Feasibility of Residual Biogas Potential–type Testing for Quantification of Digestate Methane Emissions

Workshop Summary Report

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Workshop details

11–12th March 2025, Cranfield University.

Hosted by the UK Department for Energy Security and Net Zero (DESNZ) and Cranfield University, in collaboration with the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) with financial support from the Environmental Biotechnology Network (EBNet).

Distribution of workshop attendees:

DISTRIBUTION OF ATTENDEES	
Academia	15
AD industry	12
Regulator	5
Policy	2
RBP kit provider	5
RBP service provider	6
Consultancy	2
Certification	2

Workshop organisers and hosts: Dr. Yadira Bajón Fernández and Dr. Charalampos Michalakakis.

Roundtable facilitators: Dr. Konrad Koch, Dr. Sasha Hafner (online), Dr. Sebastian Pommier, Dr. Sergi Astals, and Dr. Yadira Bajón Fernández.

Department for Energy Security & Net Zero

Cranfield University

EBNet Environmental Biotechnology

Executive summary

Methane emissions from anaerobic digestion (AD) sites significantly influence the carbon intensity of biomethane and therefore its contribution to the UK's Net Zero and energy security ambitions. While biomethane offers a route to decarbonise the gas grid and valorise unavoidable wastes, fugitive methane emissions can undermine these benefits if not adequately managed. Emissions from digestate storage are a key contribution to site emissions.

Quantifying methane emissions from digestate storage remains challenging. Existing measurement techniques are often complex, resource-intensive, and sensitive to environmental conditions, making them difficult to deploy widely across the AD sector. In this context, there is growing interest in understanding whether Residual Biogas Potential (RBP) type testing could act as a simplified measurement or proxy for methane emissions from digestate.

To explore this, DESNZ and Cranfield University, in collaboration with the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA), with financial support from EBNet, convened a two-day expert workshop as part of the Methane Emissions from Anaerobic Digestion (MEAD 2.0) project. The workshop brought together representatives from government, regulators, industry, service providers, equipment providers, consultancy and academia to assess the feasibility, limitations and requirements of using RBP-type tests to estimate digestate methane emissions.

Key conclusions from the workshop were:

- There was strong consensus that RBP-type testing can have a role as a *proxy* for digestate methane emissions, but it should not be interpreted as a direct measure of actual emissions from storage.

- Adaptations of RBP-type testing outputs or supporting modelling to consider site specific conditions and deployed abatement strategies merit further consideration for a stronger alignment of recorded data with site emissions.

- Participants broadly agreed on the need for greater consistency and guidance on RBP-type methods if they are to be used for policy or regulatory purposes in the context of process emissions.

- Critical test and sampling variables were identified that require experimental evaluation before a robust, sector-relevant protocol can be agreed.

- A standardised, proportionate RBP-like method could improve administrability and reduce measuring burdens while supporting evidence-based policy and regulation.

The workshop represents an initial step towards developing a consistent, practical approach to evidencing post-AD methane emissions from digestate. Findings are aimed at informing further experimental work under follow on projects, and future discussions on the role of simplified surrogate methods within biomethane policy and regulation.

1. Background and policy context

Biomethane has an important role to play in the transition to net zero, decarbonising the gas supply, reducing reliance on fossil fuels, and increasing the UK's energy security across a range of sectors. It has potential across a variety of end uses, including being a flexible fuel for heat, buildings, industry, power generation, transport, agriculture, and hydrogen production. Anaerobic digestion (AD) also provides a solution to mitigate greenhouse gas emissions from the waste sector and can play a role in creating a circular economy by displacing fossil fuel-based fertilizer with digestates.

Projections published within DESNZ UK Biomass Strategy indicate that increasing biomethane production to 30 - 40 TWh by 2050 would support the UK to cost-effectively meet Net Zero targets. However, fugitive methane emissions from AD sites pose sustainability challenges. If emissions are not adequately controlled, the resulting carbon intensity of biomethane may exceed eligibility thresholds under support schemes, undermining both climate benefits and policy confidence.

