste policy, Renewable heat Incentive (RHI), Green Gas Support Scheme (GGSS) and Renewable Transport Fuel Obligation (RTFO) etc) where the latter clearly favours and supports an increased use of wastes and residues in line with the principles of a circular economy. Given the payment restrictions placed under the

RHI and the GGSS on non-waste feedstocks, and the rules under the RTFO, it is almost certain that all recent and current projects built under the RHI, as well as any future projects that will be developed under the GGSS / RTFO would be unacceptable sources of CO_2 for the food and drink market.

The issue is purely one of perception, as once the CO_2 has met the food-grade specification, its quality is the same regardless of the source, and it has been subject to the same comprehensive testing and stringent quality control procedures.

'Food grade' CO_2 is currently required in livestock stunning, but for this use a lower grade should be sufficient and we understand livestock stunners are not concerned about the source of the CO_2. For these uses waste derived CO_2 should be accepted but this is currently not the case.

Economics

Capex

The other key barrier identified by members is the CAPEX costs of installing a CO_2 liquefaction plant. Given the lack of economies of scale, the unit production costs are significantly high compared to those borne by large-scale fertiliser plants. [commercially sensitive information has been deleted here].

Opex

Running costs can also be very significant due to the high-power demand from the equipment used to capture the CO_2.

Sites with CHPs will struggle to have sufficient electrical capacity to run the plant and given that the Feed-in Tariff scheme is now closed, and the producer cannot longer add generating capacity under the scheme, this could be a hurdle to adoption.

[commercially sensitive information has been deleted here].

Landfill gas sites (LFG)

As for landfill gas sites, due to the high capex and operational costs only the largest LFG sites (~1500m^3/h) would be likely to be viable in part in CO_2 capture. This is due to the significant volume of LFG required to generate electricity to run the process and economies of scale in the process.

Current market and offtakes

The producer will need to demonstrate a sufficient income from CO_2 to pay for the investment. The investment will need a reliable and assured income stream to justify the borrowing. There are currently only a small number of offtake partners. Entering into robust, decent contracts can be difficult, for an economical price per tonne of CO_2.

The Food & Drink sector is dominated by one player. There used to be 2-3 players in this sector. According to some members xxx pulled out from this sector and xxx was never interested in the sector as the production from each facility was considered too small.

The issue with one off-taker is there is no price competition. The cost of CO_2 is still very cheap within the marketplace.

Planning issues and long lead in times

A great deal of time is needed to arrange carbon capture.

- This includes getting loans, planning consent etc.
- The lead time on such a system would currently be 6-8 months from order.

Obtaining planning for carbon capture at biomethane plants has been mentioned as a significant barrier as this takes a long time. Typical planning process is a minimum of 13 weeks, therefore from project development to operation this could comfortably take over 12 months.

Space

Retrofitting a liquefaction plant at an existing AD plant requires space, which could be an issue for some of the existing plants.

Regulatory status of CO_2

If the AD industry starts to capture CO_2 derived from wastes, there needs to be clarity upfront on what is the regulatory status of this by-product and if/what regulatory controls will need to be applied when it is supplied to the market. It is also unclear if there are differences in these controls depending on the market/application. Clear guidance from the Government is required on the (waste) regulatory framework.

Permitting issues

Clarity will also need to be provided by the environmental regulators on the type of permit that is required for the relevant activity of CO_2 capture at a biomethane plant (e.g. if it falls under the scope of the Industrial Emission Directive and should be permitted as an installation). Different types of permits have different costs.

Other barriers mentioned

- Tankers used to transport the liquid CO_2 cannot mix 'impure' CO_2 with 'pure ('food grade')' CO_2, even on consecutive loads. So, if the producer wants to supply non-food grade CO_2 for other uses, they will need dedicated transporters, which are expensive. Some gas suppliers are ideally placed to provide transportation services for non-food grade CO_2, but they would need an economic incentive.
- Government's willingness to step in and subsidise CO_2 production from non-renewable sources such as by-products of fertiliser manufacture.