Current evidence indicates that methane emissions from AD sites can vary widely, influenced by site design, operational practices, asset maintenance, and feedstock type. Methane emissions originate from various sources, including feedstock storage & pre-treatment, biogas production, biogas storage & utilisation, and digestate management, with the latter being the focus of this workshop.

Methane emissions quantification is greatly valuable, but can be complex, costly and resource intensive. There is extensive work focused on developing and validating quantification techniques, many of which have so far proven more accurate at quantifying site-wide or point source emissions from leaks or biogas utilization slip than area source emissions, such as those resulting from digestate storage[1]. Quantification methods for area emissions are also frequently affected by environmental conditions (e.g. temperature, wind). While accurate quantification techniques are in development and greatly valuable for accurate reporting, in parallel there is policy interest in simplified methods that can act as proxies for emissions, enabling more consistent reporting and supporting scheme administrability.

Such a method may have to consider the dual contribution to methane emissions from digestate. Emissions can arise from both dissolved/entrapped methane in the digestate as well as from newly generated methane from remaining biological activity. The closest current method is the Residual Biogas Potential (RBP) test, already widely used within the AD sector, primarily to assess digestate stability. However, existing RBP protocols were not designed to represent methane emissions from digestate storage and can vary significantly between laboratories. Adapting RBP-type tests to better reflect emissions potential could offer a pragmatic route to generating comparable evidence on post-AD methane emissions, provided limitations are clearly recognised.

In the UK, management of post-AD emissions to date is frequently addressed by covering post-AD assets or modifying AD operation & design to reduce organic content, and thus residual biological activity, in the digestate, with other emerging strategies or technologies being under consideration (e.g. degassing, aeration, acidification, dewatering, inhibitors dosing). While most strategies are expected to have a positive impact, this is frequently quantified by the volume of additional biogas captured and there is a lack of data on emissions remaining after their implementation, which limits understanding of their net impact. There is also an evidence gap in understanding the efficacy of abatement strategies on both methane-emitting mechanisms (dissolved/entrapped and residual biological activity). An agreed proxy method to quantify emissions from open digestate storage could have the additional benefit of serving as a tool to quantify efficiency of emissions abatement strategies.

2. Workshop aims and structure

This workshop formed part of a wider DESNZ project (Methane Emissions from Anaerobic Digestion – MEAD 2.0), which comprises multiple work streams collectively aiming to identify evidence on reducing carbon intensity of biomethane production. One of these streams explores the feasibility of an RBP-like method that can act as surrogate for methane emissions from digestate,

[1] Point source emissions are considered as those generated from specific identifiable sources on site, such as leaks from assets, vents or slip from biogas utilisation technologies. Area emissions are diffuse emissions from broader site areas, such as digestate storage in open tanks.

potentially a Residual Emissions Potential (REP) or Site Emissions Potential (SEP) test. This is to be simple enough for widespread deployment across the UK AD sector, including those treating different feedstocks (e.g. waste, on-farm, crop, sludge facilities). The workshop was anticipated as the first of two:

1. Workshop 1 with industrial practitioners and biomethane potential (BMP)[2] and RBP standardisation experts, to identify critical variables that need to be tested to inform a proposed RBP-like method to be used as proxy for digestate emissions.
2. Workshop 2, building on findings from workshop 1, to discuss the results of experimental work that would test the method variables proposed during workshop 1 and agree a potential proxy method for digestate emissions.

The specific objectives of Workshop 1 were to:

- Share the policy and regulatory rationale for focusing on digestate methane emissions and RBP-type testing.
- Capture current practices used by industry and laboratories for RBP testing and identify key discrepancies.
- Draw on international experience from BMP standardisation and residual methane research.
- Identify critical test and sampling variables that would need to be evaluated experimentally before a consistent protocol could be proposed.

The two-day workshop combined expert presentations with four facilitated roundtable discussions, allowing structured exploration of both strategic and technical questions. Discussions were deliberately exploratory and aimed at identifying areas of consensus, uncertainty and evidence gaps rather than reaching immediate agreement on a protocol.