- Lack of technology readiness for CCS technologies such as incorporation into concrete or manufacture of synthetic proteins.
- For use in horticulture the main barrier is the mismatch in availability and demand – availability is constant, requirements for large scale horticulture use are seasonal, meaning that direct to consumer agreements are difficult and aggregators are needed to ensure the production has a home.
- Landfill gas sites are not eligible under the Green Gas Support Scheme (GGSS) and, in addition, even if they were in the future, existing plant conversions are not allowed so it is unclear whether existing gas collection systems and plants could be altered and be included within the GGSS.

3. Impactful actions Government could take to address these barriers

The two most impactful actions from Government that could help roll out of CO_2 capture at biomethane plants in the short to medium term are: 1) address the market perception around waste derived CO_2 and 2) provide financial support to help the business case for retrofitting or building CO_2 capture plants at biomethane plants. We have detailed these actions below, along with other actions that are also seen as important.

Perception

There is a role for Government to open and facilitate a dialogue with gas suppliers and the market (food and drink sector and other industrial users) to overcome issues associated with market perception around waste derived CO_2. Government could aid with educating and reassuring customers/markets as to the quality of waste derived, 'food grade' CO_2 and also encouraging industries to accept non-food grade CO_2 where they can.

Economics

Current incentives are not sufficient to support CO_2 capture at biomethane plants. To make CO_2 capture worthwhile at an AD plant at present, some form of financial support needs to be provided.

Capital grants

The Government could provide capital grant schemes to help fund the start of capital investment projects for CO_2. Some members believe this should be sufficient, others highlighted however that this may help with innovation, but it won't necessarily help with a rapid roll out of CO_2 capture.

Direct incentive/subsidy

The Government could provide an incentive mechanism for a short period of time (say 10 years) for the recovery of CO_2, depending on what it is used for. For example, a

higher incentive for permanent sequestration of CO_2, a lower incentive for carbon capture and usage.

Some members have commented that a financial support scheme similar to FIT/RHI/GGSS would be really helpful in supporting the viability of these installations.

For new plants, some members suggested that carbon capture should be made mandatory (e.g. under the Green Gas Support Scheme) but this would require an uplift to the GGSS tariffs. This could be a short period increase whilst the equipment is paid for and would equate to 0.5 – 1p per green gas kWh of gas produced. Finance companies could provide carbon capture structure financing packages. They suggested that the amount paid to CF industries to open the fertiliser could fund this scheme.

For AD plants that cannot capture CO_2, Government could create a short-term incentive whereby it would allow the replacement of the upgrader with one that can capture CO_2.

Installations on existing facilities would require an estimated payback of less than 10 years in order to make the project acceptable and they suggested that a tiered approach would help provide initial funding, with some level of tariff guarantee being offered.

Other financial actions mentioned by members

Subsidised loans

The Government could offer subsidised loans to end users to support their own on-site, large-scale storage and dedicated vehicles.

Carbon certificates

Some members suggested that a system of carbon certificates or carbon pricing might be workable. The plant would need to prove that the CO_2 is being utilised commercially or safely sequestered.

The Government could further develop a CO_2 market mechanism.

- The Carbon Certificate price through EUA is too low (€64/tonne).
- There needs to be another form of carbon abatement pricing mechanism that reflects the benefits of permanent sequestration of biogenic CO_2.

Markets

It would be useful to diversify the market for the CO_2/create opportunities for new markets. The reason the biogas market has focused on food and drinks is because it is the only market that can offer a long term (10 year) contract.

This market then dictates the technology (ie liquefaction, rather than making carbon black solid form of CO_2 for example).

Some members believe the food and drinks market is not making the best use of the CO_2 from these plants and permanent carbon sequestration would be better.

Alternatively, another option would be conversion of that CO_2 into more methane through the blending of hydrogen.

Finally, other members have mentioned commercial horticulture. [commercially sensitive information deleted here].

Obligation on gas suppliers

Other members suggested an obligation on the gas suppliers to source a minimum proportion of CO_2 to the market from biogenic sources.

Direct supply

Some members have said it would be more economic if the producers could be married up with the end users, and someone has capacity to transport from plant to end user directly.