3. Key discussion outcomes

3.1 Role of RBP-type testing in quantifying digestate emissions

Participants broadly agreed that RBP-type testing has a potential role as a proxy for digestate methane emissions. However, there was strong consensus that RBP results should not be interpreted as a direct measure of emissions from

[2] Biomethane potential, also referred to in the literature as biochemical methane potential (BMP), is a laboratory method used to estimate the maximum methane yield of a substrate under ideal anaerobic digestion conditions.

stored digestate. Instead, RBP represents the maximum biogas or methane potential remaining in the digestate under controlled laboratory conditions.

It was recognised that translating RBP results to actual site emissions would require careful interpretation and may benefit from supporting models that account for site-specific factors, including storage conditions, handling practices and deployment of abatement strategies.

Acknowledging the need for careful interpretation, there was broad support for the view that a widely accepted RBP-like protocol could provide useful, comparable information across the sector and support both operational benchmarking and policy objectives.

3.2 Information requirements from RBP testing

Discussions highlighted differing views on what information is most valuable from RBP-type tests. There was general agreement that methane potential is the most relevant parameter, though biogas potential and methane kinetics were also seen as informative and potentially basic requirements, particularly for understanding rates of residual activity. There were varied views about requirements for supporting analysis, such as total solids (TS), volatile solids (VS), chemical oxygen demand (COD) and volatile fatty acids (VFAs).

Participants noted uncertainty around the extent to which RBP tests should aim to capture contributions from dissolved or entrapped methane versus newly generated methane from residual biological activity. While there was no consensus on how best to address this, participants agreed that sampling protocols should be standardised to minimise loss of any methane from the original sample.

On delivery models, many participants favoured the use of external laboratories to ensure consistency and independence, while recognising potential value in hybrid approaches where operators conduct more frequent internal testing supported by periodic external verification. Discussions on how testing accuracy of external laboratories should be validated/audited took place, without a definite consensus but with laboratory round robin testing generally supported.

3.3 Current practices

Across the two-day workshop, 14 technical presentations from industry operators, certification bodies, service providing laboratories, academia and consultancy provided insight into current RBP testing practices in the UK and internationally. Presentations covered both commercial laboratory services and in-house testing carried out by operators, reflecting different objectives, equipment, and operational constraints. These presentations highlighted that, while RBP testing is widely used and well established within the sector, there is substantial variation in how tests are designed and implemented in practice. Differences were evident across key parameters including test temperature, duration and stopping criteria, use and ratio of inoculum[3], mixing regimes, headspace management, sampling points, sample handling and storage time, the use of controls and replicates and measurement of additional parameters (e.g. VS, TS). These differences were recognised as a major contributor to the limited comparability of RBP results across sites and laboratories, reinforcing the need for a more consistent, fit-for-purpose approach if RBP-type testing is to be used to inform digestate methane emissions beyond its traditional role in assessing digestate stability.

The role of existing standards was discussed extensively, particularly the PAS110 Residual Biogas Potential protocol, which is widely applied across the UK and embedded within current regulatory and certification frameworks. Participants broadly agreed that PAS110-based RBP testing plays an important role in demonstrating digestate stability. However, it was also recognised that the PAS110 protocol was developed for a different primary purpose and not designed to represent methane emissions from digestate storage. The workshop therefore considered PAS110 to provide a valuable and established foundation, but one that would require adaptation if RBP-type testing is to be meaningfully applied as a proxy for digestate methane emissions.

3.4 Protocol design: Test and sampling parameters

Roundtable discussions identified a range of test parameters that could significantly influence RBP results, including test duration or stopping criteria, use of inoculum or not, temperature, mixing, headspace management, and quality control measures. There was no agreement that any single existing approach is optimal for representing digestate emissions, reinforcing the need for experimental assessment of these variables.

Sampling-related factors were also highlighted as critical. These included sampling frequency, the collection of samples that are representative of digestate produced and stored at full-scale AD sites, time between sampling and testing, and sample handling procedures. Participants emphasised that poor sampling

[3] Inoculum refers to biologically active material, typically derived from an operating anaerobic digester, that is added to laboratory tests to provide an active microbial community and support methane production.

and sample handling practices could undermine the relevance of otherwise robust laboratory methods.

Overall, discussions converged on the view that defining a consistent, proportionate RBP-like protocol would require targeted experimental work to understand the sensitivity of results to key variables.

4. Implications and next steps

The workshop demonstrated strong cross-sector interest in developing a more consistent approach to evidencing digestate methane emissions. Its value lies in providing a pragmatic, scalable proxy that is familiar to the sector and cost-effective to deploy. A simplified, agreed RBP-like method could reduce measuring burden on AD practitioners, support policy objectives by reducing administrability burdens, improving comparability of evidence submitted under support schemes, and aligning regulatory and policy expectations.

Findings from the workshop are intended to inform follow-on experimental work by DESNZ and Cranfield University to assess the impact of key test and sampling variables on RBP outcomes. Further work is also expected to explore how RBP-type results might be interpreted alongside modelling or life-cycle assessment approaches to calculate biomethane carbon intensity (Figure 1), and how they could be used to assess the effectiveness of emissions abatement strategies at AD sites.

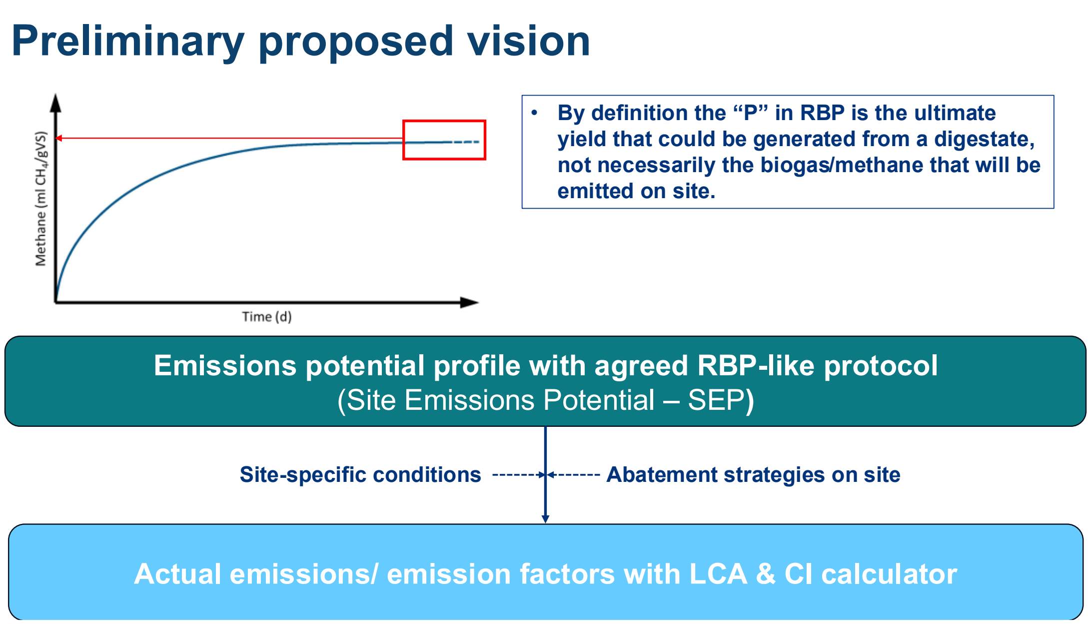

Figure 1 – Preliminary proposed vision for using RBP-type testing for estimation of digestate emissions on site. LCA – lifecycle assessment and CI – carbon intensity.

Figure 2 – Face to face attendees to the workshop. Online attendees not included.

This report summarises discussions from an expert workshop and reflects areas of consensus and uncertainty expressed by participants. It does not constitute formal guidance or policy or a government commitment for further action.