Planning

A permitted development right to add carbon capture to a plant would promote uptake. This would allow the technology to be installed and for the associated traffic movements, to automatically be granted.

Other actions Government could take to help address the barriers

- Cease support for CO_2 manufacturers who make it from non-renewable sources
- Mandate that CO_2 used in livestock stunning does not have to be 'food grade'
- Mandate that CO_2 suppliers must hold a reserve stock equivalent to 30 days sales / consumption by key market sectors.
- Actively fund R&D for novel CCS capture and storage technology development.
- Greater subsidies for LFG to biomethane
- Change subsidies for electricity generation from landfill gas sites where installed generation capacity is <750kWeq after expiration of ROCs (c.2027 onwards) to encourage the production of biomethane from landfill sites which will in turn produce large streams of CO_2 which can be captured at the upgrader and sequestered / used elsewhere. Support should instead be paid on preventing methane going to the atmosphere.
- An increase on the RTFCs for LFG upgrading to biomethane is required as most sites would be on declining gas curves therefore increased risk, along with subsidies for CO_2 production if it is continued to be categorised as the lower value non-food grade CO_2.

4. Other biogenic CO_2

Please note that in this paper we have mostly focused on CO_2 from biomethane plants as this is a type of biogenic CO_2 that can be more easily and readily captured. There are

other sources of biogenic CO_2 which should be looked at, including CO_2 from biogas and biomass CHP and boilers, other BECCS plants and potentially from composting plants.

Appendix 1 – Excerpt from EIGA specification for 'food grade' CO_2

5.1.3.2 Biogas (methane) carbon dioxide sources (Anaerobic digestion)

Anaerobic digestion is the bacterial digestion of organic matter in the absence of air, primarily into carbon dioxide and methane. This type of source is acceptable but requires particular care in evaluation as a potential source of carbon dioxide for use in foods and beverages.

Anaerobic digestion (AD) biogas plants can run on a variety of feedstock types that can be divided into purpose-grown vegetable matter referred to as energy crops, and organic waste matter.

Carbon dioxide feedgas from AD plants running purely on energy crops should be subjected to the same evaluation criteria as carbon dioxide feedgas from yeast based fermentation sources (5.1.3.1).

Carbon dioxide feedgas from a biogas plant that uses waste, or a mixture of waste and energy crops, requires greater care than for energy crops in evaluation as a potential source of carbon dioxide for use in food and beverages.

For all types of feedstock (including energy crops and waste) to the AD plant a detailed and extensive risk assessment is essential to account for any chemical and biological risks to ensure the product complies with Appendix A and is safe to use for foods and beverages. Any change of feedstock will require approval and revision of the risk assessment.

AD plant and feedstock shall be compliant with EU regulations EC 1069/2009 Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation) and EC 142/2011." Commission Regulation (EU) No 142/2011 of 25 February 2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive [9,10] The following points shall be considered within the risk assessment process for AD plants to supply liquid carbon dioxide for use in foods and beverages:

- *The food safety risk analysis includes the digester biogas process;*
- *Final product carbon dioxide is always compliant with the Appendix A; ●*

Before supply to the food and beverage customer there is either complete on-line analysis of the carbon dioxide production or a complete batch analysis. Additionally, it is strongly recommended that a food safety management system, for example ISO 22000 Food safety management, [11] is in place for the carbon dioxide plant.

Appendix 2 – technologies available for carbon capture at biomethane plants

The key technologies available to capture CO_2 at biomethane plants are listed below. This information has been taken from this document produced by NFU Energy for AHDB. The one used in the UK is cryogenic separation. Amongst the 11 biomethane plants with carbon capture in the UK, 9 have cryogenic separation supplied by xxxx and 2 from xxxx.

Absorption – in water at pressure, amine solution from which CO_2 can be released on heating.

Pressure Swing Absorption – pressurised gas is led through an absorber bed, where molecules of varying sizes are removed from the gas.

Membrane – pressurised gas is passed through a membrane system, which has selective permeability for CO_2.

Cryogenic separation – biogas is cooled until CO_2 separates out as liquid form. This is the most commonly used technology at AD plants in the UK.